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# Collecting Household Waste in Dakar: Does it Cost That Much? An Application of Contingent Valuation

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*The objective of this paper is to demonstrate how one might improve financing of the household waste collection system in Dakar, using the contingent valuation method. Our results show that household willingness to pay is far beyond what is being actually collected through TEOM ("Taxe d'Enlèvement des Ordures Ménagères", a flat-rate tax imposed by local government to finance waste collection). The implementation of a unit based collecting fee is ultimately advocated.*

Key words: *solid waste, households, contingent valuation, willingness to pay*

## 1. Introduction

In recent years, the urban management of household wastes has been of increasing interest to both researchers and policy makers. Public waste collection has several components: sorting, incinerating, recycling, burying, composting, etc. Effective waste collection is an important public service in African capital cities, the failure of which can result in many kinds of unfavorable outcomes: olfactory nuisance linked to bad smelling, emanation of flying objects, underground water and air pollution, etc. These have very serious adverse effects on public health and the environment. In response to these issues, modern systems of waste collection, transportation and treatment have progressively contributed to the emergence of a booming market of wastes. A unit based pricing of waste has become a common way of pushing households to develop a behavior of sorting out and internally processing domestic wastes, in order to make public collection easier.

In most African cities, waste collection is a tremendous headache for local governments; waste is disposed of by households only sporadically, and when it is collected, the waste is amassed in a public dump which creates very serious environmental and health concerns.



**Figure 1.** Typical waste situation in Dakar

In this paper, we seek to understand the factors that could make household waste collection more effective in

the capital city of Senegal, Dakar (see Figure 1 for a photo of a typical situation). In particular, a critical question we seek to answer is how much households would be willing to pay for efficient waste collection. To this end, we use the technique of contingent valuation to determine household willingness to pay. This method has been used in several applications in environmental costs valuation, as well as in other public policy issues[1]. It experienced a tremendous success when following the Exxon Valdez incident the US NOAA[2] officially accepted the method as the best in assessing environmental damages. In order to apply the theory, we began by asking of households a few basic hypothetical questions. This was then followed by estimating consumer surplus in the purchase of this non-marketable service. The "experiment" was conducted in Dakar in 2006, and allowed us to estimate household willingness to pay according to various scenarios.

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[1] Environmental applications of the methodology include Kwak, Yoo, and Kim (2004) on assessing the economic benefits of recycling in Korea; and Leon, Arana, and Melian (2003), on preservation benefits from big-game fishing in the Canary Islands, Treiman and Gartner (2005) on residents' willingness to pay for community forests in Missoury, USA, and Murad et al. (2007) on poor households' willingness to pay for improved access to solid waste collection and disposal services. For other applications of the methodology, the reader may also consult Asgary et al. (2005), on health insurance in Iran, Dutta et al. (2005), on water supply improvement in India, Hu (2006), on consumer willingness to pay for non genetic modification technology food in China and Japan, Yoo et al. (2006), on inconvenience costs related to spam emails, Marvasti (2006) on costumer delay in medical services, and Barget and Gouguet (2007) on an assessment of the economic value of sporting events. A very detailed description of the methodology, its limitations and advantages can be found in the report of the NOAA panel on contingent valuation, released on May 9, 2001 and which is available at www.darrp.**noaa**.gov/library/pdf/cvblue.pdf. An important body of literature in French also does exist on the subject. This includes Faburel (2002) who uses CVM to assess the costs associated with noise stemming from plane engines for people living close to airports. This also includes Heintz (2002) who uses the CVM methodology to assess household willingness to pay for waste collection. Furthermore, Scherrer (2002) applies the CVM methodology to assess environmental costs on Fontainebleau forests of a storm that occurred in 1999. Estelle Kah (2003) provides a very good discussion of the advantages and limitations of the CVM technique. Finally, francophone readers may wish to consult a very detailed study on public waste disposal that was undertaken by the French ministry of the environment, which can be downloaded from the site http://www.environnemment.gouv.fr. The reader who is interested in discussions of econometric modelling of CVM may wish to see Bengochea-Morancho (2005), Heckman et al. (2003), Canals-Cerda and Gurmu (2007). Mitchell and Carson (1989) provide further discussions on pitfalls to be aware of for the practitioner who wishes to implement the CVM methodology.

[2] National Oceanographic and Atmospheric Administration.

The rest of the paper is organized as follows: in section 1, we present a critical review of the system of waste collection in Dakar. In section 2, we provide a brief survey of the literature, emphasizing the limitations associated with the use of the CVM with respect to household waste. Section 3 discusses the "experiment" and its results. In a last section, we conclude with some policy recommendations.

