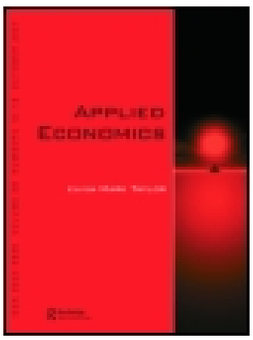

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The determinants of household recycling: social influence, public policies and environmental preferences

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ABSTRACT

Our article aims at understanding the determinants of households' selective waste-sorting behaviours, based on data from an original survey of 694 individuals in the French Provence–Alpes–Côte d'Azur region. The applied literature focuses mainly on countries with high recycling rates. We focus on a region with the lowest recycling rate in France, a country that recycles less than the European country average. We first apply polychoric principal components analysis to reduce the number of explanatory variables to a set of six factors. In a second step, we use a probit model to estimate the probability of waste sorting as a function of these factors. This model tests several hypotheses emerging from the recent literature on behavioural economics applied to households' selective sorting. This literature pays particular attention to the social influence on recycling behaviour, which has been studied mostly by sociologists and psychologists. The results of our empirical analysis confirm some of the findings in the literature. However, they also highlight some unique features, such as social influences having a negative impact on recycling. This finding contrasts with most of the literature, which finds a positive relationship of social influence on pro-environmental behaviour.

KEYWORDS

Recycling; waste; public policy; econometric modelling

JEL CLASSIFICATION

D12; Q58; Q56

I. Introduction

In the twenty-first century, environmental issues have become a priority for the international community. The significant increase in wealth at the international level has been accompanied by an increase in the production and consumption of goods and services. The amount of product packaging has grown as a result of offensive marketing methods, shorter product life cycles and multiple complementary consumption goods. However, the amount of packaging-generated waste is not generally taken into account despite its huge contribution to the increase in household waste.

In France, the waste management sector is responsible for national environmental protection activities. In 2011, the cost of environmental protection was estimated at 46 billion. Spending on waste management accounted for 33% of total spending, with expenditure on other areas (e.g., air, noise, soil and biodiversity) varying between 4% and 8%.

The waste situation in France[1] has become critical; waste volumes are growing continuously and waste management is at the core of current environmental policy. Several economic policies have been implemented in the past, but it was not until the Grenelle environment meeting in 2007 (Grenelle de l'Environnement) that a specific plan for waste management was formulated. The target was to reduce the amount of waste going to landfill or incineration by 15%, and to reduce waste production by 7% over 5 years. The national medium-term target is to reduce annual production of waste to an average 200 kg per household. This has made reducing packaging and increasing recycling the priority areas. However, there is a gap between policy objectives and the implementation of policy by local authorities

In some French regions, the situation is particularly acute; for example, in 2011, in the Provence–Alpes–Côte d'Azur (PACA) region, the amount of waste per inhabitant (e.g., selective waste collection, waste, green waste and bulky waste) was 730 kg, compared with the annual average for French households of 592 kg.[2] Recycled waste shows a similar

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[1]See 'The evolution of waste volume in municipalities of the PACA region' (Appendix Fig. A1 and Tables A1).

[2]Source: ADEME (2011).

trend, with only 56 kg per inhabitant for the PACA region, compared with 77 kg nationally. Eighty per cent of recycled waste comes from packaging. Although significant progress has been made in recycling, a considerable amount of waste is still either burnt or landfilled. To minimise these types of disposal, it is important to make policy choices based on an assessment of consumer needs and behaviours and, then, to change consumer behaviours to increase the focus on recycling.

Since the early 1980s, various types of public policies have been formulated and implemented in many countries, aimed at reducing solid waste and increasing recycling. Palmer, Sigman, and Walls (1997) employ a theoretical model and econometric simulation to show the impacts of various economic policy options related to waste reduction. They compare three policies aimed at providing economic incentives for reducing municipal waste: a consignment system, a recycling subsidy and an advance fee for disposal. Bartelings and Sterner (1999) analyse the cost of recycling and waste disposal in three Swedish communities which use three different structures (i.e., weight-based, frequency-based and flat fees). Dijkgraaf and Gradus (2004) study different pricing systems in Dutch municipalities (i.e., based on weight, frequency, volume and number of bags). The essential question is how to limit the amount of waste produced through the introduction of various economic policies. Market instruments (e.g., taxes or fees) and regulatory instruments (e.g., norms) have been at the centre of the debate, and standards and emissions limits have been set for firms in order to limit waste production at source. However, the discussion has moved rapidly to a market-based argument. For a product with a waste component, it is straightforward to apply a direct tax or charge. However, the weakness of taxes and inelastic demand limit the scope of these taxes on the overall volume of waste. Other economic policies have been proposed alongside a push for greater consumer (i.e., waste generator) awareness.

Furthermore, we need to qualify and understand the role of public institutions in waste management. Institutional mechanisms and organised waste collection and treatment by municipalities could have a significant impact on overall waste management performance. Several studies, conducted primarily in the United States, have sought to estimate waste-related costs and to understand their evolution, based on econometric models and panel data.

Numerous national and regional trajectories have been explored in the field of waste management. However, there is a lack of consensus on the optimal policy. Local contexts and consumer behaviours vary, but highlight the importance of consumers in waste management.

The present article examines the factors that influence agents' waste-sorting behaviours, based on the French PACA region – an area with one of the worst recycling rates observed in France[3] – using original data. The existing literature generally focuses on areas where environmental preferences and policies are strong (e.g., Berglund (2006) for Sweden and Brekke, Kipperberg, and Nyborg (2010) for Norway). Our data are from an online survey conducted in 2012–2013 in the PACA region. We construct a probit model to test the hypotheses of the recent literature on behavioural economics applied to households' selective sorting. We are interested in whether the inhabitants of the PACA region have certain characteristics that result in poor waste-sorting behaviour. The literature focuses, in particular, on the social influence on recycling behaviour, which, so far, has been studied mostly by sociologists and psychologists. The results of our empirical analysis confirm some of the findings in the literature. However, it also reveals some unique features. For instance, we show that social influence has a negative impact on recycling – a finding that conflicts with most of the literature, which finds a positive relationship between social influence and pro-environmental behaviours.

Section II reviews the waste management literature and identifies the hypotheses we test in the econometric analysis. Section III provides the results of our survey on household recycling behaviour in the PACA region. The survey results provide unique and original data on individual behaviours and household preferences, along with participants' views on the waste infrastructures in their communities. Section IV presents the empirical study based

[3]'Eco–emballage' in 2014 shows the ranking of PACA region compared to others French region (Eco–emballage 2014 shows the rankings for the PACA region compared to other French regions (http://www.emballages.fr/sites/default/files/documents/). Figures A2 and A3 show waste ranking for France compared to other European countries.

on a polychoric factor analysis to treat survey responses, and a probit estimation for the determinants of recycling behaviours. Section V concludes.

II. Economics, sociology and psychology literatures on waste management

This review of the literature on solid waste management is organised according to four themes: economic instruments, information and equipment policies; residential conditions; environmental preferences and social influence. These themes provide the basis for the hypotheses tested in the econometric analysis.

Economic instruments (e.g., monetary incentives) affect the benefits and costs of different individual choices. Financial taxes are often seen as complementing incentive fees or taxes. The former are used to finance the costs of waste management; the latter are used to encourage individuals to change their behaviours. Incentive fees act to reduce pollution by taxing polluters for their pollution (Pigou 1924). A tax incentive to pollute less (i.e., produce less waste) provides an option for those individuals who would rather pay the tax than change their behaviours. Incentive fees (e.g., pay-as-you-throw) seek to change household behaviours while supporting the management of household waste services. Miranda et al. (1994) classify countries according to their recycling programmes. Their results show that imposing a direct payment on households allows for a more efficient waste disposal system and increases the amount of waste that is recycled. Incentive fees are at odds with the traditional system of financial taxes, which applies a flat rate per household regardless of the quantity of waste generated by the household. Studies show that the amount of waste generated by households decreases with the imposition of user fees and programmes that increase public awareness of waste issues. Most economic studies agree that a flat-rate pricing system that is independent of the amount of waste produced is undesirable. The basic choice is between an 'input tax' and a 'downstream tax' (Bartelings, Dellink, and van Ierland 2004). An input tax might consist of a deposit system or waste tax where waste treatment costs are embedded in the price of the product. An 'output tax' could be implemented as a system of tariff rates such that the amount of the tax depends on the real quantity of generated waste or certain indicators (e.g., number of household members). A downstream tax is an incentive tax. In Bilitewski (2008) and Reichenbach (2008), incentive fees measure the amount of waste generated by each individual and then calculate the costs of its management. A downstream tax can educate individual waste producers who are taxed according to the amount of waste they generate. The more people exhibit responsible behaviour by sorting their waste, the less they will be obliged to pay. However, this solution generates negative externalities because individuals who are taxed according to the amount of waste they produce may be driven to dump their waste illegally to avoid paying its real cost. Fullerton and Kinnaman (1996) and Bartelings, Dellink, and van Ierland (2004) put the positive effects of this incentive into perspective by showing that a reduction in collected waste might result from antisocial behaviour. Studies suggest that we can expect significant levels of illegal disposal in response to a price-based waste policy.

These findings lead to our first hypothesis:

Hypothesis 1: Tax policy positively influences sorting behaviour.

