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Abstract: Environmental offsetting is a concept whereby a company can offset its environmental impacts by paying for another party to reduce its environmental impacts. Offsets are designed for greenhouse gases emissions (carbon) and biodiversity. Though the concept is new in the debate, it relies on the idea common to environmental economists of flexibility and cost efficiency where the firms that have the lowest pollution abatement costs reduce more pollution than firms that have high abatement costs. Even if the offsetting concept makes sense from an economic point of view, the public may oppose it on several grounds. It may be for moral reasons (the polluter must pay), for equity reasons (the victims of the local pollution cannot escape pollution), or for economic reasons (preference for a local public good jointly produced with the global one, or in a dynamic model, incentive for polluters to pollute less in the future). These multiple motivations make difficult eliciting preferences of consumers for products where producers used offsets. Therefore, we use stated choice to elicit these preferences for a good produced using offsets while controlling for attributes such as level and location of joint local public good (water pollution). We find that although respondents declare opposing offsets (indulgence argument), it does not translate in their purchase choices in the choice experiment when controlling for the level of joint local public good.

Key words: Offsets; Willingness to pay; Stated choice;

JEL: Q53 (Valuation of Environmental Effects); Q54 (Climate; Natural Disasters; Global Warming) ; Q58 (Government Policy)

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1. Introduction

Offsetting enables any party (firms, organizations, individuals) to offset the environmental impacts of its activities by financing a project that helps reducing its global impact on the environment. When the party's greenhouse gazes emissions are exactly offset, the activity of the party is said to be carbon neutral. From an economic point of view, it makes sense to reduce the global environmental impacts in a cost-effective way. Environmental offsets are available for greenhouse gazes emissions but also for biodiversity

But offsetting is criticized. For example, a website (http://www.cheatneutral.com/) offers in a satiric way to compensate infidelity by paying people that engage to be faithful. The point is that offsetting allows getting away from the consequences of harming the environment with a clear conscience. A similar argument is made by G. Monbiot: *"Just as in the 15th and 16th centuries you could sleep with your sister and kill and lie without fear of eternal damnation, today you can live exactly as you please as long as you give your ducats to one of the companies selling indulgences."* (The Guardian, October 18th 2006). We can classify the arguments of opponents to offsetting into three categories. Opposition may be for moral reasons (the polluter must pay), for equity reasons (the victims of the local pollution cannot escape pollution), or for economic reasons (preference for a local public good jointly produced with the global one, or in a dynamic model, incentive for polluters to pollute less in the future). The aim of our paper is to elicit consumers' willingness to pay for a good where the producer used offsetting, and to elicit the reasons behind consumers' preferences. We design a stated choice survey with the following attributes: location of production as compared to the consumers' residence location, intensive or extensive production process, use of offset or green technology, level of a local public good (water quality improvement), level of greenhouse gases emissions and product price. We collected data from 1,910 consumers from two regions in France. We find that although respondents declare opposing offsets (indulgence argument), it does not translate in their purchase choices in the choice experiment when controlling for the level of joint local public good.

The paper is organized as follows. Section 2 reviews the rationales for using offsets as a policy tool. In section 3, we present the stated choice survey design. Results are presented in section 4. Section 5 discusses results and concludes.

2.Rationales for using offsets as a policy tool

The first rationale for the use of offsets is economic. Offsets offer flexibility and cost-efficiency by enabling firms to reduce a global pollution where it is cost-effective. Offsetting is an alternative to adopting an environmentally-friendly technology to produce an impure public good (a bundle of a private good and an environmental good). As long as there is no jointness between the private good and the environmental good, offsetting is preferable if it is cost-effective. As stated by Besley and Ghatak (2007, note 11) "when the impure public good is simply a bundled version of the private good and the public good (i.e., there are no technological advantages), then introducing green markets will not affect the level of provision of the public good, which will remain at the private voluntary contributions equilibrium level." But what if there is jointness? Then, offsetting may not be cost-effective. There may be gains in producing the impure public good using a green technology than offsetting (Kotchen, 2006). Thus, if consumers are against offsets, it may be because they perceive the green technology to be more cost-effective than offsetting, for example because of jointness.

There may be other rationales for consumers preferring green technology instead of offsetting. Consumers may oppose offsets because of the polluter pay principle. Out of this reason people may have two rationales for thinking that there should be a production change rather than just a purchase of offsets (Baron, 2006).

First, consumers may think that people should clean up their own waste instead of buying their way out (indulgence argument). As stated by Baron (2006), *"A powerful intuition is that people should clean up their own waste. If you cause a problem, you own it. […]Baron et al. (1993) found that subjects preferred to have companies clean up their own hazardous waste, even if the waste threatened no one, rather than spend the same amount of money cleaning up the much more dangerous waste of a defunct company. Ordinarily, it is easiest for people to undo their own harm, but this principle may be applied even when no such justification is available."* The debate on offsets is clearly focused on that issue where producers should not buy their way out by paying for indulgences.

