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Determinants of the incentive for the pricing of the sustainable household waste management service in Ouagadougou

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Abstract

The phenomenon of environmental management in urban areas is an ever-growing concern for public authorities. Abundant literature has been provided for this purpose to sustainably control waste management. Most of these studies have focused primarily on the prerogatives of municipalities. This article empirically tests the phenomenon carried by the first beneficiaries of a healthy environment using data collected from 250 rich and poor households in the city of Ouagadougou. To achieve this, the methodological approach uses Probit-type modeling. The data show that the majority (74%) of households have a positive response to the incentive to participate in pricing for the sanitation of their living environment with regard to the two categories of households. This result corroborates the thesis according to which the involvement of households in the elaboration of development policies allows a better response of actions, the corollary of which is an increase in household savings and production and the creation of a network of collection and the need for everyone to join it based on pricing that takes into account the standard of living of each social group.

Keywords: Waste, Sustainable management, Ouagadougou, Price, pricing system.

INTRODUCTION

These last decades have been marked by many environmental challenges related to industrialization, economic development, population growth, urbanization, and changing lifestyles (Gbinlo, 2010). The rapidity of urbanization on the African continent does not spare the city of Ouagadougou, which has approximately more than 1,300,000 inhabitants and 60% of the country's urban population; the growth rate is estimated at 4.4% per year and the rate of urbanization which was 14% in 1991 reached 24% in 2010 (Mas and Vogler, 2006). This urbanization has caused an unprecedented increase in municipal spending on household waste management. The evolution of municipal expenditure in recent years in terms of household waste management raises the question of how to get households to become more involved in the management of their waste (Gareau et al, 2006). Incentive pricing based on the polluter-pays principle appears to be an interesting economic tool (Akerlof, 1970; Glachant, 2005; Archambault, 2008) and, to this end, various public policies should be put in place based on taxes and royalties (Watson and Jackson, 1982; Rajaonson et al 2008) and of which the management of household waste constitutes one of the essential links

(Samuelson, 1958; Shirley and Walsh, 2001). The management of household waste involves many players, including the central state, the municipality, and consumers. The success of the household waste management policy depends on the accountability of all players. The responsibility of households is often overlooked, while the quantity of waste produced by them continues to increase (Baldwin and Cave (1999). It is therefore useful and effective to give users an economic signal that reminds them of the costs for which they are responsible and to make them bear them (Becker, 1968; Bontemps and Rotillon, 2002). Thus, households will integrate the costs of waste management into their decision-making processes and will be able to make rational choices by adopting the « good » behaviors such as source reduction, sorting, and composting (Lancaster, 1966; Meddtl, 2009). In Burkina Faso, faced with the growing production of household waste in the city of Ouagadougou, the pricing policy for the household waste disposal service implemented so far is not likely to encourage households to reduce their production of waste (Sané, 1999). However, the regular increase in the volume of household waste and the budgetary constraints of the town hall lead the public authorities to consider strategies for the disposal of household



waste no longer relying solely on the municipal budget and in the face of the insufficiency of the price and overuse of collection and disposal services (Friedman, 1967; Gareau et al, 2006). With this in mind, one may wonder to what extent the introduction of an incentive fee for waste management can affect the behavior of households? This research studies the evolution of household behavior in terms of willingness to pay for the service (demand), the development of recycling (participation in sorting at source). Without trying to understand the technical principle of the implementation of this system in the city of Ouagadougou, this paper seeks to analyze the type of pricing that should influence the behavior of households in the said city with regard to the management of household waste. The rest of the article is organized as follows: the next section highlights the materials and methods; then the results are presented before the discussion of the results obtained; finally, we present our conclusions and policy implications at the end.

MATERIALS AND METHODS

Choice of model

For the various authors who have addressed the issue, knowing the motivations of households with regard to their waste can arouse a double interest for the public authorities. Initially, it may be the effective achievement of an objective of recycling-reduction at source or then, secondly, the achievement of a socially optimal management of household waste without favoring a priori one method of waste treatment compared to the others. In this sawing, three categories of instruments are evoked (Fenton and Hanley, 1995). First, there are the upstream instruments which affect the price of the waste-producing good and which in turn must affect consumer behavior in terms of choosing which good to consume; they therefore indirectly influence the environmental impact of household waste disposal. Then there are downstream instruments that are used directly at the waste collection level and are based on the volume or weight of waste produced by the household. These first two instruments (upstream, downstream) directly affect the behavior of households in terms of waste production. Finally, the third category is a combination of a tax on consumer goods and a recycling subsidy to encourage reduction at source and sorting. These instruments have made it possible to develop models aimed at analyzing the demand for waste disposal services by households (Fenton and Hanley, 1995). Thus, Wertz (1976) shows that in addition to the consumption of the good which positively affects the utility function of the household, there is also the waste generated by this consumption on the one hand, and on the other hand, that the waste negatively affects the household utility function. It also shows that unit pricing on the waste disposal service negatively affects consumption and, by extension, the household waste produced. It concludes that four socio-economic variables (unit pricing of waste, frequency of collection, distance separating the household from the location of the bins or garbage container, and household income) influence the quantity and composition of household waste. Jenkins (1993) and Morris and Holthausen (1994), relying for