In addition to waste management policy, communities are implementing information and equipment policies to support and encourage recycling. Studies show that user fees may limit the waste generated by households if programmes that increase public awareness of waste issues accompany these fees. For example, a study by Iyer and Kashyap (2007) shows that information policies are less efficient than incentive policies. However, their effects persist after they have been withdrawn, which is not the case with incentive policies. Information policies have a smaller, but longer lasting, effect than incentive policies. Several studies show also that information and knowledge are essential to increase recycling. Granzin and Olsen (1991) show that the most frequent recyclers are those who spend more time learning and accumulating knowledge about environmental problems from various sources (e.g., books, magazines, newspapers, television). In general, specific knowledge on waste sorting and recycling is positively correlated with selective sorting behaviour Oskamp et al. (1991). Research by De

Young (1988) shows that levels of knowledge differentiate recyclers and nonrecyclers, with recyclers being better informed about the subject. De Young (1988) shows that nonrecyclers explain their nonparticipation in recycling as resulting from a lack of information about how to sort waste. Information policies are needed; but, without a suitable infrastructure to facilitate recycling, sorting will not increase. Knussen et al. (2004) show convenience increases sorting behaviour, and discuss the perception that sorting requires specific resources. Peretz, Tonn, and Folz (2005) find that more convenient recycling programmes and higher income lead to higher recycling rates. Folz (1999) considers the positive effect of a reduction in the amount of effort required on increased selective sorting. For example, the distance that the waste has to be transported to be recycled can be reduced by eliminating the need to sort and implementing kerbside collection of recyclable materials. Berger (1997) shows that easy access to a recycling point is intermediate between socioeconomic factors and recycling practices. Other studies, including Guagnano, Stern, and Dietz (1995), show that behavioural factors associated with external conditions influence behaviour. Their main results show that the existence of a recycling bin is positively correlated with sorting behaviour. Similarly, Vining and Ebreo (1990) show that lack of equipment has a negative influence on the adoption of recycling behaviour. Abbott, Nandeibam, and O'Shea (2011) show that recycling performance in the UK improved with the introduction of kerbside collection, which eases sorting. However, they show also that there are differences between local authorities, who are free to implement different recycling policies (e.g., different frequency of collection and different size and type of containers). Moreover, the consumer policy paper by Thøgersen and Ölander (2003) shows that a fee-paying group household delivers more recycling material and compost than a non-tax-paying group. These results are consistent with the proposition that government regulation communicates norms and responsibilities and, thus, can enhance internalised motivation in the form of moral norms.

These results lead to our second hypothesis:

Hypothesis 2: Collective mean and provision of individual containers positively influences sorting behaviour.

Location, furthermore, has an impact on the availability and practicality of sorting equipment. Many studies (McEvoy III 1972; Samdahl and Robertson 1989; Schwartz and Miller 1991; Zimmer, Stafford, and Stafford 1994) find a positive relationship between residential location and concern for the environment. Zimmer, Stafford, and Stafford (1994) demonstrate that urban dwellers are more likely to care about environmental issues, while Berger (1997) shows that the size of the residential area is positively related to sorting activity.

Based on these results, we can formulate our third hypothesis:

Hypothesis 3: Residential conditions affect recycling.

Many authors consider altruistic behaviour in discussing pro-environmental attitudes. De Young (1985) finds that intrinsic motivation and personal satisfaction are the most frequent reasons for inhabitants choosing to recycle, which suggests that people act responsibly, not in the expectation of a reward, but for the personal satisfaction achieved by their action. De Young and Kaplan (1985–1986) show that people interested in ecology are guided, not by economic incentives for recycling, but by the feeling that what they do is useful and beneficial to society.[4] Abbott, Nandeibam, and O'Shea (2013) show that the 'warm-glow', or personal satisfaction an individual derives from an activity independent of any consideration of its result (Andreoni 1990), is a determinant of recycling behaviour. Hopper and Nielsen (1991) show that recycling behaviour is altruistic behaviour guided by personal standards. McCarty and Shrum (2001) invoke the concepts of individualism and collectivism. They show that individualism is negatively correlated with beliefs about the difficulties associated with recycling, while collectivism is positively correlated with beliefs about the importance of recycling. Collectivist (i.e., altruistic) individuals are convinced of the importance of recycling because they consider the future societal

[4]This idea refers to the crowding out effect. Ballet et al. (2007) define the crowding-out effect as a reduction in individuals' voluntary contributions after state intervention. They show that a convergence effect occurs when individuals increase their voluntary contributions following state intervention.

benefits of this behaviour. Individualists confer little importance on recycling because their focus is on the short-term benefits for themselves. Schultz and Oskamp (1996) show that environmental attitudes are positively correlated with participation in an experimental recycling programme. They insist on the essential role of recycling efforts in the conversion of attitudes into actual behaviours. The idea is that, if the level of effort required to recycle is high, only those with strong pro-environmental attitudes will be likely to recycle. Conversely, if the level of effort required to recycle is low, a slight or medium concern for the environment might be sufficient to induce good behaviour.

These findings lead to two further hypotheses:

Hypothesis 4a: A 'pro-environmental attitude' is positively correlated with selective sorting behaviour.

Hypothesis 4b: A 'non-environmental attitude' is negatively correlated with selective sorting behaviour.

Primarily, it is sociologists and psychologists who have developed the concept of social influence, and there is a lack of empirical research on the economic impact of the social environment on recycling behaviour. Several studies (Cheung, Chan, and Wong 1999; Courcelle et al. 1998) suggest that social pressure has a significant influence on consumer engagement in pro-environmental behaviours (e.g., selective sorting). Ajzen and Fishbein (1980) define a subjective standard in their theory of reasoned action. They suggest that perceived social norms or social pressure can be measured as individual beliefs related to the expectations of various social referents (e.g., family, neighbours, friends) about their behaviour, and the incentives to comply. They assume that an individual will adopt a behaviour if he/she feels that his/her neighbours attach importance to it. In the case of waste, many studies examine the relationship between social norms and recycling, although their findings do not always agree (Nyborg, Howarth, and Brekke 2006; Brekke, Kipperberg, and Nyborg 2010; Viscusi, Huber, and Bell 2011). Brekke, Kipperberg, and Nyborg (2010)'s study, based on survey results, tests the social interaction between 'duty orientation'[5] and Norwegian households' behaviours in relation to glass recycling. They believe that responsibility ascription is an inference (the result of the learning process) – not a choice – for a duty-oriented person. Like Nyborg, Howarth, and Brekke (2006), the authors argue that, when unsure of what is the right action, people infer their individual responsibilities by looking at others' behaviours. Decisions may be motivated by duty-oriented recycling, leading to interaction effects through social learning about individual responsibility. Brekke, Kipperberg, and Nyborg (2010) distinguish between the direct effect, which is not affected by the individual's level of uncertainty about the supposed behaviour of peers, and the indirect effect, which is due completely to this type of uncertainty (i.e., the more respondents are confused about their peers' recycling behaviours, the less they will be willing to accept responsibility). Brekke and colleagues show that respondents' willingness to accept recycling is influenced by their beliefs about others' behaviours. Thus, peer behaviour influences individuals, and they act responsibly based on their certainty about peers' behaviour. Hopper and Nielsen (1991) explore the idea that selective sorting is a form of altruistic behaviour that is guided by norms. They demonstrate that recycling behaviour is compatible with Schwartz (1977)'s altruism model, according to which behaviour is influenced by social norms, personal norms and an awareness of consequences. Recycling is costly for individuals in terms of time and energy. There is no immediate or individual reward from recycling, but it is beneficial for society, especially in the future. Hopper and Nielsen (1991) show that a programme that involves 'block leaders,' that is, residents who encourage their neighbours to recycle, influences altruistic norms and increases recycling behaviour. According to Bénabou and Tirole (2006), although some people are genuinely altruistic, others see good deeds (e.g., charitable donation) as an investment in their social image, to establish or maintain social esteem; they are concerned about what others think of them. The guilt-averse model proposed by Ellingsen et al. (2010) works in a similar way; the authors suggest

[5]Brekke, Kverndokk, and Nyborg (2003) defines a duty–oriented individual as a person who prefers a self–image of a socially responsible person who suffers loss of self–image if he/she does not fulfil his/her perceived personal duty to recycle

that people care about what others expect of them and that they develop a sense of guilt if their behaviour falls below these expectations. Abbott, Nandeibam, and O'Shea (2013) show that social norms have an effect on recycling behaviour. They recommend the implementation of measures to enable social norms, rather than imposing recycling levels on individuals. For instance, setting up a kerbside collection programme makes recycling more visible to neighbours, which promotes a social norm to recycle. Hornik et al. (1995) demonstrate the strong relationship between social influences and the propensity to recycle. They show that the social influence of neighbours, friends and family members encourages recycling behaviour. They define social influence as friends', neighbours' and family members' support for recycling.

From these results, we can formulate our fifth hypothesis.

Hypothesis 5: 'The social influence' variable is positively correlated with selective sorting behaviour.

The results for socioeconomic characteristics vary to a greater extent and are, sometimes, contradictory. Results for the influence of age are mixed. Some studies show that older people tend to recycle more (Granzin and Olsen 1991), although Oskamp et al. (1991) find no correlation between age and sorting behaviour.

The results for gender are similarly inconclusive; some studies show that women are more involved in sorting (Granzin and Olsen 1991; Stern, Dietz, and Guagnano 1995), and some find no correlation between gender and sorting behaviour (Vining and Ebreo 1990).

In relation to income, Granzin and Olsen (1991) find no significant relationship between income and adoption of sorting behaviour, although Vining and Ebreo (1990), Oskamp et al. (1991), and Berger (1997) highlight a positive significant relationship between individual income and recycling.

Finally, Berger (1997) finds a positive and significant relationship between education and sorting behaviour, while Granzin and Olsen (1995), Vining and Ebreo (1990) and Oskamp et al. (1991) find no significant relation.

III. A survey of consumption patterns and consumer choices in the PACA region

Data and survey description

This article proposes an analysis based on a survey of consumption patterns and waste management in the PACA region in France. The survey was conducted between 15 August 2012 and 15 January 2013 on LimeSurvey's online platform hosted on the University Nice Sophia Antipolis server. It provides data on the waste management behaviours of 539 individuals. The survey was designed to investigate the determinants of recycling behaviour.[6]

The questionnaire focuses on three main household waste-sorting activities. The first part deals with consumption patterns, consumers' knowledge about environmental practices and the importance of the environment in their purchasing decisions. The second part focuses on respondents' selective sorting behaviours, the context (e.g., the different options available for waste collection, public policies and information on selective sorting from local authorities) and respondents' views on public policies, especially waste policy. The third part of the questionnaire collects respondents' general characteristics (e.g., date of birth, place of residence, income).[7]

We built an initial sample of 6000 representative individuals based on the distribution of the population in the PACA region, socioprofessional categories (corresponding to regional data provided by INSEE) and gender distribution. We obtained 737 responses and 539 complete responses from the initial sample of 6000 individuals.[8] In order to check the representativeness of our sample, Table 1 compares the population distribution in the PACA Region (using INSEE data) and in our sample by occupational category, departments and gender. Our sample comprises 51.02% women (compared with 52.9% in 2012 INSEE statistics for the PACA Region) and 48.98%

[6]The survey design is presented in Appendix Fig. A4.

