

Exploring in-depth joint pro-environmental behaviors: a multivariate ordered probit approach applied to household waste recycling

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Abstract

We explore the joint commitment levels of households to recycling of materials. As commitment levels to pro-environmental activities are usually coded as ordered categorical variables, we argue that the multivariate ordered probit model is an appropriate tool to account for the effect of common unobservable variables on the outcomes of interest. Calculating not only marginal probabilities, but also joint probabilities, conditional probabilities and partial effects on these quantities, allows to explore in-depth the determinants of pro-environmental behaviors. Indeed, using French data, we show that beyond the estimation of the multivariate ordered probit model, much can be learnt from the calculation of such additional quantities.

1 Introduction

Policy makers commonly wonder how to foster the level of households' commitment to pro-environmental behaviors. Of course, this legitimate question has inspired, and still inspires, lot of academic works, be in the field of political science, sociological science or in economics, to name but a few. From an economics standpoint, pro-environmental behaviors may be encouraged by monetary, as well as non-monetary incentives. When it comes to household recycling behavior, monetary incentives include deposit-and-refund systems, pay-as-you throw (PAYT) schemes or even fines for households discarding recyclables (Bell *et al.*, 2017). For example, Viscusi *et al.* (2012) find convincing evidence that plastic water bottle deposits in the US can turn nonrecyclers into diligent recyclers. Non-monetary incentives range from improving accessibility of recycling services to providing information and even "nudges" to households (Kirakozian, 2016). Also, a still growing strand of literature focuses on the role of social norms and attitudes on household recycling, besides economic instruments (Berglund, 2002; Halvorsen, 2008; Brekke *et al.*, 2010; Czajkowski *et al.*, 2015).

Thus, the identification of enablers and constraints to households' commitment to waste recycling is still of primary importance. Also, it requires appropriate data and appropriate data analysis techniques. Most of the time, the level of households' commitment to pro-environmental behaviors is measured through Likert scale questions and, in the case of household recycling behavior, through ordinal variables constructed from recycling intensities (Jenkins *et al.*, 2002; Kipperberg, 2007; Ferrara and Missios, 2012, 2016; Saphores and Nixon, 2014). The vast majority of these later studies relies on the estimation of ordered logit models, with the recycling levels of various materials (glass, plastic, newspaper, cardboard, cans, food, metal, etc.) as dependent variables, which implies that the recycling levels are considered as unrelated, *i. e.* the recycling decisions are not jointly

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modeled. A noticeable exception is the recent paper of Ferrara and Missios (2016) who explicitly examine the relationship between waste prevention, waste recycling and waste disposal. Estimating a three-equation system, they allow the unobservables involved in each of the three behaviors to be correlated, as the error terms in the three corresponding equations are supposed to be jointly normally distributed. Likewise, they estimate a multivariate ordered probit model in order to capture possible correlations between the unobservables governing the level of recycling of five types of material.

We agree with Ferrara and Missios (2016) that allowing for such correlations is a necessary step to analyze joint recycling behaviors, more generally to analyze the level of households' commitment to pro-environmental behaviors. Therefore, we also propose to use the multivariate probit model in that purpose. However, estimating a multivariate probit model and checking for the significance of predictors is not sufficient enough to explore in-depth joint pro-environmental behaviors. In particular, we show how the computation of various quantities, such as joint probabilities, conditional probabilities, and partial effects on these quantities dramatically improves the initial picture resulting from the simple estimation of a multivariate probit model.

To sum up, this paper contributes both to the empirical literature in the household waste area and to the methodological literature regarding ordered choice models. The rest of the paper is set up as follows: Section 2 presents the data set and the variables, Section 3 describes the multivariate (trivariate) probit model and the calculation of the aforementioned quantities (joint, conditional probabilities, partial effects), Section 4 provides the results and Section 5 concludes.

2 Dataset and Variables

2.1 Dataset

This article uses data from a periodic OECD survey: the Environmental Policy and Individual Choice (EPIC) survey and more precisely, the second round conducted in 2011. The questionnaire was developed considering the recommendations of national experts through an Advisory Committee. In order to ensure comparability between first and second rounds (respectively 2008 and 2011 surveys), the 2008 questionnaire was used as a basis and refinements were made. For example, if the five same topics (energy, food, transport, waste and water) are met in both surveys, the 2011 questionnaire asked respondents to estimate approximately the percentage of a material recycled by their household between 0 and 100% while the 2008 questionnaire suggested five answers : "0%", "25%", "50%", "75%" and "100%" (plus an opt-out option).

The full sample consisted of 12,202 observations from online household panels gathered by Global Market Insite. Between February and March 2011, the survey was conducted in 11 countries (Australia, Canada, Chili, France, Israel, Japan, Korea, Netherlands, Spain, Sweden and Switzerland) and the present paper focuses on the case of France which consists of a subsample of 686 observations (see OECD, 2014).

2.2 Variables

As mentioned above, the respondents were asked to estimate the intensity of recycling for five materials (plastic, metal, paper, glass and food) out of which only the three most representative are explored in this paper (plastic, metal and paper). The dependent variable for each material reflects the household's level of recycling relatively to other households' through the assignment of 1 for "household's i recycling intensity is below first quartile / nonrecycler", 2 for "household's i recycling intensity is above first quartile but below second quartile / moderate recycler" and 3 for "household's i recycling intensity is above second quartile / diligent recycler". For example, if a dependent variable is equal to 3, it means that the household recycles that material relatively more than 50% of the households of the French sample and is thus considered as a diligent recycler. Notice that studies which analyze the intensity of recycling usually take the proportion of materials that is recycled as dependent

variables (see, for example, Ferrara and Missios, 2016). However, from a policy perspective, we consider that the level of households' commitment to recycling is better captured by ordinal variables as we define them. The distributions of the dependent variables are provided in Table 1. Beyond these distributions, Table 2 reports the spearman rank correlations, along with 95% confidence intervals, between the levels of commitment to the recycling of the three materials.

Table 1: Distribution of the dependent variables

	Plastic	Metal	Paper
Nonrecyclers	22.27	25.21	25.45
Moderate recyclers	25.76	29.16	26.51
Diligent recyclers	51.97	45.61	48.04

The spearman correlations are highly significant, and positive, suggesting as expected that households engage actively in joint pro-recycling behaviors.

Table 2: Spearman rank correlations

	Plastic	Metal	Paper
	[95% confidence interval into brackets]		
Plastic	1	-	-
Metal	0.68 [0.63 ; 0.72]	1	-
Paper	0.62 [0.57 ; 0.66]	0.57 [0.52 ; 0.62]	1

The independent variables of the model are described in Table 3. They were inspired by the independent variables in Ferrara and Missios (2012) and can be divided into three categories: household's characteristics, attitudinal variables and waste management policy variables.

Table 3: Independent variables

<i>Household characteristics</i>	
GENDER_MALE	Male indicator
AGE_CLASS_18_24	Age between 18 and 24 indicator
AGE_CLASS_25_34	Age between 25 and 34 indicator
UNDER5	Number of children under 5
EMPL_RETIRED	Retired indicator
INCOME_CONT	Annual income after tax
RESTYPE_HOUSE	House indicator
AREADDESC_ISOLATED	Isolated residence indicator
<i>Attitudinal variables</i>	
ENVCNCRN_INDX	Environmental concern index
MTVRCYLSAV_LKT	Money saving motivation
MTVRCYLDUTY_LKT	Civic duty motivation
<i>Waste management policy</i>	
RCYCLCOLDTD_PLST	Door-to-door plastic collection service indicator
RCYCLCOLDTD_MTAL	Door-to-door metal collection service indicator
RCYCLCOLDTD_PAPR	Door-to-door paper collection service indicator

Many variables were eliminated, on the basis of the *BIC* criterion, in order to develop a simple yet effective

model to explore the joint recycling behavior. Most of the variables are binary variables, notably household characteristics and waste management policy variables. *INCOME_CONT* is an exception, as it represents the household's annual income in euros. Among attitudinal variables, two possible recycling motives (civic duty and money saving) are considered and captured by four-point Likert variables with 1 indicating "not at all important" to 4 indicating "very important". The last variable, *ENVCNCRN_INDX*, is an aggregate index constructed as the mean score of the individual levels of concern regarding six environmental issues (waste generation, air pollution, climate change, water pollution, resource depletion and biodiversity). This index ranges from 1 (low aggregate index of concern) to 4 (high aggregate index of concern).

