“An applicability test of the use of deposit-refund system for managing water-sachet litter in Ilorin, Nigeria”

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ARTICLE INFO	Musa Ilias Biala and Omo Aregbeyen (2018). An applicability test of the use of deposit-refund system for managing water-sachet litter in Ilorin, Nigeria. *Environmental Economics*, *9*(4), 22-43. doi:10.21511/ee.09(4).2018.03
DOI	http://dx.doi.org/10.21511/ee.09(4).2018.03
RELEASED ON	Wednesday, 26 December 2018
RECEIVED ON	Sunday, 18 November 2018
ACCEPTED ON	Saturday, 22 December 2018

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JOURNAL	"Environmental Economics"
ISSN PRINT	1998-6041
ISSN ONLINE	1998-605X
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
44	1	8

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BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10, Sumy, 40022, Ukraine

www.businessperspectives.org

Received on: 18th of November, 2018
Accepted on: 22nd of December, 2018

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AN APPLICABILITY TEST OF THE USE OF DEPOSIT-REFUND SYSTEM FOR MANAGING WATER-SACHET LITTER IN ILORIN, NIGERIA

Abstract

Th s study used both quasi-experiment and contingent valuation survey to explore the applicability of deposit-refund system (DRS) to water-sachet litter management in Nigeria. In the experiment, a DRS was established to incentivize the participants to return emptied sachets of water. A contingent valuation survey of 454 sachet-water consumers selected using quasi-systematic sampling technique was conducted. Experimental results showed that the number of sachets returned by the experimental group – those subjected to DRS – was signifi antly greater than that of the comparison group – those not subjected to DRS. Logit regression results showed that refund size increased the odds of returning sachets by 42.0%. Increasing the redemption time decreased the odds of turning in sachets by about 16.0%. A one-minute increase in the time spent on redemption would result in about 2.4% decrease in the probability that participants would comply. Income decreased the odds of compliance by about 31.0%, while age reduced the odds of compliance by about 2.2%. These results imply that the DRS reduced water-sachet littering in the study area, and that income, refund amount, redemption time, age and perceived effectiveness of DRS influenced consumers' compliance with DRS. Hence, an appropriate motivating DRS would reduce litter and its attendant problems, such as hygiene, plastic pollution, fl oding, aesthetic loss, non-naturally degradable toxic compounds, degradation of natural habitat ant its endangered species. The government should, therefore, implement a DRS and set up recycling plants, or encourage private recycling fi ms, in order to accommodate used sachets that would end up piling up.

Keywords deposit-refund system, sachet water, litter, environmental problem, contingent valuation

JEL Classification H10, H12, H23

INTRODUCTION

Water is undeniably an essential commodity and one of the world's greatest needs that cannot be dispensed with. However, the inability of the Nigerian government to persistently provide adequate potable water for the growing population and the resultant quest by the public for a solution to the dearth of water has led to the emergence and proliferation of sachet water (Akunyili, 2003; Babatunde & Biala, 2010), the packaged water popularly called *pure water*, which typically comes in 50-cl thermoplastic sachets.

Although the so-called pure water has undoubtedly been a boon to the consumers, its packaging – that is, the plastic sachet – has a social cost. While individual sachet-water consumers derive the benefit of convenience from the use of the plastic sachets, the country at large bears the social costs of the emptied sachets littered across the country. This is because the end result of the commodity is non-biodegradable waste sachets, which generate a number of negative environmental ex-

http://dx.doi.org/10.21511/ee.09(4).2018.03

ternalities, among which are litter/environmental pollution due to poor waste management practice, the resultant localized flooding due to drains clogged by littered sachets, death of animals due to ingestion, aesthetic loss to the environment (eyesore), soil degradation, and public health problems. Studies that have documented these problems include Hati and Dimari (2010), Kajogbola (1998), Folorunsho and Awosika (2001), Aziegbe (2007), Nwachukwu et al. (2010), Nkwocha et al. (2011), Aderogba (2012), and Selby (2012).

Littering of water-sachets constitutes an environmental externality problem, the form which Kahn (1966) describes as *the tyranny of small decisions*, which arises when a consumer fails to recognize that his consumption activity or behavior (e.g., littering) could lead to a much larger problem (e.g., flooding, pollution). A sachet water consumer may regard his contribution to total litter as insignificant, but the problem becomes severe as other consumers follow suit. As a result, over 560 million of water-sachets are consumed and discarded daily as waste across the country (Idiata, 2012). These unprecedented large quantities of water sachets have generated a lot environmental concerns, which in turn, have spurred numerous noneconomic control measures such as outright ban, blanket regulations and legislations, waste-to-wealth research, campaigns, and seminars by government agencies, nongovernmental organizations as well as private individuals.

In spite of these measures, a large number of emptied sachets are still littered virtually everywhere. Littering of water sachets goes on unabated on a daily basis, making the country continue to suffer from tremendous growth of waste sachets. This necessitates the need to explore other alternative mechanisms for litter management. Meanwhile, many countries have successfully tackled litter problems, but with different measures. The most widely used and effective measure by these countries is deposit-refund system. Deposit-refund system (DRS) is a mechanism of adding a refundable monetary deposit to the price of a litter-generating product. If the consumer returns the packaging or used product to a designated place, the deposit is refunded; if otherwise, the consumer forfeits the deposit.

This mechanism has been implemented with success and positive results in terms of litter reduction in countries such as USA, Germany, Denmark, India and some other developing countries. Since research and experience over the world have revealed that, among measures of controlling litter, DRS is the most effective and efficient economic instrument, such a mechanism should produce a comparative result in the country. However, since it has not been implemented, its potential impact in the country has not been tested and therefore unknown.

Since no previous studies were found in the literature examining this issue in this country, this exploratory research was, therefore, designed to investigate the applicability of DRS to litter management in Nigeria, using water-sachet litter as the case study. Specifically, the study set out to:

1) examine ex ante the impact DRS would have on water-sachet littering behavior in the country; that is, to examine the extent to which sachet-water consumers would comply with DRS if it is implemented;
2) develop and estimate a model for explaining compliance with DRS; and
3) use the model to identify the factors that could influence consumers' compliance with DRS.

The need to find a sustainable waste management practice, especially for the proliferating sachet litter, is the primary motivation of this study. Management of solid waste has been one of the major environmental challenges facing the country. Due to the current waste management practice, both public health and environmental health are being threatened by litter arising from water sachets. According to Onyenechere (2011), if nothing tangible and effective is done quickly, the problem could be a major source of health hazards and a catalyst to an upsurge of environmental degradation. Consequently, researchers (e.g., Babatunde & Biala, 2010; Onyenechere, 2011; Aderogba, 2012; Patrick et al., 2013) have

advocated the use of deposit-refund system in Nigeria. Moreover, an investigation into the potential effects of DRS in the country is worthy of *ex ante* research, because the design of a good economic policy is often based on their expected effects. Accurately predicting the potential effects of a policy is important since the implementation of improper policies is costly, for it is often difficult to adjust policies after they have been implemented (He, 2010). This would assist the policy makers in formulating and implementing an eff ctive DRS.

The rest of this paper is organized into four sections. The review of the literature is done in section 1 & section 2 provides the methodological approach adopted. The results are discussed in section 3, while last section contains the summary and conclusions.

1. LITERATURE REVIEW

Theoretical findings on DRS have been validated empirically. Empirical evidence has suggested that DRSs can significantly reduce litter (Fletcher et al., 2012; Gupt, 2012; Viscusi et al., 2011; Porter, 1983; USEPA, 2001). A 1979 study by the Maine Department of Transportation finds that though the total litter declined by 10%, the container litter declined by 56% as a result of the imposition of deposit on containers (USEPA, 2001). In 1980, one year after the bill was passed, the Maine Department of Conservation released a report showing a 69-77% reduction in beverage container litter.

Recently, Viscusi et al. (2011) used a large national survey of households to assess the role of curbside programs, bottle bills (DRS), and social norms. They found that deposit/refund had a large impact on household recycling of plastic water bottles, and that DRSs tended to transform non recyclers into diligent recyclers. In the United States, Walls (2011) reported that in the states with DRS, 87% of survey respondents reported recycling 80% or more of the bottles they consumed, while in non-DRS states, the figure was 53%. In 1978, Michigan launched its bottle bill, and recorded a dramatic fall in beverage-related litter by 85%, and the rate at which consumers returned emptied bottles to redeem deposits was quite high, about 95% (Porter, 1983). Two independent before-and-after studies of Michigan's litter, cited in Porter (1983), found that the beverage-container roadside litter rate fell by 85% as a result of mandatory deposits.

