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# Household waste recycling: national survey evidence from Italy

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# Household waste recycling: national survey evidence from Italy

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The paper analyses the determinants of household recycling in Italy, with particular emphasis on social behaviours. The econometric analysis is based on two waves – 1998 and 2000 – of the Multipurpose Household Survey conducted annually by the Italian Central Statistics Office. In Italy, household recycling was substantially voluntary in the years from 1998 to 2000-with no monetary incentives or pecuniary sanctions. Five different materials are investigated: paper, glass, plastic, aluminium and food waste. The results of the probit regressions suggest that membership in non-profit associations, church attendance, the habit of talking politics and reading newspapers are significantly correlated with household recycling behaviour; while gender, age, education and household income play the biggest role. The findings also show that the presence of recycling bins for waste improves household recycling behaviour for all materials, whereas the difficulty of reaching recycling bins adversely affects household recycling outcomes. Household judgements on waste disposal charges have no effect on the recycling effort. Residency in southern Italy is associated with the lowest probability of recycling all materials.

**Keywords:** household recycling; social behaviour; social capital; recycling bins; flat fee, statistical matching



## 1. Introduction

The need to recycle used materials has become a pressing environmental issue over the last 30 years. Waste recycling has several positive effects in the pursuit of sustainable development. It reduces demand for virgin raw materials. There are fewer environmental impacts from material extraction, processing and transportation. Products made from recyclates, rather than virgin materials, generally consume less energy in manufacturing. Furthermore, less waste material going to landfill means a reduction in environmental and economic costs, as well as in health and environmental risks associated with landfilling (Kinnaman 2006, Martin *et al*. 2006, van den Bergh 2008).

The increasing concern regarding waste recycling is evidenced in European Union (EU) environment policies whose primary objectives are to reduce waste production, promote waste collection and recovery, as well as cut down waste materials sent to landfill. In Italy, waste recycling was introduced by the Legislative

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Decree 22/1997 (*Decreto Ronchi*). Since 1998, Italy has experienced an increase in separate waste collection, with the rate reaching 27.5% in 2007; up from 13% in 1999. Despite this trend, however, Italy continues to produce vast amounts of waste and sends large amounts of recyclable materials to landfills, as can be seen in Table 1. In 1999, Italy produced 28.4 million tons (Mt) of urban waste, of which 21.8 Mt were sent to landfill. In 2007, total waste production was 32.5 Mt, with 17 Mt disposed of in landfill.

Indeed, if we consider the main EU member states (Table 1), we observe that, apart from Germany, these countries have difficulty reducing or even stabilising the production of waste, and landfill is still the main form of waste management used. Nevertheless, Italy's waste management performance is being constantly monitored and evaluated because, until recently, some areas in southern Italy had experienced waste management crises, mainly due to the absence of serious alternatives to landfill sites and very low separate waste collection rates.

A clear picture of the current situation in Italy, as well as the relative trend, is shown in Table 2, representing the differences in the separate waste collection rate across macro regions. The average figure for the country is still dominated by low separate waste collection, significantly lower than those established by the policy makers (to recycle 35% of waste by 2006 and 40% by 2007).[1] Furthermore, there is high geographical heterogeneity, with northern Italy rapidly evolving towards high levels of recycling (42% in 2007) and southern Italy dramatically mired in low separate collection (11.6% in 2007)[2].

The aim of this paper is to investigate the determinants of household recycling in Italy using household survey data for the years 1998 and 2000. Specifically, the paper contributes to the household waste recycling literature by analysing the role of non-economic factors in a household's decision to sort and recycle domestic waste. Hence the paper contributes to the literature by carrying out the first assessment of the socio-economic determinants of household recycling in Italy from an economic perspective.

For the purposes of this paper, the years from 1998 to 2000 are of great interest because Italian households used to drop off their mixed waste in recycling bins – for paper, glass, food waste, etc. – placed along the streets and in public locations, and paid a flat rate according to parameters such as house size. Thus even if household recycling was mandatory, in practice it was voluntary with no monetary incentives or effective monetary sanctions.



Table 1. Total waste production and landfill in some EU countries.

| | Total waste production (million tons) | | Landfill (million tons) | |
|---|---|---|---|---|
| | 1999 | 2007 | 1999 | 2007 |
| Germany | 52.3 | 46.4 | 14.7 | 0.3 |
| UK | 33.4 | 34.8 | 27.5 | 19.7 |
| France | 30.6 | 34.3 | 13.5 | 11.7 |
| Italy | 28.4 | 32.5 | 21.8 | 16.9 |
| Spain | 24.5 | 26.2 | 13.1 | 15.1 |

Source: APAT-ONR, rapporto rifiuti.

Table 2. Separate collection (% of waste total production).

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|
| Italy (average) | 13.1 | 14.4 | 17.4 | 19.2 | 21.5 | 22.7 | 24.3 | 25.8 | 27.5 |
| North | 23.1 | 24.4 | 28.6 | 30.6 | 33.5 | 35.5 | 38.1 | 39.9 | 42.4 |
| Centre | 9.0 | 11.4 | 12.8 | 14.6 | 17.1 | 18.3 | 19.4 | 20.0 | 20.8 |
| South | 2.0 | 2.4 | 4.7 | 6.3 | 7.7 | 8.1 | 8.7 | 10.2 | 11.6 |

Source: APAT-ONR, rapporto rifiuti



The study uses the Multipurpose Household Survey (hereafter indicated as MHS) conducted annually by the Italian Central Statistical Office. This large dataset is one of the best available for studying household recycling in a cross-section framework as it investigates a wide range of socio-economic behaviours by means of face-to-face interviews on a sample of about 20,000 households, approximately corresponding to 60,000 individuals. However, the MHS does not collect information on household income. In order to overcome this limit, data from the MHS were merged with the Bank of Italy's Survey on Household Income and Wealth (hereafter indicated as SHIW) for two waves (1998 and 2000), using a statistical matching method. The SHIW covers 8000 households consisting of approximately 20,000 individuals. Through the statistical matching procedure, I impute the household income of an individual from the SHIW to a similar individual from the MHS in a pooled cross-section sample consisting of two waves (1998 and 2000) of the MHS. The final dataset contains 47,643 observations.

In the empirical analysis, the dependent variable is the recycling behaviour on five different materials: paper, glass, plastic, aluminium and food waste. Household recycling behaviour is measured through the question 'Does the family usually do separate waste collection and place materials in assigned recycling bins?', where possible responses are: *yes always, yes sometimes, never*. Responses are re-coded into a binary variable equal to 1 in cases of *yes always* and 0 otherwise. The paper uses the following independent variables: (1) the policy information available in the dataset as the judgement of the household on the waste disposal fee and on the presence of recycling bins for waste; (2) a rich set of social behavioural variables, such as passive and active membership in non-profit associations, relationships with friends and relatives, church attendance, political interest and the habit of reading newspapers, watching television and listening to the radio; (3) many individual and socio-economic characteristics as control variables, including household income.

The results of probit regressions suggest that membership in non-profit associations, church attendance, the habit of talking politics and reading newspapers are significantly correlated with household recycling behaviour; while gender, age and household income play the largest role. The findings also show that recycling bins for waste raise household recycling levels of all materials, whereas recycling bins that are poorly accessible affect household recycling outcomes adversely. Households' judgement on waste disposal charges have no effect on recycling effort. As expected, living in the regions of southern Italy is associated with the lowest probability of recycling all materials.

The paper is related to another strand of literature. It contributes to the literature on social capital (for an exhaustive survey see Durlauf and Fafchamps 2005).

Membership of organisations and meetings with friends are forms of social capital in the Putnam (1993) sense.