Table 4 provides summary statistics for the independent variables. Since data were collected through a household survey and despite "don't know" options, variables could be subject to declarative bias: for example, an individual could not be aware of an existing policy or think a policy exists while it does not. However, as the OECD performed several data checks (see OECD, 2014), we are confident that the data set is highly reliable. According to our sample, door-to-door collection systems are common since 60% of households claim that their plastic waste are collected by door-to-door, 56% that their paper waste are collected by door-to-door while only 53% of them benefit from this service for metal waste.

Attitudinal variables suggest that French households are concerned with environmental issues and that the motives proposed by the questionnaire appear well-suited to explain recycling. Although civic duty seems to be a more convincing recycling motive than money saving, both recycling motives are, on average, at least perceived as important.

Table 4: Summary statistics for independent variables

<i>Household characteristics</i>	
Male indicator	0.52(0.50)
Age between 18 and 24 indicator	0.13(0.33)
Age between 25 and 34 indicator	0.17(0.38)
Number of children under 5	0.19(0.46)
Retired indicator	0.17(0.37)
Income	39,189(16,023)
House indicator	0.70(0.46)
Isolated residence indicator	0.59(0.49)
<i>Attitudinal variables</i>	
Environmental concern index	3.56(0.49)
Money saving motivation	3.23(0.87)
Civic duty motivation	3.64(0.59)
<i>Waste management policy</i>	
Door-to-door plastic collection service indicator	0.60(0.49)
Door-to-door metal collection service indicator	0.53(0.50)
Door-to-door paper collection service indicator	0.56(0.50)

3 Model

Given that we focus on three materials, the trivariate version of the multivariate ordered probit model applies¹. As said, the basic idea is that recycling intensities are linked. Indeed, we can reasonably assume that an

¹The multivariate ordered probit model is presented in detail in Greene and Hensher (2010).

individual will optimize his/her recycling time by recycling not only one material at a time. Likewise, if strong environmental beliefs are expressed through recycling intensity, it is likely that these beliefs are at play for every material. This link can be estimated through a univariate or a multivariate modeling. The latter appears preferable since it allows for both observed and unobserved common variables which influence waste recycling.

$$\begin{cases} y_{i,1}^* = x_{i,1}\beta_1 + \varepsilon_{i,1} \\ y_{i,2}^* = x_{i,2}\beta_2 + \varepsilon_{i,2} \\ y_{i,3}^* = x_{i,3}\beta_3 + \varepsilon_{i,3} \end{cases} \quad (1)$$

The trivariate ordered probit model is specified in the three-equation system (1). For individual i , there is a latent variable ($y_{i,M}^*$) associated to his/her recycling intensity for material M ($y_{i,M}$), with $M = \{1, 2, 3\}$, respectively for "plastic", "metal" and "paper". The latent variable is a function of a vector of independent variables ($x_{i,M}$), a vector of parameters (β_M) and an error term ($\varepsilon_{i,M}$). The distribution of the error terms is trivariate normal with mean 0 and covariance matrix R .

$$\{\varepsilon_{i,1}, \varepsilon_{i,2}, \varepsilon_{i,3}\} \sim \mathcal{N}(0, R)$$

$$\text{and } R = \begin{pmatrix} 1 & \rho_{12} & \rho_{13} \\ \rho_{12} & 1 & \rho_{23} \\ \rho_{13} & \rho_{23} & 1 \end{pmatrix}$$

with ($\rho_{MM'}$) correlation coefficient between errors terms of materials M and M'

$$y_{i,M} = j_M \text{ if } \delta_{(j_M-1),M} < y_{i,M}^* < \delta_{j_M,M} \text{ with } j_M = \{1, 2, 3\} \quad (2)$$

For each material M , the relation between the latent variable and the observed dependent variable can be described by equation (2) and illustrated in the figure 1. If the value of the latent variable is between $\delta_{(j_M-1),M}$ and $\delta_{j_M,M}$, the latent variable results in a discrete choice such as $y_{i,M} = j_M$.

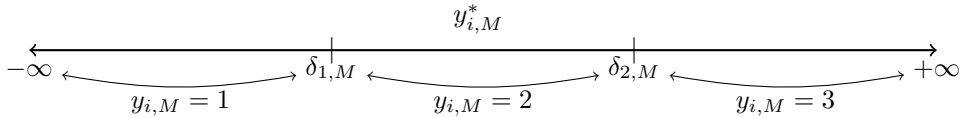


Figure 1: Relation between latent variable and dependent variable

The assessment of joint behavior calls for joint probabilities study. Indeed, joint probabilities appropriately measure the engagement in joint behavior. For example, if we are interested in the probability of a household being one of the most diligent plastic recycler of the sample while also being one of the most diligent metal recycler, the predicted joint probability of $y_{i,1}$ being equal to $j_1 = 3$ and $y_{i,2}$ being equal to $j_2 = 3$ can be computed using the following expression:

$$\widehat{Pr}(y_{i,1} = j_1; y_{i,2} = j_2) = \int_{\hat{\omega}_{j_2,2}}^{\hat{\omega}_{(j_2-1),2}} \int_{\hat{\omega}_{j_1,1}}^{\hat{\omega}_{(j_1-1),1}} \phi_2(\varepsilon_{i,1}; \varepsilon_{i,2}) d\varepsilon_{i,1} d\varepsilon_{i,2} \quad (3)$$

$$\text{with } \hat{\omega}_{p,M} = \hat{\delta}_{p,M} - x_{i,M}\hat{\beta}_M$$

Likewise, equation (4) gives the predicted joint probability of $y_{i,1}$ being equal to j_1 , $y_{i,2}$ being equal to j_2 and $y_{i,3}$ being equal to j_3 :

$$\widehat{Pr}(y_{i,1} = j_1; y_{i,2} = j_2; y_{i,3} = j_3) = \int_{\hat{\omega}_{j_3,3}}^{\hat{\omega}_{(j_3-1),3}} \int_{\hat{\omega}_{j_2,2}}^{\hat{\omega}_{(j_2-1),2}} \int_{\hat{\omega}_{j_1,1}}^{\hat{\omega}_{(j_1-1),1}} \phi_3(\varepsilon_{i,1}; \varepsilon_{i,2}; \varepsilon_{i,3}) d\varepsilon_{i,1} d\varepsilon_{i,2} d\varepsilon_{i,3} \quad (4)$$

Furthermore, both equations (3) and (4) make it possible to compute conditional probabilities. Equation (5) describes the probability of $y_{i,3}$ being equal to j_3 given that $y_{i,1}$ is equal to j_1 and $y_{i,2}$ is equal to j_2 :

$$\widehat{Pr}(y_{i,3} = j_3 | y_{i,1} = j_1; y_{i,2} = j_2) = \frac{\widehat{Pr}(y_{i,1} = j_1; y_{i,2} = j_2; y_{i,3} = j_3)}{\widehat{Pr}(y_{i,1} = j_1; y_{i,2} = j_2)} \quad (5)$$

For example, if we assume that an individual is nonrecycler for plastic and metal, we can compute his/her probability of being a diligent recycler for paper. This probability may be or may not be lower for this individual than the same conditional probability for a diligent recycler of plastic and metal. It is important here to understand that the joint distribution involves all the variables included in all the vectors of independent variables ($x_{i,M}$) through the $\hat{\omega}_{p,M}$'s. Which means that, for example, even if a variable is not included in the "plastic" vector of independent variables ($x_{i,1}$) but is included in the "metal" vector of independent variables ($x_{i,2}$), it does actually influence the conditional probabilities. Thus the calculation of partial effects of all the variables included in all the vectors of independent variables on all the conditional probabilities is potentially of great interest.