## 1. Household waste collection in Dakar: a critical review

Dakar is located in the extreme west of Senegal and the African continent, on a peninsula (see map in Figure 2). It is the capital of Senegal and served as the capital of French Western Africa during the colonialist period. The city makes up less than 0.3% of the country's total area, but is home to 30% of the country's total population. Inequality in the city is a tremendous problem. Very rich neighborhoods with housing monthly rentals amounting to more than US $ 4000 are literally cohabiting with poor slums. On the map, one can easily realize that. For example, the rich neighborhood "Almadies" has as immediate neighbor, the poor "Yoff". Likewise, the poor "Medina" has as immediate neighbor, the rich "Plateau". Intermediate income neighborhoods include Ouakam, "Parcelles Assainies", and "Rufisque". The "Mbeubeuss" public garbage dump is marked on the map as a big blue dot.



**Figure 2.** Map of Dakar

In Senegal, decentralization has resulted in the transfer of waste collection from the central government to

municipalities and local governments. The accelerated growth in the population of Dakar, however, has created a very rapid increase in household waste production. Policy makers have experimented with several different formulas to deal with waste collection in urban areas, but have yet to succeed in its proper management.

Waste collection has been under the jurisdiction of the Senegalese municipalities since independence in 1971. The Dakar municipality experienced huge difficulties in ensuring adequate collection in all neighborhoods of the capital. While downtown Dakar was often sufficiently served, other suburban areas were not. To improve the system, the government privatized it, and from 1971 onwards, a private monopoly called SOADIP (*Société Africaine de Diffusion et de promotion*) was in charge of managing waste collection in the capital. It generally succeeded until the beginning of the 1980s, when SOADIP underwent serious internal management problems leading to bankruptcy in 1984. The government then created a semi-governmental company, SIAS (*Société Industrielle d'Aménagement du Sénégal*), which operated from 1985 to 1995. SIAS also began to suffer from management problems, similar to the ones that triggered SAODIP's disappearance, and it was then that the government decided to open up the sector to competition. Market-based waste management appeared successful from 1995 to 2000, with more than 90% of all of Dakar's neighborhoods served, which was an unprecedented rate at the time. In 2000, Senegal experienced its first democratic political regime change, and the newly elected government hired the multinational company Alcyon for a long-term waste collection contract. The contract was broken after 4 years of operation, however, and a new one was signed with the French company Véolia. Véolia is currently in charge of the management of waste in Dakar.

Waste collected in Dakar is deposited in Mbeubeuss, a surburb of Dakar, 20 km from downtown. It is estimated that every year, up to 475,000 metric tons of waste are deposited in this area without any type of processing. Most NGOs qualify Mbeubeuss as an ecological bomb that may explode at any time. Environmental risks associated with waste depositing and storage are quite high: pollution of underground water reserves, air pollution, proliferation of flies and mosquitoes, etc. Several attempts have been made by the government to replace the Mbeubeuss garbage dump with a technical burying centre (TBC), none of which has succeeded. Failure of action is a result of several factors, but stems mainly from resistance from inhabitants of targeted localities that could potentially host TBCs.

On the finance side, the burden of waste collection has always been borne by the government, with a very minuscule contribution coming from households. In order to meet the costs of waste collection, the government has instituted a tax called TEOM (*Taxe d'Enlèvement des Ordures Ménagères*). The rate is a 6% land tax, which by itself represents 15% of total locative value of buildings. But due to a weak tax enforcement system, only 30% of Dakar's households pay this tax. Furthermore, even if all households did pay such a tax, the corresponding income would not be enough to meet the necessary costs for an acceptable level of waste collection; hence the need to increase household contribution and to find alternative ways of channeling it.

## 2. Contingent Valuation of household willingness to pay for waste collection: a brief survey of the literature

Traditional systems of household waste collection finance the rendered service through the application of a flat tax on households. The major limitation with such a system is that collection is not priced at its marginal cost; a fixed lump sum is simply paid out whatever the quantity of waste produced turns out to be. The economic literature on waste collection pricing tends to favor the idea that setting price in response to marginal waste production will elicit appropriate household waste management behavior (Podolsky and Spiegel, 1998 ; Nestor and Podolsky, 1998). Indeed, household waste production has been found to be negatively linked to marginal pricing. This finding is nevertheless challenged by other researchers who find that such pricing could be counterproductive (Miranda et al., 1994; Fullerton et Kinnaman, 1996). Measuring waste weight can be very costly both in terms of time and money. Moreover, households may react to marginal pricing by hiding waste and finding other ways to get rid of it (Miranda and Aldy, 1998). According to these authors, households will start paying at unit cost for removal of their waste only when all other means of avoiding such payments are exhausted. Dunne (2004) moves a step further and documents the case in which such pricing implementation gave rise to riots in Ireland. Hence, setting a payment system for waste management has a greater chance of success the greater the involvement in and adherence of households to the envisaged scheme.