Fletcher et al. (2012) reported evidence from Sweden, Denmark and Germany. They reported that as a result of the implementation of a DRS in these countries, return and recycling rates of packaging with DRS increased significantly. In Denmark, for example, return rates in 2007 were 84% for cans, 93% for plastic bottles, and 91% for glass bottles. In India, Gupt (2012) reported that the DRS in Delhi and the National Capital region was exceptionally effective in bringing used batteries into the recycling system.

A number of factors have been attributed to these varying successes or effectiveness of DRS. These factors, identified as influencing return of packaging after use, include deposit/refund amount, convenience, income, time expended on redemption (for, example, waiting time), material type, environmentalism, and demographic variables. Decision to return or not to return used packaging has been found to depend on the deposit size and the distance between the point of purchase and the point of consumption of the item in question. The larger the deposit, the higher the tendency to return a container, and the farther the distance, the lower the tendency to return the container for a refund.

A study by Felder and Morawski (2003) examined the relationship between deposit/refund levels and recovery rates (effectiveness of DRS), particularly for Canada. Data on refund levels and recovery rates were collected and compiled for various regions in the U.S, Europe and Canada. A strong, positive relationship was found between the level of deposit/refund and the recovery rate. Other factors the authors identified as the determinants of recovery rate were:

1) the scrap value of the packaging;

http://dx.doi.org/10.21511/ee.09(4).2018.03

2) regional socio-economic factors such as employment status (employed or not employed), income, etc.; and

3) non-economic factors such as method of return (i.e., return to retail store or return to depot), traditional material type (i.e., PET, glass, aluminum), duration of program (i.e., program in place for more than a decade), and the attendant level of education/public awareness), place of consumption (whether the product is consumed at home, in offices, on the go or elsewhere).

Felder and Morawski also identified the ratio of the price of the product to refund level as another factor influencing recovery rates (or effectiveness of DRSs).

However, some surveys have generally shown that easier-to-return bottles far outranked higher deposits in determining consumers' willingness to return empties (Porter, 1983). Porter (1983) examined the effectiveness of Michigan's DRS on beverage containers and reported that deposit size seemed to have little effect on return rate/effectiveness of DRS. The author argued that the real reason why return rates rise was that the number, knowledge, and convenience of container return centres made returning containers profitable to consumers, even when the recaptured deposit was small. He, therefore, concluded that effectiveness of a DRS depended on both the average subjective value of the time taken by consumers to return waste and the value of aesthetic effect associated with litter reduction. Nonetheless, Vining and Ebreo (1990) established a positive relationship between monetary incentive and recycling behavior, while Goldsby (1998) discovered a negative relationship. Vining and Ebreo (1990) also discovered that knowledge and information had significant positive impact on recycling behavior.

Ashenmiller (2011) found that low income households were much more likely to recycle for cash (return containers for a refund) than high income households. A strong negative relationship between recycling (participating in a DRS) and income was found. The study's data showed that proceeds realized from recycling for cash (i.e., refunds) provided a substantial supplemental income to a certain group of low-income cash recyclers and scavengers. The higher the income, the more costly the time spent going to the recycling centre, and the more likely one is to recycle in other less time-consuming ways. The education variables were found to be insignificant. While married and older people were more likely to recycle for cash, women were less likely to recycle for cash.

In addition, Viscusi et al. (2009) considered income and whether the respondent was an environmentalist as the principal factors influencing return of bottles. Income had a negative effect because the time cost of bottle returns is higher and the financial gains from returning bottles for cash are less consequential for those in higher income groups. Environmentalists were more likely to return the bottles for deposit. For Albertans, the most important factor influencing their decision whether or not to return containers for deposit is "getting the refundable deposit back", followed by "convenience of the location", and the "waiting time" (Reid, 2011).

2. METHODOLOGY

This section describes the methodological approach, which is broken down into data sources and nature, the experimental procedure, the contingent valuation survey, sample, sampling techniques and procedure, as well as reliability and validity issues. Also contained in this section are theoretical and empirical models as well as estimation techniques.

2.1. Theoretical model

Deposit-refund system was chosen as the theoretical framework of this study because of its plausibility, applicability, benefits, and relevance to the research problem, which are stated as follows. The DRS is most appropriate when:

1. The policy objective is to reduce littering, illegal disposal or increased recycling.

2. Monitoring and enforcement are difficult (that is, when it is difficult to monitor littering).

3. The regulated product has a light and portable packaging/container.

Litter of water sachets satisfies the above three conditions. First, littering is an example of an externality, which that is difficult to monitor directly, because various individuals are the "generators" of litter of water sachets, which are widely dispersed geographically. To ensure that the law is adhered to, inspection of the sources of litter – that is, the litterer, their homes and places of work – which is difficult or impossible, is necessary. Enforcement would, therefore, be really costly or impossible to accomplish. Besides, it is very difficult and costly to detect and identify litterers given the low probability of catching someone littering. Secondly, the commodity under investigation (water) is packaged in sachets, which are light and portable. One can easily carry one or more sachets in one's hand to the redemption centre. Furthermore, in the case of sachet water, the goal is not to limit or stop the consumption of sachet water, but to ensure proper disposal of used sachets which can be achieved via a DRS.

We thus modelled the demand for sachet water for a DRS, showing the choice between two alternative waste disposal options for an individual: littering or complying with the DRS. Following Dobbs (1991), the total demand for sachet water, Q is categorized into the demand associated with those who choose to litter, q_1, and the demand associated with those who do not, q_2. It is assumed that the demand functions are linear and that sachet water is produced competitively at a constant marginal cost *c*. Hence:

$$q_1 = \alpha_1 - \beta_1 (c + \tau) - \gamma r, \quad (1)$$

$$q_2 = \alpha_2 - \beta_2 (c + \tau - r) + \gamma r, \quad (2)$$

where α_1, α_2, β_1, β_2, γ are positive constants. Here τ denotes the deposit and *r*, the refund. The full price paid by individuals who choose to litter is $(c + \tau)$, while it is $(c + \tau - r)$ for those who choose not to. Thus, varying τ and r varies the long-run equilibrium prices individuals face.

The deposit-refund system is hypothesized to reduce sachet litter in two complementary ways:

1) the refundable deposit encourages the litterers to recycle (turn in sachets) in order to redeem the deposit: and

2) the deposit payment, which translates into a higher price, encourages such individuals to switch to alternative commodities on which DRS in not imposed.

The effect of r on shifting demand between the two markets – DRS and non-DRS – is captured by the term $-\gamma r$ in (1) and $+\gamma r$ in (2). The prices individuals face for littering and non-littering are, respectively,

$$p_1 = c + \tau, \quad (3)$$

$$p_2 = c + \tau - r. \quad (4)$$

Figure 1, adapted from Abell Foundation (2012), is the conceptual framework of the deposit-refund system showing the flow of deposits in dotted lines and sachets in solid lines. It considers a sachet which is purchased and then redeemed, and the one which is purchased but not redeemed. The process begins with the distributor. The distributor delivers sachet water to retailers, and includes the naira deposit in the price it charges the retailer. When a consumer buys the sachet water, he or she is charged the retail price plus the deposit. The consumer takes the emptied sachet to a collection centre (or the retailer) to redeem the sachet and retrieve the deposit. The redemption centre then ships the emptied sachet to the distributor in return for the deposit.