The paper is organised as follows. Section 2 contains a short review of the literature on the main determinants of household recycling behaviour, while section 3 presents theoretical explanations of the expected positive association between social behaviours and the likelihood of doing household waste recycling. Section 4 describes the data and presents a descriptive analysis. Section 5 illustrates the main results from econometric analysis, and the final section concludes.

## 2. Factors that affect household recycling: a brief review

The main focus in the empirical literature on household recycling has been how various recycling programmes and differentiated tariffs affect household recycling behaviour (Halvorsen 2008). Early studies found that household income and household size are the most important factors affecting per capita, or household, quantities of solid waste (Richardson and Haylicek 1978). Research has also indicated that refuse disposal service conditions (i.e. service frequency and collection site) and service charges affect household solid waste generation: kerbside programmes reduce waste generation, while flat fee systems induce households to generate larger amounts of waste (Wertz 1976). Hong *et al*. (1993) examined the role of price incentives and other socio-economic factors in household recycling for the city of Portland in Oregon (USA). They showed that increases in disposal fees encouraged recycling, although demand for solid waste collection services was not reduced substantially. Furthermore, household participation regarding kerbside recycling increased as the educational level rose while it decreased as the value of time increased. Fullerton and Kinnaman (1996) examined the consequences for household decisions of the implementation of volume-based pricing programmes that required households to pay for each bag or can of refuse. Individual household data for Charlottesville in Virginia (USA) were employed to estimate the effect of such a programme on the weight of refuse, the number of containers, the weight per can and the amount of recycling. Findings showed that, in response to pricing, households sometimes reduced the volume (number of bags) but not the weight. Callan and Thomas (1997) used aggregate municipality data from Massachusetts Department of Environmental Protection to show that unit pricing stimulated a community's recycling effort, and this effect was greater if used in combination with kerbside recycling services.

Linderhof *et al*. (2001) analysed the effects of weight-based pricing in the collection of household waste for households in a Dutch municipality (Oostzaan). They estimated short-run and long-run price effects for the amounts of both compostable and non-recyclable household waste and found considerable effects of prices. Jenkins *et al*. (2003) studied the impact of two popular waste programmes (kerbside and volume-based pricing) on the rate of recycling of several materials: glass bottles, plastic bottles, aluminium, newspaper and yard waste. They used a household-level dataset representing middle and upper-middle income groups of 20 metropolitan statistical areas across the USA. The main findings were as follows. Access to kerbside recycling, as well as drop-off recycling, turned out to have a significant positive effect on the percentage recycled of all five materials, but the effect of a kerbside programme on recycling effort was greater than the effect of a drop-off programme. The lifespan of the recycling programme also had a significant

positive effect on two materials. Mandatory (as opposed to voluntary) recycling programmes had an insignificant effect, for all materials considered. The level of unit price was statistically insignificant, as in Rechovsky and Stone (1994) and Fullerton and Kinnaman (1996). Authors have suggested that this can be explained by the fact that households might respond to pricing by shifting to goods that make recycling easier. Finally, with regard to socio-economic factors, age and education level had a significant positive effect on, respectively, four and three materials. However, Dijkgraaf and Gradus (2004), with data on Dutch municipalities, found that unit-based pricing stimulates recyclable waste.

Ferrara and Missios (2005) employed data from households in communities across Ontario, Canada, to estimate the relationships between several commonly recycled materials (newsprint, glass, plastic, aluminium cans, tin cans, cardboard and toxic chemicals) and individual household characteristics, recycling programme attributes and refuse collection financing methods. They found that user fees on refuse collection had significant impact on recycling levels for all materials except toxic chemicals. Kipperberg (2007) investigated the determinants of recycling behaviour in Norway on five materials: paper, glass, metals, plastic and food waste. The analysis focused on the role of user fees on waste disposal, on the provision of convenient recycling options (kerbside and drop-off programmes) and on socio-economic and demographic factors. It was found that user fees for waste disposal had a significant positive effect on recycling intensities, as well as kerbside recycling programmes. The drop-off programme presented the expected sign, but was statistically significant only in glass recycling intensity. Regarding demographic variables, age and population had, respectively, a significant positive and negative effect on household recycling behaviour for three materials.

### *2.1. Psychological motivations*

Some empirical studies have examined social and psychological motivations for household waste recycling efforts. Vining and Ebreo (1990), using data on Champaign and Urbana in Illinois (USA), showed that among the factors that discriminate recyclers from non-recyclers are knowledge and intrinsic motives, such as altruism and environmental concerns. Using experimental data, Hopper and McCarl Nielsen (1991) found that recycling behaviour is influenced by social and personal norms. Derksen and Gartrell (1993), with data on the province of Alberta, Canada, found that individual attitudes towards the environment affect recycling behaviour only in communities with easy access to a structured recycling programme. Hornik *et al.* (1995) and Schultz *et al.* (1995), in reviewing prior empirical (psychological) studies on recycling behaviour, showed that the important predictors are social influence (of friends, family members and neighbours), as well as knowledge, attitudes and commitment to recycling. More recent studies have confirmed the importance of knowledge, attitudes and subjective norms in household waste recycling (Ebreo and Vining 2000, Chu and Chiu 2003, Knussen *et al.* 2004, Sidique *et al.* 2010). Schultz *et al.* (1995) also showed that in prior empirical psychological studies on recycling behaviour, the most often reported demographic characteristics are gender, age, education and income. Overall, the results of these studies indicate an ambiguous relationship with recycling for age and education, a positive association for income and no significant correlation for gender.

### 2.2. *Moral and social norms*

Halvorsen (2008) modelled how social and moral norms and the opportunity cost of time affect household recycling efforts. He used data from Norway on six materials: paper and cardboard, drink cartons, plastic, metal, glass and organic waste. Empirical findings evidenced that indicators of warm-glow, social and moral norms increase household recycling activities. Furthermore, the estimated opportunity cost of time has a significant effect on the recycling effort, while household (gross) income has a significant positive effect on recycling. Hage *et al*. (2009) analysed the determinants of recycling efforts in Swedish households, focusing on the case of packaging waste (i.e. paper, glass, plastic and metal). They built a theoretical framework that integrated norm-motivated behaviour into a sample economic model of household choice. The results indicated that moral motives explain household recycling rates, while social norms are not statistically significant. Moreover, recycling effort was found to increase with age. The role of moral obligation in undertaking recycling activities was also emphasised by Berglund and Matti (2006).

### 2.3. *Social capital*

Social capital has also been underlined as a significant parameter influencing household environmental behaviour (Pretty and Ward 2001, Pretty 2003). Van Ha *et al*. (2006) employed a parametric deterministic input distance function for computing the relative shadow prices of social capital for household-level paper-recycling units in Vietnam. They showed that social capital – associated activity, social relations, trust and norms of reciprocity – has positive effects on the production efficiency of paper-recycling units. Torgler and García-Valiñas (2007) investigated empirically the determinants of individuals' attitudes towards preventing environmental damage in Spain, showing that social capital, such as trust and membership of voluntary environmental organisations, has a strong impact on individuals' preferences to prevent environmental damage. With data on Scotland, Collins *et al*. (2006) showed that social capital measured by charitable work is positively associated with waste recycling. Using data on Taiwan, Tsai (2008) estimated the impact of social capital on the regional recycling rate. He provided evidence that regional social capital – volunteers in associations and the number of social organisations – is highly correlated with a region's recycling rate.

## 3. Social behaviours in household waste recycling

As we saw in the previous section, over recent years researchers have started to study the impact of social behaviours on pro-environmental behaviour. In this paper, social behaviours include passive and active membership in non-profit associations, relationships with friends and relatives, political interest as well as church attendance and the habit of reading newspapers, watching television and listening to the radio. This section will suggest why a positive association is expected between social behaviours and the likelihood of recycling household waste.