The contingent valuation method (CVM) is one among many techniques that have been developed by economists to set prices for environmental goods and services. The method usually encompasses a survey in which households are administered a questionnaire which presents a hypothetical scenario and asks households to what extent they would pay for a good or service that

does not have a market value. Best practices in this area recommend beginning　　　from a closed question of the type: "Would you pay q franc in exchange for that given service?". According to the nature of the provided answer, additional questions are asked to get a better idea of what will determine acceptance or non acceptance of the requested amount to pay for the given service.

The CVM method by itself has been hailed as one of the single best tools for implementing the polluter payer principle (Flachaire and Hollard, 2005). Yet the robustness of the estimates it yields has been subject to several controversies[3]. The method is thought to be very sensitive to inking up biases, which make answers from surveyed respondents very sensitive to how the questions are formulated. This seems particularly true when explicit payment figures are proposed to the interviewee to gauge his/her willingness to accept to pay for the proposed service. It appears through several experiments that revealed willingness to pay changes when this explicit figure is modified. Hence, the robustness of the estimates obtained from the CVM may be questionable (Herriges et Shogren, 1996). One way to overcome this difficulty is to start with a closed question on willingness to pay, followed by a series of open questions on various options for such payment.

The CVM is also thought to be sensitive to informational bias (Willinger, 1996), which is another way of saying that the respondent may ignore the improvements to his own economic situation that are likely to be brought about by the proposed scenarios. However, this kind of bias seems less likely to occur in the case of waste collection, as these types of improvements are probably very tangible for households in Dakar that have long suffered under several alternative collection schemes.

## 3. Methodology and results

The methodology consists of two phases. We first collected relevant data through a survey conducted in Dakar's neighborhoods, and then used the data to econometrically model household willingness to pay.

### 3.1. A brief description of the CVM methodology

The methodology consists in administering a questionnaire to a sample of households, representative of the overall population. The sample frame is the Dakar population, by neighborhoods. Three strata are considered: rich neighborhoods, medium income neighborhoods and poor neighborhoods. The weight of each of these sub-groups in the overall population is

taken into account when drawing the sample. Each respondent surveyed is asked whether he/she is willing to pay a given amount of money to have his/her waste properly collected. The responses are coded with a dummy variable, with those answering yes being assigned 1, and those answering no assigned 0.

Particular attention should be paid to the treatment of "zeros". Two cases are to be distinguished:
  a. those who by no means would pay to have their waste collected no matter what assurance they are given that the system will be fair and effective. These are qualified the "true zeros";
  b. those who refuse to pay because they do not trust the system. For these persons, the WTP (Willingness To Pay) is not null. They would be willing to pay, provided that some conditions are met. These are called "false zeros".

Average WTP is computed by imposing some additional assumptions with respect to the "false zeros":
  - Assumption 1: average WTP is computed by only considering those who expressed a positive WTP,
  - Assumption 2: average WTP is computed by including "false zeros", affecting the mean value of the overall sample,
  - Assumption 3: average WTP is computed by affecting to "false zeros" the mean value of those who expressed a strictly positive WTP.

Regression is performed using the Heckman (1979) two-stage approach.

### 3.2 The "experiment"

In order to estimate average household willingness to pay, we led a face-to-face survey[4] in various neighborhoods of Dakar. This polling strategy is deemed more effective than one relying on telephone calls. The questionnaire has three main sections. The first one relates to general household perceptions on the quality of their environment, particularly as they relate to waste management. It encompasses questions about the perception of the quality of policies meant to preserve the environment, improvements in the system of solid waste collection, means households are employing to get rid of their waste, how often waste is collected, the amount paid by households for waste collection, etc. The second set of questions is directly linked to household willingness to pay for waste collection. It begins by asking questions meant to gauge the willingness to increase household contribution for improved waste collection, and then

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[3] See Hausman (1993), for a review of such controversies.

[4] A translated version of the questionnaire is provided as an appendix.

continues with an open ended question about the maximum amount the respondent is willing to pay. This question, in turn, is then specified to see under what conditions households are willing to pay for waste collection. Last, the final section of the questionnaire is intended to gather information on the socio-economic background of surveyed households: gender of respondents, income distribution of neighborhoods, age, level of income etc. It is worth mentioning that the unit of the survey is the household, not the individual, since payments for waste collection come from households, not individuals.

Our sample is drawn from various neighborhoods of Dakar. Ninety households were interviewed; they were chosen from the following three sets of neighborhoods:
- Dakar's rich neighborhoods: Sacré cœur 3, Cité BCEAO, Cité Sonatel, Point E, Fann Résidence, Plateau.
- Poor neighborhoods: la Médina, Grand Yoff, Yarakh
- Intermediate income neighborhoods: Pikine, Rufisque, Ouakam.