Just as in the case of redemption, in the case of a sachet purchased but not redeemed, the distributor delivers the sachet to the retailer and charges the deposit. The retailer sells the sachet to the consumer and charges the retail price plus the deposit amount. At this point, if the sachet is not redeemed, it is littered or thrown into the trash. As a result, the distributor now has an unredeemed deposit, which he or she received when the retailer was charged for the shipped sachet. The distributor either keeps the unredeemed deposit or returns the unclaimed deposit to the state (or the Green Fund) for onward disbursement to the clean-up of the littered sachets.

http://dx.doi.org/10.21511/ee.09(4).2018.03

Source: Adapted from Abell Foundation (2012)

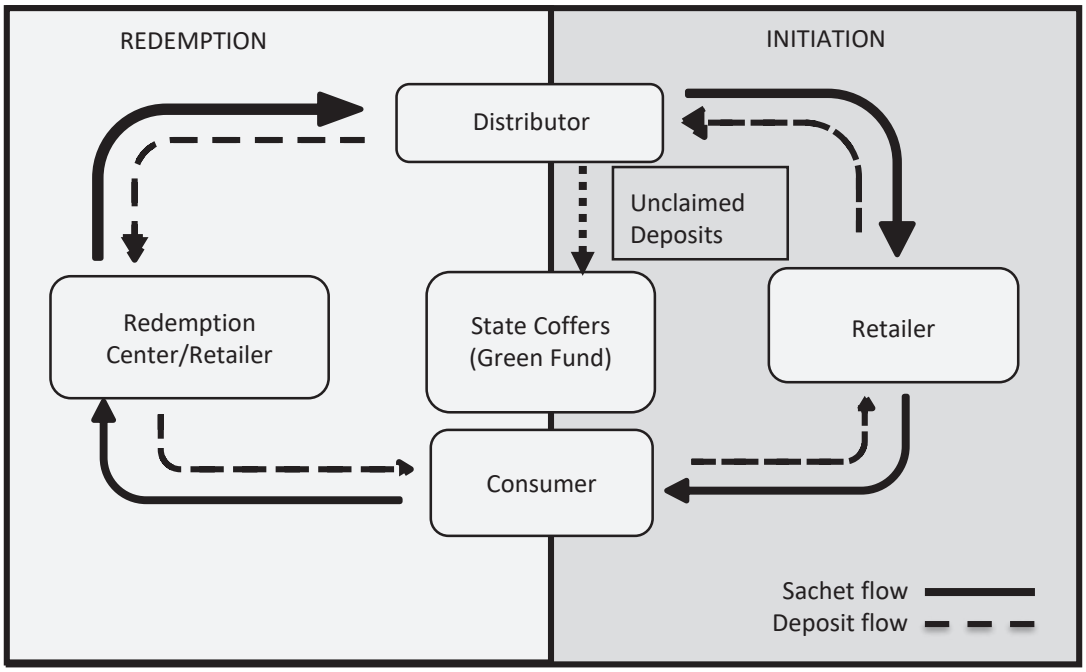


Figure 1. The conceptual framework of the mechanics of the deposit-refund system

2.2. Research design

This paper combines two different research designs – experiment and contingent valuation (CV) survey – a research design known as *triangulation* or *mixed method*. Triangulation is necessary to compensate for the weaknesses of each method so as to have a holistic view of the phenomenon (Yeasmin & Rahman, 2012; Taylor et al., 2009). Although experiment and survey are the only two main *alternative* methodologies to predict the effects of a policy that is new or whose experiences are inadequate (He, 2010), they are combined in this study to provide robust and complementary results.

2.3. Model specification

The econometric model of CV survey responses depends on the specific format of the question used in the survey. This study adopted a single-bounded question format in which the respondents were asked thus: *If DRS is implemented and you are obliged to pay ₦X*[1] *as a mandatory refundable deposit, would you return your used sachets of water to the vendor given your income, time, and the amount of sachet water you consume daily?* Th interviewers randomly selected *X*'s from *X* = ₦2.5, ₦5, ₦7.5 and ₦10. Diffe ent respondents were given different refundable deposits within this range. Given the fact that the response variable is dichotomous – compliance or noncompliance – the model could be treated as an exercise in determining the probability of an outcome, in which conventional regression methods are inappropriate. Since the decision to comply or not to comply with DRS involves a discrete choice of two alternatives, a binary logit model was employed to represent the single-bounded question. The theoretical binary logistic distribution function is given by:

$$P_i = E\left(Y = \frac{1}{X_i}\right) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki})}}, \quad (5)$$

where Y is the willingness to return sachets for a refund, and *Xs* are explanatory variables hypothesized as influencing the response variable.

By carrying out a logit transformation, equation (5) becomes

1 ₦360 = $1 at the time of the study.

$$\log(odds) = \log(\frac{P_i}{1-P_i}) = L_i = \beta_0 + \\ +\beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki} + \mu_i, \quad (6)$$

where $P_i = E(Y = 1 / X_i)$ gives the probability that a consumer would comply with DRS given the explanatory variables, L_i gives the natural log of the odd ratios. The model for the study is concerned with a measure of individuals' willingness to comply with the DRS – that is, the willingness to pay $(c+\tau)$ or $(c+\tau-r)$ as the price of sachet water as demonstrated in Equations (3) and (4) above. The consumer accepts $(c+\tau)$ if he prefers to litter, and $(c+\tau-r)$ if he chooses not to litter. The model in Equation (6) is succinctly expressed as:

$$CDRS = \Pr(response\,is\,'yes') = X\beta + \mu\,, \quad (7)$$

where CDRS refers to compliance with DRS (i.e., willingness to return sachets for a refund); X is a vector of explanatory variables hypothesized to influence CDRS; β is a vector of parameters reflecting the relationship between CDRS and variables in X; and is an independently and identically distributed error term with mean zero and variance one. With a view to investigating promising determinants of the return of sachets for refund, this study integrates relevant factors in previous studies with new factors considered as possible influences on CDRS to arrive at

$$CDRS_i = \beta_0 + \beta_1 LINCOM_i + \beta_2 SEX_i + \\ +\beta_3 MARIT_i + \beta_4 AGE_i + \beta_5 EDUC_i + \\ +\beta_6 ENVCON_i + \beta_7 ADCON_i + \\ +\beta_8 EMPLS_i + \beta_9 DEPSIZ_i + \\ +\beta_{10} TIME_i + \beta_{11} AWARE_i + \\ +\beta_{12} PERDR_i + \beta_{13} LEVLIT_i + \beta_{14} EXP_i + \mu_i. \quad (8)$$

These variables are defined and measured as in Table 1. Due to the nonlinear and discrete nature of the response variable $(CDRS_i)$, which assumes either 1 or 0, the study used the method of maximum likelihood (ML) in a logit model to estimate parameters in the model. The method of ML is a robust technique for estimating qualitative response models, because the heteroscedasticity in $\mathrm{var}(y/x)$ is automatically accounted for (Wooldridge, 2006). The software used for the analysis of the logit model and other tests was STATA 12.0 (Special Edition).

Table 1. Definition and measurement of variables

Source: Author's compilation.[2,3,4]

Variables	Definition/measurement
$ADCON_i(+)$	Respondent's average daily consumption of sachet water, measured by number of sachets consumed per day
$AGE_i(-)$	Respondent's age (years)
$AWARE_i(+)$	Dummy variable = 1 if respondent was aware that certain problems are caused by sachet litter.
$CDRS_i$	Dummy variable: 1 = if respondent agreed to comply with DRS, 0 = noncompliance. It measures a respondent's decision to return sachets for a refund after consumption
$DEPSIZ_i(+)$ [1]	Deposit/refund amount posted to the respondent (from ₦2.50, ₦5, ₦7.5 and ₦10)
$EDUC_i(+)$ [2]	Respondent's level of education, measured by years of schooling
$EMPLS(\pm)$	Dummy for employment status: 1 if currently employed; 0 otherwise
$ENVCON_i(+)$	Dummy for environmental concern: 4 = very concerned, 3 = slightly concerned, 2 = concerned, and 1 = not concerned: it measured how concerned the respondent was with the litter problem
$EXP_i(+)$	Dummy variable = 1 if the respondent had experienced any of the problems associated with water sachets; 0 otherwise
$LEVLIT_i(+)$	Respondent's perception of the level of sachet litter in the environment: 3= the environment was heavily littered, 2= slightly littered, 1= not littered. It measured environmental condition
$LINCOM_i(-)$ [3]	Log of respondent's monthly income (in thousands of naira)
$MARIT_i(\pm)$	Dummy variable for marital status =1 if respondent was married; 0 otherwise
$PERDR_i(+)$	Respondent's perception about the effectiveness of DRS = 1 if respondent thought DRS would prevent littering; 0 otherwise. It measures consumers' attitude towards DRS
$SEX_i(\pm)$	Dummy variable for gender: 1 if consumer was male, 0 otherwise
$TIME_i(-)$	Redemption time = time (in minutes) required to return used sachets for redemption

2 Th s corresponds to τ in Equations (3) and (4)

3 Expected signs in parentheses

4 Logarithmic transformation of income is used in order to reduce the skewness and heteroscedasticity of income distribution (Gujarati & Porter, 2009)

http://dx.doi.org/10.21511/ee.09(4).2018.03

2.4. Data and Data Sources

This study relied extensively on triangulated primary data collected from two experiments and a survey conducted in March and April 2015, respectively. The experimental data were obtained through direct observation of the attitudinal behavior of sachet water consumers towards a refund for return of sachets. The data from the survey were collected through a contingent valuation interview schedule administered to a cross-section of sachet water consumers at a shopping mall located in Ilorin. The data collected included respondents' perception of the DRS, the refund amount offered, respondents' attitude towards DRS and their socio-economic characteristics. The experimental data were observed and recorded as the participants purchased and returned sachets.