[7]To increase the number of respondents, we asked local authorities (i.e., municipalities), political parties, universities and other local organisations to disseminate the survey. Some advertised it in local newspapers or on websites; others used their social networks to encourage people to participate in the online survey. We also contacted political organisations and asked them to inform their members about the survey; two major parties responded favourably.

[8]The data collection methodology is summarised in Appendix Table A2.

Table 1. Distribution of the demographic variables.

	Population		Sample		
Variable	Number	Per cent	Number	Per cent	Weight
Occupational category					
Farmers–Farm workers	19 442	0.5	3	0.56	0.89
Craftsmen, storekeepers, businessmen	178 984	4.4	19	4.08	1.08
Professional – executives	320 580	7.8	53	9.83	0.79
Intermediate profession	549 800	13.4	73	13.54	0.99
Employee	694 450	17	102	18.92	0.9
Workmen	424 709	10.4	58	10.76	0.97
Without employment	1 905 495	46.5	231	42.86	1.08
Total	4 093 461	100	539	100	
Department					
Bouche du Rhône	1 984 784	40.2	200	37.11	1.08
Alpes Maritimes	1 082 014	21.9	212	39.33	0.56
Var	1 021 669	20.7	75	13.91	1.49
Other departments	847 109	17.2	52	9.65	1.78
Total	4 935 576	100	539	100	
Gender					
Man	1 928 451	47.1	264	48.98	0.96
Women	2 165 010	52.9	275	51.02	1.04
Total	4 093 461	100	539	100	

men (compared with 47.1% in 2012 INSEE statistics for the PACA Region). Distributions according to gender are close enough to negate any need to calculate post-stratification weights to correct for eventual biases. The sample is representative also of occupational categories in the PACA Region. The weights calculated for each category are always close to 1. In relation to departments, post-stratification correction is needed (Himelein 2013; Levy and Lemeshow 2013). For example, 39.33% of the sample respondents live in Alpes–Maritimes, whereas this department represents only 21.9% of the PACA Region. We apply a weight of 0.56 to correct this bias.[9]

Preliminary statistics

Table A3 presents the mean, minimum and maximum values and standard deviations of some of the survey questions. Eighty-one per cent of respondents said they sorted their waste. However, this result does not mean that households recycle all the time, and recycle all materials (see Fig. 1). For example, 20.8% of household never recycle glass, 3% recycle glass sometimes, 4.6% do so occasionally and 71.6% of respondents always recycle glass. The reverse trend was observed for organic waste: 81.3% never recycle organic waste and only 16.9% of respondents always recycle organic waste. This difference may be due to the sorting/collection facilities; 92% of respondents have a rubbish bin, 81% have a recycling bin and only 20% have a composter. Forty-three per cent declared being satisfied or very satisfied with the efficiency of their Garbage Collection Stations (GCS). Among those who considered them inefficient, 24% said they were too far from their home; 15% said that they were often full and 8.5% said that more GCS were needed. Forty-one per cent of respondents live in individual housing and 22% live in a rural area. Table 2 shows there is a high propensity to recycle (94%) among people living in rural areas and among house-dwellers, against 79% for urban areas. The trend is similar for the difference between people who live in houses and people living in blocks of flats. Residents of individual houses recycle more than flat-dwellers (88% versus 75%). Home-owners recycle slightly more than renters. Finally, sociodemographic characteristics show that the propensity to sort waste is lower in younger people (under 25 years) and increases with age. We note that sorting behaviour also increases with income; the highest income households sort more.

IV. Empirical evidence

Polychoric factor analysis

The literature review shows that the determinants of selective sorting behaviour include specific public policies (e.g., taxes, penalties, information, deposit policy, infrastructure, communication and waste

[9]Note that a potential bias is inherent in this kind of survey design: respondents may have specific characteristics which are correlated with their sorting behaviours.

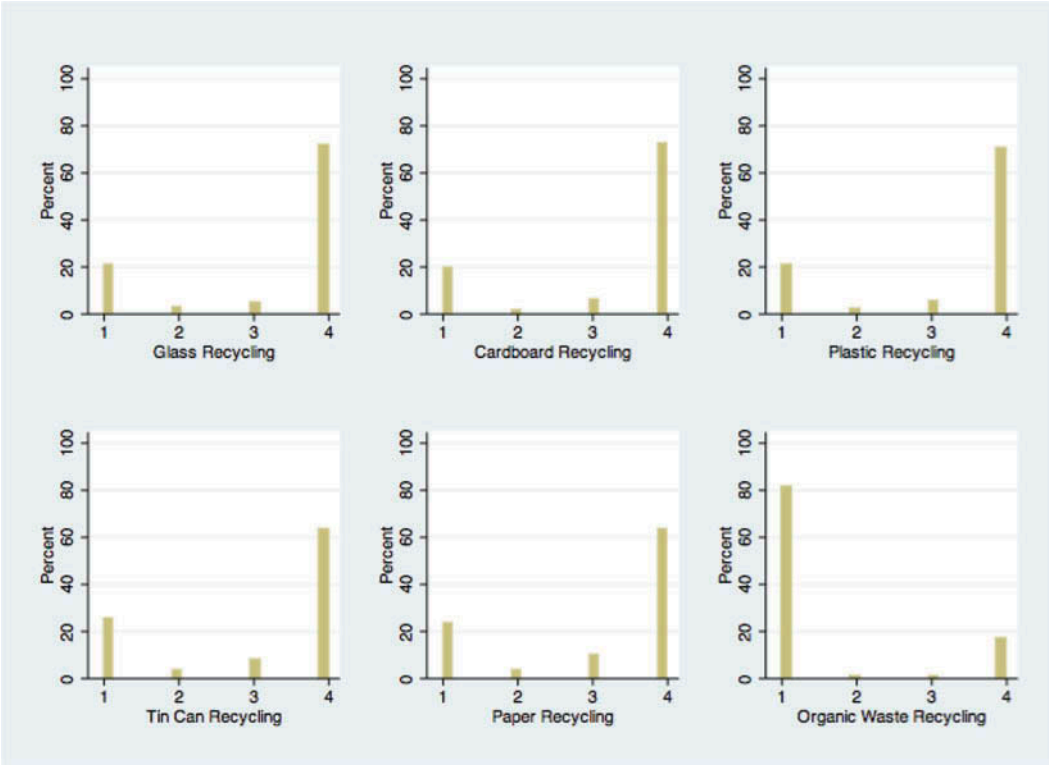

Figure 1. Distribution of recycling intensity by material type. *Source*: These variables are constructed from the responses to the questions: How frequently do you sort your glass/cardboard/plastic/metal/paper/organic waste? (Never/A few times/Occasionally/always).

Table 2. Recycling by housing area and by type of housing.

	Habitat area				Housing		
Recycling	Urban area	Rural area	Total	Recycling	Apartment	House	Total
No recycle	85	16	101	No Recycle	78	23	101
Recycle	336	102	438	Recycle	242	196	438
Total	421	118	539	Total	320	219	539

container availability), individual preferences (e.g., pro-environmental or nonenvironmental), individual behaviour (e.g., social influence) and residence-related characteristics (e.g., place of residence and type of housing). All of these elements were covered by the 22 questions in the questionnaire.[10]

Before the probit analysis, which tests the propensity to sort selectively, we conducted a polychoric factor analysis. The first step is to implement factor analysis. Factor analysis provides an empirical base by creating fewer (but independent) variables from the many highly correlated variables.[11] This analysis generates a set of all possible factor axes, and arranges them based on their eigenvalues in a correlation matrix. The eigenvalues represent the variance in each of the axes generated. This technique also reduces multicollinearity among the explanatory variables; although the variables included in these factors are correlated, the factors are not. The new variables are the 'factor axes'. Each variable is correlated with every other factor although the correlations may be weak. In order to put a label on each factor, we attach each of the variables to the factor with which it is most correlated. Thus, for each factor, a number of variables are ignored. The remaining variables allow a label to be attached to each factor.

The above-described procedure is applied to the 22 variables extracted from our questionnaire results, in six homogeneous factor groups. We select the factor axes with an eignenvalue above or near one. Six

[10]See 'Survey questions on consumption patterns in the PACA region' (Appendix Table A4).
[11]Cronbach's alpha, a coefficient of reliability used to test whether items are sufficiently interrelated to justify their combination in an index, is estimated at 0.72.

Table 3. Factor analysis.

Item	Loading	Item	Loading
Factor 1: Pro-environmental attitude		**Factor 4: Not environmental**	
Environmental impact	0.4491	Environmental indifference	0.7191
Change behaviour to higher cost	0.9184	Environmental interest	0.6935
Pay more	0.9372	Financial gains	0.6776
Environmental sacrifice	0.6999	Duty recycling	−0.3536
Eigenvalue:	**4.40374**	**Eigenvalue:**	**1.70991**
Factor 2: Collective mean		**Factor 5: Tax policy**	
Recycling coach	0.7476	Policy tax on other	0.9041
Sorting brochure	0.8035	Policy tax on myself	0.9212
Advertising campaign	0.8178		
Garbage collection station full	−0.5972		
Garbage collection station far	−0.4367		
Eigenvalue:	**2.81978**	**Eigenvalue:**	**0.96367**
Factor 3: Social influence		**Factor 6: Containers**	
Opinion of loved ones	0.8678	Rubbish bin	0.5766
Opinion of neighbours	0.8906	Recycling bin	0.5603
Influence of neighbours	0.6590	Composter	0.6567
Influence of friends or loved ones	0.6406		
Eigenvalue:	**2.26166**	**Eigenvalue:**	**0.90452**

factors, representing 93.23% of the total variance, are selected. The first factor axis has a variance of 4.40374. This first factor explains 31.43% of the total variance. The second factor explains 20.12% of the total variance, the third 16.14%, the fourth 12.20%, the fifth 6.88% and the sixth explains 6.46% of the total variance. The correlation coefficient between these factors and the variables are presented in Appendix Table A5. Following this procedure, we labelled the six factors that are presented in Table 3.[12] The detailed statistics of these factors are presented in Appendix Table A6 and Fig. A5.