Computing all these quantities requires the evaluation of multivariate normal integrals, which do not have closed-form solution, but can be approximated by numerical methods². Marginal effects on conditional probabilities can then be calculated as differences in predicted probabilities and standard errors by bootstrap. The main interest of the multivariate modeling resides in taking into account the link between the unobserved variables which affect the dependent variables. Hence, the calculation of partial effects coherent with the underlying multivariate distribution of the data generating process enriches the analysis. However, it comes at a cost: computing all these quantities and the associated standard errors is very time intensive, which explains why they are seldom found, if ever, in the literature.

4 Results

The results of the trivariate probit model are reported in Table 5. Notice, as will be shortly made more clear, that the significance of individual parameters do not say much on the significance of the marginal effects of variables on the joint/conditional probabilities of being nonrecycler, moderate recycler or diligent recycler, etc. As Greene (2011, p. 830) notes, "without a fair amount of extra calculation, it is quite unclear how the coefficients in the [univariate] ordered probit model should be interpreted". What is true for the univariate ordered probit model is all the more true for the multivariate ordered probit model.

First, the estimated coefficients of correlation between the unobservables governing the three levels of commitment to recycling (ρ 's) are found highly significant and positive, which supports the use of a multivariate ordered probit model to analyze the data. In line with the observed positive spearman rank correlation, a random increase in the level of commitment to the recycling of any material tends to correspond to a random increase in the level of commitment to the recycling of all the other materials.

Second, of the household characteristics, gender seems to be only a significant predictor of the level of commitment to metal recycling, as well as being retired, while age (18-24) matters for metal and paper. Income, which is often presented as a proxy of the opportunity cost of time spent recycling, appears to influence significantly and negatively the level of commitment to paper recycling. However, the interpretation of the income as reflecting the opportunity cost of time spent recycling has to be taken with caution. In a recent paper, using a discrete choice experiment approach, Beaumais and Prunetti (2017) show that the opportunity cost of recycling is highly heterogeneous across individuals, making it difficult to be captured by a single income coefficient. On the contrary, the type of house (living in a detached house) has a clear effect across all recyclables.

²We used Stata MP 14. The trivariate model was estimated with `cmp` (Roodman, 2011) and the joint probabilities, conditional probabilities, marginal effects were computed using `mvtnorm` (Grayling, 2015).

Table 5: Trivariate ordered probit model

	Plastic coefficient (std)	Metal coefficient (std)	Paper coefficient (std)
GENDER_MALE	-0.009 (0.101)	0.195* (0.105)	-0.137 (0.102)
AGE_CLASS_18_24	-0.215 (0.161)	-0.554*** (0.171)	-0.384** (0.164)
AGE_CLASS_25_34	0.196 (0.147)	0.077 (0.151)	-0.186 (0.145)
UNDER5	-0.087 (0.104)	-0.086 (0.108)	-0.024 (0.101)
EMPL_RETIRED	-0.125 (0.143)	-0.396*** (0.145)	0.118 (0.145)
INCOME_CONT	0.001 (0.003)	0.001 (0.003)	-0.006* (0.003)
RESTYPE_HOUSE	0.209* (0.119)	0.284** (0.123)	0.386*** (0.119)
AREADESC_ISOLATED	0.200* (0.108)	0.109 (0.111)	0.316*** (0.109)
ENVCNCRN_INDX	0.115 (0.111)	0.031 (0.114)	0.109 (0.111)
MTVRCYLSAV_LKT	-0.100* (0.059)	-0.061 (0.060)	0.010 (0.058)
MTVRCYLDUTY_LKT	0.388*** (0.099)	0.534*** (0.103)	0.343*** (0.101)
RCYCLCOLDTD_X	0.183** (0.087)	0.401*** (0.090)	0.327*** (0.088)
$\delta_{1,M}$	1.102**	1.709***	1.292***
$\delta_{2,M}$	1.921***	2.558***	2.062***
ρ_{1M}		0.800***	0.778***
ρ_{2M}	0.800***		0.719***
ρ_{3M}	0.778***	0.719***	

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Attitudinal effects are less clear-cut, at least at first sight. The environmental concern index is never found significant, while the money-saving motive for recycling only affect significantly the level of commitment to paper recycling, with a negative coefficient. The latter could be interpreted as reflecting the fact that respondents stating that they recycle to save money actually consider recycling as a burden. Conversely, the civic duty motive acts significantly and positively on the level of commitment to the recycling of the three materials, which is in line with the findings of Ferrara and Missios (2012). This personal motive, based on social considerations, can be seen as a desire to behave responsibly.

Finally, we did not find evidence that PAYT schemes increase the level of commitment to recycling, which can be explained by the fact that, for now, PAYT is rarely implemented in France (about 5% of the respondents). Of the policy variables, door-to-door waste collection (availability of curbside disposal) improves the intensities of recycling, which, again, is in line with the previous literature (see, for example, Ferrara and Missios, 2012).

Beyond these results, we now turn to the calculation of additional quantities, both to illustrate the richness of the multivariate ordered probit model and to assess the significance and magnitude of partial effects of the independent variables on the level of households' commitment to recycling of materials. To illustrate the properties of the trivariate probit model, we present some of the conditional probabilities (see equation (5)) in the text body, while the full results are given in Appendix. Also, we only comment the marginal effects for one variable of each category listed in Table 4, namely gender, door-to-door collection services and civic duty

motive, while all the marginal effects are provided in Appendix.

Table 6 provides the conditional probabilities predicted by the estimated model for a given individual³. Most of these results are highly significant and only two conditional probabilities are not found to be significant: the probability of the household to be a paper nonrecycler while being a plastic and metal diligent recycler and the probability of the household to be a plastic diligent recycler while being a metal and a paper nonrecycler. The fact that those non significant probabilities refer to opposite recycling efforts is consistent with the intuition of linked recycling levels. Other results can also be interpreted as being consistent across recycling levels: given that the two recycling levels are the same, the highest probability is that the third material is recycled at the same level as the others.

Of particular interest are the cases in which the recycling levels are extreme (nonrecycler *versus* diligent recycler): the probabilities are unevenly distributed. As mentioned above, the highest probability is that the households' level of recycling for the third material is the same as the others but we can notice that the lowest probability is that the effort of recycling for the third material is the opposite of the two others. Furthermore, those lowest probabilities, when significant, are very low. This can be interpreted as a commitment to recycling: once an individual chooses to be a moderate recycler or a nonrecycler for two materials, he is most likely to act in the same way for the third material.

Table 6: Conditional probabilities

		Probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic nonrecycler and a paper...	nonrecycler	0.582***	0.353***	0.064***
	moderate recycler	0.346***	0.495***	0.159***
	diligent recycler	0.211***	0.517***	0.272***
given that the household is a plastic moderate recycler and a paper...	nonrecycler	0.203***	0.515***	0.283***
	moderate recycler	0.110***	0.464***	0.426***
	diligent recycler	0.051***	0.358***	0.591***
given that the household is a plastic diligent recycler and a paper...	nonrecycler	0.049*	0.355***	0.596***
	moderate recycler	0.020*	0.235***	0.745***
	diligent recycler	0.003*	0.070***	0.927***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

To a lesser extent, one can notice that if the household is a diligent recycler for at least one of the materials, the highest probability tends to be that the household is also a diligent recycler for the third material, while the lowest probability tends to be that the household is a nonrecycler for the third material. This can be seen as a ripple effect in which the commitment to be a diligent recycler for at least one material favors the recycling of another material. However, an opposite ripple effect is not found in the results: if a household is a nonrecycler for at least one of the material, it does not seem to exhibit a specific level of recycling for the third material.