In terms of passive membership, membership of social associations contributes to increasing the overall level of public concern about the environment. In turn, this influence can encourage individuals to participate in activities that require a high degree of co-operation, as is the case for waste separation and recycling. Moreover,

social associations are also responsible for the flow of information on environmental issues (Jones *et al*. 2010). Finally, to the extent that social associations influence the internalisation of norms and values, peer pressure will determine behaviour (Durlauf and Fafchamps 2005).

Individuals who participate actively in social associations (active membership) are expected to do more waste recycling, mainly through the channels of altruism and moral norms. The literature on volunteering suggests that the reasons why individuals supply unpaid work include the pleasure of giving, also referred to as 'warm-glow' (Andreoni 1990, Fiorillo 2011, 2012). Hence, volunteers may recycle because they have a higher preference for environmental protection. Moreover, they gain utility from contributing to a just cause (feeling good about doing something for the environment). Finally, individuals who actively participate in social associations may develop and enforce moral norms that may positively affect their recycling behaviour. In other words, in the latter case pro-recycling moral norms are activated through volunteering.

In terms of the frequency of meetings with friends and relatives, how many friends and relatives we interact with, and how frequent these interactions are, determine the access to information that is required to evaluate the environmental impact of one's effort (Videras *et al*. 2012). Furthermore, reliance on friends and relatives can reduce the cost of engaging in recycling efforts. Finally, friends and relatives can operate as mechanisms of social support in the case of recycling (social pressure in Vining and Ebreo 1990, Tucker 1999).

Church attendance may enhance recycling behaviour in several ways. First, churchgoing and religious affiliation may provide knowledge and information on household recycling programmes adopted in the community where the church is situated. Second, religious traditions include world views, ethical precepts and spiritual elements that shape perceptions about the natural environment and can act as guiding principles regarding how our acts and choices affect nature (Owen and Videras 2007). Thus, such religious traditions can strengthen moral norms which may positively influence recycling behaviour. Hence, in this case moral norms for recycling are activated through religious events and spiritual norms. Finally, church attendance can reduce individual opportunism and motivate individuals (households) to devote more effort to action to protect the environment, such as recycling.

Political interest has had little attention in the studies on pro-environmental behaviour. According to Torgler and García-Valiňas (2007, p. 540), politically interested people are well-informed and have a high level of current knowledge about what is going on in politics and, thus, may also be aware of environmental issues and problems which are supposed to lead to a higher willingness to contribute. Hence, following this argument, people with the habit of talking politics and the habit of listening to political debates are expected to do more waste recycling because they may be well informed about environmental problems and may have greater willingness to participate in recycling programmes.

The habit of reading newspapers, watching television and listening to the radio may be seen as information sources about recycling programmes. Hence, these social behaviours, as information sources, are expected to have a high impact on recycling waste behaviour. First, newspapers, television and radio are a variety of mass media that alone or together are used by public authorities to communicate their recycling programmes and effort (Evison and Read 2001, Timlett and Williams 2008). Second,

recycling rates improve when a variety of media are used (Tucker and Speirs 2002, Nixon and Saphores 2009).

## 4. Sample description and empirical strategy

The dataset used in the present study is drawn from the MHS, a cross-sectional survey administered annually by ISTAT. The new MSH series was initiated in 1993. Every year a representative sample of approximately 20,000 Italian households (roughly corresponding to 60,000 individuals) is surveyed on key aspects of daily life and behaviour. Although the MSH is annual, it is not panel data. Among information provided, there are data on social behaviour, on a wide range of household recycling behaviour as well as socio-demographic characteristics.

However, the MSH does not collect information on household income. To fill this gap, the ISTAT MSH was combined with the SHIW carried out by the Bank of Italy. The SHIW covers 8000 households (20,000 individuals) and contains detailed information on income and wealth of family members, as well as socio-demographic characteristics of the household. Both samples are representative of the Italian population at national and regional levels. Basically, through the statistical matching procedure, the household income of an individual is imputed from the SHIW to a similar individual from the MHS, in a pooled cross-section sample consisting of two waves (1998 and 2000) of the MHS (see the Appendix for further details). The unit of analysis is the household head. The final dataset contains 47,643 observations. Table 3 shows definitions and measurements of variables used in the econometric analysis. Weighted summary statistics are reported in Table 4.

### 4.1. Dependent variable

The dependent variable is household recycling behaviour on five different materials: paper, glass, plastic, aluminium and food waste. Household recycling behaviour is measured through the question 'Does the family usually do separate waste collection and place materials in assigned recycling bins?', where possible responses are: *yes always, yes sometimes* and *never*.

Responses are re-coded into a binary variable which is equal to 1 in cases of *yes always* and 0 otherwise. As we can see in Table 4, glass and paper are the materials subject to most recycling in the Italian sample, whereas recycling behaviour for plastic, food and aluminium is significantly lower in Italy.

### 4.2. Judgement on waste disposal fee, recycling bins and pro-environmental behaviour

The availability of an effective recycling infrastructure that enables households to recycle their waste, as well as waste disposal fees, are clearly crucial parts of any recycling programme (Martin *et al*. 2006). In the dataset, the policy information available for the econometric analysis is the judgement of the household head on the waste disposal fee and on the presence of recycling bins for waste (Table 3). The inclusion of the judgement of the household head on the waste disposal fee follows a simple hypothesis: if the household head considers the waste disposal service expensive, this might mean that the waste disposal service is inefficient and thus the household head might decide not to co-operate with the disposal service, which in the present analysis means doing less waste recycling.

Table 3. Detailed description of variables.

| Variable | Description |
|---|---|
| *Dependent variables* | |
| Paper recycling | Family accustomed to doing paper recycling, 1 = yes always |
| Glass recycling | Family accustomed to doing glass recycling, 1 = yes always |
| Aluminium recycling | Family accustomed to doing aluminium recycling, 1 = yes always |
| Plastic recycling | Family accustomed to doing plastic recycling, 1 = yes always |
| Food waste recycling | Family accustomed to doing food recycling, 1 = yes always |
| *Independent variables* | |
| *Policy variable* | |
| Judgement on waste disposal fee | Household judgement on the waste disposal service charge, 1 = high |
| Recycling bin for paper | Presence in the area where the household lives of paper recycling bins, 1 = yes |
| Recycling bin for glass | Presence in the area where the household lives of glass recycling bins, 1 = yes |
| Recycling bin for aluminium | Presence in the area where the household lives of aluminium recycling bins, 1 = yes |
| Recycling bin for plastic | Presence in the area where the household lives of plastic recycling bins, 1 = yes |
| Recycling bin for food waste | Presence in the area where the household lives of food waste recycling bins, 1 = yes |
| Recycling bin for paper_dtr | Presence in the area where the household lives of paper recycling bins, 1 = yes but difficult to reach |
| Recycling bin for glass _dtr | Presence in the area where the household lives of glass recycling bins, 1 = yes but difficult to reach |
| Recycling bin for aluminium_dtr | Presence in the area where the household lives of aluminium recycling bins, 1 = yes but difficult to reach |
| Recycling bin for plastic_dtr | Presence in the area where the household lives of plastic recycling bins, 1 = yes but difficult to reach |
| Recycling bin for food waste_dtr | Presence in the area where the household lives of food waste recycling bins, 1 = yes but difficult to reach |
| *Pro-environmental behaviour* | |
| Environmental problems | Environmental problems are the main problem of the nation, 1 = yes |
| *Social behaviour variables* | |
| Passive membership | Participation in meetings of formal organisations, 1 = voluntary service, ecological, cultural, political party and unions |
| Active membership | Unpaid activity for formal organisations, 1 = voluntary service, other, political party and unions |
| Meeting friends | Meeting with friends, 1 = every day or more than once a week |
| Visiting relatives | Meeting with relatives, 1 = everyday or more than once a week |
| Church attendance | Whether the respondent goes to church once or more a week, 1 = yes |
| Talk politics | Talks politics, 1 = every day or more than once a week |
| Listen to politics | Whether the respondent listens to political debates, 1 = yes |
| Newspapers | Whether the respondent reads newspapers every day, 1 = yes |

