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Households' Willingness to Pay for Improved Solid Waste Collection Services in Kampala City, Uganda

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Abstract

This study identifies the determinants of households' willingness to pay for an improvement in solid waste-collection services based on 381 households in Kampala. Employing the double-bounded contingent valuation method, households' mean willingness to pay for improved solid waste collection service was estimated to be USh 2,439 per month. Both the decision to pay and the amount households are willing to pay for improved solid waste collection services are influenced by income, education, age, and home ownership. A socially acceptable fee which the majority of people are willing to pay should be set to avoid the free-rider problem.

Keywords

willingness to pay, contingent valuation, solid waste, Kampala, households

Introduction

The economic and demographic growth of cities in Uganda is posing serious challenges to the urban local authorities. With rapidly swelling urban population, the requirement for infrastructure and services increase manifold. Solid waste management

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(SWM) is one such service that needs to be adequately provided to ensure an urban environment conducive to the well-being and productivity of the residents. The solid waste problem is due to high waste generation, inadequate waste collection, and poor disposal habits by the households/individuals. In Uganda, the local government authorities are responsible for SWM services, but these services are only at secondary level (collection from dumping grounds/skips). Like all other parts of the country, primary collection (waste removal from houses) is neglected by Kampala City Council (KCC) and yet a poor primary collection means exposed waste in the vicinity and an unhealthy environment. Lack of infrastructure, inefficient institutional setup, and limited financial and technical resources have led to an inadequate and inefficient level of provision of services even at the secondary level and yet the rate of waste generation is increasing each day. Kampala City, with a population of about 2 million people (projected from the 2002 census), generates about 1,580 tonnes of solid waste per day. Of the total waste generated, about 53% is residential solid waste (Banga, 2008). However, only 40% of the total waste generated is collected by both KCC and the private sector.[1] Therefore, the significant amount of solid waste generated is either burnt on the streets or ends up in drainage channels, marshy areas, and empty plots. In addition to the low collection rate, there is inequality in the geographical distribution of the service. High-income residential areas and the city center receive better services from both KCC and private companies, whereas low-income areas and the informal settlements receive little (and in some areas, no) waste-collection services.

In an attempt to reduce the burden facing KCC in solid waste management, KCC has decided to explore the alternative of privatizing solid waste-management services, whereby people pay for the services (i.e., the collection of the waste that they themselves generate). Indeed, in 1999, following the establishment of the solid waste-management ordinance, which empowers the participation of the private sector in solid waste-management services, KCC started contracting private firms to improve on solid waste-collection services. Although privatization may be a viable option to the solid waste problem, in most cases, it is done hurriedly and not given much thought and, as a result, its intended purpose may not be achieved. There is lack of information on whether households are willing to pay for the services that private firms provide and, if so, how much they are willing to pay to have the services provided to them. To answer these questions, this study undertook a contingent valuation survey to assess the households' willingness to pay (WTP) for solid waste-collection services in Kampala.

Contingent valuation method (CVM) is a nonmarket valuation method commonly used to find the economic value of environmental commodities. It is a method that uses hypothetical survey questions to elicit people's preferences for public good by finding out what they are willing to pay for specified improvements in them (Mitchell & Carson, 1989). The CVM has been used by several scholars to study WTP for solid waste-management services (Altaf & Deshazo, 1996; Basili, Matteo, & Ferrini, 2006; Fonta, Ichoku, Ogujiuba, & Chukwu, 2008; Jin, Wang, & Ran, 2006; Zain, 1999). These studies used the random utility approach proposed by Hanemann (1984) and did

not go further to reparameterize the coefficients to explain the marginal contributions of the independent variables to the underlying WTP. Majority of these studies (see, for example, Altaf & Deshazo, 1996; Fonta et al., 2008; Zain, 1999) found that income positively influences household's WTP. In addition, Jin et al. (2006) found that education and resident's concern about solid waste problems positively influenced households' WTP. However, Fonta et al. (2008) found gender of the respondent to influence household WTP. These earlier studies conclude that majority of the households are willing to pay for improved waste-management services, contrary to widely held belief that most households consider free provision of solid waste-collection services to be a responsibility of the government. They also conclude that solid waste-collection service is a normal economic good and not a luxury good.

Our study follows the approach proposed by Cameron and James (1987) and Cameron (1988), which gives separate estimates for the location and scale variable, and the coefficients of the explanatory variables can be easily interpreted as marginal contributions to the dependent variable. Unlike the previous studies which looked only at who is willing to pay, the current study looks at both who is willing to pay and who is willing to pay more for improved solid waste management.

Data

Kampala is divided into five administrative units (divisions). However, only four divisions (Nakawa, Kawempe, Rubaga, and Makindye) were considered for this study because the fifth division (Central Division) is better serviced by both KCC and a private company.[2] From each of the four divisions, one parish was chosen to participate in the survey, each with an equal allocation of 100 households. Within each parish, five local councils (LCs) were sampled from which households for interviews were randomly selected.[3] The enumerators were instructed to interview household heads, and in cases where the household head was not around, they interviewed someone who is involved in decision making or one with knowledge about household expenditures and commitments.