Second, consumers may favor production change because it deters firms from causing harm. "*Another justification of the polluter-pays principle is that, when enforced, it deters people from causing harm. But the deterrent effect of this principle is absent when people do not know what they are causing, or when alternatives are too costly."* (Baron, 2006). With

this argument, we move away from the static framework and consider firms behavior in the long term.

3.Stated choice survey design

3.1.Choice of product and attributes and experimental design

We consider an application to milk produced in two regions in France: Bretagne (Western France) and Picardie (Northern France). We chose milk for two reasons. First, milk is a relatively homogenous product and the several versions will only vary in the attributes of interest (production process). Second, milk production implies cattle breeding, which is the first contributor to GHG emissions of agriculture in France (the agricultural sector as a whole contributes to 20% of GHG emissions in France[1]). We chose two contrasted regions in France. Bretagne is intensive cattle breeding farming whereas Picardie is extensive cattle breeding farming and crop production. Bretagne is a big contributor (6.9 for CH4 and 5.3 for N2O) and Picardie a smaller contributor (1.1 for CH4 and 2.5 for N2O). Bretagne and Picardie belong to two separate hydrological basins. Efforts to enhance water quality in one region have no effect on water quality in the other region. Water quality is then a local public good in each region.

The aim of the survey is to elicit consumers' preferences for milk produced in a farm in the consumer's residence location (SAME), with intensive or extensive process (COW), using offsets or green technology (OFF), producing varying levels of a local public good (H2O), an emitting varying levels of greenhouse gases (GHG). Table 1 gives a description of the attributes used in the stated choice survey (including the price).

[1] This relatively high figure is due to the fact that France has a relatively low level of GHG emissions for the energetic sector (nuclear energy).

Attribute	Description	#attribute levels	Description of levels
SAME	Production is located where the respondent lives	2	Not the same location Same location
COW	Reduction in #cows by own efforts	2	No reduction in #cows Reduction in #cows by own efforts
OFF	Reduction in #cows by offsetting	3	No reduction in #cows Reduction in #cows by offsetting
H2O	Improvement in water quality	3	+0% +40% +60%
GHG	Reduction in GHG emissions	3	-0% -40% -60%
PRICE	Price of the good	4	+0% +10% +20% +40%

Table 1: Attributes used in stated choice survey

Table 2 presents an example of a choice set. In this example, the two alternatives to the usual milk are produced in two different regions. But because of the use of offsets in the first alternative to the usual milk, water pollution is improved in Picardie for both alternatives.

Your usual milk	**Milk produced in Picardie**	**Milk produced in Bretagne**
Produced with the **usual number of cows** per hectare. The farmer **pays no one** to reduce pollution.	Produced with **a reduced number of cows** per hectare. The farmer **pays no one** to reduce pollution.	Produced with the **usual number of cows** per hectare. The farmer **pays a farmer in Picardie** to reduce pollution.
No improvement in water quality	**40% improvement** in water quality **in Picardie**	**20% improvement** in water quality **in Picardie**
No reduction in GHG emissions	**40% reduction** in GHG emissions	**60% reduction** in GHG emissions
Usual price	Usual price + 20 %	Usual price + 40%

Table 2: Example of a choice set

3.2.Sample selection

We used an Internet survey. A lot of studies do compare web surveys to mail surveys. Response rate is the result which is the most commonly studied for this comparison. Some authors find the response rate to be lower in web surveys (Shih, Fan, 2007; Meckel et al, 2005; Fan, Zheng, 2010) whereas others observe higher response rates with web surveys

(Olsen, 2009; Fleming, Bowden, 2009). However, sampling procedures, reminder strategy and survey scope differ a lot between these studies, explaining these contrasted results. As highlighted by Farrell and Petersen (2010), internet users are not perfectly representative of overall population of a country. For instance, in France, internet users are younger and are characterized by a higher income and a higher education than the average of French population[2]. However, as stated by Farrell and Petersen, it only implies that results have to be analysed taking care of this potential representativity limit. Two authors do compare web survey to mail survey in the field of non-market goods valuation, one studies the willingness to pay for environmental protection (Olsen, 2009), the other estimates recreation value through transport cost method (Fleming, Bowden, 2009). In these two papers, internet survey gives the same result as mail survey, even when web sample and mail sample do differ in their socio-economic characteristics.

45,000 e-mails were randomly sent in the two regions of interest (Bretagne and Picardie). There were 1,910 responses (30% from Bretagne, 70% from Picardie).

4.Results

4.1.Econometric model

In random utility theory, consumer *i* chooses among several alternatives the alternative that yields the greatest utility. The probability of selecting an alternative increases as the utility associated with it increases. The individual consumer's utility level associated with the choice of an alternative c in the set of alternatives j writes:

$$U_{cji} = V_{cji} + e_{cji} \qquad (1)$$

where V_{cji} is a deterministic component and e_{cji} is a stochastic component.

Say consumer *i* prefers alternative *c* in the set of alternatives *j*. The consumer chooses the alternative *c* that brings him the highest utility U_{cji}.

$$U_{cji} = Max \left\{ U_{1ji}, U_{2ji}, U_{3ji} \right\} \qquad c = 1,2,3; j = 1,...,J; i = 1,...,N \qquad (2)$$

In random utility models, the utility function is linear (i) with the level a_{kcj} of attribute k of alternative c in set j, (ii) with the payment vehicle ρ_{jc} (price of good) of alternative c in set j.