(*continued*)

Table 3. (*Continued*).

| Variable | Description |
|---|---|
| Television | Whether the respondent watches television every day, 1 = yes |
| Radio | Whether the respondent listens to the radio every day, 1 = yes |
| *Demographic and socio-economic characteristics* | |
| Male | Gender of the respondent, 1 = male. *Reference group: female* |
| Married | Marital status of the respondent, 1 = married. *Reference group: single* |
| Divorced | Marital status of the respondent, 1 = divorced |
| Widowed | Marital status of the respondent , 1 = widowed |
| Age 31–40 | Age of the respondent, 1 = age between 31 and 40. *Reference group: age 16-30* |
| Age 41–50 | Age of the respondent, 1 = age between 41 and 50 |
| Age 51–60 | Age of the respondent, 1 = age between 51 and 60 |
| Age 61–70 | Age of the respondent, 1 = age between 61 and 70 |
| Age 71–80 | Age of the respondent, 1 = age between 71 and 80 |
| Household size | Number of people who live in family |
| Children 0_5 | Age of children, 1 = children aged between 0 and 5 years. *Reference group: no children* |
| Children 6_12 | Age of children, 1 = children aged between 6 and 12 years |
| Children 13_17 | Age of children, 1 = children aged between 13 and 17 years |
| Low education | Education of the respondent, 1 = no education, completed elementary school (5 years) and completed junior high school (8 years) |
| High school (diploma) | Education of the respondent, 1 = completed high school (13 years). *Reference group* |
| Bachelor's degree | Education of the respondent, 1 = university degree and/or doctorate (18 years and more) |
| Household income (ln) | Natural logarithm of imputed household income (sum of labour income, capital income and pensions) |
| Poor health | Whether the respondent assesses his/her state of perceived health as poor, yes = 1. *Reference group: fair health* |
| Good health | Whether the respondent assesses his/her state of perceived health as good, yes = 1 |
| Unemployed | Employment status of the respondent, 1 = unemployed. *Reference group: employed* |
| Entrepreneur | Employment status of the respondent, 1 = entrepreneur |
| Self-employed | Employment status of the respondent, 1 = self-employed |
| Retired | Employment status of the respondent, 1 = retired |
| Homeowner | Whether the respondent owns his/her home outright, yes = 1 |
| Council house | Whether the respondent lives in a council house, yes = 1 |
| Rooms | Number of rooms, 1 = between 1 and 5 rooms |
| *Perception of community problems* | |
| Micro-criminality | Whether the respondent has been pickpocketed, yes = 1 |
| No parking problems | Whether the respondent states that there is no difficulty parking in the area where he/she lives, yes = 1 |
| No traffic problems | Whether the respondent states that there is no traffic in the area where he/she lives, yes = 1 |
| No pollution | Whether the respondent states that there is no pollution in the area where he/she lives, yes = 1 |

(*continued*)

Table 3. (*Continued*).

| Variable | Description |
|---|---|
| No dirtiness problems | Whether the respondent states that there is no filth in the area where he/she lives, yes = 1 |
| Household problems reaching bins | Whether the respondent states that his\her family has problems reaching recycling bins, 1 = yes |
| *City size* | |
| Metropolis | Whether the respondent states that he/she lives in a metropolitan area, yes = 1. *Reference group: <2000* |
| Neighbouring metropolis | Whether the respondent states that he/she lives in a municipality close to a metropolitan area, yes = 1 |
| >50,000 | Whether the respondent states that he/she lives in a municipality with more than 50,000 inhabitants, yes = 1 |
| 10,000–50,000 | Whether the respondent states that he/she lives in a municipality with 10,000–50,000 inhabitants, yes = 1 |
| 2,000–10,000 | Whether the respondent states that he/she lives in a municipality with 2,000–10,000 inhabitants, yes = 1 |



The MSH asked individuals how they judged the cost for waste disposal services. The answers were; (1) high; (2) fair; (3) low. A dummy 'judgement on waste disposal fee' was created, assuming the value 1 if the household head judges the cost of the waste disposal service as high. In the Italian sample (Table 4), 67% of respondents judge the cost of waste disposal to be high.

With regard to recycling bins for waste, the MSH asked respondents the question 'Are there recycling bins for separate waste collection in the area where the household lives?' The answers were; (1) yes and easy to reach; (2) yes but difficult to reach; (3) no; (4) I do not know. Responses (1) and (2) were used and a dummy variable was created for recycling bins for each of the five materials (Table 3).

Recycling bins appear to be common in Italy; according to 71% of Italian household heads there were recycling bins for glass in the area where they lived; 63% stated there were facilities for paper recycling and 52% for plastic. Only 43 and 41% of household heads stated there were recycling bins for aluminium and food waste, respectively. In contrast, a small percentage of the Italian sample found it difficult to reach recycling bins for separate waste collection.

With respect to pro-environmental behaviour, i.e. whether according to Italian households environmental problems are the main problem in Italy, only 17% of respondents agreed with this statement.

### *4.3. Social behaviour variables*

Social behaviours described in Section 3 are measured through the following set of variables (Table 3):

*Passive and active membership*:

- Membership of associations, distinguished between passive membership (if the individual participated in meetings of an association in the 12 months prior to the interview), and active membership (if the individual did unpaid work for an association in the 12 months prior to the interview). The associations allowed

for are voluntary, charitable, ecological and cultural associations, political parties and trade unions.

*Relationships with friends and relatives*

- The frequency of meetings with friends, coded as 1 if the interviewee meets friends every day or at least twice a week.
- The frequency of meetings with relatives, coded as above.

*Church attendance*

- Church attendance as measured through a binary variable which is equal to 1 if the interviewee goes to a church or another place of worship one or more times a week.

*Political interest*

- The habit of talking politics, coded as 1 if the interviewee speaks about politics every day or more than once a week.
- The habit of listening to political debates as measured through a binary variable which is equal to 1 if the interviewee listens to political debates.

*The habit of reading newspapers, watching television and listening to the radio*

- Newspapers as measured through a binary variable which is equal to 1 if the interviewee reads newspapers every day.
- Television as measured through a binary variable which is equal to 1 if the interviewee watches television every day.
- Radio as measured through a binary variable which is equal to 1 if the interviewee listens to the radio every day.

These variables measure a variety of social behaviours and are capturing different links with household waste recycling, as explained in Section 3.

Table 4 shows that 25% of the respondents are members of organisations, while 14% of the interviewees supply unpaid labour for organisations; respectively 67% and 30% of Italian households meet friends and relatives one or more times per week; 35% of the sample attend churches or other places of worship one or more times per week; with regard to politics, respectively 43% and 23% of respondents have the habit of talking politics and the habit of listening to political debates. With regard to the mass media (newspapers, television, radio), 88% of the respondents indicated that they watch television every day. Radio is a distant second, with 39%. The least common source of information is newsprint, with 29% of interviewees reporting they read newspapers every day.