The survey was carried out using a face-to-face interview approach in accordance with the National Oceanic and Atmospheric Administration (NOAA) Panel recommendation (Arrow et al., 1993). Five graduates were recruited and thoroughly trained to carry out the survey. To ensure quality control, the enumerators were not split into groups; they all visited each parish together. This was done to prevent the respondents who had been interviewed from discussing the content of the questionnaire with other respondents who were yet to be interviewed.

Empirical Design and Method

The elicitation method used in this study was a closed-ended format (double bounded) and the payment vehicle was a monthly garbage fee to be paid directly to the private company (the service provider). In designing the questionnaire used in this study,

focus group discussions and a pilot survey of 80 respondents were first conducted. The aim of the focus groups was to help determine how much information to present as well as to refine the questions used in the valuation section. Four focus group sessions of eight people were organized and conducted in July 2007.[4] The findings from the focus groups were used in the development of a draft Contingent Valuation Survey Questionnaire, which was subsequently used in the pilot survey. The pretest was divided into two: the first 50 respondents were presented with an open-ended question to get the bid design and, as the final survey was to be carried out using the closed-ended elicitation format, the last 30 respondents were presented with a closed-ended valuation question. The final version of the questionnaire was based on the results from the pilot survey. Information from the focus group and pilot survey exercises suggested a bid vector of 1,000, 2,000, 3,000, and 4,000 Ugandan Shillings (USh).[5]

Following the pilot testing of the questionnaire, the main survey was carried out for a period of 8 weeks on a sample of 400 households from four divisions of Kampala City. These divisions included Nakawa, Naguru, Kawempe, and Rubaga. Recent research (Fujita, Fujii, Furukawa, & Ogawa, 2005) indicates that at least 600 samples are needed for single-bounded format and at least 400 samples for a double-bounded format to ensure statistical reliability of WTP estimations. In addition, for each type of community or area to be surveyed, a sample of between 100 and 200 respondents is desired (Cointreau-Levine, Coad, & Gopalan, 2000). Taking this into account and given the budget constraint, we decided to take a sample of 400 households.

The households were first informed about the current waste-management situation before the scenario for the planned improvement in waste management was presented. The respondents were also reminded about their budget constraint in relation to the responses they give to the valuation questions. In doing so, it is assumed that the respondents would take into consideration their ability to pay if the described improvement is implemented. To reduce the hypothetical bias, which is inherent in CVM survey mechanism, a "cheap talk"[6] section that reminds respondents about the importance of truthfulness in their answers was included. Cummings and Taylor (1999), List (2001), and Lusk (2003) have found cheap talk to effectively remove hypothetical bias for respondents.

In this study, respondents were first asked if they would be willing to pay anything, even a small amount, for the improvement explained to them in the scenario. For those who said yes to the participation question, a dichotomous format (double bounded) of the valuation question was asked. In this case, the respondent was presented with an initial bid and asked whether he or she was willing to pay that amount or not. If the response to the initial bid was "yes," the respondent was then presented with a higher bid (twice the initial bid) and asked if he or she was willing to pay the offered amount. If the response to the initial bid was "no," the respondent was presented with a lower bid (half the initial amount) and asked if he or she was willing to pay that amount. The double-bounded format was finally followed by an open-ended follow-up question soliciting the maximum amount that the household was willing to pay. The follow-up

question helps in identifying inconsistent responses and outliers. Four different bids (1,000, 2,000, 3,000, and 4,000) were used in this study and households were assigned randomly to any one of these bids. For those who said "no" to the participation question, they were asked to give reasons why they were not willing to pay anything.

Theoretical Model

Dichotomous choice CVM is based on random utility theory, which assumes that choices are based on utility comparisons between the available alternatives, and the alternative that provides the highest utility will be the preferred choice (Louviere, Hensher, & Swat, 2000; McFadden, 1974). This study follows the approach to modeling CV data by Cameron and James (1987) and Cameron (1988), which bypasses the underlying utility model and estimates the parameters of the latent WTP distribution directly. This approach permits the straightforward calculation of marginal values for all arguments in the WTP function and are easy to interpret.

Cameron's approach is derived from the expenditure function as follows:

$$WTP(z^0, z^1, u^0; s) = e(z^0, u^0, s) - e(z^1, u^0, s) \quad (1)$$

where z^1 is the situation with improvement in solid waste management, z^0 is the current solid waste-management situation, s is a vector of socioeconomic variables, and u^0 is the utility level before the introduction of improved solid waste-management service.

Assuming a linear functional form for the WTP, the econometric model is as follows:

$$Y_i = x_i'\beta + \varepsilon_i \quad (2)$$

where Y_i is the unobserved true individual WTP for solid waste collection at the time the dichotomous choice question is posed. Y_i is assumed to depend on individual socioeconomic characteristics contained in the vector x_i plus an unobservable random component ε_i (distributed $N[0, \sigma^2]$), which absorbs all unmeasured determinants of the value of the resource to this individual. Y_i is considered a latent continuous censored variable: the observed variable is y^*_i which takes the answer "yes" or "no" regarding whether the individual would be willing to pay a given amount t_i. The individual will state that he is willing to pay the offered amount ($I_i = 1$) if $y^*_i \geq t_i$ and unwilling to pay the offered amount ($I_i = 0$) if $Y^*_i < t_i$. The discrete response indicator variable I_i is the single endogenous (dependent) variable in this framework.