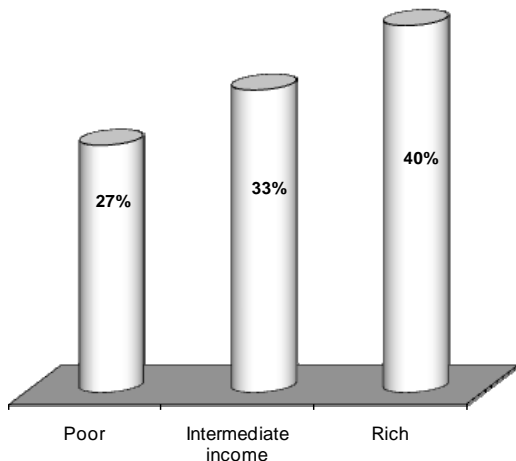Figure 3 displays the distribution of our sample in these three strata.

**Figure 3.** Total sample breakdown into rich, intermediate, and poor income neighborhoods

From our survey, 52.8% of interviewees are male and 42.2% are female. A percentage of 28.9% among them are employed, while 23.3% are students. The rest of the sample is either retired, self-employed, or exercising no regular activities (Figure 4).

When asked about their overall perception of the quality of their environment, only 14.4% deem it acceptable, while 38.9% find it very bad, and 44.4% find it average. When asked whether household waste is a problem for them, 68.8% answer yes. What is worth noting at this

level, is that in all our three strata, an overwhelming majority of interviewees find that the system of waste collection in Dakar is rather poor (Figure 5).
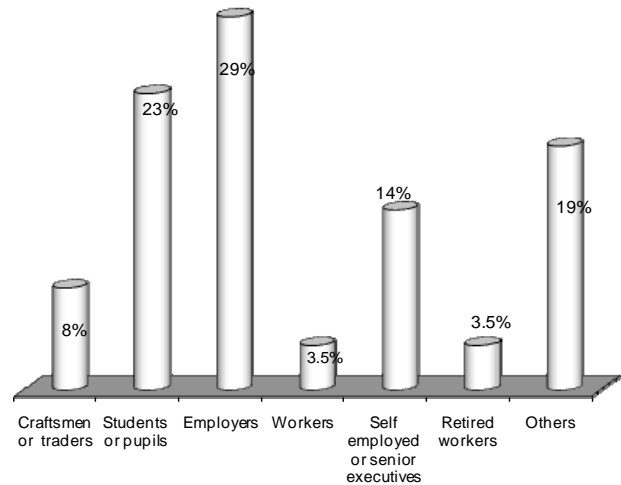
**Figure 4.** Household distribution into to professional categories

A percentage of 55% of surveyed households are unhappy about the service of waste collection. When asked why, they point to a lack of punctuality and irregular collecting. Households are using alternative ways to get rid of their waste in order to bypass deficient public service: incineration, burial, and payment to cart drivers. Households often have no idea what the final destination of the waste will be, with waste frequently deposited in unoccupied urban spaces, etc (Figure 6).
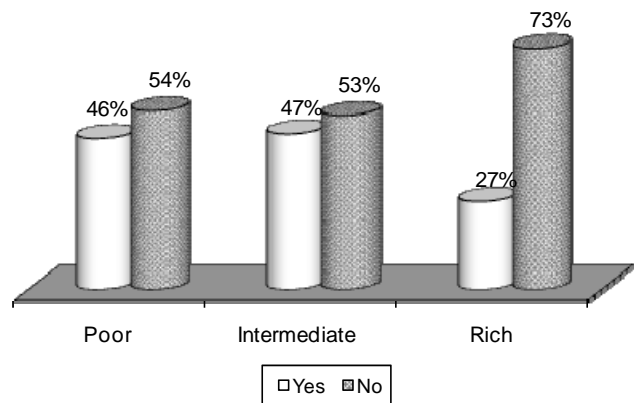
**Figure 5.** Do you believe there is a problem with waste collection?

A percentage of 88% of our sample reported not being aware of the TEOM tax. Only 48.9% of the interviewees would accept a rise in the level of the TEOM as a means to increase service quality. Those who refuse give the following reasons:
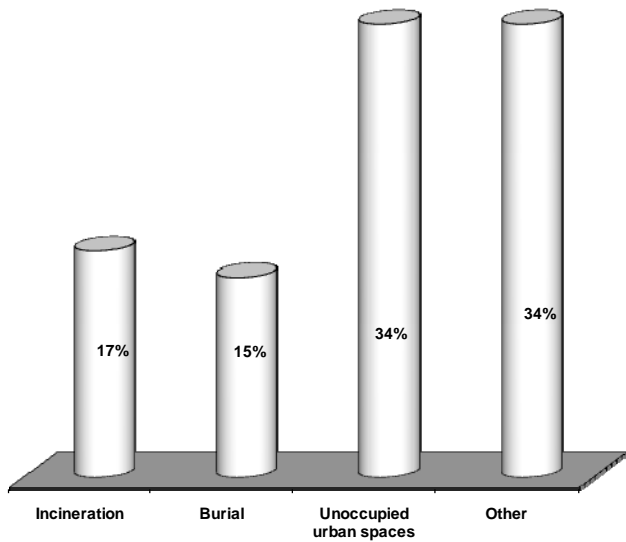- It is not us who should have to pay (34%)