### *4.4. Demographic and socio-economic characteristics*

The study controlled for many demographic and socio-economic characteristics such as gender, marital status, age, family size, presence and age of children, education, imputed household income (sum of labour income, capital income and

Table 4. Weighted descriptive statistics.

| Variable | Mean | Standard deviation | Minimum | Maximum | Observations |
|---|---|---|---|---|---|
| Paper recycling | 0.50 | 0.50 | 0 | 1 | 46,936 |
| Glass recycling | 0.55 | 0.50 | 0 | 1 | 47,000 |
| Aluminium recycling | 0.31 | 0.16 | 0 | 1 | 46,540 |
| Plastic recycling | 0.44 | 0.50 | 0 | 1 | 46,741 |
| Food waste recycling | 0.40 | 0.49 | 0 | 1 | 46,333 |
| Judgement on waste disposal fee | 0.67 | 0.47 | 0 | 1 | 47,201 |
| Recycling bin for paper | 0.63 | 0.48 | 0 | 1 | 47,051 |
| Recycling bin for glass | 0.71 | 0.45 | 0 | 1 | 47,106 |
| Recycling bin for aluminium | 0.41 | 0.49 | 0 | 1 | 46,830 |
| Recycling bin for plastic | 0.52 | 0.50 | 0 | 1 | 46,896 |
| Recycling bin for food waste | 0.43 | 0.49 | 0 | 1 | 46,703 |
| Recycling bin for paper_dtr | 0.14 | 0.35 | 0 | 1 | 47,051 |
| Recycling bin for glass_dtr | 0.17 | 0.37 | 0 | 1 | 47,106 |
| Recycling bin for aluminium_dtr | 0.12 | 0.32 | 0 | 1 | 46,830 |
| Recycling bin for plastic_dtr | 0.13 | 0.33 | 0 | 1 | 46,896 |
| Recycling bin for food waste_dtr | 0.06 | 0.25 | 0 | 1 | 46,703 |
| Environmental problems | 0.17 | 0.37 | 0 | 1 | 47,643 |
| Passive membership | 0.25 | 0.43 | 0 | 1 | 46,487 |
| Active membership | 0.14 | 0.34 | 0 | 1 | 46,341 |
| Meeting friends | 0.67 | 0.47 | 0 | 1 | 47,297 |
| Visiting relatives | 0.30 | 0.46 | 0 | 1 | 47,643 |
| Church attendance | 0.33 | 0.47 | 0 | 1 | 46,632 |
| Talk politics | 0.43 | 0.49 | 0 | 1 | 46,708 |
| Listen to politics | 0.23 | 0.42 | 0 | 1 | 46,035 |
| Newspapers | 0.29 | 0.45 | 0 | 1 | 46,738 |
| Television | 0.88 | 0.33 | 0 | 1 | 46,479 |
| Radio | 0.39 | 0.49 | 0 | 1 | 46,479 |
| Female | 0.24 | 0.42 | 0 | 1 | 47,643 |
| Married | 0.67 | 0.47 | 0 | 1 | 47,643 |
| Divorced | 0.07 | 0.25 | 0 | 1 | 47,643 |
| Widowed | 0.15 | 0.35 | 0 | 1 | 47,643 |
| Age 31–40 | 0.19 | 0.39 | 0 | 1 | 47,643 |
| Age 41–50 | 0.20 | 0.40 | 0 | 1 | 47,643 |
| Age 51–60 | 0.19 | 0.40 | 0 | 1 | 47,643 |
| Age 61–70 | 0.20 | 0.40 | 0 | 1 | 47,643 |
| Age 71–80 | 0.16 | 0.37 | 0 | 1 | 47,643 |
| Household size | 2.73 | 1.29 | 0 | 12 | 47,643 |
| Children 0_5 | 0.15 | 0.42 | 0 | 1 | 47,643 |
| Children 6_12 | 0.19 | 0.47 | 0 | 1 | 47,643 |
| Children 13_17 | 0.15 | 0.41 | 0 | 1 | 47,643 |
| Low education | 0.62 | 0.48 | 0 | 1 | 47,643 |
| Bachelor's degree | 0.08 | 0.28 | 0 | 1 | 47,643 |
| Household income (ln) | 10.67 | 0.46 | 8.69 | 12.22 | 47,643 |
| Poor health | 0.09 | 0.29 | 0 | 1 | 46,942 |
| Good health | 0.71 | 0.45 | 0 | 1 | 46,942 |
| Unemployed | 0.03 | 0.16 | 0 | 1 | 47,643 |
| Entrepreneur | 0.07 | 0.25 | 0 | 1 | 47,643 |
| Self-employed | 0.09 | 0.29 | 0 | 1 | 47,643 |
| Retired | 0.33 | 0.47 | 0 | 1 | 47,643 |

(*continued*)

Table 4. (*Continued*).

| Variable | Mean | Standard deviation | Minimum | Maximum | Observations |
|---|---|---|---|---|---|
| Homeowner | 0.69 | 0.46 | 0 | 1 | 47,643 |
| Council house | 0.62 | 0.48 | 0 | 1 | 46,958 |
| Rooms | 3.15 | 1.75 | 1 | 5 | 47,058 |
| Micro-criminality | 0.03 | 0.17 | 0 | 1 | 47,474 |
| No parking problems | 0.36 | 0.48 | 0 | 1 | 47,228 |
| No traffic problems | 0.21 | 0.41 | 0 | 1 | 47,181 |
| No pollution | 0.26 | 0.44 | 0 | 1 | 47,181 |
| No dirtiness problems | 0.26 | 0.44 | 0 | 1 | 47,249 |
| Household problems reaching bins | 0.05 | 0.22 | 0 | 1 | 46,915 |
| Metropolis | 0.24 | 0.43 | 0 | 1 | 47,643 |
| Neighbouring metropolis | 0.08 | 0.27 | 0 | 1 | 47,643 |
| >50,000 | 0.16 | 0.36 | 0 | 1 | 47,643 |
| 10,000–50,000 | 0.21 | 0.41 | 0 | 1 | 47,643 |
| 2000–10,000 | 0.24 | 0.43 | 0 | 1 | 47,643 |



pensions), self-reported health, employment status, homeownership, the home's characteristics (whether it is 'council') and number of rooms. I also controlled for the quality of the surrounding environment where the respondent lives. These variables are designed to measure the respondent's beliefs regarding potential environmental problems related to the area where he/she lives. These indicators of subjective perception are: the safety where the household lives and a number of other issues such as traffic and parking problems, pollution and dirtiness. Moreover, I also controlled for household problems about getting to recycling bins. This variable is not a perception of community problems. It is a subjective perception of the respondent concerning household problems reaching recycling bins. Finally, I controlled for city size.

Regarding individual characteristics, Table 4 shows that almost half of the respondents are female and married, while 62% of the respondents have low education (elementary school and/or junior high school completed). The largest groups of individuals (20%) are aged between 41 and 50 and between 61 and 70. Half of the sample comprises respondents with children aged between 0 and 17. Interestingly, 71% of interviewees stated they were in good health, 69% are homeowners and 62% live in a council house.

### *4.5. Econometric model*

The empirical model of household recycling behaviour can be represented through the following estimation equation:

$$HR_{it}^{*} = \alpha + PV_{it}^{'}\varphi + SB_{it}^{'}\beta + \lambda Y_{it} + Z_{it}^{'}\delta + \varepsilon_{it} \quad (1)$$

where $HR^{*}$ is the recycling behaviour of the household head $i$ at time $t$; $PV$ are the policy variables defined at the level of the household head; $SB$ are the social behaviour variables defined at the level of the household head; $Y$ is the annual

household income; the $Z$ matrix consists of the other variables that are known to influence household recycling behaviour and $\varepsilon$ is a random-error term.

I do not observe the 'latent' variable $HR^{*}_{it}$ in the data. Rather, I observe $HR_{it}$ as a binary choice which takes the value 1 if the household head always recycles. Thus, the structure of (1) makes it suitable for estimation as a probit model:

$$\Pr(HR_{it} = 1) = \Phi(\alpha - PV_{it}{}'\varphi - SB'_{it}\beta - \lambda Y_{it} - Z'_{it}\delta) \quad (2)$$

where $\Phi(\cdot)$ is the cumulative distribution function of a normal standard.