Let P_1 be the probability that $Y^*_i > t_i$ and P_0 be the complementary probability. In the double-bounded model, we have four response probabilities because each participant is presented with two bids. The level of the second bid is contingent on the response to the first bid. If the respondent says "yes" to the first bid (t^L_i), meaning that he is willing to pay the amount of the first bid, he is presented with a second bid (t^H_i)

that is some amount greater than the first bid ($t_i^I < t_i^H$). If the individual responds with a "no" to the first bid, he is presented with a second bid (t_i^L) that is some amount smaller than the first bid ($t_i^I > t_i^L$). In this case, we observe two dichotomous variables: the answers to the first question and its follow-up. The outcomes to this method are (a) "no" to both bids, (b) a "no" followed by a "yes," (c) a "yes" followed by a "no," (d) "yes" to both bids. The second offered threshold is clearly not independent of valuation information, which the respondent has revealed in answering the first WTP question. The sequence of questions isolates the range in which the respondent's true WTP lies, placing it into one of the following four intervals:

$$(-\infty, t_i^L), (t_i^L, t_i^I), (t_i^L, t_i^H), or\ (t_i^u, +\infty).$$

The second bid, in conjunction with the response to the initial preference decision, allows both an upper and a lower bound to be placed on the respondent's unobservable true WTP. If the second decision is in the same direction as the first ("yes, yes"; "no, no"), it raises the lower bound or lowers the upper bound, respectively. We therefore have the following response probabilities:

$$\Pr(yes, yes) = \Pr(Y_i \geq t_i^H \geq t_i^I) = 1 - F(t_i^H) \tag{3}$$

$$\Pr(yes, no) = \Pr(t_i^I \leq Y_i \leq t_i^H) = F(t_i^H) - F(t_i^I) \tag{4}$$

$$\Pr(no, yes) = \Pr(t_i^L \leq Y_i \leq t_i^I) = F(t_i^I) - F(t_i^L) \tag{5}$$

$$\Pr(no, no) = \Pr(Y_i \leq t_i^L \leq t_i^I) = F(t_i^L) \tag{6}$$

Given this data, a log-likelihood formulation of the double-bounded model is applicable.

$$\begin{aligned} LogL = \sum_{i=1}^{n} \{ & (I_i I_i^H) \log[F((t_i^H - x_i'\beta)/\sigma)] + \\ & I_i (1 - I_i^H) \log[F((t_i^H - x_i'\beta)/\sigma) - F((t_i^I - x_i'\beta)/\sigma)] + \\ & I_i^L (1 - I_i) \log[F((t_i^I - x_i'\beta)/\sigma) - F((t_i^L - x_i'\beta)/\sigma)] + \\ & (1 - I_i)(1 - I_i^L) \log[F((t_i^L - x_i'\beta)/\sigma)] \} \end{aligned} \tag{7}$$

where t_i^I is the bid offered in the first question; I_i, t_i^H,I_i^L are dichotomous variables with value 1 if the answer to the initial bid or the corresponding follow-up has been positive, and 0 otherwise. Maximization of the log likelihood will yield separate estimates of β and σ and their individual asymptotic standard errors. This is made possible because of the presence of t_i in the likelihood function.

The estimated parameters of Cameron's approach can be interpreted in the same way ordinary least squares (OLS) results are interpreted. In other words, the βs can be interpreted as the marginal contribution to change in WTP resulting from a one unit change in the explanatory variable. In the same way, the transformations of Y_i commonly used in OLS models can readily be employed by applying them to t_i. This method also produces asymptotic standard error estimates directly, and no additional computations are required (Cameron & James, 1987). The advantage with this approach is that one is able to determine (systematically and easily) the effect of changes in the levels of each explanatory variable on the conditional expectations of WTP (Cameron, 1988).

As suggested by Kriström (1997), a participation question introduces a spike in the model, and this allows for a nonzero probability of zero WTP. If the respondent answers "no" to the participation question, then his or her WTP is assumed to be zero with a positive nonzero probability *a*. If the response is positive, the second question asks whether the individual is willing to contribute t_i, where t_i is one of the possible bids in the study. For household *i*, let $S_i = 1(0)$ if the response to the first question is yes (no) and let I = 1(0) if the response to the bid t_i is yes (no). Therefore, (S_i, *I*) can take on the values (1, 1), (1, 0), and (0, 0). The sample log-likelihood function corresponding to these possibilities is as follows:

$$\ln L = \sum_{i=1}^{N} [S_i I \ln(1 - G(t_i)) + S_i I \ln(G(t_i)) + (1 - S_i) \ln(1 - G(0))] \tag{8}$$

where *N* is the sample size, $G(0) = \alpha \in (0, 1)$ and the probability of a "yes" response (i.e., that the household accepts the bid, t_i, is assumed to be normally distributed $N[0, \sigma^2]$).

To allow for the estimation of a double-bounded model with a spike and the incorporation of explanatory variables, we use the method proposed by Reiser and Shechter et al. (1999) which suggests breaking up the likelihood function in Equation 8 into two separate parts. In the first part, the spike is estimated using a probit regression, where the dependent variable *w* for each household is 1 or 0 according to whether the WTP is greater or equal to zero.

$$probit\, w_i = \alpha + \gamma x_i \tag{9}$$

where *x* is the vector of household characteristics.