The first factor is labelled 'pro–environmental attitude'. It is based on the following variables: 'environmental impact' (i.e., the attention paid to the environmental impact of purchased products), 'pay more' (i.e., the ability to pay more for environmentally friendly products), 'environmental sacrifice' (i.e., the willingness to make daily sacrifices to promote environmental protection) and 'changing one's consumption at higher cost' (i.e., the capacity to change one's consumption patterns to protect the environment, even if it costs more).

The second factor, 'collective mean', includes variables related to the availability of local waste infrastructures (i.e., the proximity and the efficacy of GCS), and information about how and where to recycle (i.e., the existence of recycling coach, brochures on sorting, and municipal advertising campaigns).

The third factor is labelled 'social influence' and combines four variables: 'Opinion of loved', 'Opinion of neighbours', 'Influence of neighbours', and 'Influence of friends and loved'. These variables were constructed based on responses to the following respective questions: 'loved one's tell me that I should sort', 'I think the fact that my neighbours sort has or may have an influence on my willingness to sort' and 'I like to do what my neighbours or my family think I should do'. These questions capture the idea that an individual affected by 'social influence' cares about what others think about recycling (first and second questions), pays attention to what others thinks about his/her recycling behaviour (fourth question) and worries about others' recycling behaviours (third question).

The fourth factor is labelled 'not environmental'. It includes four variables related to lack of concern over environmental issues. First, 'Environmental indifference' captures individuals' beliefs that environmental consequences are so far in the future that they consider there is no reason to worry. Second, 'Environmental interests' captures whether individuals think there is too much concern expended on environmental issues. Third, 'Financial gain' asks individuals about their disposition to act in an environmentally friendly way even if this does not involve individual monetary gain. Finally, 'Duty recycling' captures whether individuals consider recycling to be a duty.

The fifth factor is labelled 'Tax policy'. It includes two variables revealing what individuals think about

[12]The different items included in each factor refer to a specific question in the survey. These questions are presented in Appendix Table A4.

what the effectiveness of incentive tax policy might be on residual waste.[13]

Finally, the sixth factor is labelled 'Individual containers'. It includes variables assessing the impact of an individual 'Composter', 'Rubbish bin' and 'Recycling bin' on individual recycling behaviour.

We apply a Mokken scale analysis,[14] and multiple correspondence analysis (MCA),[15] to check the consistency of our polychoric factor analysis results. The Mokken scale analysis generates five scales based on the same 22 variables used in the factor analysis. Most of the scales regroup the same items from our factor analysis, except for Scale 4 (i.e., 'collective mean'), which excludes two variables (i.e., 'GCS full, and GCS too far away') and includes 'Recycling bin'.[16] Therefore, we can consider that the results of the polychoric factor analysis are supported. On the basis of these results, we conduct an MCA, which allows us to calculate the scores for each variable appearing in the different factors.[17] These results are used for the probit regression, which allows us to check the robustness of the probit using the results of the polychoric factor analysis.

Econometric analysis

Table 4 show our independent variables used in econometric model of the literature. Having determined our factors, we apply a probit model to estimate their impact on the probability that an individual will undertake selective sorting. Our estimation of the determinants of recycling behaviour is in line with the following model:

$$\begin{aligned} Recycling_i = {} & \beta_0 + \beta_1 ProEnvironmentalAttitude_i \\ & + \beta_2 CollectiveMean_i + \beta_3 SocialInfluence_i \\ & + \beta_4 IndividualContainers_i + \beta_5 TaxPolicy_i \\ & + \beta_6 NotEnvironmental_i + \beta_7 Housing_i \\ & + \beta_8 HabitatArea + X_i + u_i \end{aligned}$$

As our sample is cross-sectional, we need to include a set of variables to control for individuals' socioeconomic characteristics (e.g., age, gender, department and occupational category) based on the questionnaire responses.

Table 4. Independent variables used in the econometric model.

Variables	Definitions	Sources
Dependent variable		
Recycling	The adoption of the recycling behaviour	
Environmental preferences		
Pro-environmental attitude	The preferences of individuals for the environment	De Young (1985), De Young and Kaplan (1985–1986), Hopper and Nielsen (1991)
Not-environmental	The lack of concern of individual for the environment	Schultz and Oskamp (1996), McCarty and Shrum (2001)
Public policy		
Tax policy	The point of view of individuals on the implementation of a tax policy	Miranda et al. (1994), Kinnaman (1996), Bartelings, Dellink, and van Ierland (2004), Bilitewski (2008)
Collective mean	The means of communication or infrastructure established by local communities	De Young (1988), Vining (1990), Granzin et Olsen (1991), Folz (1991), Oskamp et al. (1991), Guagnano, Stern, and Dietz (1995), Berger(1997), Knussen et al. (2004), Iyer and Kashyap (2007)
Other variables		
Social influence	The social influence can have the entourage of individuals	Ajzen et Fishbein (1980), Hopper and Nielsen (1991), Hornik (1995), Cheung, Chan, and Wong (1999)
Housing condition	Place of residence, type of housing and the fact of	Mc Evoy (1972), Samdahl and Robertson (1989)
	Having or not a composter	Zimmer, Stafford, and Stafford (1994), Berger (1997)
Socioeconomic variables		
Gender	Gender of individuals	Vining et Ebreo (1990), Stern, Dietz, and Guagnano (1995), Granzin and Olsen (1991)
Age	Age range of individuals	Granzin and Olsen (1991), Oskamp et al. (1991)
Education	Level of education	Granzin and Olsen (1991), Oskamp et al. (1991), Berger (1997)
Wage	Income range of individuals	Granzin and Olsen (1991), Oskamp et al. (1991), Berger (1997)

[13]Note that no such policy exist in the PACA Region where the preference is for a flat fee. As a consequence these questions referred respondents to a hypothetical situation.
[14]The Mokken scale analysis is a uni-dimensional scale that consists of hierarchically ordered items which measure the same underlying, latent concept.
[15]The MCA is a weighting method allowing data reduction for the categorical variable.
[16]The Mokken scale table is provided in Appendix Table A7.
[17]MCA examines the association among several variables. It reveals the different eigenvalues calculated. Theses value decrease and their sum is equal to the total inertia. It provides further information on modalities, such as coordinates, quality of representation, and the relative inertia of each modality by the number of dimensions selected. Then, using this information, we can focus on the modalities that have the best representation quality in the dimension and that contribute most to the formation of the dimension. See Table A10 in the appendix.

Table 5. Probit estimation results with post-stratification.

	With polychoric factor		With MCA axes	
	Probit	Marginal effects	Probit	Marginal effects
Dependent variable				
Recycling				
Independent variables				
Pro-environmental attitude	0.762***	0.135***	0.578***	0.104***
	(0.13)	(0.02)	(0.20)	(0.03)
Collective mean	0.865***	0.154***	0.883**	0.159**
	(0.28)	(0.05)	(0.41)	(0.07)
Social influence	−0.306***	−0.054***	−0.404***	−0.073***
	(0.07)	(0.01)	(0.14)	(0.02)
Not environmental	−0.418***	−0.074***	−0.170	−0.030
	(0.10)	(0.02)	(0.17)	(0.03)
Tax policy	0.246	0.043	0.097	0.017
	(0.17)	(0.03)	(0.14)	(0.02)
Individual containers	1.562***	0.277***	2.353***	0.423***
	(0.25)	(0.05)	(0.50)	(0.09)
Housing	0.604***	0.101***	0.747***	0.125***
	(0.19)	(0.03)	(0.20)	(0.03)
Habitat area	−0.352	−0.071	−0.334	−0.067
	(0.22)	(0.05)	(0.23)	(0.051)
Farmers–farm workers	−0.868	−0.240	−1.380*	−0.442
	(0.93)	(0.34)	(0.71)	(0.28)
Craftsmen, storekeepers, businessmen	0.875*	0.090 ***	1.111**	0.101***
	(0.46)	(0.02)	(0.49)	(0.02)
Professional executives	1.725***	0.133***	1.759***	0.136***
	(0.51)	(0.02)	(0.44)	(0.02)
Intermediate profession	0.531**	0.073***	0.456*	0.066**
	(0.25)	(0.03)	(0.24)	(0.03)
Employee	0.141	0.024	0.188	0.031
	(0.19)	(0.03)	(0.19)	(0.03)
Workmen	0.228	0.036	0.168	0.028
	(0.22)	(0.03)	(0.22)	(0.03)
Without employment	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Alpes Maritimes	0.475*	0.078*	0.394	0.066
	(0.26)	(0.04)	(0.27)	(0.04)
Bouches du Rhône	0.552**	0.092**	0.464*	0.079*
	(0.27)	(0.04)	(0.27)	(0.04)
Var	0.835***	0.101***	0.700**	0.091***
	(0.32)	(0.03)	(0.33)	(0.03)
Other departments	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Gender	−0.078	−0.014	−0.066	−0.012
	(0.15)	(0.03)	(0.15)	(0.02)
_cons	−1.017*		0.319	
	(0.49)		(0.28)	
N	539		539	

Notes: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$; standard errors are given in parentheses.

The results are presented in Table 5, which includes two probit estimations – the first based on polychoric factor analysis and the second on the axes generated by the MCA. But, in the discussion, we only comment the result with polychoric factor because there is no major difference between two estimations. In the discussion, we comment only on the results based on the polychoric factor because there are no major differences between the two estimations. Appendix Table A8 provides the results of the probit estimation without correction for sample bias.

The results of our econometric estimates show the correlations between our independent variables and the dependent variable.

First, the variables for individuals' environmental preferences ('Pro-environmental attitude' and 'Not environmental'), both have a significant impact on our dependent variable. 'Pro-environmental attitude' has a positive and significant impact on recycling behaviour. In relation to the marginal effects, we see that a 1% increase in 'Pro-environmental attitude' increases the probability of sorting by 13.5%. This positive relationship between pro-environmental attitude and recycling behaviour is in line with the findings in Schultz and Oskamp (1996), who suggest that their findings relate to important constraints associated with recycling. Our 'Not environmental' variable has a negative impact on recycling behaviour; a

1% increase in non-environmental behaviour reduces adoption of recycling behaviour by 7.4%.