**Figure 6.** Alternative ways used by households for getting rid of waste

- We are coping quite well with our waste and there is no need to waste money on an increased tax (20%),
- Service is poor (20%)
- We cannot afford it (15%)
- The government can take care of the issue without raising taxes (11%)

Additional questions were asked of those who accepted an increase in payment for an increase in service quality. Average willingness to pay is only computed for households who reported willingness to pay a positive sum. The corresponding willingness to pay is CFA 17,945. Expressed willingness to pay varies between CFA 1,000 to CFA 60,000. The computation of average willingness to pay depends on how "false zeros" are treated. Among those who report an unwillingness to pay, we can distinguish the ones who do so because they cannot afford payment or because they definitely reject the proposed service improvement, and the ones who expressed refusal to pay only because they do not agree with the proposed scenario or mode of payment. The former are categorized are "true zeros" because they cannot or do not want a service improvement, while the latter are categorized as "false zeros" because their objection to service improvement could be reversed if another scenario for service delivery or another method of payment was proposed to them. That is why they can be referred to as "protest zeros". True zeros make up only 35% of all refusals. Three hypotheses have been considered in the treatment of "false zeros":

**Assumption 1:** average willingness to pay is computed by assigning a value of zero to all zeros, be they « true » or « false ». That is, apart from those who expressed a positive WTP, all the remaining observations are given a value of zero. The average is then CFA 7,180.

**Assumption 2:** average willingness to pay is computed by affecting to « false zeros » the mean of all other observations. The average is then CFA 12,561.

**Assumption 3:** average willingness to pay is computed by affecting to « false zeros » the mean of revealed positive amounts. The corresponding figure is CFA 14,755 FCFA.

## 4.  An econometric model of WTP

The usual method for modeling willingness to pay (WTP) is the one proposed by Hanemann et al. (1991), Aurelia-Morancho et al. (2005). In this method, a double-bounded WTP question is asked respondents. It consists of a sequence of two bids and asks for a "yes" or "no" vote as to whether the respondents's WTP is equal to each bid. In this model, the mean WTP is computed as the ratio of the coefficient estimate for the constant parameter to the coefficient estimate of the first bid. Although this model is widely used in the literature, it does not correspond to the one used in this paper, since we choose to instead use an open-ended question to calculate revealed WTP.

In modeling WTP we rely on a probit/linear regression model (Heckman 1979), as in Scherrer (2002), with a two-stage regression. First we estimate the probability of having a positive WTP, using the following selection equation:

$$P(z_i = 1) = \Phi(w_i \gamma) \qquad (1)$$

where $z_i$ is equal to 1 for a positive WTP, 0 otherwise, $w_i$ is a set of predictors and $\gamma$ is a vector of coefficients (including a constant) for the selection equation. Here the density and cumulative density functions of the standard normal distribution are denoted by $\phi$ and $\Phi$ as is customary.

The second stage ("substantive") regression is estimated using the following equation:

$$y_i = x_i \beta + \varepsilon_i \qquad (2)$$

with $y_i$ observable only when a positive WTP is revealed, $x_i$ a set of predictors, $\beta$ a vector of coefficients (including a constant) and $\varepsilon_i$ a vector of random errors for the substantive equation.

The Heckman two-stage procedure consists of first estimating regression parameters using a maximum likelihood probit model (selection equation), and then estimating a substantive equation by ordinary least squares. Once the selection equation is estimated, the fitted linear combinations $w_i\hat{\gamma}$ are used to form a new variable called the Inverse Mills Ratio (IMR, denoted by $\lambda$). The ratio $\lambda$ is computed as the ratio of the standard normal probability density function to the cumulative density function, evaluated at $w_i\hat{\gamma}$; in other words $\lambda = \varphi(w_i\hat{\gamma})/\Phi(w_i\hat{\gamma})$. The IMR is included as an explanatory variable in the substantive equation to correct for the bias associated with censoring non-positive observations in equation (2) (Heckman, 1979, 1998). When the dependent variable in the substantive equation is continuous, as in our case, the Heckman method provides consistent estimates. But a major limitation of this methodology is its great sensitivity to the quality of selection model specification. If the model is not well specified, and the variables in the selection model do not correctly predict acceptance and refusal to pay, then the method may have limited power to detect bias.