The second part consists of optimizing the cumulative distribution function $F(t_i)$ of the subpopulation that is willing to pay. In this estimation, the log-likelihood function in Equation 7 is estimated. The WTP distribution is assumed to be log-normal. The mean WTP with a spike (unconditional mean i.e., taking into account those with zero WTP) is then calculated as follows:

$$E(WTP) = E(WTP \mid WTP > 0) \times \Pr(WTP > 0) + 0 \times (\Pr(WTP = 0)) \tag{10}$$

Results and Discussion

Socioeconomic Characteristics of Respondents

Of the 400 questionnaires used in the survey, 381 were valid (with complete information). The sample characteristics are given in Table 1. First, the majority of respondents (66.2%) were females and this was mainly because they were the ones found at home at the time of the interview. Second, even in cases where both husband and wife were at home, the husbands preferred their wives to be interviewed claiming that they are the ones concerned with handling waste. The average age of respondents was 36.7 years, and the average family size was six people (the national figure stands at 5). Education wise, 15% had at least a diploma. The average monthly per household income was USh 541,563.80, with the majority of households (65.1%) having one person contributing to household income. In terms of ownership of the houses, 52.2% were staying in their own houses, 45.2% were renting normally, while only 2.6% were staying in houses rented by a relative or supplied free by the employer. About 41% of the houses had compounds. Households who stay in houses with compounds have alternative ways of disposing waste such as digging pits or throwing it in their backyards.

Current Waste-Management Practices

Respondents were asked how they store their household waste before disposal. Most of the respondents (81.1%) reported having containers where they store their solid waste before disposal. The containers are usually durable plastic bags (50-100 kg capacity) and the practice is to throw away the solid waste and reuse the plastic bags. The remaining 18.9% who do not have containers throw their waste in the backyard, in pits, or burn it in their compounds. In terms of the waste-collection service to their households, 22.8% reported that a collection vehicle goes around and they take their waste at a particular pickup point. The largest percentage (34.9%), however, take their waste to communal containers supplied by KCC,[7] whereas 23.3% empty their waste onto an open pile. The results also show that 4% of the respondents hire informal private waste collectors who carry away the waste but they do not know where it is disposed of. Table 2 shows the different ways households dispose of solid waste.

The households which do not burn or throw their waste in their backyards were further asked who normally takes the waste bins out to be emptied. The results indicate that 32.4% of the households make use of private informal waste collectors within the community to take the waste bins out. This is followed by the housewives (20.7%) and by children between the age of 13 and 18 who constitute 17.5% (see Table 3). This result shows that the informal private sector plays a major role in solid waste management, and therefore, there is a need to integrate them into waste-management planning.

Respondents were also asked about their perception of the present garbage-collection systems. Only 24% of the respondents were satisfied with the present waste-collection

Table 1. Description, Summary Statistics, and Expected Signs of the Variables

Variables	Description	*M*	*SD*	Expected sign
Age	Actual age of respondent in years	36.73	13.50	−
Hhsize	Household size measured by number of adults and children feeding from the same source	5.92	2.76	+/−
Education	Education level of the respondent; 1 = *diploma and above*, 0 otherwise	0.15	0.36	+
Income	Monthly household expenditure (in Ugandan Shillings)	541,563	457,120	+
Gender	1 = *male*, 0 = *female*	0.34	0.47	−
Pay	Whether household has ever paid for waste collection in any form (1 = *yes*, 0 = *no*)	0.46	0.50	+
Tenure	Home ownership (1 = *owned*, 0 = *renting*)	0.52	0.50	+
Yard	Whether the house has a compound (yard) or not (1 = *presence of a yard*, 0 = *no yard*)	0.41	0.49	−
Problem	Whether household reported solid waste as a major problem (1 = *yes*, 0 = *no*)	0.55	0.50	+
Separate	Whether household separates solid waste or not (1 = *yes*, 2 = *no*)	0.63	0.48	−

Source: Authors' computation from survey data.

Table 2. Current Major Waste Management (Collection Services) in the Surveyed Areas

Management practices	No. of respondents	Percentage
Collection vehicle at a pickup point	87	22.8
Throwing in a communal container	135	35.4
Throwing in open field (illegal pile)	72	18.9
Throwing in backyard/pit or burying in own land	72	18.9
Don't know	15	4
Total	381	100

Source: Authors' computation from survey data.

systems. This result implies that there is an urgent need for improvement in solid waste-management services in the study areas. The main reasons why people were not satisfied with the current waste-collection services in order of importance were as follows: the interval between collections is too long (40.3%), persistent squalor at the communal containers/illegal piles (27.1%), service being unreliable (12.5%), and the location of the communal container or pickup point is unsatisfactory (11.1%). Some of those who take their solid waste to the garbage-collection truck complained of the irregularity of the truck, which results into it getting too full whenever it comes to collect garbage.

Table 3. Who Normally Takes the Waste Bin Out to Be Emptied?

Position in the household	Frequency	Percentage
Head of household	22	7.1
Spouse (female)	64	20.7
Any member of the household	33	10.7
Maid/houseboy	19	6.2
Any child between the age of 6 and 12	16	5.2
Any child between the age of 13 and 18	54	17.5
Informal garbage collector (scavenger)	100	32.4
Don't know	1	0.3
Total	309	100

Source: Authors' computation from survey data.