2.5. The quasi-experiment[5]

To achieve the first specific objective of this study, a real market in which used sachets were exchanged for cash refund was "contrived" by the researcher on the campus of KWASU, an area where such a market is nonexistent. The choice of a university campus for the experiments was influenced by the fact that campuses are one of the places where water-sachet waste is most rampant. The choice of the campus was due to its manageable size and the fact that sachet water was sold there for ₦10, the price which gave the researcher the opportunity to use a refund of ₦5, the acceptable minimum denomination of naira. Two field experiments (one for DRS and the other for recycling subsidies) were conducted over a period of two weeks.

In the DRS quasi-experiment, participants (i.e., the purchasers of sachets water) were asked to return their emptied sachets for a refund of ₦5 out of ₦10 paid for the water. The DRS experiment involved 1650 participants who purchased sachet water under two sets of experimental treatments: information and refund of ₦5. The purpose of the experiment was to determine the effect of the refund on the rate of return of used sachets. The experimental hypothesis was that the return rates of participants who were offered the refund would be greater than that of those who were provided with information to return sachets. The sachet water for the experiment was a brand not currently sold on the campus. This was done to identify *hustling* - a situation of fraudulent redemption of deposit in which sachets already used before the experiment would be returned with a view to getting a refund.

We could just administer the treatment to see whether or not sachets will be returned. We were most interested in the change of behavior from before to after introducing the DRS. Littering behavior was rampant before implementing the DRS. We just needed to see whether there would be a change of behaviour from littering to nonlittering. Littering resumed after the experiment.

Comparison/control group for the experiment consisted of those who purchased sachets water from the 16 stores located on the campus on the day the persuasive information was given, while the experimental group was composed of those who purchased sachet water the day the refund was offered[6]. That is, the experimental group was offe ed the experimental treatment (the refund), while the comparison group was not offered the refund opportunity but *information* – a "placebo" treatment considered to be ineffective. Assignment of participants was done by assigning those participants that came to buy sachet water on Day 1 of the experiment to the comparison group and those who came to buy sachet water on Day 2 to the experimental group. Prior the experiment, no consumer returned sachets; that is, sachets were being used and dumped.

On Day 1, a placebo experiment was conducted in which the purchasers (the participants of the experiment) were exposed to the persuasive normative information or message: *Research has discovered that litter of used sachets of water could harm you and your environment. You should, therefore, please return used sachets to where you purchase them.* This information was crafted to persuade the participants to return sachets without DRS opportunity. It was to test whether, instead of DRS, such information would be effective in controlling

5 The choice of experimental design as part of the methodology for the study was informed by its strengths - the ability to enable the experimenter to have a relatively high degree of control over the data generating process so as to isolate the main effect of interest.

6 For the purpose of anonymity and confide tiality, the stores were labeled A through P.

litter. This was necessary before implementing the DRS, because introducing formal incentives for activities which people are already doing voluntarily can be dangerous (Reeson & Tisdell, 2008).

When the DRS was introduced on Day 2, the purchasers of sachet water were told at the point of purchase that a refund of ₦5 out of the price paid for sachet water would be returned to them if they returned their emptied sachets. The refund, which lasted only for that day, was financed by the researcher and offered to purchasers through the research assistants who were attached to the sachet water vendors/shops and recompensed for both the experiment and the survey. The research assistants were composed of some final-year environmental economics students of the university who were trained by the researcher. They were provided with experimental sheets to record visible or identifiable characteristics of the participants. Such characteristics include gender, status (student or non - student), dress color/style, and whether sachet water was consumed at point of sale (POS) or taken away. Efforts were made to ensure that the sample size for each day was large to strengthen the power of the study. In order to test the hypothesis that the DRS would affect sales of sachet water (i.e., the quantity sold), we asked the water vendors their average sales per day recorded before the experiment and compared it with the sales recorded during the experiment.

2.6. The contingent valuation survey

In addition to the experiments, this study also employed an intercept CV survey to achieve the second specific objective[7]. The CV survey was conducted on Monday 20th through Sunday 26th April 2015. A very large shopping mall was chosen as the survey spot because the mall serves as a shopping rendezvous for all and sundry residing in Ilorin. The mall stocks almost all household goods. Although it does not sell sachet water, it is a point of convergence for sachet water consumers. Unlike some CV surveys that deal with issues far removed from the daily experience of the respondents, this survey deals with a situation well known to the respondents.

2.7. Sample, sampling techniques and procedure

The sample for this study consisted of 454 customers of the mall who were selected by a systematic sampling technique. The sample size was determined by Yamane's formula (Yamane, 1967), which gives a minimum sample size[8]. The choice of the formula was informed by the fact that it employs proportions which assume dichotomous response for the attributes being measured. This sample size coincides with the common practice of using a minimum total sample size of 400 in market research, which represents a reasonable balance between robustness of results and cost of field work. The sample size also conforms to the guidelines for best practices in CV studies conducted using personal interviews.

The individual consumers of sachet water constituted the unit of analysis, as both the purchase of sachet water and generation of waste sachet (litter) are undertaken by individual consumers. Following He (2010) and De Groot et al. (2013), every third shopper at the mall was approached by the interviewers and asked if they would like to participate in the survey. If a selected shopper refused to participate, or said he/she was not a sachet water consumer, the interviewer approached the very next shopper. If the person agreed to participate, then the interviewers would complete the survey, and then proceed to the next "third" shopper. The choice of this technique over other probability sampling techniques was due to the difficulty or impossibility of getting a sampling frame that would contain all the sachet water consumers in the city.

2.8. Research instruments

The research devices used for data collection were contrived observation and face-to-face structured interview schedule[9]. With the contrived direct ob-

7 An intercept survey is a variant of survey in which a potential respondent is found at some location (other than their home or place of work) and interviewed at that location.

8 $n = N / \left(1 + N\left(e\right)^2\right)$, where n is the sample size, N is the population size of Ilorin (847,582) as estimated by the National Bureau Statistics (2009) and e is the level of precision usually 0.05. Although the formula gives 400, the sample size was increased to 500 (in order to increase the representativeness of the sample) out of which only 454 questionnaires were usable.

9 For detailed exposition on contrived or structured observation, see Gravetter and Forzano (2006)

http://dx.doi.org/10.21511/ee.09(4).2018.03

servation, littering behavior of sachet-water consumers was observed in a DRS setting arranged by the researcher during the experiment. The direct interview has been shown to be the most reliable for CV studies (Arrow et al., 1993; Carson & Hanemann, 2005). The choice of this instrument was also informed by the need to interpret the questions for some illiterate respondents. The CV interview schedule assessed three groups of information:

1) environmental concerns/behavior;

2) the contingent valuation (i.e., of the deposit-refund policy); and

3) socio-economic characteristics of the consumers.

The interview included a focus group discussion conducted in a classroom at KWASU, a pilot study, and a pretest with a total of 42 respondents after which minor changes were made to the interview schedule. The pretest, which was conducted in January 2015 at the mall, consisted of consumers of sachet water selected from different walks of life – lecturers, school teachers, environmental consultants, civil servants, some staff of National Environmental Standards Regulation and Enforcement Agency at Ilorin office, business men/women, and artisans such as masons, carpenters. At the end of the pretest questionnaire, there was an open question for comment about the questionnaire itself, and the respondents provided useful comments in it. The questionnaire was then revised based on the answers and the comments given. The mean interview length was 13 minutes.

The CV survey began with an introduction informing the respondents about the current state, problems, and estimates of sachet litter. The respondents were asked if they were fully aware of the problems associated with the litter of emptied sachets. Contingent valuation was the second section of the questionnaire. The purpose of this section was to assess sachet water consumers' willingness to return sachet for a refund. This section of the questionnaire explained to the respondents what a DRS is and how it works. This was because they were expected to have a clear understanding of DRS and what was being valued. The respondents were also told that eventual implementation of the policy depended on their compliance. The third section elicited information about the socio-economic characteristics of the respondents.