As suggested by Greene (2011), we computed additional partial effects in order to clarify the interpretation of the coefficients (Tables 7, 8, 9). While gender was only significant for metal in the estimated model, its marginal effects on both metal and paper are found to be significant. As could have been expected according to the estimated model, being male appears to increase the probability of being a metal diligent recycler, regardless of the recycling level. Some marginal effects are strong enough to change the predicted decision and favors a higher recycling level for males. For example, while a woman whose household is a plastic diligent recycler and a paper nonrecycler is predicted to be a metal moderate recycler, a man is predicted to be a metal diligent recycler.

³A more than 55 years old man whose annual income is 39,000€ and who lives in an isolated house. His environmental concern is estimated to be 3.5. His stronger motive is civic duty ("very important") but he also considers saving money as "important". His plastic, metal and paper wastes are collected by door-to-door services.

Table 7: Gender marginal effects on the commitment to metal recycling

		Marginal effects of gender on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	-0.133***	0.098***	0.035*
	moderate recycler	-0.154***	0.076**	0.078**
	diligent recycler	-0.128***	0.016	0.112**
given that the household is a plastic moderate recycler and a paper...	nonrecycler	-0.125***	0.010	0.115***
	moderate recycler	-0.093***	-0.053*	0.146***
	diligent recycler	-0.054**	-0.095**	0.149***
given that the household is a plastic diligent recycler and a paper...	nonrecycler	-0.055**	-0.102**	0.156***
	moderate recycler	-0.029**	-0.113***	0.142***
	diligent recycler	-0.006*	-0.051***	0.056***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

One interesting result is the significance of gender marginal effects on commitment to recycling paper while the variable was not significant in the model. The marginal effects significance is lower (at the 5% or the 10% level) but allows us to notice a gender specific effect. Men tends to be less likely paper diligent recyclers than women, regardless of the recycling level. Again, some predicted decisions are changed: marginal effects on paper recycling favor a lower paper recycling level for men. These results indicate that a variable can have effects on a material conditional probability while not being a significant explanatory variable in the estimated model. As mentioned above, this is due to the fact that joint probabilities include all the model variables.

Table 8: Door-to-door metal collection marginal effects on the commitment to metal recycling

		Marginal effects of a door-to-door metal collection on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	-0.212***	0.163***	0.049**
	moderate recycler	-0.257***	0.145**	0.111***
	diligent recycler	-0.234***	0.063	0.171***
given that the household is a plastic moderate recycler and a paper...	nonrecycler	-0.231***	0.056	0.175***
	moderate recycler	-0.178***	-0.051	0.230***
	diligent recycler	-0.115***	-0.144***	0.259***
given that the household is a plastic diligent recycler and a paper...	nonrecycler	-0.113**	-0.145***	0.258***
	moderate recycler	-0.062**	-0.179***	0.241***
	diligent recycler	-0.014*	-0.101***	0.115***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Likewise, such a result is observed with door-to-door metal collection. The availability of a metal curbside disposal increases the probability for the household to be a metal diligent recycler and decreases the probability to be a metal nonrecycler. Again, the magnitude of some marginal effects is sufficient to favor higher predicted recycling levels. To a lesser extent, the availability of a door-to-door metal collection service has significant marginal effects on paper and plastic conditional probabilities while not being an explanatory variable of those materials recycling probabilities at all. Those marginal effects tend to increase the probability of the household to be a paper or a plastic nonrecycler and are strong enough to favor lower predicted recycling levels. Given that those marginal effects are computed for an individual whose paper and plastic waste are collected by a door-to-door service, implementing a door-to-door metal collection service may not result in increased recycling efforts, but rather in a reallocation of recycling efforts in favor to metal. Looking at plastic and paper door-to-

door marginal effects, this "reallocation rather than increase" effect also appears and could be interpreted as a time limit effect. This goes along with the findings of Bell *et al.* (2017) who support single-stream recycling as an incentive to recycling. By enabling household to recycle materials without sorting them, single-stream recycling reduces recycling time costs and can thus increase recycling efforts.

Table 9: Civic duty marginal effects on the commitment to metal recycling

		Marginal effects of civic duty being a "very important" motive on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	-0.147***	0.110***	0.037
	moderate recycler	-0.147***	0.073**	0.075**
	diligent recycler	-0.123***	0.014	0.109**
given that the household is a plastic moderate recycler and a paper...	nonrecycler	-0.121***	0.009	0.112**
	moderate recycler	-0.087**	-0.051*	0.139***
	diligent recycler	-0.053**	-0.096**	0.149***
given that the household is a plastic diligent recycler and a paper...	nonrecycler	-0.052	-0.097**	0.149***
	moderate recycler	-0.027	-0.109***	0.136***
	diligent recycler	-0.007	-0.071***	0.079***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Finally, although civic duty is found to be the most significant variable in the estimated model, the associated marginal effects are only found significant when it comes to the conditional probability of recycling metal. In general, a shift from considering civic duty as "important" to "very important" increases the probability of an household being a metal diligent recycler and decreases the probability of being a metal nonrecycler. Those marginal effects also shift some of the predicted decisions to a higher metal recycling level which is consistent with the literature (Ferrara and Missios, 2012 ; Halvorsen, 2012). The civic duty may be more associated with metal since it was the first recycled material since Bronze Age.

5 Concluding remarks

In this paper, we show that the multivariate ordered probit model is an appropriate tool to fully unveil the subtlety of joint pro-environmental behaviors. We acknowledge that it comes as a cost, given that the calculation of the relevant quantities - joint probabilities, conditional probabilities, partial effects - is burdensome⁴. But, the calculation of these quantities also considerably enriches the analysis. In particular, in that kind of simultaneous equation framework, the channels through which an independent variable influences the outcomes of interest cannot be summarized by simple partial effects computed on the marginal distribution of these outcomes. The calculation of additional quantities is necessary to understand all the aspects of the phenomenon at stake.

From a waste economics perspective, this paper contributes to the previous literature by exploring factors associated with the level of commitment to recycling of materials. Households characteristics, as well as attitudinal variables and policy variable matter to explain why individuals engage more or less in recycling. The desire to act responsibly is a strong driver of the engagement in recycling activities. Also, we do not find that PAYT schemes matter, which can be simply explained by the fact that PAYT schemes just start to be implemented in France. Therefore, for now, providing door-to-door collection services seem to be an efficient way to foster households commitment to recycling. Results regarding household characteristics which influence recycling rates could help to design targeted waste management strategies.

⁴Using Stata MP4, it took approximately two months to compute all these quantities on a computer with a quad-core i7, 3.4 Ghz processor and 8 GB of RAM.

Finally examining other facets of households' waste management behavior in France, such as waste prevention, would require specific data, which, for now, is not available, but is clearly worthy to be made available.

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A Conditional probabilities

Table 10: Conditional probabilities

		Probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic nonrecycler and a metal...	nonrecycler	0.706***	0.249***	0.045**
	moderate recycler	0.479***	0.399***	0.122***
	diligent recycler	0.311***	0.459***	0.230***
given that the household is a plastic moderate recycler and a metal...	nonrecycler	0.350***	0.451***	0.199***
	moderate recycler	0.213***	0.455***	0.333***
	diligent recycler	0.108***	0.385***	0.507***
given that the household is a plastic diligent recycler and a metal...	nonrecycler	0.135**	0.418***	0.448***
	moderate recycler	0.063**	0.315***	0.622***
	diligent recycler	0.011	0.106***	0.882***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 11: Conditional probabilities

		Probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic nonrecycler and a paper...	nonrecycler	0.582***	0.353***	0.064***
	moderate recycler	0.346***	0.495***	0.159***
	diligent recycler	0.211***	0.517***	0.272***
given that the household is a plastic moderate recycler and a paper...	nonrecycler	0.203***	0.515***	0.283***
	moderate recycler	0.110***	0.464***	0.426***
	diligent recycler	0.051***	0.358***	0.591***
given that the household is a plastic diligent recycler and a paper...	nonrecycler	0.049*	0.355***	0.596***
	moderate recycler	0.020*	0.235***	0.745***
	diligent recycler	0.003*	0.070***	0.927***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 12: Conditional probabilities

		Probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal nonrecycler and a paper...	nonrecycler	0.810***	0.178***	0.011
	moderate recycler	0.520***	0.418***	0.062**
	diligent recycler	0.271***	0.536***	0.193***
given that the household is a metal moderate recycler and a paper...	nonrecycler	0.480***	0.442***	0.078***
	moderate recycler	0.231***	0.546***	0.223***
	diligent recycler	0.078***	0.439***	0.483***
given that the household is a metal diligent recycler and a paper...	nonrecycler	0.190***	0.527***	0.283***
	moderate recycler	0.058**	0.391***	0.551***
	diligent recycler	0.006**	0.101***	0.894***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

B Marginal effects

B.1 Gender marginal effects

Table 13: Gender marginal effects on the commitment to paper recycling

		Marginal effects of gender on probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a metal...	nonrecycler	0.105**	-0.070**	-0.035**
	moderate recycler	0.121**	-0.047	-0.074**
	diligent recycler	0.097**	0.002	-0.099**
given that the household is a plastic moderate recycler and a metal...	nonrecycler	0.102**	-0.009	-0.093**
	moderate recycler	0.077**	0.039*	-0.115**
	diligent recycler	0.044*	0.066**	-0.110**
given that the household is a plastic diligent recycler and a metal...	nonrecycler	0.055*	0.067**	-0.122**
	moderate recycler	0.030*	0.082**	-0.113**
	diligent recycler	0.006	0.036*	-0.042*

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 14: Gender marginal effects on the commitment to metal recycling

		Marginal effects of gender on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	-0.133***	0.098***	0.035*
	moderate recycler	-0.154***	0.076**	0.078**
	diligent recycler	-0.128***	0.016	0.112**
given that the household is a plastic moderate recycler and a paper...	nonrecycler	-0.125***	0.010	0.115***
	moderate recycler	-0.093***	-0.053*	0.146***
	diligent recycler	-0.054**	-0.095**	0.149***
given that the household is a plastic diligent recycler and a paper...	nonrecycler	-0.055**	-0.102**	0.156***
	moderate recycler	-0.029**	-0.113***	0.142***
	diligent recycler	-0.006*	-0.051***	0.056***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 15: Gender marginal effects on the commitment to plastic recycling

		Marginal effects of gender on probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal non recycler and a paper...	nonrecycler	0.020	-0.017	-0.002
	moderate recycler	0.021	-0.013	-0.009
	diligent recycler	0.028	0.003	-0.030
given that the household is a metal moderate recycler and a paper...	nonrecycler	0.040	-0.026	-0.014
	moderate recycler	0.023	0.001	-0.024
	diligent recycler	0.015	0.036	-0.051
given that the household is a metal diligent recycler and a paper...	nonrecycler	0.019	-0.002	-0.018
	moderate recycler	0.005	0.004	-0.009
	diligent recycler	0.001	0.009	-0.010

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

B.2 18-24 years old marginal effects

Table 16: 18-24 years old marginal effects on the commitment to paper recycling

		Marginal effects of being between 18 and 24 years old on probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a metal...	nonrecycler	0.064	-0.048	-0.016
	moderate recycler	0.066	-0.034	-0.032
	diligent recycler	0.069	-0.014	-0.054
given that the household is a plastic moderate recycler and a metal...	nonrecycler	0.075	-0.026	-0.049
	moderate recycler	0.057	0.007	-0.063
	diligent recycler	0.043	0.042	-0.085
given that the household is a plastic diligent recycler and a metal...	nonrecycler	0.043	0.024	-0.067
	moderate recycler	0.023	0.035	-0.058
	diligent recycler	0.009	0.044	-0.053

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 17: 18-24 years old marginal effects on the commitment to metal recycling

		Marginal effects of being between 18 and 24 years old on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	0.191***	-0.145***	-0.045**
	moderate recycler	0.209**	-0.111	-0.098**
	diligent recycler	0.190**	-0.040	-0.150***
given that the household is a plastic moderate recycler and a paper...	nonrecycler	0.191**	-0.037	-0.154**
	moderate recycler	0.139*	0.056	-0.195***
	diligent recycler	0.091	0.132***	-0.223**
given that the household is a plastic diligent recycler and a paper...	nonrecycler	0.087	0.127**	-0.214**
	moderate recycler	0.045	0.146**	-0.191**
	diligent recycler	0.012	0.095**	-0.107**

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

B.3 25-34 years old marginal effects

Table 18: 18-24 years old marginal effects on the commitment to plastic recycling

		Marginal effects of being between 18 and 24 years old on probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal non recycler and a paper...	nonrecycler	-0.080	0.068	0.013
	moderate recycler	-0.136	0.078	0.058
	diligent recycler	-0.105	-0.012	0.117
given that the household is a metal moderate recycler and a paper...	nonrecycler	-0.142	0.072	0.069
	moderate recycler	-0.098*	-0.029	0.127
	diligent recycler	-0.041	-0.103	0.144
given that the household is a metal diligent recycler and a paper...	nonrecycler	-0.081	-0.043	0.124
	moderate recycler	-0.030	-0.090	0.120
	diligent recycler	-0.003	-0.026	0.029

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 19: 25-34 years old marginal effects on the commitment to paper recycling

		Marginal effects of being between 25 and 34 years old on probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a metal...	nonrecycler	0.130***	-0.100***	-0.029**
	moderate recycler	0.186***	-0.113**	-0.073**
	diligent recycler	0.191***	-0.068	-0.123***
given that the household is a plastic moderate recycler and a metal...	nonrecycler	0.194***	-0.085*	-0.109**
	moderate recycler	0.168***	-0.013	-0.156***
	diligent recycler	0.122**	0.071**	-0.193***
given that the household is a plastic diligent recycler and a metal...	nonrecycler	0.137**	0.043	-0.181***
	moderate recycler	0.084**	0.100***	-0.184***
	diligent recycler	0.019*	0.069**	-0.089**

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

B.4 Under 5 child marginal effects

Table 20: 25-34 years old marginal effects on the commitment to metal recycling

		Marginal effects of being between 25 and 34 years old on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	-0.015	0.012	0.003
	moderate recycler	-0.021	0.010	0.010
	diligent recycler	-0.008	0.003	0.005
given that the household is a plastic moderate recycler and a paper...	nonrecycler	-0.002	-0.003	0.005
	moderate recycler	-0.006	-0.007	0.013
	diligent recycler	-0.001	0.000	0.001
given that the household is a plastic diligent recycler and a paper...	nonrecycler	-0.003	-0.015	0.019
	moderate recycler	-0.003	-0.025	0.028
	diligent recycler	-0.001	-0.010	0.011

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 21: 25-34 years old marginal effects on the commitment to plastic recycling

		Marginal effects of being between 25 and 34 years old on probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal non recycler and a paper...	nonrecycler	-0.113*	0.096**	0.017
	moderate recycler	-0.172**	0.098**	0.073*
	diligent recycler	-0.120**	-0.011	0.131*
given that the household is a metal moderate recycler and a paper...	nonrecycler	-0.149**	0.072*	0.077*
	moderate recycler	-0.110**	-0.038	0.148**
	diligent recycler	-0.044**	-0.109**	0.153**
given that the household is a metal diligent recycler and a paper...	nonrecycler	-0.092**	-0.069	0.161**
	moderate recycler	-0.037**	-0.134**	0.171***
	diligent recycler	-0.004*	-0.049**	0.053**

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

B.5 Retired marginal effects

Table 22: Under 5 child marginal effects on the commitment to paper recycling

		Marginal effects of having an under 5 years old child on probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a metal...	nonrecycler	-0.019	0.013	0.006
	moderate recycler	-0.028	0.013	0.015
	diligent recycler	-0.025	0.002	0.023
given that the household is a plastic moderate recycler and a metal...	nonrecycler	-0.027	0.006	0.021
	moderate recycler	-0.021	-0.006	0.027
	diligent recycler	-0.013	-0.016	0.028
given that the household is a plastic diligent recycler and a metal...	nonrecycler	-0.015	-0.014	0.029
	moderate recycler	-0.008	-0.018	0.026
	diligent recycler	-0.001	-0.006	0.007