Valuation Results

The majority (79.8%) of the 381 households considered in this study were willing to pay for a door-to-door waste-collection service (their WTP > 0). The main reasons given by the 20.2% who were not willing to pay (WTP = 0) were as follows: they could not afford to pay for garbage collection (40.5%), it is a responsibility of KCC (29.1%), satisfied with the current way they dispose of their garbage (16.3%), and they do not believe the service will be reliable (13.9%).

Of the 77 respondents with a zero valuation for WTP, 32 (41.6%) were considered to be protest responses to the valuation question, constituting 8.4% of the whole sample. Two inconsistent responses were also identified. Thus, in total, we had 34 invalid responses.

Ordinarily, in estimating the determinants of WTP for a project, the most convenient approach would be to discard the invalid responses and use the valid ones. However, simply discarding the invalid responses could lead to sample selection bias, which may possibly affect the validity of the estimates obtained from the given sample for the purpose of policy inference. This is because the sample remaining after excluding the invalid responses may not be a random sample (although the initial sample was a random one; see Calia & Strazzera, 2000; Fonta & Ichoku, 2005; Mekonnen, 2000; Strazzera, Genius, Scarpa, & Hutchinson, 2003; Strazzera, Scarpa, Calia, Garrod, & Willis, 2003).

Removal of invalid responses can be justified if the group of respondents with invalid responses is not significantly different from the remainder of the sample, at least in terms of the covariates employed in the WTP model. The means of the variables of the valid and invalid response groups are compared and any significant difference between these two groups of respondents is an indicator of the presence of sample selection bias and justifies the use of a sample selection WTP model (Strazzera, Genius, et al., 2003; Strazzera, Scarpa, et al., 2003; Vella, 1998). Vella (1992, 1998)

Table 4. Sample Frequencies to the Willingness to Pay Questions for Door-to-Door Solid Waste Collection (n = 302)

Initial bid (USh)	Yes[a]	Yes-Yes[b]	Yes-No	No-Yes	No-No	Number asked
1,000	92.8	35 (50.7)	29 (42)	5 (7.2)	0.0	69
2,000	56.8	15 (20.3)	27 (36.5)	26 (35.1)	6 (8.1)	74
3,000	33.8	9 (11.3)	18 (22.5)	30 (37.5)	23 (28.8)	80
4,000	13.9	7 (8.9)	4 (5.1)	34 (43.0)	34 (43.0)	79

Source: Authors' computation.
Note: This table shows only those who were willing to pay. As there was a participation question, the bid values were presented to only those respondents who were willing to contribute something.
a. Column 2 refers to a yes response to the initial bid only.
b. In parentheses are percentages.

argues that once there is no significant difference in the characteristics of the two subsamples, then there is no need of using a sample selection model.

To test whether the respondents with valid responses and those with invalid responses differ significantly in characteristics, the individual t test is used. The null hypothesis is that there is no difference in means of variables between the valid responses and invalid responses. That is, the t statistic is calculated for the null hypothesis $\bar{x}^{valid} - \bar{x}^{invalid} = 0$, where $\bar{x}^{valid}$ is the mean characteristic of respondents with valid responses and $\bar{x}^{invalid}$ is the mean characteristic of those with invalid responses. All the absolute values of t statistics for the variables did not exceed the critical value (1.96) at the 5% level, thus the null hypotheses could not be rejected. This study therefore uses only the valid responses as there is no significant difference between the characteristics of the valid subsample and the invalid subsample.

Sample frequencies to WTP. Table 4 column 2 shows that the share of "yes" responses decreases as the bid amount increases, ranging between 93% and 14%. Ninety-three percent of the respondents who were asked a bid amount of USh 1,000 answered "yes"; at bid amount of USh 2,000, the percentage of those who said "yes" decreased to 56.8; and at the highest bid amount of USh 4,000, only 13.9% answered "yes." In a well-developed CVM survey, the number of "yes" answers should decline as the bid amount increases (Carson, 2000).

Furthermore, the proportion of "yes-yes" answering pattern falls as the bid amount is increased. For example, of those who were asked an initial bid of USh 1,000, around 50.7% were willing to pay at least USh 2,000 for a door-to-door solid waste-collection system, whereas only 8.9% were willing to pay at least USh 8,000. The proportion of "no-no" answers increases as the bid amounts on the WTP question are increased. At bid amount of USh 1,000, there is no "no-no" respondents, implying that all the households (who are willing to pay something) are willing to pay at least USh 500[8] for door-to-door solid waste-collection service, whereas 43% answered "no-no" to the highest bid. The remaining answering patterns, "yes-no" and "no-yes" responses, indicate that the respondents' maximum WTP lies between the initial bid amount and the increased,

Table 5. Survival Probabilities Estimated for Double-Bounded Responses

Bid (USh)	Number of available participants	Number of participants who are willing to pay the bid	Probability of saying yes
500	69	69	1
1,000	143	132	0.923
1,500	80	57	0.713
2,000	222	122	0.549
3,000	80	27	0.338
4,000	153	26	0.169
6,000	80	9	0.113
8,000	79	7	0.089

Source: Authors' computations.
Note: We use Terawaki's (2003) Second Nonparametric Approach for Double-Bounded Dichotomous Contingent Valuation. For an extensive discussion of the method, see Terawaki (2003).