this purpose on the work of Becker (1965) relating to the optimal allocation of time, show that households arbitrate between the time taken for a rejection of mixed waste (relatively low) and that sent for recycling (relatively high and therefore involving an opportunity cost) to opt for the disposal service. This places their model at the heart of the analysis of the decision to produce mixed and recycled waste. He concludes that the consumption of one good, relative to another, decreases when the relative proportion of waste it generates increases, whether the additional waste is recyclable or not. This result is due to the additional cost in terms of time devoted to recycling. By issuing a reserve right, following the Jenkins (1993) model, Morris, and Holthausen (1994) propose the use of a utility function that takes into account the preference for recycling by integrating recycled materials. For him, the introduction of the latter into the utility function is explained by the fact that goods can be purchased, either for their direct utility in the consumption activity of the household or for the indirect effect on the household usefulness provided by their ability to be recycled. This last effect, therefore, favors the consumption of goods generating a large quantity of waste, which can be easily recycled. The utility function is written:

$$U=U(X,L,R). (1)$$

where X is the vector of goods produced and consumed by the household from market goods and consumption time, L is leisure time, and R the amount of recycled materials which in turn depends on the time spent on the activity of recycling of commercial goods and the proportion of waste contained in each of them. In this model, we see that faced with a pricing proportional to the volume of waste collected, the household will make a choice between reducing at source by buying goods that generate less waste or whether it has a preference for recycled materials, he will opt for recycling, which depends on the time needed to sort the waste. The author, therefore, estimates that the demand for waste disposal services and the level of waste separation effort depend on the production of domestic services. He thus deduces that households combine time and market goods to produce final goods that provide them with utility. These goods generate waste that is a by-product of consumption. The waste can either be discharged as a mixture or be recycled; which requires an allocation of part of the household's available time to separate final waste from biodegradable and recyclable materials. Morris and Holthausen (1994) continue the analysis by showing that the recycling effort and the mixed rejection of waste depend on the particular characteristics of the household (its preferences), the domestic production activities, the pricing of the collection service mixed household waste, and the opportunity cost of the time spent on the recycling activity.

The models developed by Jenkins (1993) and Morris Holthausen (1994) have a limit, that of not taking into account illegal diversions. Indeed, these models assume that the household makes a choice between three options: consume and produce waste, consume goods with a low waste content, and produce less waste by devoting time to separating

recyclable waste and biodegradable ones. But they can also divert waste to illegal and socially undesirable solutions such as uncontrolled individual incineration, so-called «wild» dumping, in the bins of other agents, or in public gardens (Glachant, 2004). Although the pricing advocated by Jenkins and Holthausen is consistent with Pigou's principle (1920), it does not allow optimal management of household waste due to the possibility of illegal waste diversion. But the use of incentive pricing can lead households to illegally divert their waste. According to Palmer et al (1997), if the standard content of recycled products encourages their use and discourages the use of virgin materials, it contributes to the increase in output and therefore waste. Like Dinan (1993) and Fullerton and Kinnaman (1995), they show that it is possible to achieve the social optimum by combining an input tax and a recycling subsidy. Glachant (2004), for his part, considers that these different theoretical contributions only model the choice of households and conceal the choices made upstream of the final market for goods by producers and distributors. However, the volume of waste resulting from the consumption of goods depends to a large extent on the production process (Andreoni and Levinson, 2001). These different models presented above did not take into account the influence of production process decisions on the flow of household waste. The models allowing this information to be processed while respecting previous developments are the dichotomous choice models (the Probit model and the Logit model).