In the CV scenario, a DRS was proposed as a mechanism to restore the environmental quality to the level it was before the advent of sachet water. The proposed change (better environment that is devoid of the litter of water sachets) requires the respondents to contribute labor (that is, time spent in returning sachets) or money (forfeited refund if the sachet is not returned). By requesting the sachet-water consumers to pay either labor time for the return of sachets or cash deposit if sachets are not returned, the new policy (the DRS) should halt the littering in the environment. Implementation of the policy depends largely on the consumers' compliance (i.e., labor time contribution).

The single-bounded dichotomous choice question format was used. This format now dominates the CV literature and has been endorsed by NOAA panel. The popularity of this format among researchers stems from its inherent market resemblance and incentive compatibility (i.e., the respondents have the incentive to answer truthfully), which are necessary in order to considerably reduce many biases inherent in other formats (Arrow et al., 1993). This dichotomous choice questions format was used to evaluate the respondents' willingness to comply with the DRS.

The payment vehicles used for this study were deposit payment and effort (labor time) payment expended in returning water sachets. The vehicles were informed by the nature of the policy. The respondents were told that the deposit payment would be mandatory. This was necessary because the voluntary payment mechanism in CV surveys is prone to hypothetical bias. These payment vehicles are credible, because they are the only two ways consumers can pay for improved environmental quality associated with DRS: consumers can either pay time for returning containers or forfeiture of deposit if the sachet is not returned. Besides, when respondents were asked during the pretest about using a deposit or tax as the payment vehicle, they favored the deposit as interesting and good as against the use of tax. Respondents were told that implementing the policy would cost them a deposit, say ₦5, to be paid as an addition to

the price of sachet water, and which would be refunded to them if the sachet was returned. The respondents were asked whether they would be willing to return a used sachet of water for a refund chosen from ₦2.5, ₦5, ₦7.5, and ₦10, amounts determined from a focus group discussion and a pretest with open-ended questions. These are the four randomized refund values selected for the willingness-to-return questions.

2.9. Reliability and validity issues

In order to guarantee the reliability of the results of the CV survey, statement of confidentiality of participants' responses and closed-ended questions were included in the schedule to ensure face validity and valid responses from the participants. Since expert judgment is an important method of checking the validity of a measure (Babbie, 2007), copies of the schedules were distributed to some experts in the social sciences for necessary correction and validation. Relevant experts were requested to check the suitability of question items, clarity of language, and content coverage. Consequently, ambiguous items were removed, simplified and clarified accordingly based on the experts' recommendations. Thereafter, pretest and pilot study were carried out. The pretest was conducted in order to uncover any challenges in interpreting the questions and to identify the final bid vector or refund amounts that were included in the final CV questionnaire. We then took a sufficiently large sample.

More importantly, the study followed some of the recommendations made by the NOAA panel for conducting CV surveys and ensuring reliable estimates (Arrow et al., 1993). The study adopted such recommendations as the use of face-to-face structured interviews, pretesting and piloting, binary discrete choice (yes or no) question format, accurate description of the policy (or scenario), photographs, and a credible payment vehicle. In line with the recommendations, the participants were provided with the following information to acquaint them with what they were to evaluate:

1) the current state or level of sachet litter in the country;

2) showing them photographs of some of the problems associated with sachet litter;

3) the proposed change in the environment; and

4) the procedure to be used to finance the proposed change (payment objective and method).

Considering the lack of experience on the part of the respondents in dealing with this kind of survey, the respondents were provided with the foregoing information for the dual purpose of reliability and validity of the instruments. The interview schedule was carefully designed to provide respondents with adequate and accurate information necessary to get them acquainted with the hypothetical market situation, make them reveal their true valuations, and therefore reduce the rate of rejection from the respondents. This is because the more people are exposed to an environmental good or problem, the greater they tend to value the resources or problems and the more robust are the valuation estimates and vice versa (Dixon, 2008).

A great deal of criticisms on the CVM emanate from the fact that the CVM is based on a hypothetical market situation in which no real payment is involved. This problem was overcome by using the dichotomous question format and including a cheap-talk script in the CV questionnaire in order to reduce the chances of having hypothetically biased responses (Mitchell & Carson, 1989). The dichotomous choice format was used to reduce the occurrence of strategic and hypothetical biases. True preference revelations (i.e., valid responses) were further guaranteed by telling the respondents that the implementation of the policy was contingent upon their stated compliance with the policy.

CV measures should conform to theoretical expectations (theoretical validity) and be correctly correlated with other measures of the model (convergent validity). This study, therefore, incorporated socio-demographic variables as controls into the logit model. This was done to enhance the internal validity (the theoretical construct validity) of the logit model (Mitchell & Carson, 1989) and to ensure that the measures produced by the estimated model were related to other measures as predicted by DRS theory.

Triangulation – using two or more research instruments to collect data – was another attempt

http://dx.doi.org/10.21511/ee.09(4).2018.03

made on validity. When a conclusion is supported by data collected from a variety of instruments or methods, its validity is thereby enhanced and established (Fraenkel & Wallen, 2000). Thus, to further enhance the validity of the findings, this research used interview schedule and personal observation to collect the data for the study. The results generated from the experiments through direct observation were used to cross-check the results obtained via the interview schedule. Since experiments are the best tool for testing causal relationships and are inherently reliable because of their replicability, the author conducted two short-lived field experiments whereby people, other than just students, constituted the subject/participant pool. The experiments were conducted within that short period to enhance the internal validity. Using a short period reduced the effects of *history* and *maturation* of participants, which could confound the effects of the treatment. The field experiments, which were based on real-life situation, were also useful in crosschecking and overcoming hypothetical bias arising from the hypothetical market of the CVM in which participants faced a hypothetical situation and made choices without real money.

participants were 426 (48.74%), while the remaining 448 (51.26%) were females. The total number of participants in the experimental group was 776, consisting of 544 (70.1%) students and 232 (29.9%) non students. Total male participants were 362 (46.65%), while 414 (53.35%) were females.

Since the proportions of participants in the comparison and experimental groups were almost equal, it is reasonable to assume that any change in behaviour regarding littering of water sachets was clearly due to the DRS and the information mechanism. Thus, any differences in outcomes were ascribed to the treatments.

Table 2. Demographic distribution of the participants

Source: Author's computations.

	Comparison group	Experimental group
Male	426 (48.74)*	362 (46.65)
Female	448 (51.26)	414 (53.35)
Total	874	776
Students	649 (74.26)	544 (70.1)
Nonstudents	225 (25.72)	232 (29.9)
Total	874	776

Note: * Figures in parentheses are percentages.

3. RESULTS AND DISCUSSION

This section presents the results of the field experiments and the survey. It contains the demographic characteristics of the participants in the experiments and the survey. While it analyzes the results of the experiments by using *descriptive* statistics and *t*-tests, the results of the logit model are evaluated at the .01 and .05 significance levels using Wald (Z^2) test, the individual p-values, LR χ^2 and Wald χ^2 of the logit coefficients, odd ratios, and marginal effects.

3.1. Experimental results

This section describes the main demographic characteristics of the participants of the experiments. Of the 1650 participants in the DRS experiment, comparison group was composed of 874 subjects who purchased sachet water from 16 stores on the day the persuasive information was provided (Table 2). This consisted of 649 students (74.26%) and 225 non-students (25.74%). The total male

Of 1,078 sachets of water purchased by the 874 participants in the comparison group, only 143 (13.27%) emptied sachets were returned by them (Table 3). This gap between the amount purchased and the amount returned implies that the information did not exert perceptible influence on the return rate of used sachets: large amounts of used sachets were still discarded as waste. In Table 3, only four stores (i.e., store A, B, D, E, and M) recorded relatively high return rates while others recorded low return rates. Overall, the return rate was very low, (13.27%) across all stores.

Out of 143 sachets recovered, male subjects returned 59 (41.26%), while females returned 84 (58.74%). The one-tailed *t*-test carried out to see whether there was a significant mean difference between the amounts of sachets returned by the males and the females showed $p = 0.037$, implying that the amount returned by the female participants was significantly greater than that of the males. This indicates that women are

Table 3. Number of sachets purchased and returned by the comparison group

Source: Author's computations.