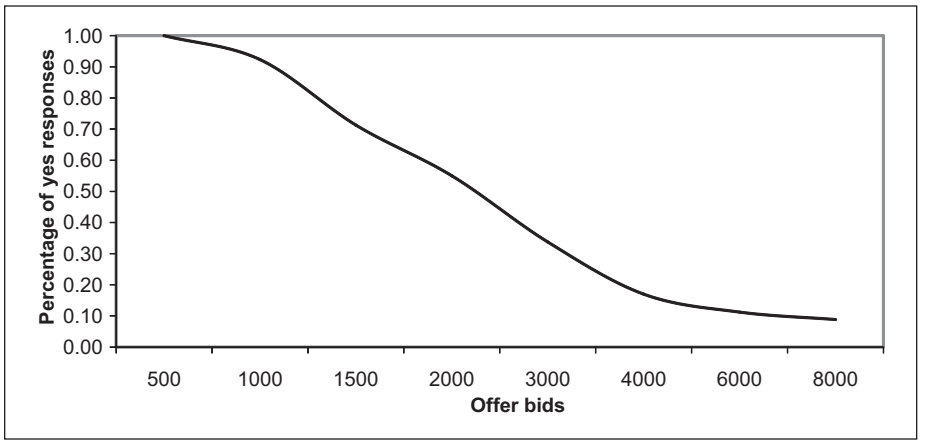

Figure 1. Survival function for the double-bounded responses

and decreased, bid amounts, respectively. These results can therefore be interpreted as a signal of the internal validity of the CVM answers, confirming the selection of an efficient bid design. Table 5 and Figure 5.1 show the survival probabilities from the nonparametric analysis of the double-bounded responses.

The distribution of the WTP helps us to know the percentage of the sample that would be willing to pay for the service at each particular bid value. For example, from Figure 1, it can be seen that at bid amount of 500, all the sample respondents (who are ready to participate in the program) are willing to pay for the service. At bid amount of 1000, 92% of the respondents would be willing to pay to have the service. At 1500, only 71% of the households will be willing to pay for the service. The median WTP is USh 2,100 and at this price, 50% of the households would be willing to pay.[9] This

Table 6. Estimation Results for the Double-Bounded Model

Variables[a]	The spike (probit)	Participants (double bounded)
Constant	−1.99 (–0.04)	3.49 (3.26)***
Lincome	0.26 (2.70)**	0.36 (4.10)***
Gender	0.16 (0.55)	0.16 (1.18)
Tenure	0.52 (1.99)**	0.21 (1.88)*
Education	0.58 (1.71)*	0.25 (1.90)*
Age	–0.03 (–3.17)***	–0.01 (–3.05)***
Pay	0.64 (2.77)**	0.18 (1.63)
Problem	0.44 (2.06)**	–0.08 (–0.83)
Waste		–0.03 (–0.79)
Household size		–0.003 (–0.12)
Separate	–0.01 (–0.03)	–0.17 (–2.33)**
Kawempe	0.73 (2.11)**	
Makindye	0.09 (0.30)	
Rubaga	0.01 (0.03)	
Log pseudolikelihood	−113.13	−316.57
Sample size	347	302
Wald χ^2	Wald $\chi^2(11) = 52.40$	Wald $\chi^2(10) = 81.17$
Prob > χ^2	0.0000	0.0000
Pseudo R^2	.19	

a. The dependent variable in column 2 is a dummy variable that assumes the value of 1 if participants or else it assumes the value of 0 if does not.
b. The dependent variable in column 3 is the interval in which the willingness to pay falls.
c. The numbers in parentheses are z statistics.
d. Kawempe, Makindye, and Rubaga are location dummies. Nakawa is the reference. These are the four divisions that were surveyed.
*significant at the 10% level. **significant at the 5% level. ***significant at the 1% level.

information is necessary for the policy makers and private companies when deciding on tariffs.

Determinants of WTP. Before estimation of the WTP function, a starting point bias test was performed to check if the double-bounded model was the most appropriate model to estimate. Alberini (1995) and Alberini, Veronesi, and Cooper (2005) show that when there is no starting point bias, the double-bounded model is the correct model, and the estimates of the mean WTP are virtually unbiased. To test for the presence of starting point bias, three bid set dummy variables[10] were included among the regressors of the double-bounded model, and then the null hypothesis that the coefficients on these dummies are jointly equal to zero was tested.[11] Using the Wald test statistic, the null hypothesis that all the coefficients of the bid set dummies in the model are not significantly different from zero could not be rejected, implying that there is no evidence of starting point bias on the bid amounts.The final results of the estimations are shown in Table 6. Column 2 presents the results of the spike probit in

which the dependent variable is either 1 or 0 corresponding to whether the household's WTP is greater than or equal to zero. The third column shows the results of the double-bounded estimation for only those with a positive WTP. It is to be noted that in the final analysis, only 381 observations were used. It is therefore important that the interpretation of the results is taken with caution, thus avoiding too much generalization. This could be considered as one of the limitations of the study.

The hypothesis that all coefficients except the constant terms (in the two models) are simultaneously equal to zero was tested using the Wald statistic. The calculated Wald chi-squares are 52.40 and 81.17 in column 2 and column 3, respectively, leading to the rejection of the hypothesis at a 0.01 probability level, with 11 and 10 degrees of freedom, respectively. This indicates the capability of the models to explain the variation in WTP for improved solid waste-management services.