These findings support Hypothesis 4a ('Pro-environmental attitude' variable is positively correlated with recycling behaviour) and its corollary Hypothesis 4b.

The variables related to the implementation of local public policies (i.e., 'Collective mean') are positively and significantly associated with recycling behaviour. In the same vein, 'Individual containers' have a positive impact on selective sorting. However, the 'tax policy' variable has no significant impact.

The 'collective mean' variable is positively correlated with sorting behaviour. If the infrastructure provided by the authorities increases by 1%, then the probability of adopting sorting behaviour increases by 15.4%. Better provision of information from local government on available waste management services is crucial for optimal sorting. Individuals need to know the routines and locally available facilities. De Young (1988) and Vining and Ebreo (1990) show that complexity can have a negative influence on sorting behaviour. This negative influence might be due to a lack of knowledge or lack of information about sorting. Questions such as 'How do we sort?', 'Where do we sort?' and 'Why should we sort?', need to be addressed, and this is usually best done through awareness campaigns organised by national institutions (e.g., ADEME) and local communities. The objective of these campaigns is to educate people and change their behaviours. Communications could focus, for example, on the benefits of recycling and/or the disadvantages of not recycling Lord and Putrevu (1998). Perrin (2004) provides evidence of successful communication campaigns related to kerbside recycling, while Knussen et al. (2004) show that, to be efficient, information policies need to be complemented by an adequate recycling infrastructure to facilitate sorting behaviour.

The presence of rubbish and recycling bins in the building is important. An increase in the availability of individual containers of 1% increases the probability of adopting sorting behaviour by 27.7%. While bins may be considered a necessity, provision or ownership of them is not systematic, and some buildings (especially older buildings and buildings in town centres) do not have dedicated spaces for rubbish and recycling bins. This requires more effort to dispose of rubbish and recycling. Moreover, without a daily visit to a GCS, residents are forced to store their rubbish and recycling. Guagnano, Stern, and Dietz (1995) show that proximity to a rubbish and recycling centre positively influences the adoption of sorting behaviour. Some newer buildings provide space for waste containers, but not provision for sorting; municipalities will usually supply free rubbish bins following a request from the building trustee or house-owner. According to our respondents, many households do not have sorting containers.

Finally, our econometric estimation shows that the 'tax policy' variable is not significant, and has no influence on individual sorting, although the sign is positive. Note that all municipalities in the region have the same 'billing' policy (i.e., a flat rate tax); therefore, all users pay the same amount for waste management. Under this tax regime, an individual who recycles pays the same amount as someone who does not. Moreover, the tax-related results were obtained from the responses to a question about a hypothetical tax. The hypothetical nature of this question might have affected respondents' answers; people might answer differently to a hypothetical question than if a tax had been implemented.

In the case of sorting policies, local governments expect people to understand that their participation in sorting affects the collective welfare. Because the personal gains from sorting are limited, free-riding behaviours may hamper the effectiveness of these policies (Pieters 1991). Incentive-driven policies (e.g., pricing policies for waste management) mean that free riders are penalised financially (Maystre et al. 1994; Bartelings, Dellink, and van Ierland 2004; Bilitewski 2008; Reichenbach 2008). If the community implements a pricing policy for waste management, which imposes a new constraint on agents; not all individuals will perceive and react to these obligations in the same way. Its imposition might generate negative behaviours from some individuals who resent being told how to behave. Before selective sorting became more generalised, individuals were not concerned about waste management policies. It is necessary for individuals to understand the importance of their roles in this process. Information and communication policies focus on the importance of sorting (using financial and ecological arguments) and the sorting process (i.e., how to sort), both of which are needed to reduce the gap between awareness and behavioural change.

The results for the impact of public policies support hypotheses 2 and 3; there is a positive correlation between collective mean and sorting behaviour, and there is a positive influence of individual container availability on recycling behaviour. We find no support for Hypothesis 1 with regard to the impact of tax policy.

Our analysis also considers social influence to identify social norms. Our results show that social influence has a significant and negative effect on recycling, meaning that neighbours negatively influence individual recycling behaviours. Social influence, as previously underlined, refers to the effect of what others think about recycling, paying attention to what others thinks about one's own recycling behaviour and worrying about others' recycling behaviours.[18]

Our econometric results reveal a negative and significant impact of social influence on sorting behaviour. A 1% increase in the social influence variable decreases the probability of adopting recycling behaviour by 3.06%. According to the social esteem model in Bénabou and Tirole (2006), individuals care about how others perceive them. They feel pleased if others admire them, and ashamed if the opposite applies.

An individual (who recycles or does not) can modify his or her behaviour to conform to the behaviour of neighbours. However, PACA residents fall far below the national average for recycling; therefore, the social norm in PACA is not to recycle.

Traditionally, scientists have assumed that social influence has a positive impact on people's recycling behaviours. However, our results contradict this assumption. This result is unexpected because most respondents claimed to be recyclers. For individual recyclers, we assume that this result is due to the negative influence of their non-recycling neighbours. For instance, individuals might be discouraged from recycling or discontinue it completely because they think it is futile in the face of neighbours' behaviours. Finally, the literature and our results show that social influence is crucial for recycling behaviour. However, contrary to several pioneering studies, we observe a negative correlation, which means that these results cannot be generalised. Despite these conflicting findings, this analysis should be standardised to provide a better understanding of social influence and improve or promote selective sorting behaviour in different communities and countries.

As confirmed by our econometric results, the variable related to housing is important for sorting; the 'housing' variable is positive and significant. When the dwelling house increases by 1%, recycling behaviour increases by 6.04%. Waste sorting requires some organisation, but it also requires bins to enable separation of different types of recycling. Individuals living in houses recycle more, perhaps because they have more room to store recycling bins compared to flat-dwellers. This finding confirms Zimmer, Stafford, and Stafford (1994) results, which show a link between residence location and environmental concern. In addition, shared recycling bins can become 'polluted' with nonrecyclable waste if residents do not adhere to or know about correct recycling behaviour. This observation suggests that an individual who recycles is more likely to do so if he/she does not share a recycling bin; we know what is in our own rubbish, but we do not know what is in other people's rubbish. Moreover, people living in houses may be less influenced by their neighbours' negative behaviours. We can confirm this insight with two additional probit estimations (see Appendix Table A11). We estimated separately the probabilities of adopting recycling behaviour by people who live in a house compared to residents of blocks of flats. Both models show a negative and significant relation between social influence and recycling. Thus, for people living in individual housing, if social influence increases by 1%, recycling behaviour decreases by 5.2%, whereas it decreases by 7.3% for people living in a block of flats. An additional constraint for apartment-dwellers is that bins/collection equipment may be located in another building. Furthermore, Zimmer, Stafford, and Stafford (1994) show that individuals living in rural areas are more likely to care about environmental issues; however, in our study, rural/urban area is not significant. Finally, our results show that socioeconomic characteristics have no impact on the adoption of recycling behaviour.

We also tested the adjustment quality of our model and its degree of prediction. The adjustment quality test shows that 84.42% of our predictions are

[18]To further analyse the dynamics behind this result would require specific data on individual social interactions and localisation (number of neighbours, visibility, etc.), not available from our survey.

good. The goodness-of-fit test allows us to accept our initial assumption of a good fit. Finally, using the data on recycling intensity by type of material, we estimated an ordered probit model. The results are presented in Appendix Table A9. The main part of our previous results is confirmed.

V. Conclusion and remarks

Refusing to comply with recycling behaviour means that consumers do not care about the increasing amount of waste and its environmental consequences. In the survey we conducted in the PACA region in France, some respondents indicated that they would be willing to change their behaviour if it did not involve too much additional cost and effort. This article investigates the determinants of household recycling with the help of a probit analysis using data from our survey.

Our results show that households' environmental preferences are important determinants and (positively or negatively) affect recycling. Municipalities responsible for managing household waste should obtain more information by administering surveys to households in their area in order to adapt their waste policies.

Collective mean – a variable combining equipment and information – has a positive impact on recycling. However, the variables for poor public provision (GCS too far away or too full) have a negative impact on recycling behaviours. Thus, as a consequence, municipalities have to develop equipment and control their efficacy. Individual containers and provision of composter have a positive impact. Municipalities should consider providing this equipment at no cost in order to improve the management of household waste.

These results confirm many studies of geographical areas with good household recycling rates. However, it finds a different impact of social influence. We find social influence to be significant, but negative, which contrasts with most of the literature. This result can be explained by our survey population being mostly not good recyclers. Therefore, the harmonisation that social influence is expected to create reduces recycling behaviours. To overcome this difficulty, municipalities should communicate on positive social norms enhancing recycling behaviours.

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Appendix

Table A1. The evolution of household waste (HW) and recycled waste (RW) volume of PACA department.

	2005		2007		2009		2011	
	HW (kg/hab)	RW (kg/hab)	HW (kg/hab)	RW (kg/hab)	HW (kg/hab)	RW (kg/hab)	HW (kg/hab)	RW (kg/hab)
Alpes-de-Haute-Provence	621.63	50.28	599.23	77.28	653.35	59.47	678.55	58.72
Alpes-Maritimes	708.6	43.74	721.26	57.24	729.64	61.52	770.35	65.57
Bouches-du-Rhône	721.69	35.11	635.83	39.59	695.45	40.94	698.18	42.21
Hautes-Alpes	716.6	84.9	710.51	83.15	759.51	86.69	750.97	91.06
Var	722.7	50.1	669.05	55.75	830.71	63.69	764.31	63.42
Vaucluse	652.18	49.21	660.11	49.36	682.24	57.51	711	59.49

Table A2. Sampling.