## 5. Econometric results

In this section, I analyse the impact of policy variables, pro-environmental behaviour as well as social behaviours and individual features upon household waste recycling behaviour. Section 5.1 shows results for baseline models.

### *5.1. Baseline findings*

In Table 5, Columns (I)–(V) present the probit estimations of Eq. (2), marginal effects and standard errors corrected for heteroskedasticity, using as a dependent variable the recycling behaviour of the household head on five different materials: paper, glass, plastic, aluminium and food waste. In addition to the variables discussed in Section 4, I include regional dummies to control for policy influences operating beyond the city size. In the next subsections, I discuss the results for the three groups of independent variables: judgement on waste disposal fee, recycling bins for waste and pro-environmental behaviour; social behaviours; demographic characteristics and regional dummies.

#### *5.1.1. Judgement on waste disposal fee, recycling bins and pro-environmental behaviour*

The results in Table 5 suggest that the opinion of the household head on the cost of the waste disposal service has no effect on waste recycling behaviour of any of the five materials. These findings seem to indicate that fees for waste disposal do not have an effect on the recycling effort. However, because the data do not provide information on waste disposal fees, but only on the households' opinion on the cost of waste disposal services, the effect of a fee on recycling behaviour remains unclear.

The results reported in Table 5 show that for all materials the recycling bin programme has a positive and significant impact on waste recycling behaviour. The marginal effects reported in Table 5 show that the magnitude of the effect of recycling bins is quite similar across materials. Introducing a recycling bin for paper increases the probability of recycling by 24%; for glass and aluminium the marginal effect is, respectively, 27 and 28% while for plastic it is 31%. These results seem to suggest that the recycling bins programme has a smaller impact on materials for which there were recycling options. For example, charity drives have traditionally focused on collecting newspapers. Adding a local recycling bin programme is likely to have little impact on this type of recycling behaviour (Jenkins *et al.* 2003).

Table 5. Probit results: marginal effects.

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| Variable | Paper | Glass | Plastic | Aluminium | Food waste |
| Judgement on waste disposal fee | −0.003(0.006) | −0.005(0.006) | −0.004(0.006) | −0.004(0.005) | −0.001(0.005) |
| Recycling bin for paper | 0.243***(0.006) | | | | |
| Recycling bin for glass | | 0.266***(0.006) | | | |
| Recycling bin for plastic | | | 0.313***(0.005) | | |
| Recycling bin for aluminium | | | | 0.279***(0.005) | |
| Recycling bin for food waste | | | | | 0.396***(0.005) |
| Recycling bin for paper_dtr | 0.170***(0.007) | | | | |
| Recycling bin for glass_dtr | | −0.160***(0.007) | | | |
| Recycling bin for aluminium_dtr | | | −0.174***(0.007) | | |
| Recycling bin for plastic_dtr | | | | −0.133***(0.005) | |
| Recycling bin for food waste_dtr | | | | | −0.180***(0.007) |
| Environmental problems | 0.025***(0.007) | 0.028***(0.007) | 0.022***(0.007) | 0.026***(0.006) | 0.023***(0.007) |
| Passive membership | 0.054***(0.008) | 0.057***(0.007) | 0.041***(0.007) | 0.029***(0.006) | 0.035***(0.007) |
| Active membership | 0.053***(0.009) | 0.046***(0.009) | 0.050***(0.009) | 0.029***(0.008) | 0.017**(0.009) |
| Meeting friends | 0.010(0.006) | 0.025***(0.006) | 0.003(0.006) | 0.011**(0.005) | 0.008(0.005) |
| Visiting relatives | 0.004(0.006) | 0.008(0.006) | 0.010*(0.006) | 0.006(0.005) | 0.010*(0.006) |
| Church attendance | 0.042***(0.006) | 0.044***(0.006) | 0.024***(0.006) | 0.026***(0.005) | 0.020***(0.006) |
| Talking politics | 0.029***(0.006) | 0.020***(0.006) | 0.026***(0.006) | 0.017***(0.005) | 0.013**(0.006) |
| Listening to politics | 0.013*(0.006) | 0.020***(0.006) | 0.008(0.006) | 0.007(0.005) | 0.015**(0.006) |
| Newspapers | 0.047***(0.006) | 0.026***(0.006) | 0.026***(0.006) | 0.021***(0.005) | 0.011**(0.006) |
| Television | 0.015*(0.009) | 0.022**(0.009) | 0.020**(0.008) | 0.006(0.007) | 0.005(0.008) |
| Radio | 0.016***(0.006) | 0.015***(0.006) | 0.010*(0.005) | 0.011**(0.004) | 0.001(0.005) |
| Female | 0.067***(0.010) | 0.068***(0.010) | 0.050***(0.009) | 0.026***(0.008) | 0.034***(0.009) |
| Married | 0.051***(0.011) | 0.063***(0.011) | 0.053***(0.011) | 0.023**(0.009) | 0.025**(0.010) |
| Divorced | −0.027**(0.013) | −0.023*(0.013) | −0.019(0.013) | −0.018*(0.010) | −0.010(0.012) |
| Widowed | 0.002(0.013) | −0.012(0.012) | −0.008(0.012) | −0.011(0.010) | −0.027**(0.011) |
| Age 31–40 | 0.048***(0.014) | 0.043***(0.014) | 0.039***(0.014) | 0.036***(0.012) | 0.015(0.013) |
| Age 41–50 | 0.068***(0.015) | 0.049***(0.015) | 0.034**(0.014) | 0.035***(0.013) | 0.020(0.014) |

(*continued*)

Table 5. (*Continued*).