In the context of this research, the Probit model is favored over the Logit because it makes it possible to decompose the variance-covariance matrix and to identify the unobservable correlation between the two alternatives, moreover, there is very little difference between them (Amemiya, 1981). For this purpose, let y be the binary qualitative variable taking the value 1 ($y = 1$), if the household adheres to the unit pricing of waste based on weight or volume and 0 ($y = 0$) otherwise. Let also be the auxiliary quantitative variable y^* underlying y and corresponding to the amount that the household is willing to pay for each kg of waste produced presented for pre-collection. The latter can be approximated by a linear model and is presented as follows:

$$y_i^* = x_i b + \mu_i \quad (2)$$

The disturbances are assumed to be independent, with zero mean and such that the variables μ_i / σ where σ is a positive parameter. They follow the same law of distribution function

F. the observed qualitative variable is defined there from this latent variable such that:

$$y = \begin{cases} 1 & y_i^* > 0 \\ 0 & y_i^* \leq 0 \end{cases} \quad (3)$$

From this previous condition, it is possible to deduce the law y :

$$\begin{aligned} p[y = 1] &= p[y_i^* > 0] = p[y_i^* = X_i b + \mu_i > 0] \quad (4) \\ &= p[\mu_i / \rho > -X_i b / \rho] \\ &= 1 - F[-X_i b / \rho] \\ &= F[X_i b / \rho] \end{aligned}$$

If the law is symmetric.

This model (4) makes it possible to estimate the probability of accepting unit pricing based on the weight or volume of waste presented by the household for collection as well as to identify the variables affecting this probability. To this end, several variables that must take this reality into account are therefore taken into account on the data collected from this population in order to identify the motivations of households to actively participate in the elimination of this waste.

Presentation of the data used and the variables of the study

The data used in this study come from a survey of a sample of 250 households in the city of Ouagadougou. Households include both those who pay a fixed fee for the collection of their waste (subscription) and those who are not subscribers. The variables used correspond to the socioeconomic characteristics of the households surveyed. They make it possible to highlight the factors that influence the willingness of households to adhere to a unit pricing policy. The analyzes have focused on the influence of these variables on the quantity and composition of household waste and show that the number of people per dwelling, age, frequency of collection, price, and marginal cost of waste collection are significant factors that influence the demand for disposal. They also report a waste reduction ranging from 2.36 to 3.18 kg per person per year following a one percent increase in the marginal cost of waste collection. This variation, therefore, reduces the demand for waste disposal in favor of an increase in selective collection. In order to analyze the probability of acceptance of a unit pricing of household waste in the city of Ouagadougou to replace the current pricing and to understand the behavior of households faced with an incentive pricing policy, the explanatory variables likely to explain this probability are presented in Table 1.

Table 1: Dictionary of variables

Variables	Définition	Effects	Values
Demcol	Request the household waste collection service in the presence of unit pricing linked to weight or volume	/	1 if yes; 0 if not.
Explanatory variables			
Probenvt	Would like to improve the quality of the environment	+	1 if yes; 0 if not.

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Typhbta	Type of dwelling	+/-	1 if banco 2 if semi-hard 3 if hard
Tailmen	Household size	-	Number of people in the household
Age	Respondent's age	+/-	digital
Age²	Square of respondent's age	+/-	digital
Revmen	Monthly household income bracket in FCFA	+	1 if <100000 2 if [100000 - 200000[3 if [200000 - 300000[4 if [300000 - 400000[5 if >400000
Catsocio	Socio-professional category	+	1 if income-generating activity; 0 otherwise
Zonehabita	Respondent's area of residence	+	1= high standing 2= medium standing 3= low status

Source: Authors.

By introducing these variables into the model (4) in its linear form, we obtain:

$$Demscol_d = \beta_0 + \beta_1 zonehabita + \beta_2 typhbta + \beta_3 revmen + \beta_4 age + \beta_5 catsocio + \beta_6 tailmen + \beta_7 probenvt + \beta_8 age^2 + \varepsilon \quad (5)$$

With ε , the normally distributed random term which captures the omission of certain variables important to the explanation of the phenomenon.

The empirical model (5) of the study thus defined must now be subjected, on the one hand, to statistical analyzes in order to highlight the various conjectures that could exist due to the composition of the sample and/or the various variables; and on the other hand, to econometric analyzes using the maximum likelihood method in order to identify the real effect of these variables on the decision of a household to request a household waste collection service.

RESULTS

This is to highlight the composition of the sample and analyze the statistical results first, and then proceed to the analysis of the econometric results.

Descriptive statistics and categorical characteristics of variables

The main descriptive statistics and the list of variables used are given in Tables 2 below.