Department	Population (%)	Initial sampling (%)	Final sampling (%)	Return rate (%)
Alpes Maritimes	1 082 014 (21.9)	1315 (21.91)	212 (39.33)	(16.12)
Bouche du Rhône	1 984 784 (40.2)	2413 (40.21)	200 (37.11)	(8.23)
Var	1 021 669 (20.7)	1242 (20.7)	75 (13.91)	(6.04)
Vaucluse	546 314 (11.1)	664 (11.07)	40 (7.42)	(6.02)
Alpes de HP	161 241 (3.2)	196 (3.27)	7 (1.3)	(3.57)
Haute Alpes	139 554 (2.8)	170 (2.83)	5 (0.93)	(2.94)
Total	4 935 576	6000	539	**(8.98)**

Table A3. Summary statistics of the variables.

Variable	Mean	Std. dev.	Min.	Max.
Recycling	0.81	0.39	0	1
Glass recycling	3.27	1.23	1	4
Plastic recycling	3.26	1.23	1	4
Cardboard recycling	3.31	1.2	1	4
Paper recycling	3.13	1.26	1	4
Metal recycling	3.09	1.3	1	4
Organic waste recycling	1.54	1.13	1	4
Change behaviour to higher cost	0.52	0.5	0	1
Environmental impact	2.22	0.58	1	3
Regardful about environmental problems	4.27	0.76	1	5
Financial gains	1.59	0.9	1	5
Pay more	3.42	1.18	1	5
Duty recycling	4.35	0.83	1	5
Too much worry about environment	1.71	0.99	1	5
Environmental sacrifice	3.78	1.02	1	5
Environmental indifference	1.6	0.89	1	5
Rubbish bin	0.92	0.27	0	1
Recycling bin	0.81	0.39	0	1
Composter	0.2	0.4	0	1
Recycling coach	0.08	0.28	0	1
Sorting brochure	0.31	0.46	0	1
Advertising campaign	0.16	0.37	0	1
Garbage collection station far	0.24	0.43	0	1
Garbage collection station full	0.15	0.36	0	1
Influence of neighbours	2.87	1.35	1	5
Opinion of loved ones	2.34	1.21	1	5
Opinion of neighbours	2.06	1.05	1	5
Influence of friends or loved ones	2	1.04	1	5
Tax policy on me	0.54	0.5	0	1
Tax policy on others	0.28	0.45	0	1
Occupational category	5.5	1.58	1	7
Department	1.96	0.95	1	4
Gender	0.49	0.5	0	1
Housing	0.41	0.49	0	1
Habitat area	0.22	0.41	0	1

Table A4. Survey questions on consumption patterns in the PACA region.

Question	Questions	Variables names	Modalities
6.3	Would you be willing to change your modes of consumption (higher cost) to preserve the environment?	Change behaviour to higher cost	Yes = 1; No = 0
10	How much attention do you pay to the environmental impact of your purchases?	Environmental impact	No importance = 1 Moderate importance = 2 Great importance = 3
18	How about the following?		
	18.2. Acting for the environment is worthwhile only if there are financial gains	Financial gains	
	18.5. I am willing to pay more for products that are kinder to the environment	Pay more	Totally disagree = 1
	18.6. We consider recycling as a duty	Duty recycling	Somewhat disagree = 2
	18.7. We are too much worried about environmental issue	Environmental interest	Neither agree nor disagree = 3
	18.8. I am willing to make sacrifices every day to promote environmental protection	Environmental sacrifice	Somewhat agree = 4
	18.9. The impacts of climate change are so far in the future that I have no reason to worry	Environmental indifference	Totally agree = 5
20	Do you sort your waste?	Recycling	Yes = 1; No = 0
25	In your home or neighbourhood, what means do you have to manage your waste?		
	25.1. Rubbish bin	Rubbish bin	Yes = 1; No = 0
	25.2. Recycling bin	Recycling bin	Yes = 1; No = 0
	25.3. Composter	Composter	Yes = 1; No = 0
23	How frequently do you sort your		
	23.1. Glass waste	Glass recycling	
	23.2. Cardboard waste	Cardboard recycling	Never
	23.3. Plastic waste	Plastic waste recycling	A few times
	23.4. Metal waste	Metal recycling	Occasionally
	23.5. Paper waste	Paper recycling	All the time

(*Continued*)

Table A4. (Continued).

Question	Questions	Variables names	Modalities
	23.6. Organic waste	Organic waste recycling	
27	What are the resources put in place by your municipality to inform you about how to sort?		
	27.1 Visit recycling coach	Recycling coach	Yes = 1; No = 0
	27.2. Creation of sorting brochure	Sorting brochure	Yes = 1; No = 0
	27.3. Advertising campaign	Advertising campaign	Yes = 1; No = 0
29	You are not completely satisfied by the means implemented by your community because		
	29.1. Garbage collection stations are too far from home	Garbage collection station far	Yes = 1; No = 0
	29.2. Garbage collection stations are often full	Garbage collection station full	
31.1	Do you think tax policy implemented by your municipality is effective on yourself?	Policy tax on myself	Yes = 1; No = 0
31.2	Do you think tax policy implemented by your municipality is effective on others?	Policy tax on others	Yes = 1; No = 0
39	How about the following?		
			This is completely false = 1
	39.1. I think the fact that my neighbours sort, has or may have an influence on my willingness to sort	Influence of neighbours	This is false = 2
	39.2. Loved ones tell me that I should sort	Opinion of loved ones	It is neither true nor false = 3
	39.3. My neighbours tell me that I should sort	Opinion of neighbours	This is true = 4
	39.4. I like to do what my neighbours or my family think I should do	Influence of friends or loved ones	This is very true = 5
40	You are	Gender	Male = 1; Female = 2
41	What age range do you belong to	Age	Under 25 years = 1/Between 25 and 50 years = 2 Between 50 and 75 years = 3/Over 75 years = 4
44.1	Where do you live?	Habitat area	Rural area = 1; Urban area = 0
44.2	What kind of dwelling do you live?	Housing	Detached housing = 1; Group housing = 0
49	What is your occupational category	Occupational category	Farmers–farm workers = 1/Craftsmen, storekeepers, businessmen = 2 Professional – executives = 3/Intermediate profession = 4 Employee = 5/Workmen = 6/Housewife of housemen = 7 Student = 8/Unemployed or retired = 9

Table A5. Rotated factor loadings and unique variances for polychoric factor analysis.

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Uniqueness
Environmental impact	0.4921	0.1010	−0.0553	−0.0450	−0.1523	0.3544	0.5937
Change behaviour to higher cost	0.9504	−0.0214	−0.0757	0.0161	−0.1458	0.0979	0.0595
Pay more	0.9542	0.0210	0.0253	0.0308	−0.0681	0.009	0.0829
Duty recycling	0.3489	0.0532	−0.1413	−0.0112	−0.3207	0.2472	0.6914
Environmental sacrifice	0.7365	0.0541	−0.0253	−0.0428	−0.2164	0.1142	0.3923
Recycling coach	0.0336	0.7692	−0.0907	−0.0236	0.1369	0.1990	0.3401
Sorting brochure	0.0822	0.8160	0.0220	0.0558	0.0366	0.1773	0.2911
Advertising campaign	−0.0306	0.8124	−0.0654	0.0592	0.0019	−0.1530	0.3079
Garbage collection station full	0.1345	−0.5860	−0.0496	−0.1376	0.0832	0.0036	0.6101
Garbage collection station far	−0.1038	−0.4496	0.1115	−0.0147	0.1705	−0.3188	0.6437
Opinion of loved ones	−0.0567	−0.0358	0.8739	−0.0049	0.0183	−0.1071	0.2200
Opinion of neighbours	−0.0694	0.0112	0.8949	−0.0200	0.0785	−0.0011	0.1877
Influence of neighbours	0.0652	−0.1377	0.6569	0.0002	−0.0167	−0.0439	0.5430
Influence of friends of loved ones	0.0296	−0.0407	0.6387	−0.0622	0.0862	0.0562	0.5751
Composter	0.2052	0.1551	−0.0947	−0.0353	−0.0545	0.6337	0.5191
Recycling bin	0.1679	0.2762	−0.1015	0.0768	−0.2078	0.5311	0.5540
Rubbish bin	0.1187	0.0280	−0.0383	0.0626	−0.0035	0.5669	0.6584
Tax policy on me	0.1154	0.0750	−0.0496	0.9087	−0.0901	0.0224	0.1442
Tax policy on others	−0.0867	0.0177	0.0091	0.9228	0.0273	−0.0054	0.1397
Financial gains	−0.2877	0.0468	0.1280	−0.0519	0.6454	−0.0287	0.4785
Environmental indifference	−0.2523	0.0412	0.0276	−0.0498	0.6937	−0.0452	0.4482
Too much worry about environment	−0.2823	0.0882	0.0803	−0.0513	0.6621	−0.0950	0.4560

Table A6. Summary statistics of factor analysis.

Variable	Mean	Std. Dev.	Min.	Max.
Pro-environmental attitude	2.15	0.75	0.53	3.6
Collective mean	0.07	0.3	−0.47	1.18
Social influence	3.62	1.1	1.15	6.76
Individual containers	0.99	0.33	−0.28	1.83
Not environmental	2.4	0.78	0.51	5.24
Tax policy	0.78	0.43	0	1.62
N	539			

Table A7. Mokken scale analysis.

Item	Loevinger H coefficients	Item	Loevinger H coefficients
Scale 1: Pro-environmental attitude		**Scale 4: Collective mean**	
Environmental sacrifice	0.56152	Advertising campaign	0.48641
Duty recycling	0.32353	Recycling bin	0.47332
Environmental impact	0.43553	Recycling coach	0.57222
Change behaviour to higher cost	0.69514	Sorting brochure	0.61082
Pay more	0.57618		
H coefficients:	**0.51838**	**H coefficients:**	**0.53569**
Scale 2: Tax policy		**Scale 5: Not environmental**	
Policy tax on myself	0.89910	Financial gains	0.37396
Policy tax on other	0.89910	Environmental indifference	0.44079
		Environmental interest	0.43795
H coefficients:	**0.8991**	**H coefficients:**	**0.4176**
Scale 3: Social influence			
Influence of friends or loved ones	0.46557		
Influence of neighbours	0.48552		
Opinion of neighbours	0.61100		
Opinion of loved ones	0.59491		
H coefficients:	**0.53925**		

Table A8. Probit estimation results without post-stratification.