| Variable | I<br>Paper | II<br>Glass | III<br>Plastic | IV<br>Aluminium | V<br>Food waste |
|---|---|---|---|---|---|
| Age 51–60 | 0.085***(0.016) | 0.064***(0.015) | 0.052***(0.015) | 0.043***(0.013) | 0.031**(0.015) |
| Age 61–70 | 0.080***(0.017) | 0.063***(0.017) | 0.050***(0.017) | 0.036**(0.015) | 0.017(0.016) |
| Age 71–80 | 0.030(0.019) | 0.007(0.018) | 0.006(0.018) | 0.008(0.015) | 0.004(0.017) |
| Household size | 0.003(0.004) | −0.001(0.004) | 0.003(0.004) | 0.000(0.003) | 0.005(0.004) |
| Children 0_5 | −0.023***(0.008) | −0.014(0.008) | −0.019**(0.008) | −0.016**(0.007) | −0.009(0.008) |
| Children 6_12 | −0.008(0.007) | −0.007(0.007) | −0.012*(0.007) | −0.004(0.006) | −0.002(0.006) |
| Children 13_17 | −0.003(0.008) | 0.000(0.008) | 0.007(0.008) | 0.006(0.006) | 0.003(0.007) |
| Low education | −0.045***(0.009) | −0.034***(0.008) | −0.040***(0.008) | −0.014**(0.007) | −0.006(0.008) |
| Bachelor's degree | 0.027**(0.011) | 0.018(0.011) | 0.007(0.011) | −0.003(0.009) | −0.001(0.010) |
| Household income (ln) | 0.082***(0.014) | 0.065***(0.013) | 0.041***(0.013) | 0.035***(0.011) | 0.002(0.013) |
| Poor health | −0.037***(0.011) | −0.038***(0.011) | −0.033***(0.011) | −0.019**(0.009) | −0.014(0.010) |
| Good health | 0.009(0.007) | −0.007(0.007) | −0.003(0.007) | −0.008(0.006) | −0.001(0.007) |
| Unemployed | −0.011(0.018) | −0.024(0.017) | −0.021(0.017) | −0.007(0.015) | −0.047***(0.015) |
| Entrepreneur | −0.020*(0.011) | −0.021*(0.011) | −0.015(0.011) | −0.011(0.009) | −0.007(0.010) |
| Self-employed | −0.024**(0.010) | −0.015(0.010) | −0.029***(0.009) | −0.020**(0.008) | −0.009(0.009) |
| Retired | 0.058***(0.009) | 0.054***(0.009) | 0.044***(0.009) | 0.033***(0.007) | 0.029***(0.008) |
| Homeowner | −0.000(0.008) | 0.021***(0.008) | 0.007(0.007) | 0.004(0.006) | 0.024***(0.007) |
| Civil house | 0.021***(0.006) | 0.017***(0.006) | 0.013**(0.005) | 0.007(0.005) | −0.001(0.005) |
| Rooms | 0.003**(0.001) | 0.003**(0.001) | 0.003**(0.001) | 0.002*(0.001) | 0.002(0.001) |
| Micro-criminality | 0.005(0.017) | −0.009(0.017) | 0.009(0.016) | −0.003(0.013) | −0.010(0.015) |
| No parking problems | 0.016**(0.007) | 0.045***(0.007) | 0.033***(0.006) | 0.022***(0.005) | 0.042***(0.006) |
| No traffic problems | −0.005(0.009) | −0.003(0.008) | −0.007(0.008) | 0.008(0.007) | 0.003(0.008) |
| No pollution | −0.030***(0.008) | −0.008(0.008) | −0.020***(0.008) | −0.020***(0.006) | −0.009(0.007) |
| No dirtiness problems | 0.011*(0.007) | 0.013**(0.006) | 0.014**(0.006) | 0.006(0.005) | 0.009(0.006) |
| Household problems reaching bins | −0.032***(0.013) | −0.025*(0.013) | −0.002(0.012) | −0.005(0.010) | 0.011(0.012) |
| Metropolis | −0.007(0.011) | −0.020*(0.011) | −0.018*(0.011) | −0.018**(0.009) | −0.004(0.010) |
| Neighbouring metropolis | 0.005(0.014) | −0.025*(0.014) | −0.003(0.013) | −0.007(0.011) | −0.002(0.013) |

(*continued*)

Table 5. (*Continued*).

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| Variable | Paper | Glass | Plastic | Aluminium | Food waste |
| >50,000 | −0.017(0.012) | −0.035***(0.012) | −0.030***(0.011) | −0.014(0.009) | −0.019(0.011) |
| 10,000–50,000 | −0.008(0.012) | −0.024**(0.011) | −0.019*(0.011) | −0.006(0.009) | −0.004(0.011) |
| 2000–10,000 | −0.008(0.011) | −0.028**(0.011) | −0.022**(0.011) | −0.019**(0.009) | −0.005(0.010) |
| Regional dummies | Yes | Yes | Yes | Yes | Yes |
| Year dummies | Yes | Yes | Yes | Yes | Yes |
| No. of observations | 42,094 | 42,204 | 41,851 | 41,646 | 41,400 |
| Pseudo R-squared | 0.26 | 0.23 | 0.23 | 0.24 | 0.21 |
| Log-likelihood | −21,545.84 | −22,353.20 | −21,762.57 | −18,665.82 | −21,405.61 |

Notes: The dependent variable *household recycling* takes value 1 if the household head always recycles. The model is estimated with a standard probit. Regressors' legend: see Table 3. Regional and year dummies are omitted from the Table for reasons of space. The standard errors are corrected for heteroskedasticity. The symbols ***, **, * denote that the coefficient is statistically different from zero at 1, 5 and 10%, respectively.

Table 6. Probit results. Regional marginal effects.

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| Variable | Paper | Glass | Plastic | Aluminium | Food waste |
| Piedmont + VdA | −0.325***(0.009) | −0.356***(0.011) | −0.295***(0.007) | −0.198***(0.004) | −0.222***(0.008) |
| Trentino-AA | −0.132***(0.017) | −0.175***(0.018) | −0.246***(0.010) | −0.063***(0.010) | −0.176***(0.010) |
| Veneto | −0.229***(0.012) | −0.266***(0.014) | −0.206***(0.010) | −0.092***(0.008) | −0.182***(0.009) |
| Friuli-VG | −0.210***(0.016) | −0.268***(0.017) | −0.222***(0.012) | −0.154***(0.006) | −0.232***(0.009) |
| Liguria | −0.360***(0.009) | −0.407***(0.010) | −0.340***(0.006) | −0.228***(0.003) | −0.278***(0.006) |
| Emilia-R | −0.275***(0.011) | −0.325***(0.012) | −0.285***(0.008) | −0.184***(0.005) | −0.250***(0.007) |
| Tuscany | −0.301***(0.011) | −0.358***(0.011) | −0.323***(0.006) | −0.186***(0.005) | −0.260***(0.007) |
| Umbria | −0.430***(0.006) | −0.482***(0.007) | −0.372***(0.004) | −0.226***(0.003) | −0.323***(0.004) |
| Marche | −0.386***(0.008) | −0.412***(0.010) | −0.324***(0.006) | −0.210***(0.004) | −0.256**(0.008) |
| Lazio | −0.415***(0.007) | −0.451***(0.009) | −0.365***(0.005) | −0.212***(0.004) | −0.265***(0.007) |
| Abruzzi | −0.451***(0.005) | −0.485***(0.007) | −0.375***(0.004) | −0.225***(0.003) | −0.300***(0.006) |
| Molise | −0.447***(0.005) | −0.498***(0.006) | −0.370***(0.004) | −0.224***(0.003) | −0.290***(0.006) |
| Campania | −0.506***(0.004) | −0.543***(0.005) | −0.395***(0.004) | −0.252***(0.003) | −0.350***(0.004) |
| Puglia | −0.419***(0.007) | −0.488***(0.007) | −0.348***(0.006) | −0.233***(0.003) | −0.305***(0.006) |
| Basilicata | −0.463***(0.004) | −0.522***(0.005) | −0.377***(0.004) | −0.227***(0.003) | −0.314***(0.005) |
| Calabria | −0.485***(0.003) | −0.549***(0.004) | −0.397**(0.003) | −0.243***(0.003) | −0.332***(0.004) |
| Sicily | −0.490***(0.005) | −0.544***(0.005) | −0.390***(0.004) | −0.240***(0.003) | −0.305***(0.006) |
| Sardinia | −0.474***(0.004) | −0.510***(0.006) | −0.400***(0.003) | −0.244***(0.003) | −0.329***(0.004) |

Note: Lombardy is the reference region.

Introducing a recycling bin for food waste raises the recycling probability by 40%. This indicates that the presence of recycling bins has a greater effect on food waste than first appears (Jenkins *et al.* 2003).

As expected, if recycling bins are difficult to reach this has a negative and significant effect on recycling behaviour for all five materials. This result is in line with previous analyses (Sterner and Bartelings 1999, Gonzalez-Torre and Adenso-Diaz 2005). The magnitude of the marginal effect is quite similar across materials. However, food waste and plastic have the highest negative marginal effect. This comes as no surprise because, compared with newspapers and aluminium, food waste, plastic and glass have high transportation and storage costs. Hence, improving the proximity of recycling bins should reduce households' transportation and storage costs, which could increase household recycling levels.

Unsurprisingly, having a pro-environmental behaviour leads to a higher recycling effort. The probability of always recycling rises from 2.3% (plastic and food waste), 2.6% (for paper and aluminium) to 2.9% (glass).