In our analysis, $w_i$ and $x_i$ are observable socio-demographic variables; it is assumed that the random errors $\varepsilon_i$ follow a normal distribution $N(0;\sigma_\varepsilon^2)$.

**Variable description**

The variables included in our regressions are listed in Table 1.

The results of our baseline regression are displayed in Table 2. The Wald statistic is 132.86 for the baseline regression, so the hypothesis that all the regression coefficients are zero is rejected. The selection equation was estimated using the whole set of observations, including both those who gave a positive WTP and those who did not. For the second stage regression, we used only the observations from individuals who expressed a positive WTP. Our results indicate that for the selection equation, all independent variables are significant except for Probom1 and Sexe1. Our results further show that the older the individual, the lower his/her probability of having a positive WTP. This seems counterintuitive since, according to common findings in the literature, older people are thought to be more concerned about environmental issues. In our case, it may only indicate that older people used to contributing to waste collection are no longer convinced by the effectiveness of the system. In addition, the opinion of the household about the quality of waste management is not found to

**Table 1.** Variables used in regression models

| Variables | Description | Reference to questionnaire |
|---|---|---|
| Quartie1 | 1 when the respondent lives in a residential area, 0 otherwise. | Question n°17 |
| Quartie2 | 1 when the respondent lives in a middle-income neighborhood, 0 otherwise. | Question n°17 |
| Quartie 3 | 1 when the respondent lives in a poor neighborhood, 0 otherwise. | |
| Probom1 | 1 when the respondent finds that waste collection is an issue, 0 otherwise. | Question n°3 |
| Structom1 | 1 when there is a waste collection service in the neighborhood, 0 otherwise. | Question n°4 |
| Qualigom1 | 1 when the respondent finds that waste collection has recently been improved, 0 otherwise. | Question n°2 |
| Qualigom2 | 1 when the respondent finds that waste collection has recently deteriorated, 0 otherwise. | Question n°2 |
| Sexe1 | 1 when the respondent is a male, 0 otherwise. | Question n°18 |
| Typehab1 | 1 when the respondent lives in an individual house, 0 otherwise. | Question n°23 |
| Age | Age in years of the respondent | Question n°19 |

influence the amount that the household would be willing to pay significantly. We noticed that those who expressed a positive WTP often held contradicting opinions about the quality of such management. By the

**Table 2.** Baseline regression results

| | Coefficient | p-value |
|---|---|---|
| **Substantive equation** | | |
| quartie1 | 6,278.61 | 0.355 |
| quartie2 | 17,144.20 | 0.004 |
| probom1 | -7,517.56 | 0.268 |
| Structom1 | 16,260.87 | 0.063 |
| Qualgom1 | 3,327.60 | 0.661 |
| Qualgom2 | 5,433.04 | 0.398 |
| Constant | -12,636.04 | 0.480 |
| **Selection equation** | | |
| Age | -0.030 | 0.039 |
| Qualgom1 | 6.347 | 0.000 |
| Qualgom2 | 5.696 | 0.000 |
| Qualgom3 | 5.969 | 0.000 |
| probom1 | 0.302 | 0.443 |
| sexe1 | 0.170 | 0.572 |
| typehab1 | 0.941 | 0.008 |
| Constant | -6.122 | |
| Lambda | 9,500.61 | 0.328 |
| Wald statistic | 132.86 | 0.000 |

*Note:* The sample is restricted to non-zero observations.

same token, households who live in an individual house have a higher probability of WTP than those who don't. This result tends to confirm that WTP is positively correlated with income.

We also estimated models with different treatment of the "false zeros" but major conclusions from these models are close to those of the baseline model, so we do not report the results here.

## Conclusion and policy recommendations

Managing household waste collection in Senegal has revealed itself as being a very complicated issue for policy makers. Several different collection methods have been experimented with in order to address this very critical policy issue, but none of them has proven sustainable. Using the CVM technique, we have found that Dakar households would be willing to contribute an average amount varying between CFA 7,180 and 17,945 (between about US$ 18 and US$ 45) per year, depending on how the average is computed. This would be more than enough to meet aggregate costs of waste collection in Dakar. Currently, only 10% of such costs are met by the actual level of TEOM collection.

In order to further improve the system of collection, the following actions need to be undertaken:
a. The government needs to privatize not only waste collection, but also the financing of the overall system. Right now the proceeds of taxes collected to finance household waste management are managed by public treasury, and are often used to meet alternative government needs. A special public agency or private entity should be in charge of exclusively managing the system. This would ensure effective collection of household contributions.
b. Household contributions to the financing of collection services should be determined by weight and not on a lump sum basis as currently it is the case with the TEOM. This would force households to develop better behavior with respect to the sorting and recycling of waste before sending it out for collection. It is estimated that half of household generated waste in Dakar consists of sand and other easily recyclable material.