	With polychoric factor		With MCA axes	
	Probit	Marginal effects	Probit	Marginal effects
Dependent variable				
Recycling				
Independent variables				
Pro-environmental attitude	0.759***	0.135***	0.583***	0.104***
	(0.13)	(0.02)	(0.18)	(0.03)
Collective mean	0.821***	0.146***	0.823*	0.148*
	(0.29)	(0.05)	(0.46)	(0.08)
Social influence	−0.300***	−0.053***	−0.407***	−0.073***
	(0.07)	(0.01)	(0.15)	(0.03)
Not environmental	−0.422***	−0.075***	−0.175	−0.031
	(0.10)	(0.02)	(0.17)	(0.03)
Tax policy	0.256	0.046	0.100	0.018
	(0.18)	(0.03)	(0.15)	(0.02)
Individual containers	1.568***	0.279***	2.372***	0.425***
	(0.26)	(0.05)	(0.51)	(0.09)
Housing	0.605***	0.101***	0.754***	0.125***
	(0.19)	(0.03)	(0.20)	(0.03)
Habitat area	−0.328	−0.065	−0.314	−0.063
	(0.24)	(0.05)	(0.23)	(0.05)
Farmers–farm workers	−0.868	−0.241	−1.385*	−0.443
	(0.74)	(0.27)	(0.80)	(0.32)
Craftsmen, storekeepers, businessmen	0.878*	0.090***	1.118*	0.101***
	(0.56)	(0.02)	(0.57)	(0.02)
Professional executives	1.732***	0.133***	1.765***	0.135***
	(0.55)	(0.02)	(0.56)	(0.02)
Intermediate profession	0.532**	0.074***	0.456*	0.066**
	(0.25)	(0.03)	(0.25)	(0.03)
Employee	0.144	0.024	0.191	0.031
	(0.19)	(0.03)	(0.19)	(0.03)
Workmen	0.231	0.036	0.172	0.028
	(0.24)	(0.03)	(0.24)	(0.036)
Without employment	0.000	0.000	0.000	0.000

(*Continued*)

Table A8. (Continued).

	With polychoric factor		With MCA axes	
	Probit	Marginal effects	Probit	Marginal effects
	(.)	(.)	(.)	(.)
Alpes Maritimes	0.479*	0.079*	0.401	0.067
	(0.25)	(0.04)	(0.25)	(0.04)
Bouches du Rhône	0.560**	0.093**	0.471*	0.08*
	(0.25)	(0.04)	(0.25)	(0.04)
Var	0.809***	0.099***	0.683**	0.089**
	(0.34)	(0.03)	(0.33)	(0.03)
Other departments	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Gender	−0.088	−0.015	−0.080	−0.014
	(0.16)	(0.03)	(0.15)	(0.028)
_cons	−1.042*		0.315	
	(0.50)		(0.26)	
Pseudo R^2	0.2699		0.2709	
N	539	539	539	539

Notes: *$p < .1$; **$p < .05$; ***$p < .01$; standard errors are given in parentheses.

Table A9. Ordered probit estimation results by material type.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Glass recycling	Plastic recycling	Cardboard recycling	Paper recycling	Metal recycling	Organic waste recycling
Pro-environmental attitude	0.840***	0.734***	0.798***	0.747***	0.707***	1.511***
	(7.65)	(7.00)	(7.31)	(7.70)	(7.46)	(7.03)
Collective mean	0.719**	0.832***	0.836***	0.572**	0.472*	0.783*
	(3.20)	(3.55)	(3.56)	(2.79)	(2.36)	(2.48)
Social influence	−0.268***	−0.291***	−0.309***	−0.262***	−0.215***	−0.214*
	(−4.34)	(−4.69)	(−4.84)	(−4.44)	(−3.69)	(−2.14)
Not environmental	−0.407***	−0.410***	−0.383***	−0.311***	−0.354***	−0.463**
	(−4.41)	(−4.66)	(−4.36)	(−3.67)	(−4.32)	(−2.82)
Tax policy	0.017	0.119	0.050	0.067	0.174	0.173
	(0.11)	(0.84)	(0.34)	(0.50)	(1.31)	(0.73)
Individual containers	1.297***	1.762***	1.669***	1.686***	1.491***	5.958***
	(5.85)	(7.84)	(7.30)	(8.14)	(7.37)	(9.55)
Housing	0.515***	0.548***	0.547***	0.507***	0.143	0.990***
	(3.38)	(3.47)	(3.40)	(3.66)	(1.07)	(4.83)
Habitat area	−0.148	−0.298	−0.429*	−0.093	−0.170	0.116
	(−0.80)	(−1.64)	(−2.30)	(−0.55)	(−1.04)	(0.52)
Farmers–farm workers	−0.833	−7.590***	−0.738	−0.548	−6.973***	−4.429***
	(−0.85)	(−26.49)	(−0.71)	(−0.51)	(−28.11)	(−8.08)
Craftsmen, storekeepers, businessmen	0.551	0.292	0.279	0.384	0.591	0.586
	(1.68)	(1.14)	(0.84)	(1.28)	(1.90)	(1.52)
Professional – executives	1.056***	0.877**	1.253***	0.627**	0.602**	0.944**
	(4.03)	(3.18)	(3.96)	(2.83)	(2.70)	(3.03)
Intermediate profession	0.226	0.443*	0.427*	0.254	0.311	0.114
	(1.19)	(2.16)	(2.14)	(1.43)	(1.71)	(0.36)
Employee	−0.004	0.184	0.243	0.161	0.288	0.171
	(−0.02)	(1.08)	(1.39)	(0.98)	(1.79)	(0.64)
Workmen	0.301	0.184	0.239	0.318	0.048	0.041
	(1.42)	(0.88)	(1.20)	(1.56)	(0.26)	(0.13)
Without employment	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
Alpes Maritimes	0.566*	0.526*	0.440	0.580**	0.528*	0.423
	(2.38)	(2.24)	(1.93)	(2.59)	(2.40)	(1.02)
Bouches du Rhône	0.411	0.588*	0.544*	0.311	0.377	0.515
	(1.71)	(2.46)	(2.31)	(1.37)	(1.66)	(1.22)
Var	0.763**	0.863**	1.061***	0.739**	0.630*	0.483
	(2.78)	(3.10)	(3.62)	(2.78)	(2.31)	(1.05)
Other departments	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
Gender	0.046	−0.147	−0.028	0.048	−0.216	0.063
	(0.35)	(−1.12)	(−0.21)	(0.40)	(−1.76)	(0.31)
_cons	0.989*	1.185*	1.146*	1.535***	1.255**	10.699***
	(2.17)	(2.52)	(2.51)	(3.66)	(2.87)	(8.19)
_cons	1.119*	1.289**	1.231**	1.678***	1.383**	10.775***
	(2.44)	(2.74)	(2.69)	(3.99)	(3.15)	(8.23)
_cons	1.304**	1.534**	1.494**	2.048***	1.661***	10.887***
	(2.84)	(3.26)	(3.26)	(4.85)	(3.76)	(8.28)
N	539	539	539	539	539	539

Notes: *$p < .1$; **$p < .05$; ***$p < .01$; standard errors are given in parentheses.

Table A10. Multiple correspondent analysis.

Item	Contribution	Item	Contribution
Dimension 1: Pro-environmental attitude		**Dimension 4: Collective mean**	
Environmental Sacrifice	0.133	Advertising Campaign	0.212
Duty recycling	0.264	Recycling bin	0.078
Environmental impact	0.277	Recycling Coach	0.19
Change behaviour to higher cost	0.096	Sorting Brochure	0.288
Pay more	0.231	GCS Full	0.11
		GCS Far	0.124
Principal inertia:	**0.1964**	**Principal inertia:**	**0.0358**
Dimension 2: Tax policy		**Dimension 5: Not environmental**	
Policy tax on myself	0.5	Financial gains	0.293
Policy tax on other	0.5	Environmental indifference	0.347
		Environmental interest	0.36
Principal inertia:	**0.2666**	**Principal inertia:**	**0.2103**
Dimension 3: Social influence		**Dimension 6: Individual containers**	
Influence of friends or loved ones	0.194	Composter	0.239
Influence of neighbours	0.205	Recycling bin	0.417
Opinion neighbours	0.297	Recycling bin	0.34
Opinion of loved ones	0.304		
Principal inertia:	**0.3377**	**Principal inertia:**	**0.0256**

Table A11. Probit estimation if housing = Individual house (Model 1); Housing = Collective dwelling (Model 2).

	Model 1		Model 1	
	Probit	Marginal effect	Probit	Marginal effect
Dependent variable:				
Recycling				
Independent variables:				
Pro-Environmental attitude	0.817***	0.090**	1.013***	0.243***
	(0.31)	(0.04)	(0.17)	(0.04)
Collective mean	0.405	0.045*	0.710*	0.171**
	(0.74)	(0.08)	(0.36)	(0.08)
Social influence	−0.472**	−0.052***	−0.304***	−0.073***
	(0.21)	(0.02)	(0.11)	(0.02)
Not environmental	−0.521**	−0.057*	−0.692***	−0.166***
	(0.22)	(0.31)	(0.14)	(0.03))
Tax policy	0.351	0.039	0.368	0.088
	(0.38)	(0.39)	(0.24)	(0.06)
Individual containers	0.923**	0.102**	2.352***	0.566***
	(0.42)	(0.05)	(0.41)	(0.1))
Habitat area	−0.317	−0.036	−0.606	−0.183
	(0.30)	(0.04)	(0.42)	(0.15)
Farmers–farm workers	0.000	0.000	−1.260	−0.442
	(.)	(.)	(1.28)	(0.49)
Craftsmen, storekeepers, businessmen	0.000	0.000	1.200**	0.153***
	(.)	(.)	(0.50)	(0.03)
Professional executives	0.000	0.000	1.877**	0.184***
	(.)	(.)	(0.77)	(0.03)
Intermediate profession	0.522	0.044	0.633*	0.118***
	(0.61)	(0.03)	(0.32)	(0.45)
Employee	0.508	0.045	0.171	0.039
	(0.43)	(0.03)	(0.27)	(0.06)
Workmen	1.073	0.034**	−0.032	−0.008
	(0.66)	(0.03)	(0.30)	(0.07)
Without employment	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Alpes Maritimes	0.691	0.065	0.206	0.048
	(0.44)	(0.06)	(0.36)	(0.08)
Bouches du Rhône	0.546	0.081	0.387	0.09
	(0.49)	(0.04)	(0.35)	(0.08)
Var	1.418*	0.034**	0.516	0.099
	(0.57)	(0.06)	(0.45)	(0.065)
Other departments	0.000	0.0000	0.000	0.000
	(.)	(.)	(.)	(.)
Gender	−0.192	0.005	0.004	0.001
	(0.35)	(0.04)	(0.21)	(0.05)
_cons	0.678		−1.474*	
	(1.07)		(0.62)	
N	179	179	320	320

Notes: *$p < .1$; **$p < .05$; ***$p < .01$; standard errors are given in parentheses.