From the results in column 2, it can be seen that household income, tenure, education level of the respondent, age of the respondent, whether the household has ever paid for garbage collection, whether solid waste is viewed by the household as a major problem, and household being located in Kawempe are the main factors determining the household's decision of whether to pay or not to pay for the proposed door-to-door solid waste-collection service. The negative coefficient on the age variable implies that the young respondents are more willing to pay for the improvement than the old. Income, education and whether solid waste is viewed by the household as a major problem, tenure, and pay positively affect the decision to pay for the improved solid waste-management service, implying that richer households, the educated, those who perceive solid waste as a major problem, and those who have ever paid for solid waste collection are more willing to pay for the improvement than the poorer, the less educated, and those households who perceive solid waste as not being a major problem to them.

The more educated being more willing to pay may be explained by the fact that educated people can access information about the environment and health more easily than the less educated. Educated people are more likely to read newspapers and magazines and, therefore, have a higher awareness of the dangers of poor waste management and the benefits of proper waste disposal.

From the coefficients of the location dummies, only Kawempe has a positive and significant coefficient, implying that households in Kawempe Division are more willing to pay for solid waste-collection service than those in Nakawa. There is no significant difference between Makindye, Rubanga, and Nakawa. This result is not surprising, given the fact that among all the divisions, there were no KCC communal containers in Kawempe. Thus, the households depended on the garbage trucks (which were irregular) and the informal waste collectors.

Despite the fact that solid waste–related issues are handled by females in the home, the results show that gender does not significantly influence WTP. Previous studies (see, for example, Fonta et al., 2008) found gender to significantly influence household's WTP. Also, the amount of waste generated by a household and whether the household practices some form of waste separation at source have no significant influence on the decision to pay for solid waste collection.

Column 3 gives the results of the double-bounded estimation for only those respondents who have a positive WTP. Household income has a statistically significant and positive effect on the amount a household is willing to pay; the amount of money a household is willing to pay for door-to-door solid waste-collection service increases with household income. For example, if monthly household income increases by 10%, the amount of money a household is willing to pay for door-to-door solid waste collection will increase by 3.6% per month.[12]

The coefficient on the age variable has a negative sign, which means that monetary valuation decreases with age of the respondent. Younger respondents are found to be willing to pay more for door-to-door solid waste-collection service. This could be explained by the fact that older people are more resistant to changing the ways of doing things around their houses, and as paying for waste-collection service is relatively new in Kampala, older respondents are less likely to be willing to pay more. For each additional year in age, the WTP for door-to-door solid waste collection decreases by 1.4%. This result is consistent with the previous findings by Altaf and Deshazo et al. (1996) which showed a negative relationship between age of respondent and WTP for improved solid waste management for Gujranwala (Pakistan).

As expected, households who are staying in their own homes (Tenure) are willing to pay more than those who are renting. This may reflect a security aspect of WTP, where the homeowners know that they will be staying in their homes for long or if they decide to move, the waste-collection service in the area will have increased the value of the home. Homeowners are willing to pay 21% more for solid waste-collection service than those who are renting. The implication of this result is that as those who are renting are willing to pay less for door-to-door solid waste-collection service, the garbage fee can be included in their house rent so that it becomes the responsibility of the landlord to pay to the service provider.

In this model, the reference education level is those with a level below diploma. The sign on the education variable is positive and significant. This implies that the higher the education level of the respondent, the more the amount he is willing to pay for door-to-door solid waste-collection service. The finding that a higher educational level increases the amount that a household is willing to pay for solid waste management is not surprising as more education enhances an individual's willingness to take responsibility for his or her own health. Those who have attained at least a diploma are willing to pay 25% more than those with an education level below diploma.

As anticipated, households who do separate their waste are willing to pay less than those who do not separate. They are willing to pay 17% less than their counterparts. This finding is not surprising because households find other uses for the separated waste. For example, they give peelings to domestic animals, some metals are sold, and plastic containers are used as flowerpots. In this way, the amount of waste available for disposal reduces and therefore the household will not be willing to pay more for the available solid waste.

Table 7. Mean Willingness to Pay per Household per Month and Their Confidence Intervals (in Uganda Shillings)

	Double bounded, without a spike	Double bounded, with a spike
Mean without covariates	3,089.4 [2,796.4, 3,382.4][a]	2,409.7 [2,181.2, 2,638.3]
Mean with covariates	2,678.5 [2,366.9, 2,990]	2,438.6 [2,154.9, 2,722.3]

Source: Authors' own computation.
a. The confidence intervals are estimated using the delta method.

The variables Problem, Pay, Gender, Waste, and Hhsize are found not to significantly influence the amount a household is willing to pay for solid waste-collection services.

The results in columns 2 and 3 show that some variables may not influence a household's decision to pay, but do influence the amount that the household is willing to pay for a door-to-door solid waste-collection service, for example, Separate. However, some variables may influence the decision to pay for solid waste collection but not the amount the household is willing to pay, for example, Problem and Pay.