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 23: Under 5 child marginal effects on the commitment to metal recycling

		Marginal effects of having an under 5 years old child on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	0.024	-0.017	-0.007
	moderate recycler	0.022	-0.009	-0.013
	diligent recycler	0.016	0.001	-0.016
given that the household is a plastic moderate recycler and a paper...	nonrecycler	0.014	0.002	-0.017
	moderate recycler	0.010	0.010	-0.021
	diligent recycler	0.005	0.013	-0.019
given that the household is a plastic diligent recycler and a paper...	nonrecycler	0.006	0.016	-0.021
	moderate recycler	0.003	0.017	-0.020
	diligent recycler	0.001	0.009	-0.009

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

B.6 Annual income increase marginal effects

Table 24: Under 5 child marginal effects on the commitment to plastic recycling

		Marginal effects of having an under 5 years old child on probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal non recycler and a paper...	nonrecycler	0.018	-0.016	-0.002
	moderate recycler	0.028	-0.020	-0.008
	diligent recycler	0.022	-0.005	-0.016
given that the household is a metal moderate recycler and a paper...	nonrecycler	0.024	-0.016	-0.009
	moderate recycler	0.021	-0.001	-0.019
	diligent recycler	0.009	0.014	-0.023
given that the household is a metal diligent recycler and a paper...	nonrecycler	0.019	0.005	-0.024
	moderate recycler	0.009	0.022	-0.031
	diligent recycler	0.001	0.013	-0.014

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 25: Retired marginal effects on the commitment to paper recycling

		Marginal effects of being retired on probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a metal...	nonrecycler	-0.157**	0.099**	0.059**
	moderate recycler	-0.182***	0.058	0.124**
	diligent recycler	-0.144**	-0.019	0.163**
given that the household is a plastic moderate recycler and a metal...	nonrecycler	-0.151**	-0.002	0.153**
	moderate recycler	-0.111**	-0.073*	0.183***
	diligent recycler	-0.062**	-0.109**	0.171***
given that the household is a plastic diligent recycler and a metal...	nonrecycler	-0.078**	-0.111**	0.188***
	moderate recycler	-0.041**	-0.124***	0.166***
	diligent recycler	-0.008*	-0.050**	0.057**

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

B.7 House marginal effects

Table 26: Retired marginal effects on the commitment to metal recycling

		Marginal effects of being retired on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	0.200***	-0.153***	-0.047**
	moderate recycler	0.238***	-0.133**	-0.105***
	diligent recycler	0.205***	-0.049	-0.155***
given that the household is a plastic moderate recycler and a paper...	nonrecycler	0.200***	-0.040	-0.160***
	moderate recycler	0.155***	0.055	-0.210***
	diligent recycler	0.093***	0.129***	-0.222***
given that the household is a plastic diligent recycler and a paper...	nonrecycler	0.096**	0.140***	-0.236***
	moderate recycler	0.055**	0.171***	-0.226***
	diligent recycler	0.012*	0.092***	-0.103***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 27: Retired marginal effects on the commitment to plastic recycling

		Marginal effects of being retired on probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal non recycler and a paper...	nonrecycler	0.003	-0.003	0.000
	moderate recycler	0.010	-0.010	0.000
	diligent recycler	-0.010	-0.008	0.018
given that the household is a metal moderate recycler and a paper...	nonrecycler	-0.022	0.016	0.006
	moderate recycler	-0.006	0.000	0.006
	diligent recycler	-0.011	-0.030	0.041
given that the household is a metal diligent recycler and a paper...	nonrecycler	-0.005	0.010	-0.005
	moderate recycler	0.003	0.020	-0.023
	diligent recycler	0.000	0.002	-0.002

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

B.8 Isolated house marginal effects

Table 28: Annual income increase marginal effects on the commitment to paper recycling

		Marginal effects of an income increase on probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a metal...	nonrecycler	0.016**	-0.012**	-0.004*
	moderate recycler	0.020**	-0.010**	-0.010**
	diligent recycler	0.018**	-0.003	-0.015**
given that the household is a plastic moderate recycler and a metal...	nonrecycler	0.019**	-0.005	-0.014**
	moderate recycler	0.015**	0.003	-0.019**
	diligent recycler	0.010**	0.011**	-0.020**
given that the household is a plastic diligent recycler and a metal...	nonrecycler	0.012**	0.009	-0.021**
	moderate recycler	0.007**	0.013**	-0.019**
	diligent recycler	0.001*	0.007**	-0.009**

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 29: Annual income increase marginal effects on the commitment to metal recycling

		Marginal effects of an income increase on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	-0.006	0.004	0.002
	moderate recycler	-0.006	0.002	0.004
	diligent recycler	-0.004	0.000	0.005
given that the household is a plastic moderate recycler and a paper...	nonrecycler	-0.004	-0.001	0.005
	moderate recycler	-0.003	-0.003	0.006
	diligent recycler	-0.001	-0.003	0.005
given that the household is a plastic diligent recycler and a paper...	nonrecycler	-0.002	-0.005	0.006
	moderate recycler	-0.001	-0.005	0.006
	diligent recycler	0.000	-0.002	0.002

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

B.9 Environmental concern marginal effects

Table 30: Annual income increase marginal effects on the commitment to plastic recycling

		Marginal effects of an income increase on probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal non recycler and a paper...	nonrecycler	-0.006	0.005	0.001
	moderate recycler	-0.011	0.008	0.003
	diligent recycler	-0.008	0.002	0.007
given that the household is a metal moderate recycler and a paper...	nonrecycler	-0.009	0.005	0.004
	moderate recycler	-0.008	0.000	0.008
	diligent recycler	-0.003	-0.005	0.009
given that the household is a metal diligent recycler and a paper...	nonrecycler	-0.007	-0.003	0.010
	moderate recycler	-0.003	-0.009	0.012
	diligent recycler	0.000	-0.003	0.004

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 31: House marginal effects on the commitment to paper recycling

		Marginal effects of living in a house on probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a metal...	nonrecycler	-0.098**	0.076**	0.023*
	moderate recycler	-0.122**	0.070*	0.052**
	diligent recycler	-0.119**	0.034	0.085**
given that the household is a plastic moderate recycler and a metal...	nonrecycler	-0.123**	0.047	0.076**
	moderate recycler	-0.102*	-0.003	0.105**
	diligent recycler	-0.072*	-0.056*	0.128**
given that the household is a plastic diligent recycler and a metal...	nonrecycler	-0.080*	-0.039	0.119**
	moderate recycler	-0.049*	-0.072**	0.121**
	diligent recycler	-0.015	-0.066**	0.081**

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

B.10 Saving money motive marginal effects

Table 32: House marginal effects on the commitment to metal recycling

		Marginal effects of living in a house on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	-0.052	0.037	0.015
	moderate recycler	-0.036	0.012	0.023
	diligent recycler	-0.032	-0.004	0.036
given that the household is a plastic moderate recycler and a paper...	nonrecycler	-0.036	-0.002	0.038
	moderate recycler	-0.021	-0.020	0.040
	diligent recycler	-0.014	-0.035	0.049
given that the household is a plastic diligent recycler and a paper...	nonrecycler	-0.012	-0.028	0.040
	moderate recycler	-0.005	-0.024	0.030
	diligent recycler	-0.002	-0.022	0.023

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 33: House marginal effects on the commitment to plastic recycling

		Marginal effects of living in a house on probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal non recycler and a paper...	nonrecycler	0.024	-0.020	-0.004
	moderate recycler	0.062	-0.040	-0.022
	diligent recycler	0.047	-0.005	-0.041
given that the household is a metal moderate recycler and a paper...	nonrecycler	0.051	-0.029	-0.022
	moderate recycler	0.045	0.005	-0.050
	diligent recycler	0.018	0.033	-0.051
given that the household is a metal diligent recycler and a paper...	nonrecycler	0.035	0.015	-0.050
	moderate recycler	0.016	0.042	-0.058
	diligent recycler	0.001	0.005	-0.006