Store	Sachets purchased	Sachets returned*	Sachets returned		Sachets returned	
			M	F	Student	Nonstudent
A	40	9(22.5)	7	2	8	1
B	59	20(33.9)	8	12	11	9
C	21	3(14.29)	1	2	1	2
D	38	12(31.58)	4	8	4	8
E	43	10(23.26)	5	5	4	6
F	19	3(15.79)	2	1	2	1
G	37	6(16.22)	2	4	4	2
H	39	3(7.69)	2	1	1	2
I	58	2(3.45)	1	1	1	1
J	22	4(18.18)	1	3	1	3
K	103	11(10.68)	2	9	8	3
L	201	25(12.44)	9	16	15	10
M	18	6(33.33)	4	2	3	3
N	21	3(14.29)	1	2	2	1
O	62	5(8.07)	2	3	3	2
P	297	21(7.07)	8	13	14	7
–	1,078	143(13.27)	59	84	82	61

Note: * Return rates in parentheses.

more environmentally concerned than men are. The one-tailed *t*-test of the significant difference between the numbers of sachets returned by the student and the non-student participants showed that there was no significant difference between the numbers of sachets returned by the two categories (p = .126).

Although 1,237 sachets were purchased by the experimental group, 1,448 sachets (117.06%) were returned: the number of sachets returned was larger than the number purchased by 17.06% (Table 4), a situation attributed to hustling. This positive impact of deposit/refund, or incentive in general, was also established by Vining and Ebreo (1990), Felder and Morawski (2003), and Viscusi et al. (2011). This result indicates that the refund incentivized the subjects to scavenge for sachets that were used elsewhere or previously used before the experiment and return them for a refund. As shown in the fifth column of Table 4, about 211 extra sachets were hustled or scavenged by the participants. Negative figures represent "surplus" sachets recorded by the stores – that is, the amount by which the number of sachets recovered was greater than the number sold. This hustling activity is consistent with the findings by Ashenmiller (2011).

Out of the 1,448 sachets returned, the female participants returned 820 (56.63%), while the males returned 628 (43.37%). The return rate by the female participants was significantly higher than that of the males (p = .0075). This suggests that females were more interested in the deposit-refund program than males: that is, the program induced more females than males to return sachets. Students and non-students were found to have returned 739 and 709 sachets, respectively. The difference between the figures was not statistically significant, for p = .6950.

The numbers of sachets returned by both the comparison group and the experimental group were compared. The comparison showed that the difference was statistically significant (p = .0029). The number of sachets returned by the experimental group was significantly greater than that of the comparison group by 912.6% (1448 143), for p = .0014. The sum of the sachets recovered from both the comparison and experimental groups was 1,591, about 91% of which was attributed to the refund system, while the information mechanism contributed about 9%. This suggests that DRS was far more effective than the persuasive information mechanism. It is reasonable to say that the change in behavior from littering to non-litter-

http://dx.doi.org/10.21511/ee.09(4).2018.03

Table 4. Number of sachets purchased and returned by the experimental group

Source: Author's computations.

Store	Sales (CG)[a]	Sales (EG)[b]	Sachets returned[c]	Sachets hustled[d]	Sachets returned[e]		Sachets returned[f]	
					M	F	Student	Non student
A	40	43	70	–27	37	33	29	41
B	59	71	67	04	18	49	37	30
C	21	18	25	–07	10	15	18	07
D	38	43	62	–19	23	39	29	33
E	43	39	48	–09	30	18	30	18
F	19	28	52	–24	25	27	40	12
G	37	50	80	–30	27	53	50	30
H	39	43	29	14	5	24	11	18
I	58	55	41	14	15	26	19	22
J	22	18	14	04	8	6	06	08
K	103	130	144	–14	64	80	79	65
L	201	235	290	–55	120	170	119	171
M	18	22	60	–38	38	22	25	35
N	21	19	34	–15	15	19	20	14
O	62	78	70	08	29	41	34	36
P	297	345	362	–17	164	198	193	169
(%)	1,078	1,237	1,448	–211	628 (43.37)	820 (56.63)	739	709

Notes: a – number of sachet water (in sachets) purchased by the comparison group before the DRS experiment; b – number of sachet water (in sachets) purchased by the experimental group; c – total number of sachets returned by the experimental group; d – number of sachets hustled (scavenged) by the experimental group = number of sachets sold number of sachets returned; e – number of sachets (and percentage) returned by gender; f – number of sachets returned by students and non-students.

ing was due to the DRS. Furthermore, a one-tailed *t*-test carried out showed that the refund program did not adversely affect the quantities of sachet water demanded by the experimental group (p = .0091). Instead, the sales rose by 159 (= 1237 – 1078) sachets, a difference that could be said to be due to the impact of the DRS in making sachet water cheaper by refunding.

The difficulty involved in making a refund lower than ₦5 denomination necessitated using another variant of DRS – recycling subsidy – through which we solicited for lumped sales of emptied sachets from the participants. A notice was put up for the participants to bring their used sachets in exchange for money. First in the notice was an offer of ₦5 for 2 sachets, followed by an offer of ₦5 for 5 sachets, and then ₦5 for 10 sachets. Anyone that turned in sachets for recycling was offered the payments. The results of this experiment showed that despite the fact that the prices placed on an emptied sachet were lower than that of DRS, people still turned in massive sachets for cash. On the first day of the recycling-subsidy experiment, a notice was placed for the subjects to exchange 2 sachets for ₦5 (equivalently ₦2.50k per sachet), and 700 sachets were turned in, with 1, 364 on the second day, and 974 on the third day (Table 5). As shown in Table 5, a significant amount of sachets were still recorded when the price was further brought down to ₦5 for 5 sachets (that is, ₦1 per sachet), and later ₦5 for 10 sachets. This suggests

Table 5. Number of sachets turned in during the recycling subsidy experiment

Source: Author's computations.

Day	2 sachets for ₦5		5 sachets for ₦5		10 sachets for ₦5	
	Sachets	Cost (₦)	Sachets	Cost (₦)	Sachets	Cost (₦)
Day 1	700	1,750	596	596	910	455
Day 2	1,364	3,410	643	643	503	251.5
Day 3	974	2,435	610	610	423	211.5
Total	3,037	7,595	1,849	1,849	1,836	918

that people would always want to turn in sachets if incentives are provided.

3.2. Descriptive statistics of the sample from the CV survey

Table 6 presents the demographic characteristics of the sample of sachet water consumers surveyed. These include gender, age, educational qualification, monthly income, marital status, employment status and respondents' perception about the potential effectiveness of the DRS. Of the 454 respondents surveyed, 343 (about 76%) intended to return used sachets if the policy was implemented, while 111 (about 24%) respondents did not. This suggests that those who agreed to comply with the DRS dominated the sample. This implies that the majority of the consumers of sachet water would comply with DRS. This is probably because about 80% of them were aware of problems associated with water sachets (Table 6). While 60% felt very concerned about sachet litter problems, only 9% felt no concern, 17% felt slightly concerned, and 14% felt just concerned.

In terms of educational attainment of the respondents, the average year of education of the respondents was approximately 13 years. Fifteen had no formal education, 29 had primary education, 129 had secondary school education, 121 had NCE/OND[10] certificate, and 160 were graduates. This implies that the 160 graduates constituted the majority (about 35%) followed by those who had secondary education (28%). Thus, 35% of the sample were well educated, 38% were not (no formal school, primary and secondary) and about 27% were averagely educated (those with NCE/OND). The sample was almost evenly distributed. On average, the respondents earned about ₦29,000 as monthly income which ranged from ₦1000 to ₦ 500, 000.

Of the 454 respondents, 114 were offered a refund of ₦2.50k, 113 a refund of ₦5,113 a refund of ₦7.50k, and 114 a refund of ₦10 – almost equal proportion of the respondents was offered a different refund level. That is, 25% of the sample was assigned to each deposit level. 54%, 68%, 84%, and 96% of those who were offered ₦2.50k, ₦5, ₦7.50k and ₦10, respectively, declared they would return sachets if those refunds were offered. These increasing percentages suggest a positive relationship between deposit/refund size and compliance with DRS. The higher the refund level offered, the higher the percentage of those who were willing to return their used sachets.

Table 6. Summary statistics for logit regression variables

Source: Author's computations.