[2] Bigot, R., Croutte, P., 2009, La diffusion des technologies de l'information dans la société française, Nov 2009, CREDOC (http://www.arcep.fr/uploads/tx_gspublication/etude-credoc-2009-111209.pdf).

$$U_{cji} \equiv \alpha_i + \sum_{k=1}^{5} \beta_{ki}\, a_{kcj} - \beta_{\rho i}\, \rho_{cj} + e_{cji} \qquad (3)$$

Individual parameters β_{ki} and $\beta_{\rho i}$ are associated to attributes k and price of good ρ of the different alternative goods. They are assumed to depend neither on the set of alternatives j nor on the alternative c. The error terms, e_{cji}, are independent and identically distributed, and follow a Gumbel law (0, 1).

In the choice modeling, consumer *i* chooses alternative 1 in the set *j* if and only if:

$U_{1ji} - U_{cji} > 0$ with $c = 2, 3$

Therefore, only utility level differences enter in individual observed choices.

$$U_{1ji} - U_{cji} = \sum_{k=1}^{5} \beta_{ki}(a_{k1j} - a_{kcj}) + \beta_{\rho i}(\rho_{1j} - \rho_{cj}) + e_{1ji} - e_{cji}$$

In this case, the probability that consumer *i* chooses product 1 in the set of products *j* is given by:

$$P\left[y_{ji} = 1 / \beta_{ki}, \beta_{\rho i}, a_{kcj} \right] = P\left[U_{1ji} > U_{3ji}, U_{1ji} > U_{2ji} / \beta_{ki}, \beta_{\rho i}, a_{kcj} \right]$$

To simplify, we assume individual preferences are homogenous:

$\beta_{ki} = \overline{\beta_k}$ and $\beta_{\rho i} = \overline{\beta_\rho}$

The specification of this probability is then:

$$P\left[y_{cji} = 1 / a_{ji}, \rho_{cj}; \overline{\beta_k}, \overline{\beta_\rho} \right] = \frac{\exp\left[\sum_k \overline{\beta_k} a_{kcj} - \overline{\beta_\rho} \rho_{cj} \right]}{\sum_c \exp\left[\sum_k \overline{\beta_k} a_{kcj} - \overline{\beta_\rho} \rho_{cj} \right]} = \frac{\exp\left[u_{cj} \right]}{\sum_c \exp\left[u \right]}$$

This is the expression of an alternative choice probability in a conditional or multinomial logit model (McFadden, 1981). When the consumer chooses a product, we consider the consumer compares the utility the “reference alternative” (standard production process, no offset) brings him with the two other alternatives’ utility. He then chooses the product with the highest utility. Therefore, the estimation of the model allows to identify

significant attributes in consumers' preferences and to observe their effect on the probability consumers choose an alternative different from the reference one.

Parameter $\overline{\beta}_k$ is the positive or negative utility variation (utility units) attached to attribute k by comparing attribute k level with the reference alternative.

4.2.Results

Table 1 presents the parameter estimates of the conditional Logit. All parameters are statistically significant except for the use of offsets. Consumers care for locally-produced goods (significant and positive parameter), for extensification of cattle breeding (significant and positive parameter), for an improvement in water quality (significant and positive parameter) and for a reduction in greenhouse gases emissions (significant and positive parameter). The parameter estimate for the use of offsets is negative but not significant. The indulgence argument does not seem to hold. This result is independent of the level of joint local public good since the stated choice survey enables to control for local public good effects such as water pollution.

	Parameter estimate (standard error)	Willingness to pay (%)
SAME	0.1802[a] (0.067)	6,96
OFF	-0.1702 (0.116)	-6,57
COW	0.365[a] (0.111)	14,09
H2O	0.018[a] (0.002)	0,69
GHG	0.007[a] (0.001)	0,27
PRICE	-0.026[a] (0.003)	–

[a] 1% significance, [b] 5% significance, [c] 10% significance

Table 1: Parameter estimates of the conditional Logit model (1,910 observations)

5.Discussion and conclusion

We find that respondents are willing to pay for like cattle reductions, lower levels of pollution (greenhouse gases and water pollution). Respondents have a positive and significant

willingness to pay for local products (SAME). We find that the parameter estimate for the use of offsets is negative but not significant (Pr=0.1419). Thus, when local effects are controlled for, people seem not to oppose offsets and consider it similar to green technology.

Several variables in the questionnaire allow us to investigate the reasons behind their choices. From the descriptive statistics, we find that the most likely reasons people are WTP to reduce the number of cows is it reduces water pollution and improves animal welfare - improving the landscape is not very important. Although the parameter for offsets is not significant, the questionnaire helps us understand why some respondents declare they dislike offsets. The most likely reasons people are against offsets is that the original victims of the pollution still suffer and it is not acceptable to pay someone else to avoid reducing one's own pollution (indulgences argument). However, this does not translate into their purchase choices.

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