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## REFERENCES

Asgary A., Willis, K., Taghvaei A.A, and Rafein M. 2004. Estimating rural household's willingness to pay for health insurance. *European Journal of Health Economics* 5:209-215.

Barget E., and Gouguet J.J. 2007. The total Economic Value of sporting Events Theory and Practice. *Journal of Sports Economics* 8:165-182.

Bonnieux F. 1998. Principes, mise en oeuvre et limites de l'évaluation contingente. *Economie Publique* 1:47-90.

Canals-Cerda J., and Gurmu S. 2007. Semiparametric competing risk analysis. *Econometrics Journal* 10:193-215.

Dunne L. 2004. An Investigation into Waste Taxes and Charges. *University College Dublin*.

Dutta V., Chander S., and Srivastava L. 2005. Public Support for Water Supply Improvements: Empirical Evidence from Unplanned Settlements of Delhi, India. *The Journal of Environment Development* 14:439.

Faburel G. 2002. Evaluation du coût social du bruit des avions. Application de la méthode d'évaluation contingente au cas d'Orly . *Les Cahiers Scientifiques du Transport* 42 :43-74.

Flachaire E., and Hollard G. 2005. Une approche comportementale de l'évaluation contingente. *Cahiers de la Maison des Sciences Economiques* v05077, Université Panthéon-Sorbonne (Paris 1).

Fullerton D., and Kinnaman T. C. 1996. Household Responses to Pricing Garbage by the Bag. *The American Economic Review* 86(4):971-984.

Hanemann W.M., and Kanninen B. 1991. Statistical efficiency of double-bounded dichotomous choice contingent valuation. *American Journal of Agricultural Economics* 73:1255-1263.

Hausman J. A. 1993. *Contingent valuation: A critical Assessment*, North-Holland.

Heckman J. 1979. Sample selection bias as a specification error. *Econometrica* 47:153-161.

Heckman J. 1998. Detecting Discrimination. *Journal of Economic Perspectives* 12(2):101-116.

Heckman J., Tobias J. and Vytlacil E. 2003. Sample Estimators for treatment parameters in a latent-variable framework. *The review of Economics and Statistics* 85(3):784-755.

Heintz V. 2002. Comment évaluer l'amélioration du bien être individuel issue d'une modification de la qualité du service d'élimination des déchets ménagers ?. *Working Paper 2002.11. Bureau d'Economie Théorique et Appliquée, ULP Strasbourg*.

Herriges J. A. and Shogren J. F. 1996. Starting point bias in dichotomous choice valuation with follow-up questioning. *Journal of Environmental Economics and Management* 30:112-131.

Hu W. 2006. Comparing consumer' preferences and willingness to pay for non-GM oil using a contingent valuation approach. *Empirical Economics* 31:143-150.

Kah E. 2003. La Méthode d'évaluation contingente appliquée aux déchets urbains. *Espace Géographique* 1 :47-59.

Kwak, S. J., Yoo, S.H., and Kim C.J. 2004. Measuring the economic benefits of recycling: the case of the waste agricultural film in Korea. *Applied Economics* 36:1445-1453.

Leon, C.J., Arana, J.E., and Melian A. 2003. Tourist use and preservation benefits from big-game fishing in the Canary Islands. *Tourism Economics* 9(1):53-65.

Marvasti A. 2006. **A** contingent valuation of customer delay in medical services. *Eastern Economic Journal* 32(1).

Miranda M. L. and Aldy J. E. 1998. Unit Pricing of Residential Municipal Solid waste: Lessons from Nine Case Study Communities. *Journal of Environmental Management* 52(1):79-93.

Miranda M. L., Everett J., Blume D., and Roy B. 1994. Market based incentives and residential municipal solid waste. *Journal of Policy Analysis and Management* 13(4):681-697.

Mitchel R.C. and Carson R.T. 1989. *Using Surveys to value Public Goods: The contingent Valuation Method.* Resources for the Future.

Morancho A.B., Fuertes-Eugenio A., and Del Saz-Salazar S. 2005. A comparison of empirical models used to infer the willingness to pay in contingent valuation. *Empirical Economics* 30:235-244.

Murad M.W., Raquid M.A., and Diwar C. 2007. Willingness of the poor to pay for improved access to solid waste collection and disposal services. *The Journal of Environment and Development* 16(1):84-101.

National Oceanographic And Atmospheric Administration 2001. *Report of the NOAA Panel on Contingent Valuation* May.

Nestor D.V., and Podolsky, M. J. 1998. Assessing Incentive-Based environmental policies for reducing household waste disposal. *Contemporary Economic Policy* 16(4):401-411.