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

B.11 Civic duty marginal effects

Table 34: Isolated house marginal effects on the commitment to paper recycling

		Marginal effects of an isolated residence on probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a metal...	nonrecycler	-0.095**	0.073**	0.022*
	moderate recycler	-0.118**	0.067**	0.050**
	diligent recycler	-0.108**	0.031	0.078**
given that the household is a plastic moderate recycler and a metal...	nonrecycler	-0.112**	0.041	0.071**
	moderate recycler	-0.094**	-0.004	0.098**
	diligent recycler	-0.062*	-0.049*	0.111**
given that the household is a plastic diligent recycler and a metal...	nonrecycler	-0.073*	-0.039	0.112**
	moderate recycler	-0.046*	-0.071**	0.117**
	diligent recycler	-0.012	-0.057**	0.069**

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 35: Isolated house marginal effects on the commitment to metal recycling

		Marginal effects of an isolated residence on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	0.037	-0.022	-0.015
	moderate recycler	0.053	-0.014	-0.038
	diligent recycler	0.039	0.010	-0.049
given that the household is a plastic moderate recycler and a paper...	nonrecycler	0.036	0.012	-0.048
	moderate recycler	0.025	0.033	-0.058
	diligent recycler	0.013	0.037	-0.050
given that the household is a plastic diligent recycler and a paper...	nonrecycler	0.013	0.042	-0.055
	moderate recycler	0.006	0.039	-0.045
	diligent recycler	0.001	0.009	-0.009

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

B.12 Door-to-door plastic collection

Table 36: Isolated house marginal effects on the commitment to plastic recycling

		Marginal effects of an isolated residence on probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal non recycler and a paper...	nonrecycler	-0.019	0.018	0.002
	moderate recycler	-0.009	0.006	0.003
	diligent recycler	-0.012	0.000	0.013
given that the household is a metal moderate recycler and a paper...	nonrecycler	-0.024	0.017	0.007
	moderate recycler	-0.009	0.000	0.009
	diligent recycler	-0.008	-0.017	0.025
given that the household is a metal diligent recycler and a paper...	nonrecycler	-0.010	0.003	0.008
	moderate recycler	-0.001	0.001	0.001
	diligent recycler	-0.001	-0.013	0.014

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 37: Environmental concern marginal effects on the commitment to paper recycling

		Marginal effects of an increase in environmental concern on probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a metal...	nonrecycler	-0.005	0.003	0.001
	moderate recycler	-0.005	0.002	0.002
	diligent recycler	-0.004	0.001	0.003
given that the household is a plastic moderate recycler and a metal...	nonrecycler	-0.004	0.001	0.003
	moderate recycler	-0.003	-0.001	0.004
	diligent recycler	-0.002	-0.002	0.004
given that the household is a plastic diligent recycler and a metal...	nonrecycler	-0.002	-0.002	0.004
	moderate recycler	-0.001	-0.003	0.005
	diligent recycler	0.000	-0.002	0.003

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

B.13 Door-to-door metal collection

Table 38: Environmental concern marginal effects on the commitment to metal recycling

		Marginal effects of an increase in environmental concern on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	0.005	-0.003	-0.002
	moderate recycler	0.006	-0.002	-0.004
	diligent recycler	0.005	0.001	-0.006
given that the household is a plastic moderate recycler and a paper...	nonrecycler	0.005	0.001	-0.006
	moderate recycler	0.003	0.003	-0.007
	diligent recycler	0.002	0.005	-0.007
given that the household is a plastic diligent recycler and a paper...	nonrecycler	0.002	0.005	-0.007
	moderate recycler	0.001	0.004	-0.005
	diligent recycler	0.000	0.001	-0.001

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 39: Environmental concern marginal effects on the commitment to plastic recycling

		Marginal effects of an increase in environmental concern on probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal non recycler and a paper...	nonrecycler	-0.005	0.004	0.001
	moderate recycler	-0.006	0.004	0.002
	diligent recycler	-0.005	0.001	0.005
given that the household is a metal moderate recycler and a paper...	nonrecycler	-0.007	0.004	0.003
	moderate recycler	-0.005	0.000	0.005
	diligent recycler	-0.003	-0.005	0.007
given that the household is a metal diligent recycler and a paper...	nonrecycler	-0.004	-0.001	0.005
	moderate recycler	-0.002	-0.004	0.006
	diligent recycler	0.000	-0.003	0.003

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

B.14 Door-to-door paper collection

Table 40: Saving money motive marginal effects on the commitment to paper recycling

		Marginal effects of saving money being a "very important" motive on probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a metal...	nonrecycler	-0.035	0.024	0.011
	moderate recycler	-0.047*	0.020	0.027
	diligent recycler	-0.043	0.002	0.041*
given that the household is a plastic moderate recycler and a metal...	nonrecycler	-0.046*	0.009	0.038
	moderate recycler	-0.035	-0.012	0.047*
	diligent recycler	-0.022	-0.029	0.051*
given that the household is a plastic diligent recycler and a metal...	nonrecycler	-0.026	-0.025	0.050*
	moderate recycler	-0.014	-0.031	0.045*
	diligent recycler	-0.003	-0.014	0.016

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 41: Saving money motive marginal effects on the commitment to metal recycling

		Marginal effects of saving money being a "very important" motive on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	0.012	-0.009	-0.003
	moderate recycler	0.010	-0.005	-0.005
	diligent recycler	0.004	-0.001	-0.003
given that the household is a plastic moderate recycler and a paper...	nonrecycler	0.003	0.001	-0.004
	moderate recycler	0.003	0.003	-0.006
	diligent recycler	0.001	0.001	-0.002
given that the household is a plastic diligent recycler and a paper...	nonrecycler	0.001	0.005	-0.007
	moderate recycler	0.001	0.008	-0.009
	diligent recycler	0.000	0.004	-0.004

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 42: Saving money motive marginal effects on the commitment to plastic recycling

		Marginal effects of saving money being a "very important" motive on probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal non recycler and a paper...	nonrecycler	0.033*	-0.029*	-0.003
	moderate recycler	0.056*	-0.043	-0.015
	diligent recycler	0.046	-0.012	-0.034
given that the household is a metal moderate recycler and a paper...	nonrecycler	0.052	-0.034	-0.018
	moderate recycler	0.044	-0.005	-0.039
	diligent recycler	0.021	0.029	-0.049
given that the household is a metal diligent recycler and a paper...	nonrecycler	0.039	0.006	-0.046*
	moderate recycler	0.019	0.039*	-0.058*
	diligent recycler	0.003	0.022*	-0.025*

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 43: Civic duty marginal effects on the commitment to paper recycling

		Marginal effects of civic duty being a "very important" motive on probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a metal...	nonrecycler	-0.013	0.011	0.002
	moderate recycler	0.007	-0.004	-0.004
	diligent recycler	0.005	-0.001	-0.004
given that the household is a plastic moderate recycler and a metal...	nonrecycler	0.004	0.000	-0.004
	moderate recycler	0.005	0.001	-0.006
	diligent recycler	0.000	-0.001	0.001
given that the household is a plastic diligent recycler and a metal...	nonrecycler	0.004	0.004	-0.009
	moderate recycler	0.002	0.006	-0.008
	diligent recycler	-0.002	-0.018	0.021

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 44: Civic duty marginal effects on the commitment to metal recycling

		Marginal effects of civic duty being a "very important" motive on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	-0.147***	0.110***	0.037
	moderate recycler	-0.147***	0.073**	0.075**
	diligent recycler	-0.123***	0.014	0.109**
given that the household is a plastic moderate recycler and a paper...	nonrecycler	-0.121***	0.009	0.112**
	moderate recycler	-0.087**	-0.051*	0.139***
	diligent recycler	-0.053**	-0.096**	0.149***
given that the household is a plastic diligent recycler and a paper...	nonrecycler	-0.052	-0.097**	0.149***
	moderate recycler	-0.027	-0.109***	0.136***
	diligent recycler	-0.007	-0.071***	0.079***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 45: Civic duty marginal effects on the commitment to plastic recycling