Variables (n = 454)	Mean	Std. Dev.	Min.	Max.
DRS	0.7555	0.430	0	1
Educational attainment (in years)	13.286	3.657	0	18
Income (in naira)	29310	52601	1000	500000
Gender	0.5154	0.500	0	1
Age	31.143	11.93	10	80
Refund amount	6.2500	2.803	2.5	10
Marital status	0.4405	0.498	0	1
Employment status	0.6167	0.487	0	1
Average daily consumption	5.7115	3.281	1	20
Perceived level of litter	2.5176	0.604	1	3
Perceived effect. of DRS	0.7004	0.459	0	1
Aware of sachet problems	0.8040	0.397	0	1
Time spent on redemption	3.4460	2.668	0.5	8
Environmental concern	3.2885	1.002	1	4
Experience with sachet problem	0.6498	0.478	0	1
Log of income	9.7089	0.969	6.91	13.12

10 NCE means Nigerian Certifi ate of Education, and OND means Ordinary National Diploma. NCE is awarded by colleges of education, while OND is awarded by polytechnic institutions.

http://dx.doi.org/10.21511/ee.09(4).2018.03

Gender was almost equally represented in the sample. The number of males that were interviewed was 234 (about 52%) while females were 220 (about 48%). The mean age of the respondents was 31 years with a minimum of 10 years and a maximum of 80 years. About 44 percent of the respondents were married, while 56% were not. Specifically, 200 respondents were married and 254 not married. 62% (280) of the respondents were employed, while the remaining 38% were not. The average number of sachets of water consumed daily by the respondents was 6 with a minimum of 1 and maximum of 20 sachets per day. Majority of the respondents consumed 4 to 5 sachets per day.

As regards the respondents' perceptions about the level of sachet litter in the environment (environmental condition), about 6% described the environment as not littered, while 37% and 57% of the respondents viewed the environment as slightly and heavily littered, respectively. This indicates that 94% perceived the environment as littered with sachets of water, and portrays the extent to which the environment is littered with water sachets. The average perception of the extent to which the environment is littered was 2.52, suggesting that the respondents perceived the environment as being highly littered.

To gauge the respondents' perception about the potential effectiveness of DRS, we polled the opinion of the sample of whom about 70% believed that the policy would help reduce the level of water-sachet litter. The percentage was high enough to justify the effectiveness and viability of the policy. This result is in line with the percentage (76%) that intended to return sachets if the policy was eventually implemented.

Another important variable in the analysis of DRS is time expended on redeeming the deposit. Of the 77 respondents who were asked whether they would return sachets if it cost them 30 seconds, 86% said they would. Given that the redemption time was 1, 2, 4, 6 and 8 minutes, 86% of 80 respondents, 67% of 81 respondents, 84% of 73 respondents, 80% of 61 respondents, and 48% of 67 respondents, respectively, declared that they would return sachets. This indicates a decreasing percentage as redemption time increases. Overall, about 76% of all the respondents intended to return sachets even if it cost them between 30 seconds and 8 minutes. Furthermore, 65% of the respondents had experienced at least one of the problems associated with water-sachets litter, the remaining 35% had not.

3.3. Logit-model estimation results

Table 7 presents the binary logit model results for the CV sample. The table contains the variables, the logit coefficients, the odd ratios, the marginal effects of the explanatory variables, the standard errors and robust standard errors of the coefficients, the Wald's z-statistic and its p-values. All the figures in the table are summarized and rounded to three decimal places from the STATA output.

All the policy variables and the intercept were statistically significant. They had the expected signs, and were significantly related to consumers' compliance at the same level of significance. One of the compelling results of the logit model is that the deposit/refund amount had positive and significant impact on the sachet water consumers' compliance with DRS – a result similar to that of the experiment.

As shown in Table 7, DRS compliance was positively and significantly influenced by deposit/refund size. This corresponds to the results of Vining and Ebreo (1990), Felder and Morawski (2003), and Viscusi et al. (2011). The deposit/refund amount had the expected sign and was statistically significant at the 1% level (p = .000). This indicates that the higher the deposit/refund amount imposed on sachet water, the higher the probability that consumers would return sachets. Increasing the deposit/refund increased the odds that a consumer would return sachets by 42% (odds ratio being 1.42). In other words, a one-naira increase in the deposit brought about 5% increase in the probability that the consumers would return sachets, ceteris paribus. This is an indication that if the deposit is high enough, consumers would most likely return sachets after use.

As expected a priori, the time expended on getting a refund had a strong negative effect on the probability of returning sachets after use. The time taken in returning a sachet for a refund was statisti-

Table 7. Estimated binary logit model results

Source: Author's computations, (2015).

Compliance with DRS (decision to return sachet)	Coef.	Odds ratio	Marg. effects	Std. error	Robust S.E.	Z	p-value
Education	–0.062	0.940	–0.009	0.044	0.042	–1.40	0.162
Gender†	0.012	1.012	0.002	0.277	0.280	0.04	0.965
Age	–0.022***	0.978	–0.003	0.013	0.013	–1.72	0.086
Refund amount/size	0.354*	1.424	0.049	0.054	0.053	6.50	0.000
Marital status†	0.160	1.173	0.022	0.349	0.352	0.46	0.647
Employment status†	0.104	1.109	0.015	0.335	0.335	0.31	0.757
Average daily consumption	0.035	1.036	0.005	0.043	0.039	0.82	0.414
Perceived level of litter	0.020	1.020	0.003	0.227	0.219	0.09	0.930
Perceived effect of DRS†	1.603*	4.968	0.271	0.272	0.272	5.89	0.000
Aware of neg. effects†	–0.172	0.842	–0.023	0.383	0.371	–0.45	0.652
Time spent on redemption	–0.170*	0.844	–0.024	0.050	0.047	–3.39	0.001
Environmental concern	0.031	1.032	0.004	0.139	0.138	0.23	0.821
Experienced sachet problem†	0.338	1.402	0.049	0.319	0.315	1.06	0.289
Log of income	–0.366**	0.693	–0.051	0.168	0.173	–2.18	0.029
Constant	3.357**	28.69	–	1.497	1.506	2.24	0.025

Notes: sample size = 454, LR $chi^2(14)$=143.18, prob. > chi^2 = 0.0000, Pseudo R^2 = 0.2835, Count R^2 = 0.8623. Log likelihood = –180.92613, convergence after 4 iterations. † Reference categories: females, single, not employed, DRS would not prevent littering, not aware, had not experienced any of the problems. *, **, and *** represent statistical signifi ance at the 1%, 5% and 10% levels, respectively.

cally significant at the 1% level of significance (p = 0.01). Increasing the redemption time decreaSed the odds that the consumers would turn in the sachet by about 16% (odds ratio being 0.84). In other words, a one-minute increase in the time spent on redemption resulted in about 2.4% decrease in the probability that the consumers would return sachets for redemption, holding all other factors constant.

Consumers' monthly income also significantly influenced the return of sachets for a refund. Income had a negatively significant relationship with the consumers' compliance with the DRS at the 5% level (p = .029). Higher income decreased the odds that the consumers would return sachets by about 31% – a 1% increase in income brought about 5% decrease in the probability that the consumers would return sachets.

The econometric model includes a number of socioeconomic, demographic and other variables describing various characteristics of the respondents. Although these variables were incorporated in the model as controls, the statistical significance of their effects on the decision to comply or not is discussed below. Among these variables, only age and the consumers' perceptions about the effectiveness of DRS were significantly related to DRS compliance. A negative and statistically significant relationship was found between age variable and DRS compliance at the 10% level of significance (p = .086). Incrementing age reduced the odds that the consumer would comply with the DRS by about 2.2% (odds ratio being 0.978), and that a one-year increase in age decreased the probability of complying with the DRS by 0.3%.

The consumers' perception about the effectiveness of DRS in reducing litter was statistically significant at the 1% level in explaining DRS compliance (p = .000). The consumers' perception was positively related with the probability of returning sachets. The probability that a consumer who perceived DRS as an effective litter-control measure would comply was about 27% higher than that of a consumer who did not feel so. The degree of belief that a consumer had in DRS as an effective measure for reducing litter was found to be positively related with compliance probability. A consumer who perceived DRS as an effective litter solution was about 5 times (odds ratio being 4.968) as likely to comply as those who did not. The remaining control variables were not statistically significant.