Table 2a: Descriptive statistics of the variables used						Table 2b: Categorical characteristics used		
Variables	Obs	Mean	Std. Dev.	Min	Max	Variable Name	Terms	%
Number of collection service requesters	250	1,26	0,440	0	1	monthly household income	<100000	57,6
							[100000 - 200000[27,6
Number of people wishing to improve the quality of the environment	250	1,26	0,44	0	1	Respondent's area of residence	[200000 - 300000[4,4
							[300000 - 400000[4,8
							>400000	5,6
							High Standards	7,6
						Medium	48,4	

Number of people in the household	250	8,33	5,215	1	36	standing	
Age reached in year of survey	250	37,61	14,035	16	75	Low standing	44,0
Socio-professional category of the respondent	250	0,24	0,428	0	1	Socio-Professional Category	
						With a job	76,0
						Unemployed	24,0
						Collection Service Request	
						asked	74,0
						don't ask	26,0
						Improved environmental quality	
						Want improvement	70,8
						Are not interested	29,2
						Type of dwelling	
						Banco	4,0
						Semi-hard	32,4
						Hard	63,6

Source: Authors based on field survey data.

Table 2a shows that on average a household has 8 people whose average age is 37.61 years. This shows that households are in a position to produce significant household waste. The number of people could therefore influence the decision of the household to subscribe to a collection service. It could also depend on the income of the household and the locality in which it is located. A review of these indicators (Table 2b) would provide better visibility of the phenomenon. Table 2b suggests that most of the households surveyed (57.6%) have an income of less than 100,000 FCFA while, on the contrary, a very small proportion earns an income above 400,000 FCFA. The intermediate classes represent respectively 27.6%; 4.4% and 4.8%. This configuration is very similar to that of African cities where disparities in terms of income are significant. Added to this is a strong preponderance of dwellings in so-called medium-standing areas (48.4%) whose type of dwelling is almost permanent (63.6%). This, therefore, suggests that said households would be more likely to opt for a change in household waste collection pricing (74%) and thus contribute to improving the environment (70.8%). The small proportion (26%) of non-requesters would be mainly involved by the lack of financial means (88.42%) to which would be added a reluctance regarding an increase in taxes linked to the collection service (7.6 %) as shown in Table 3, which also presents the results of the estimation of the Probit model.

Econometric analysis

The main results of this analysis are recorded in Table 3. The obvious importance of the econometric results linked to the empirical model of the study (model 5) lies in the sign assigned to the various coefficients. To this end, the interpretation that could result from it only focuses on these signs to give the meaning of causality only to the variable on the probability of consenting to a payment or not.

Table 3: Estimation of the Probit model and choice of not requesting a waste collection service

Variables	Probit model Coefficients	Reasons for choosing not to request collection	
		Pattern	%
household income	1.13e-06** (1.89)	Don't want to pay more tax	7,6
Squared age of head of household	.0000879 (0.86)		
Socio-professional category of the head of the household	-.0749384* (-1.66)	Got no money for it	88,42
Type of household dwelling	.1693078 (1.22)		
Household living area	.7435436*** (4.37)	Don't understand	2,58

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		any of this	
Age of head of household	.04518442 (0.88)		
Household size	-.0354121** (-1.03)	can't decide	1,4
Improvement of the quality of the environment (probenvt)	.0412842** (2.17)		
Constant	-1.419254** (-2.51)	Don't want to pay for others	0

Number of observations = 250 ; LR chi2 (7) = 39.09 ; Prob > chi2 = 0.0000 ;

Pseudo R2 = 0.13 ; Log semblance = -123.71884

Significance: *** p < 0.01; ** 1% ≤ P < 5%; * 5% ≤ P < 10%.

Source: Authors.

The estimation results (Table 3) show that almost all the coefficients associated with the different variables are significant at the 10% level. Indeed, the estimation results indicate that all other things being equal, an increase in household income of 1% would lead to an increase in the incentive to subscribe to the pricing of the waste collection service by 1.13%. On the other hand, the size of the household acts significantly and negatively on the adoption of the pricing system for the collection of household waste. Also, the age of the head of household (even taken squared) has no significant impact on the incentive to charge.