Welfare Analysis

The main purpose of conducting a CVM study is to obtain a welfare measure, such as mean or median WTP. In this study, the welfare measure refers to the amount that households are willing to pay monthly for a door-to-door solid waste-collection service. The results can be used as a guide for policy makers concerning issues such as tariff and is also an indication of the benefits of improving solid waste management. For the open-ended question, the mean is obtained as USh 2,288. Table 7 presents the welfare estimates with the corresponding 95% confidence interval. The unconditional mean WTP estimate was obtained using Equation (10) and is USh 2,439. This implies that on average, each household is willing to pay USh 2,439 (US$1.34) per month to have a door-to-door solid waste-collection service. Also, the mean WTP of the double-bounded model is greater than the mean WTP from the open-ended question.

Analysis of Cost and Revenue Generated From Garbage Fees

In this section, the revenues and costs of residential garbage collection are discussed. The cost of 100% collection of solid waste from Kampala is said to be about USh 500 million per month (Kasozi, 2008). Residential solid waste generation is estimated to be 840 tonnes per day, which is about 53% of the total solid waste generated in Kampala (Banga, 2008). Therefore, the cost of collection of residential solid waste would be USh 265 million. The total number of households in the surveyed divisions

is 283,404. Taking the bid value as the amount to be charged and the percentage of households willing to pay at each bid value as the compliance rate, we find that the least amount of revenue will be generated when the garbage fee is USh 500 and the highest revenue will be generated when the fee is USh 2,000. At USh 500, there is total compliance, but the revenue generated does not cover the cost of collection. At USh 2,000, the revenue and thus the profits are maximum, but with only 55% compliance. At the mean WTP of USh 2,439, the compliance rate would be 45%. The firm will break even if the fee is between USh 500 and USh 1,000. At USh 1,000, there will be profits realized and the compliance rate is also high (92%).

Conclusion

Generally, our results have not deviated much from previous findings in the literature. Few cases are however noted in our results. Gender was found to have no significant influence on the decision to pay for improved solid waste management. In Uganda, like many other developing countries, the issue of waste collection is a duty of females in the households, it should have been expected therefore to find significant role of women in the decision of waste management. Previous studies, like that of Fonta et al. (2008), have shown that gender significantly influences the decision of WTP for solid waste management. Probably, this could be an indication of the lack of women's decisions when it comes to issues of paying for something at the household level, more especially if the issue involves monthly contribution from the household income.

The positive relationship between education and the decision to pay and amount to pay is not surprising as the more educated can easily access information. In a country like Uganda where the number of people who go beyond secondary-level education is still low, there is a need to instill a certain behavior of waste management among children right from primary level such that even if they do not go beyond primary-level education, they will be equipped with some knowledge on proper waste management.

Another interesting result is that households who are staying in their homes are willing to pay more for waste collection than those who are tenants. One way to make tenants comply and pay for solid waste collection is by landlords including the garbage fee in the house rent such that it becomes the responsibility of the landlord to pay for waste-collection services. In this way, there will be total compliance to pay for waste collection as the tenants have to pay rent.

The results show that a high percentage of households are willing to pay for a door-to-door solid waste-collection service. This is contrary to the common belief that people are opposed to paying for solid waste-management services and that it is the responsibility of government. The mean WTP obtained is 2,439 (US$1.3) and is an indicator of what people are willing to pay, on average, for a door-to-door solid waste-collection service per month. However, although it is important to calculate the mean WTP, the mean alone does not convey much information to the policy maker. From the distribution of the WTP values, we see that at the mean WTP, about 45% of the

sample (those willing to pay something) would be willing to pay that amount. This would imply that the garbage problem is not solved. The question is "Should the garbage charge be based on the mean WTP?" To avoid the free-rider problem, a socially acceptable fee should be set in which the majority of people are willing to pay. The government could then come in to subsidize the private company if need be.

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Notes

1. City Mayor, personal communication (26th, November, 2006).
2. It is also the administrative division and houses most of the wealthier households, including the Statehouse.
3. Sampling frames were obtained from the local council leaders.
4. Four parishes (Naguru, Nakulabye, Mulago, and Nsambya) were used in the study. Therefore, there was one focus group for each parish.
5. At the time of the survey, 1 USD = 1,820 USh.
6. Cheap talk is a nonbinding communication between a researcher and the respondent prior to administration of the contingent valuation method valuation questions.
7. We found communal containers in two of the parishes surveyed (Naguru and Nsambya). Kampala City Council had withdrawn the containers from the other areas studied.
8. As USh 1,000 was the lowest bid in the bid design and the follow-up bid was halved if the response to the initial bid was no, the lowest follow–up bid asked was USh 500.
9. The median is the value of the willingness to pay at which the survival function equates to 0.5.
10. Bid set dummies mean a set of dummies where the first dummy takes on a value of 1 if the respondent was assigned to the first bid set used in the survey, and 0 otherwise.
11. This method was also used by Whittington, Briscoe, Mu, and Barron (1990), Green and Tunstall (1991), Cameron and Quiggin (1994), Altaf and Deshazo (1996), and Chien, Huang, and Shaw (2005).
12. As explained in the section on theoretical model, when the Cameron approach is used, the resulting coefficients can be interpreted in the same way ordinary least squares estimates are interpreted. As we have assumed a log-normal distribution and the income variable is in logs, the income coefficient can be interpreted as a percentage change.

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