Although these control variables were not individually significant, they altogether had a significant impact on DRS compliance. Overall test of signif-

http://dx.doi.org/10.21511/ee.09(4).2018.03

icance suggests that all the explanatory variables together had a statistically significant effect on the probability of complying with DRS, as the LR statistic was 143.18 with a p-value of about 0.0000 (prob > chi^2 = 0.0000) and Wald of 105.57 with prob. This signifies that at least one of the individual coefficients differs significantly from zero. Although goodness of fit is of secondary importance in binary response models (Gujarati & Porter, 2009), pseudo R^2 of 0.28 (or the count R^2 of 0.86) suggests that the model fitted the data well and that the addition of the explanatory variables improved the fit of the model by 28%, for pseudo R^2 value of 0.15 is the minimum suggested for CV survey (Mitchell & Carson, 1989). Using pairwise correlations, no serious multicollinearity was detected among the explanatory variables (see Appendix, Table 1A).

3.4. Discussion

An implication of the overall results is that factors such as income, deposit size, redemption time, age, and perceived effectiveness of DRS exert significant influences on consumers' compliance with DRS. A further implication of this is that if DRS is implemented with a motivating deposit and redemption time, water-sachet litter and its associated problems would be reduced. Taking cognizance of the significant variables will assist policy makers in formulating and implementing an effective DRS.

As regards the results from the experiment, the positive impact of deposit/refund, also established by Vining and Ebreo (1990), Felder and Morawski (2003), and Viscusi et al. (2011), indicates that the refund incentivized the participants to scavenge for sachets that were used elsewhere or previously used before the experiment and return them for a refund. This hustling activity is consistent with the findings by Ashenmiller (2011). This suggests that, due to the implementation of DRS, the participants returned more sachets than they bought, and the number of sachets returned by those who were exposed to the treatment (refund) was significantly greater than that of those who were not exposed to it. This was an indication that the implementation of the DRSs on the campus drastically reduced litter of sachets during the experiments. This finding confirms the hypothesis that if DRS is implemented, it would reduce litter of water-sachets and its attendant problems.

The return rate by the female participants, which was significantly higher than that of the males, suggests that females were more interested in the deposit-refund program than males; that is, the program induced more females than males to return sachets. The higher number of sachets returned by the experimental group as compared with that of the comparison group indicates that DRS was far more effective than the persuasive information mechanism. It is reasonable to say that the change in behavior from littering to non-littering was due to the DRS. Furthermore, the increase in sales of sachet water during the experiment is an indication of the role of the DRS in making sachet water cheaper by refunding.

Furthermore, the positive and significant effect of deposit/refund size on DRS compliance discovered in the survey corresponds to the results of Vining and Ebreo (1990), Felder and Morawski (2003), and Viscusi et al. (2011). This suggests that the higher the deposit/refund amount imposed on sachet water, the higher the probability that consumers would return sachets. It is an indication that if the deposit is high enough, consumers would most likely return sachets after use. The strong negative effect of the time expended in getting a refund is in line with findings of Porter (1983) and Reid (2011). This indicates that the longer the time spent on deposit redemption, the lower the probability that consumers would return a used sachet of water. This suggests that time spent on redemption should be reduced to the possible barest minimum in order to encourage many consumers to return sachets.

Consumers' monthly income also significantly influenced the return of sachets for a refund. This result is consistent with that of Ashenmiller (2011) and Viscusi et al. (2009). The higher the consumer's income, the lower the probability that the consumer would return sachets for a refund. This result suggests that if the policy is implemented, high-income consumers of sa-

chet water would less likely return sachets than would low-income consumers and thus, low-income people would be more likely to participate in the system than high-income consumers. This is because the higher the income, the higher the opportunity cost involved in returning sachets. Higher incomes increase the time opportunity costs of returning sachets, which in turn lower the compliance rate. Therefore, more affluent consumers would not want to incur the opportunity cost and thus would prefer not to return sachets for a refund. That is, they would be less motivated by the financial reward, for a 5 deposit means nothing to them. Such costs may be addressed by making return and redemption more convenient through measures such as the availability of nearby redemption centres. However, the program provided a very strong incentive for very low-wage consumers to return used sachets and therefore provided them with additional income.

The negative and statistically significant relationship found between age variable and compliance variable indicates that older consumers of sachets water were less likely to return sachets than the younger ones. The older a consumer was, the lower the probability that the consumer would turn in sachets for a refund. The consumers' perception was positively related with the probability of returning sachets. This suggests that, holding all other factors constant, the degree of belief that a consumer had in DRS is an effective measure for reducing litter.

Both the experiment and the survey validated deposit/refund size as the major determinant of DRS compliance. This convergence of results suggests that the findings established in this study are both internally and externally valid an indication that the logit model developed in this study can accurately predict compliance with the DRS.

CONCLUSION

This paper has shown that DRS can influence littering behavior in the country. The DRS implemented on the campus drastically reduced litter of water sachets, and a very large proportion of sachet-water consumers were willing to comply with the system. Hence, DRS can influence water-sachet littering behavior and thereby reduce its attendant problems in the country. The government and policy makers should therefore put in place a motivating deposit-refund system instead of the noneconomic measures to reduce water-sachet littering. The public should be provided with information and evidence on the effectiveness of DRS in other countries, so as to heighten their belief and thus their compliance with it.

Further empirical work relating to litter externalities in the country should be extended to other noticeable and non-biodegradable litter items or packaging such as that of bottled water, detergents, biscuits, candies, and canned products. Further studies in this regard will, in no small measure, significantly improve on the current study. Although the sample size used in this study was relatively large, we suggest that similar studies with larger sample sizes comprising the country's six geo-political zones (North Central, North-East, North-West, South-East, South-South, South-West) be conducted. A similar study, with equal or larger sample size, could also be carried out on this same topic in other states of the federation.

This paper did not in any way consider the consumers' willingness to pay to environmental remediation. Thus, another important research direction is the estimation of consumers' willingness to pay for cleaner environment in Nigeria. This would assist the policy makers in determining the appropriate deposit/refund size. Furthermore, since we did not find evidence to support the hypothesis that such socioeconomic and demographic variables as education, marital status, etc. affect the decision to comply with DRS, future research should further address the significance of these variables so as to eventually ascertain whether they truly exert no significant effects on the decision to comply with DRS.

http://dx.doi.org/10.21511/ee.09(4).2018.03

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http://dx.doi.org/10.21511/ee.09(4).2018.03

http://dx.doi.org/10.21511/ee.09(4).2018.03

APPENDIX

Table 1A. Correlation matrix for the explanatory variables

. cor EDUC INCOM GENDER AGE DEPSIZ MARIT EMPLS ADCON LEVLIT PERDRS AWARE TIME ENVC > ON EXP (obs=454)

	EDUC	INCOM	GENDER	AGE	DEPSIZ	MARIT	EMPLS	ADCON	LEVLIT	PERDRS	AWARE	TIME	ENVCON	EXP
EDUC	1.0000													
INCOM	0.2316	1.0000												
GENDER	0.0591	0.0671	1.0000											
AGE	-0. 0774	0.1883	-0.0031	1.0000										
DEPSIZ	0.0431	-0.0289	-0.0433	-0.1443	1.0000									
MARIT	-0.0598	0.1836	-0.0984	0.5735	-0. 1228	1.0000								
EMPLS	0.0494	0.2125	0.0878	0.3733	-0. 0769	0.4257	1.0000							
ADCON	0.1569	0.0843	0.0773	0.0602	0.0411	0.1350	0.1310	1.0000						
LEVLIT	0.0996	0.0131	0.0283	0.0133	0.0505	-0. 0774	-0.1121	-0.0024	1.0000					
PERDRS	-0.0146	-0. 0588	-0.0183	-0.1148	0.1803	-0. 0977	-0. 0012	0.0275	0.0589	1.0000				
AWARE	0.0676	0.0138	-0.0236	0.1037	-0.0173	0.0358	-0. 0013	0.0750	0.1661	0.0768	1.0000			
TIME	-0.0092	0.0912	0.1028	0.0189	0.0138	-0. 0220	0.0248	0.0628	-0.0860	-0.1278	-0.0850	1.0000		
ENVCON	-0.0075	0.0261	-0.1343	0.1296	0.0540	0.0810	0.0371	-0.0008	0.1866	0.0684	0.1866	-0.0879	1.0000	
EXP	0.0335	-0.0073	0.0550	0.1282	-0.0928	0.0562	-0. 0089	0.0509	0.2012	-0. 0265	0 .4633	-0.1240	0.2392	1.0000