DISCUSSION

The results of the estimation show that almost all of the coefficients associated with different variables have significant effects at the 10% threshold on the incentive to adopt the household waste management service pricing system in the city of Ouagadougou. Thus the level of income reached by the household encourages the latter to request a waste collection service and when the household has a constant average income, it is more likely to use this type of service insofar as its time does not allow it. does more to ensure their destruction. Moreover, because of his social rank, he has the right to do so to preserve this responsibility, which will subsequently lead to a reduction in waste. On the other hand, when this income drops, the use of this service becomes less in demand. This situation is amplified if the household is large and of very low socio-professional category. This result confirms the work of Ebreo and Vining (2001) and Garcès et al. (2002) who think that it then creates spills in nature of this waste or an artisanal destruction that does not take into account environmental principles if necessary. This result allows us to say that households with high income are more inclined to accept unit pricing linked to the volume of waste produced by the household, while low-income households prefer flat pricing or are more likely to participate in the sorting their garbage. In the absence of these alternatives, they illegally divert their waste from the formal disposal circuit. Beyond income, it is clear that the area of residence also positively and significantly influences the decision to

subscribe to the tariff. On this point, Ebreo and Vining (2001), Garces et al. (2002), and Jenkins et al. (2003) estimate that income, although having a strong influence on the decision to subscribe to a waste recovery service, the contribution of the residential area remains relevant because the latter influences the probability of demand of such a service, insofar as the type of residential area imposes on the resident a certain form of conduct in environmental matters and everyone is implicitly forced to do so in this dynamic. This could also be explained by the quest of the residents of these areas for a certain quality of the environment in which they live (hence the significance of this variable) due to the awareness of the dangers that can be caused by the accumulation of waste in the environment and on people (Yi et al., 1999). At this level, it should be specified that we are confronted with problems of management of externalities because the existence of externalities which can be at the origin of market failures and a negative externality such as pollution imposes a cost on society which is not taken into account by the emitter of this externality. According to the work of Gbinlo (2010), individuals exposed to the degradation of the quality of the environment suffer damage and would be willing to pay for its improvement. In this case, externalities in the household waste sector can take several forms; these externalities are observed at the level of the different stages of the sector, namely: collection, transport, and the method of processing waste, which present significant external costs (Gbinlo, 2010).

As the saying goes, you need a healthy mind in a healthy body, which requires a healthy environment conducive to the optimal development of the potential of agents and which can inevitably lead to an improvement in human capital and therefore productivity. To benefit from an adequate environmental framework, households are therefore ready to express the demand for the service even if there is a reform of the tariff system because their well-being depends on it.

In short, the results of this research indicate that the pricing linked to the weight of household waste seems best suited in the city of Ouagadougou. To this end, and in confirmation of the predictions of Bonnieux (2001), all policies for its implementation should take into account all these factors for the success of its objectives. On the other hand, the

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association of stakeholders in the definition of these policies would allow a better involvement of the first actors. As a result, the immediately perceptible effect would be the creation of the jobs that underpin it for the poorest. This would be a boon to be seized for this category of social class. In addition, the organization of this sector of activity could prove to be effective in combating urban unemployment in the long term but provided that the State invests in it by making this sector one of the jewels of the economic life of the nation. According to Abdoulaye (2001), the use of recycling activities could therefore be a lever in the face of the structural problems of the economy in terms of job creation, preservation of the environment and its ecosystem and Bandyopadhyay and Shafik (1992) add that this allows the improvement of the health well-being of the populations. All this having as a corollary an increase in household savings and production because the low productivity in most urban areas of Burkina Faso (Ouagadougou in particular) could therefore be explained primarily by the dysfunction of the waste households collection sector and the precarious state of health of the inhabitants due to the harmful externalities of this dysfunction (European Commission, 2000).

Conclusion

The results of this research have identified the many efforts that are made regarding pricing and waste management in the urban municipality of Ouagadougou. However, the waste management system still has problems that are mainly related to the behavior of the population and the effective management of waste also depends on the contribution of households from a well-done pre-collection. Note that the problem related to pre-collection has increased due to the presence of externalities due to a lack of information and periodic awareness of the population on the environmental and health consequences of poor waste management. From this paper, we sought to see the determinants of the incentive to adhere to a pricing system for the management of household waste in the city of Ouagadougou. The results indicate that the pricing linked to the weight of household waste seems the best suited in the city of Ouagadougou. For an effective management of household waste in the city of Ouagadougou, the association of stakeholders in the definition of these policies would allow a better involvement of the first actors, which would allow the creation of jobs and would constitute a godsend to be seized for this category of social class. In addition, the State must invest in making this sector one of the jewels of the nation's economic life in order to fight effectively and sustainably against urban unemployment. The use of recycling activities could therefore be a lever in the face of structural problems of the economy in terms of job creation, preservation of the environment and its ecosystem, improvement of the health well-being of populations, increase in household savings and production. Hence, as suggested by Akbostanci et al. (2006), the importance of the collection network and the need for everyone to join it based on pricing that takes into account the standard of living of each social group.

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Conflicts of interest

The authors have no conflict of interest.

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