		Marginal effects of civic duty being a "very important" motive on probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal non recycler and a paper...	nonrecycler	-0.014	0.013	0.001
	moderate recycler	-0.005	0.005	0.000
	diligent recycler	0.001	0.003	-0.004
given that the household is a metal moderate recycler and a paper...	nonrecycler	0.005	-0.003	-0.002
	moderate recycler	0.003	0.000	-0.003
	diligent recycler	0.002	0.005	-0.006
given that the household is a metal diligent recycler and a paper...	nonrecycler	-0.001	-0.005	0.006
	moderate recycler	-0.003	-0.014	0.017
	diligent recycler	-0.002	-0.024	0.026

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 46: Door-to-door plastic collection marginal effects on the commitment to paper recycling

		Marginal effects of a door-to-door plastic collection on probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a metal...	nonrecycler	0.034*	-0.022*	-0.011
	moderate recycler	0.050*	-0.020	-0.030
	diligent recycler	0.051	0.001	-0.051*
given that the household is a plastic moderate recycler and a metal...	nonrecycler	0.056*	-0.010	-0.045
	moderate recycler	0.041*	0.015	-0.056
	diligent recycler	0.027	0.039	-0.066*
given that the household is a plastic diligent recycler and a metal...	nonrecycler	0.031*	0.029	-0.060*
	moderate recycler	0.016*	0.034	-0.050*
	diligent recycler	0.003	0.017*	-0.020*

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 47: Door-to-door plastic collection marginal effects on the commitment to metal recycling

		Marginal effects of a door-to-door plastic collection on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	0.045*	-0.026*	-0.019
	moderate recycler	0.051*	-0.010	-0.040
	diligent recycler	0.045	0.016	-0.061*
given that the household is a plastic moderate recycler and a paper...	nonrecycler	0.046*	0.015	-0.061
	moderate recycler	0.028*	0.038	-0.067*
	diligent recycler	0.016	0.053*	-0.069*
given that the household is a plastic diligent recycler and a paper...	nonrecycler	0.015*	0.047*	-0.062*
	moderate recycler	0.007*	0.038*	-0.044*
	diligent recycler	0.001	0.014*	-0.015*

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 48: Door-to-door plastic collection marginal effects on the commitment to plastic recycling

		Marginal effects of a door-to-door plastic collection on probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal non recycler and a paper...	nonrecycler	-0.072*	0.066**	-0.007
	moderate recycler	-0.128*	0.097*	0.031*
	diligent recycler	-0.118*	0.041	0.077*
given that the household is a metal moderate recycler and a paper...	nonrecycler	-0.129*	0.091	0.038*
	moderate recycler	-0.113*	0.026	0.087**
	diligent recycler	-0.059	-0.066*	0.126*
given that the household is a metal diligent recycler and a paper...	nonrecycler	-0.100	0.002	0.098**
	moderate recycler	-0.048	-0.078*	0.126*
	diligent recycler	-0.007	-0.051*	0.058

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 49: Door-to-door metal collection marginal effects on the commitment to paper recycling

		Marginal effects of a door-to-door metal collection on probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a metal...	nonrecycler	0.061***	-0.042***	-0.019**
	moderate recycler	0.080***	-0.036***	-0.044**
	diligent recycler	0.060***	-0.005	-0.055**
given that the household is a plastic moderate recycler and a metal...	nonrecycler	0.059***	-0.008	-0.051***
	moderate recycler	0.049***	0.020	-0.069***
	diligent recycler	0.026***	0.033**	-0.059***
given that the household is a plastic diligent recycler and a metal...	nonrecycler	0.036*	0.042***	-0.078***
	moderate recycler	0.022**	0.059***	-0.081***
	diligent recycler	0.004**	0.022***	-0.029***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 50: Door-to-door metal collection marginal effects on the commitment to metal recycling

		Marginal effects of a door-to-door metal collection on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	-0.212***	0.163***	0.049**
	moderate recycler	-0.257***	0.145**	0.111***
	diligent recycler	-0.234***	0.063	0.171***
given that the household is a plastic moderate recycler and a paper...	nonrecycler	-0.231***	0.056	0.175***
	moderate recycler	-0.178***	-0.051	0.230***
	diligent recycler	-0.115***	-0.144***	0.259***
given that the household is a plastic diligent recycler and a paper...	nonrecycler	-0.113**	-0.145***	0.258***
	moderate recycler	-0.062**	-0.179***	0.241***
	diligent recycler	-0.014*	-0.101***	0.115***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 51: Door-to-door metal collection marginal effects on the commitment to plastic recycling

		Marginal effects of a door-to-door metal collection on probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal non recycler and a paper...	nonrecycler	0.085***	-0.072***	-0.013*
	moderate recycler	0.118***	-0.068**	-0.050***
	diligent recycler	0.099***	0.015	-0.114***
given that the household is a metal moderate recycler and a paper...	nonrecycler	0.141***	-0.075***	-0.066**
	moderate recycler	0.091***	0.024	-0.115***
	diligent recycler	0.041***	0.109***	-0.151***
given that the household is a metal diligent recycler and a paper...	nonrecycler	0.077***	0.034	-0.112***
	moderate recycler	0.027***	0.075***	-0.102***
	diligent recycler	0.003**	0.033***	-0.037***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 52: Door-to-door paper collection marginal effects on the commitment to paper recycling

		Marginal effects of a door-to-door paper collection on probability of an household being a paper...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a metal...	nonrecycler	-0.142***	0.111***	0.031**
	moderate recycler	-0.199***	0.123***	0.076***
	diligent recycler	-0.201***	0.074	0.127***
given that the household is a plastic moderate recycler and a metal...	nonrecycler	-0.205***	0.091**	0.113***
	moderate recycler	-0.179***	0.016	0.163***
	diligent recycler	-0.128***	-0.071**	0.199***
given that the household is a plastic diligent recycler and a metal...	nonrecycler	-0.147***	-0.045	0.191***
	moderate recycler	-0.093**	-0.109***	0.202***
	diligent recycler	-0.024**	-0.087***	0.111***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 53: Door-to-door paper collection marginal effects on the commitment to metal recycling

		Marginal effects of a door-to-door paper collection on probability of an household being a metal...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a plastic non recycler and a paper...	nonrecycler	0.047***	-0.030***	-0.017**
	moderate recycler	0.059***	-0.018	-0.041**
	diligent recycler	0.040***	0.007	-0.047**
given that the household is a plastic moderate recycler and a paper...	nonrecycler	0.033**	0.012	-0.045***
	moderate recycler	0.026**	0.033**	-0.059***
	diligent recycler	0.012**	0.034**	-0.046***
given that the household is a plastic diligent recycler and a paper...	nonrecycler	0.013	0.046***	-0.059**
	moderate recycler	0.007	0.048***	-0.055***
	diligent recycler	0.001*	0.015***	-0.016***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.

Table 54: Door-to-door paper collection marginal effects on the commitment to plastic recycling

		Marginal effects of a door-to-door paper collection on probability of an household being a plastic...		
		nonrecycler...	moderate recycler...	diligent recycler...
given that the household is a metal non recycler and a paper...	nonrecycler	0.050***	-0.043***	-0.007*
	moderate recycler	0.103***	-0.066***	-0.038**
	diligent recycler	0.073***	-0.006	-0.067**
given that the household is a metal moderate recycler and a paper...	nonrecycler	0.077***	-0.041**	-0.036**
	moderate recycler	0.069***	0.012	-0.081***
	diligent recycler	0.027***	0.052**	-0.079***
given that the household is a metal diligent recycler and a paper...	nonrecycler	0.057**	0.036	-0.092***
	moderate recycler	0.026**	0.086***	-0.111***
	diligent recycler	0.003*	0.028***	-0.031***

1%, 5% and 10% significance are expressed through *, ** and ***, respectively.