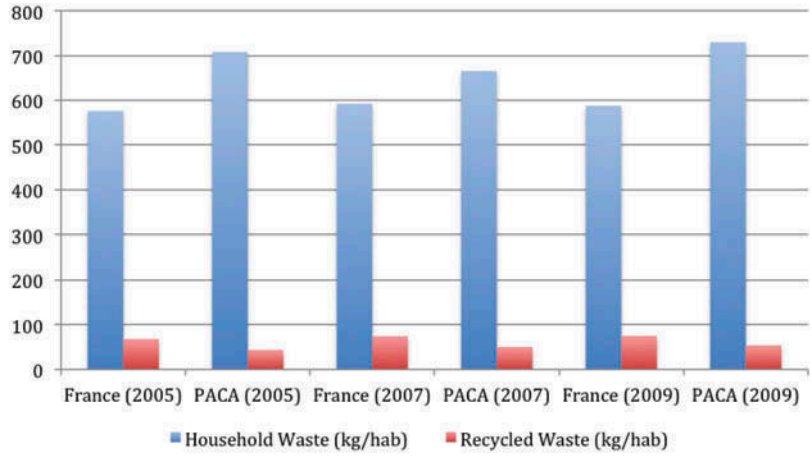

Figure A1. The evolution of waste volume in the PACA region.

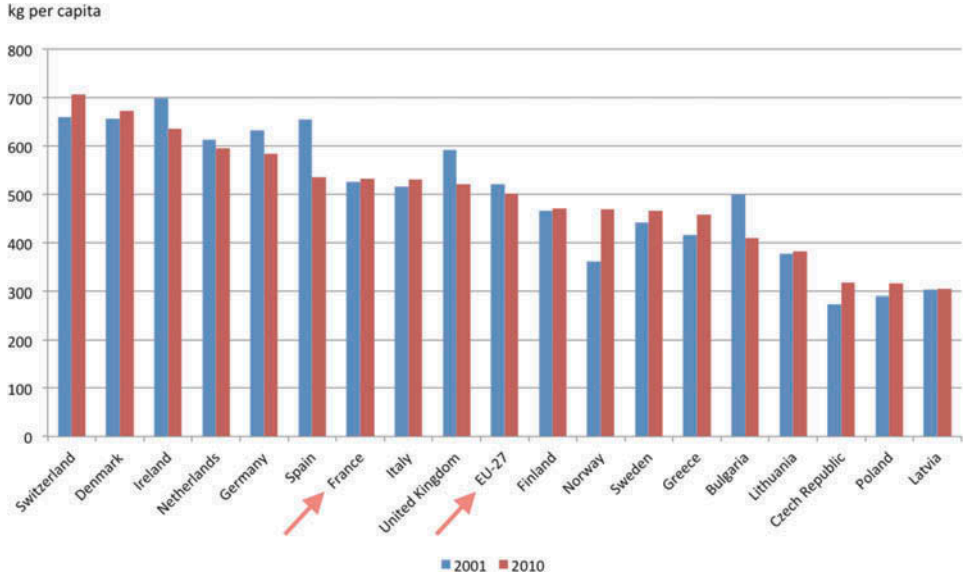

Figure A2. Municipal waste generated per capita in 2001 and 2010.

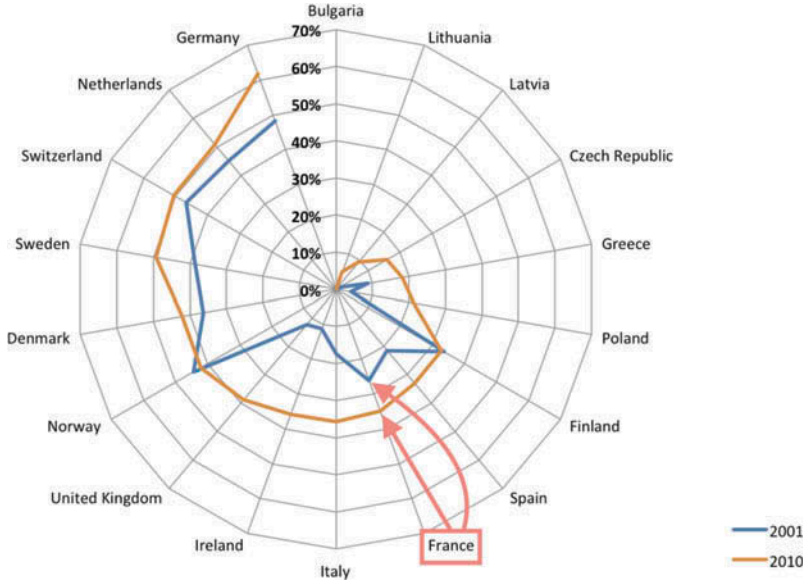

Figure A3. Municipal waste recycling rates in 30 European countries.

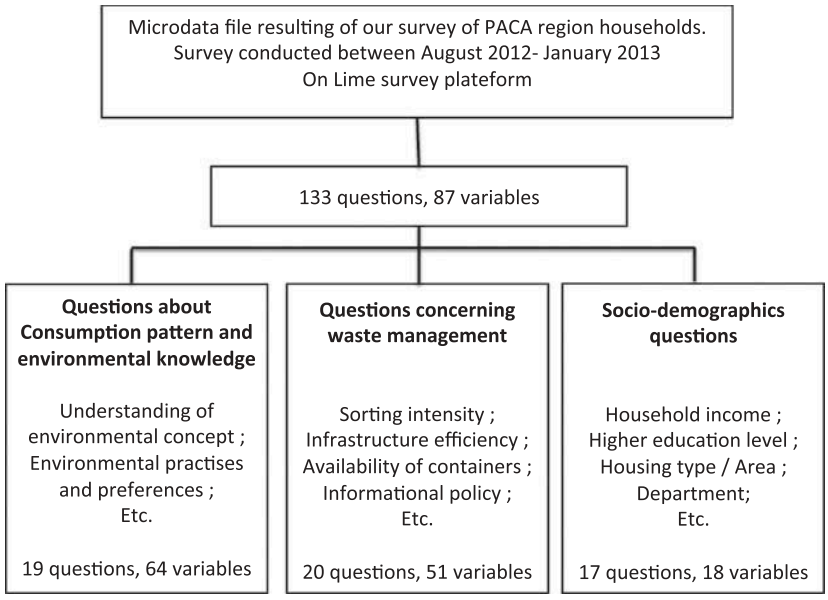

Figure A4. Survey design.

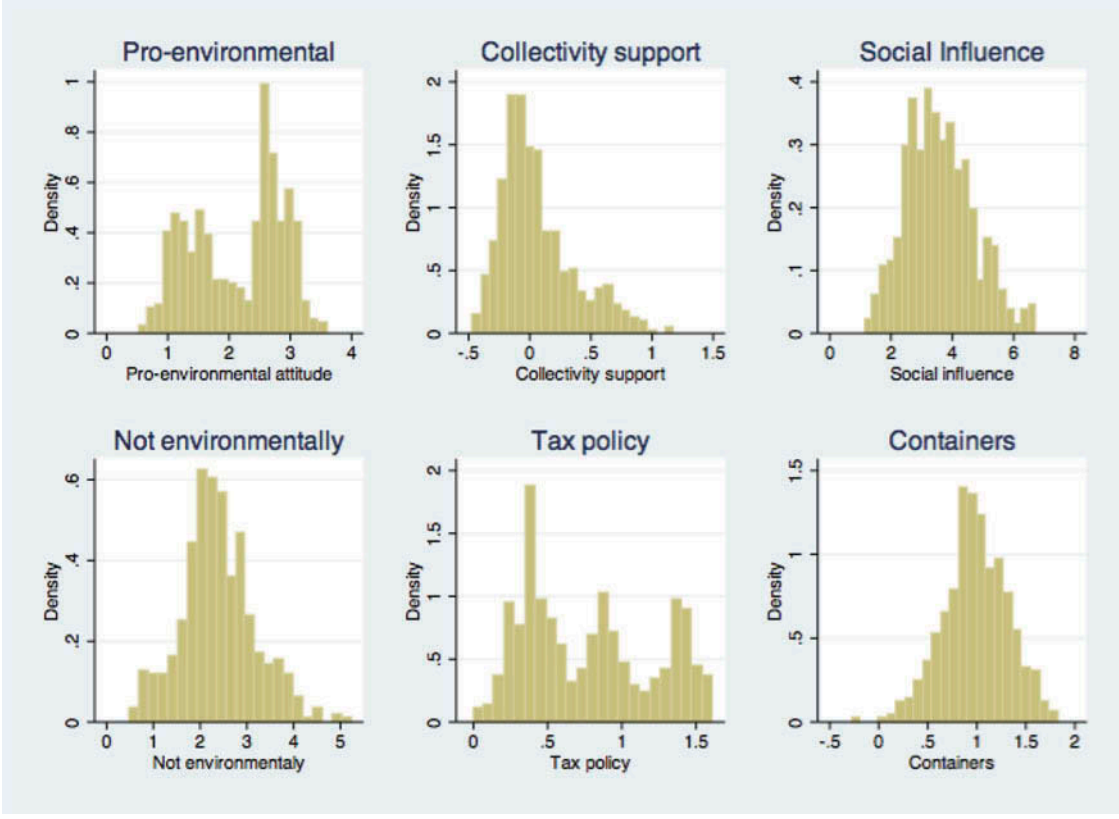

Figure A5. Factors distribution.