Podolsky M. J., and Spiegel M. 1998. Municipal Waste Disposal: Unit-Pricing and Recycling opportunities. *Public Works Management and Policy* 3 (1):27-39.

République Française, Ministère de l'Ecologie et du Développement, Direction des Etudes Economiques et de l'Evaluation Environnementale 2006. *Consentement Local à Payer et Localisation d'une décharge*, document de synthèse.

Scherrer S. 2002. Les pertes d'usages récréatif du patrimoine forestier après les tempêtes de 1999 : le cas de la forêt de Fontainebleau. *Economie et Statistique* 357-358 :153-172.

Treiman T., and Gartner J. 2006. Are Residents Willing to pay for their Community Forests? Results of a contingent Valuation Survey in Missouri, USA. *Urban Studies* 43(9):1537-1547.

Willinger M. 1996. La méthode d'évaluation contingente : de l'observation à la construction des valeurs de préservation *Nature, Sciences, Sociétés* 4(1) :6-22.

Yoo S.H., Shin C.O., and Kwak S.J. 2006. Inconvenience cost of spam mail: a contingent valuation study. *Applied Economics Letters* 13:933-936.

## Appendix

## Questions used in data collecting instrument for willingness-to-pay computation (translated from French)

Date:                    Name of interviewer:
Questionnaire n°:

Approximate time for filling out questionnaire: 1 hour.
Mode of interview: face-to-face.

MARCH 2005 - CREA

*CREA is currently leading a survey on household waste collection id Dakar. This interview is intended to gather some information from your household, to feed in our policy recommendations that will be drawn from this study.*

**I. Household perception of the overall system of environment protection and waste collection in Dakar**

1.  Overall, how would you rate the quality of your environment?

 1. Excellent          2. Good              3. Average
 4. Poor               5. Very poor         6. No answer

2.  How do you evaluate the recent evolution in the system of waste collection?

1. Improved      2. Deteriorated  3. No observed  4. No answer
                                      change

3.  Do you thing solid waste collection is a big problem for you and your neighbors?

 1. Yes                            2. No

4.   Do you have a formal system of waste collection in your neighborhood?

   1. Yes                              2. No

5.   What are the means you use to collect your solid waste?

   1. Dump truck     2. Cramming tub        3. Horse-pulled cart

6.   At what frequency does collection take place?

1. Daily   2. Every two days   3. Weekly   4. Monthly   5. Other

7.   In case your waste is not collected what alternative ways are available to you to get rid of them?

1. Incineration 2. Burial   3. Deposit in unoccupied   4. Other
                                urban spaces

8.   Do you regularly pay the Taxe d'Enlèvement des Ordures Ménagères (TEOM)

   1. Yes                 2. No                 3. No answer

9.    If yes, how much is your annual contribution through this tax?

## II. Assessment of household and willingness to pay

*Scenario description: an improved system of waste collection is implemented to ensure waste is regularly collected. This would generalize TEOM collection and bring about a slight increase in the level of contribution.*

10.   Personally, would you be favorable to an increase in TEOM, in order to improve the system of waste collection?

   1. Yes                              2. No

11.    If the answer to Q10 is yes, how much would you accept to pay as your maximum contribution to this scheme?

12.   If no to Q10, why?

| 1. We are not the ones who have to pay for that | 2. We already pay for a pretty poor service | 3. We cannot afford it |
|---|---|---|
| 4. The current system is satisfactory and does not need any improvement | 5. Other reasons | |

13.   If a local system of waste collection independent from the government were to be implemented, would you accept to join it?

   1. Yes                              2. No

14.   If yes to Q13, how much would you accept to contribute to this scheme as a maximum per year?

15.   If no to Q13, for which reasons?

| 1. We are not the ones who have to pay for that | 2. We already pay for a pretty poor service | 3. We cannot afford it |
|---|---|---|
| 4. The current system is satisfactory and does not need any improvement | 5. Other reasons | |

## III. Information on the household

16.   What is the area of your usual residence in Dakar?

17.   (to the interviewer), please note the place in which the interview took place

   1. Rich        2. Intermediate income            3. Poor

18.   You are

   1. Male                         2. Female

19.   Age?

20.   Are you head of household?

   1. Yes                         2. No

21.   Occupation?

| 1. Salaried employee | 2. Craftsman | 3. Self-employed or senior executive | 4. Trader |
|---|---|---|---|
| 5. Student | 6. Retired | 7. Farmer | 8. Other |

22.   What income group from among the following do you belong to (FCFA)? (interviewer, please make sure that you consider the total household income by summing up individual incomes)

1. <50,000        2. [50,000 – 100,000[    3. [100,000 – 150,000[

4. [150,000 – 200,000[        5. [200,000 – 250,000[    6. [250,000 – 300,000

7. >300,000

23.   Do you live in an:
1 individual house     2 apartment    3. other