### *5.1.2. Social behaviours*

This section focuses on the relationship between social behaviours and household recycling effort. In Table 5, Columns (I)–(V) show a positive correlation (statistically significant at 1%) between membership in non-profit associations and the choice of the household head to always recycle all five materials. Membership of associations is correlated with a 5.7% higher probability of recycling glass, a 5.4% higher probability of recycling paper and a 4.1% higher probability for plastic. For food waste the marginal effect is 3.5% and for aluminium it is 2.9. As indicated in Section 3, these findings may well be explained by the fact that individuals who participate in social associations have stronger preferences for (local) public goods. Furthermore, social associations, such as social networks, are also responsible for the flow of information on environmental issues (Jones *et al.* 2010). Finally, social associations may influence the internalisation of pro-environmental norms and values through peer pressure (Durlauf and Fafchamps 2005).

The impact of active membership (volunteer labour supply) in non-profit associations is positive and statistically significant at 1% as well (except for food waste significantly at 5%). Active membership of associations is correlated with a 5.3% higher probability of recycling paper, a 5.0% higher probability for plastic and a 4.6% higher probability for glass. For aluminium the marginal effect is 2.9% and for food waste it is 1.7%.

This is likely to happen because there may well be channels of altruism and moral norms. Volunteers may recycle because they gain utility from contributing to a just cause (protecting the environment). Moreover, individuals who actively participate in non-profit associations may develop and enforce moral norms that may positively affect their recycling behaviour. This suggests that moral norms for recycling behaviour are activated by volunteer labour supply.

The effect of meetings with friends on household recycling is positive and statistically significant for glass (1%) and aluminium (5%), whereas visiting relatives has a low positive impact (10%) only for plastic and food waste. Thus, relationships with friends and relatives do not seem important social behaviours of recycling behaviour. In other words, friends and relatives do not appear to operate as an

information source and/or social pressure as suggested by previous studies (see Section 3).

Church attendance has a positive and statistically significant effect at 1% on household recycling for all five materials. If the head of a family goes to a church or another place of worship one or more times a week, the probability that he/she always recycles increases by 4.4% in the case of glass, 4.2% in the case of paper, 2.6% for aluminium, 2.4% for plastic and 2.0% for food waste. As indicated in Section 3, religious participation may provide knowledge and information on recycling programmes, Moreover, religious traditions and religious participation may support moral norms which may positively influence recycling behaviour. If so, this implies that pro-recycling moral norms are activated by religious events and spiritual norms. Finally, church attendance can reduce individual opportunism and motivate household heads to devote more effort to action to protect the environment, such as recycling.

Table 5 also shows that the habit of talking politics matters. Talking politics every day, or several times a week, leads to a higher probability of always recycling for all materials. The habit of talking politics is associated with a 2.9% higher probability of recycling paper, a 2.6% higher probability for plastic and 2.0% for glass. For aluminium the marginal effect is 1.7% and for food waste it is 1.3. Instead, the habit of listening to political debates presents a positive and significant association with household recycling only for glass (1%), food (5%) and paper (10%).

A feasible reason for these findings recalls the argument according to which politically interested people are well-informed and have a high level of current knowledge about what is going on in politics (Torgler and García-Valiňas 2007). Hence, politically interested people may be well informed about environmental issues and problems and may have greater willingness to participate in recycling programmes.

The relationship between the decision to recycle and the habit of reading newspapers, watching television and listening to the radio seen as an information source about recycling programmes is also examined in Table 5. Household heads who read newspapers every day are more likely to always recycle all materials. The reading of newspapers is correlated with a 4.7% higher probability of recycling paper, 2.6% for glass and plastic, 2.1% for aluminium and 1.1% for recycling food waste. These results seem in line with previous research (Tucker and Speirs 2002, Nixon and Saphores 2009).

Watching television every day is associated with a higher recycling probability for paper, glass and plastic, while individuals who listen to the radio every day are more likely to recycle all materials, except for food waste. Nevertheless, the magnitude of the marginal effects of the television and radio variables on recycling is lower than that of the newspaper variable. Newspapers, television and radio are potential information sources about recycling. Thus, the importance of newspapers compared with the other sources should not be surprising since they leave a visible record of usable information (Nixon and Saphores 2009).

### *5.1.3. Demographic and socio-economic characteristics*

As seen in Section 2, the existing literature on household recycling focuses on the demographic characteristics of recyclers. The econometric analysis presented in

Table 5 includes a number of demographic characteristics of the household head. The statistical significance and magnitude of the effects of these variables on recycling behaviour are quite similar across the five materials. Below, I discuss those variables that have a statistically significant effect.

Being female increases the likelihood to recycle for all materials (statistically significant at 1%). Being female is associated, respectively, with a 6.8%, 6.7% and 5.0% higher probability of recycling glass, paper and plastic. For food waste the marginal effect is 3.4% and for aluminium it is 2.6%. Thus *female* is one of the most significant and important quantitative coefficients in the specifications.

In Table 5 a statistically non-linear U-shaped relationship is observed between age dummies and recycling behaviour for all materials, except for food waste. Being in the age class between 51 and 60 increases the recycling probability by 8.5% for paper, 6.4% for glass, 5.2% for plastic, 4.3% for aluminium and 3.1% for food waste. Hence, also the marginal effect of the age 51–60 dummy can be seen as one of the most significant and important quantitative coefficients of all those used. The significant relationship among age dummies and recycling outcomes is in line with previous studies (Jenkins *et al.* 2003, Kipperberg 2007, Hage *et al.* 2009, Nixon and Saphores 2009).

*Low education* enters the recycling behaviour equations with a negative sign and is statistically significant (1%) in the regressions for paper, glass, plastic and aluminium. This means that a household head who has completed elementary school and/or junior high school recycles less than a household head with a high school (diploma). In the recycling behaviour for paper, university graduates also have a higher probability of recycling than high school-leavers. These results suggest a positive correlation between education and recycling behaviour and are consistent with the findings of Hong *et al.* (1993) and Jenkins *et al.* (2003).

Household income has a significant and positive effect on recycling behaviour for all materials, except for food waste. This suggests that household recycling behaviour is a normal good. This result is in line with one strand of the literature (Richardson and Haylicek 1978, Schultz *et al.* 1995, Jenkins *et al.* 2003, Halvorsen 2008).

A number of other socio-economic variables also influence recycling behaviour. Being married raises the recycling probability for all materials, while being divorced decreases the recycling outcomes for paper, glass and aluminium. Finally, widowed status is associated negatively and significantly (5%) with recycling behaviour for food waste.

Recycling behaviour does not seem to depend on household characteristics. Household size is not statistically significant, nor is the presence of children aged between 6 and 17. Nevertheless, a household head with children under the age of 6 has a lower probability of recycling paper, plastic and aluminium. These results appear to conflict with previous research which indicates that larger households are more likely to recycle (Ando and Gosselin 2005, Nixon and Saphores 2009).

Perceived health and employment status matter. A household head who perceives their health status as poor is less likely to recycle all materials (except food waste). With regard to employment status, entrepreneurs recycle less paper and glass, the self-employed recycle less paper, plastic and aluminium, the unemployed recycle less food waste, while the retired recycle all five materials to a greater extent. Interestingly, being retired is correlated with 5.8% higher probability of recycling paper, a 5.4% higher probability for glass, 4.4% for plastic, 3.3% for aluminium and

2.9% for food waste. One explanation for these results could be that the retired have a lower opportunity cost.

Recycling studies frequently focus on whether a respondent owns or rents his/her home and on the home's characteristics. These issues are also examined here. Homeowners are more likely than tenants to recycle glass and food waste. This may indicate that homeowners are more attached to their community and/or are more concerned with the perceptions of their neighbours and recycle more as a result (Ferrara and Missios 2005).

Household heads who live in a council house are more likely to recycle paper, glass and plastic. Living in a house with between one and five rooms increases the probability of recycling all materials (except food waste), although the magnitude of the marginal effects is low. A possible explanation for this result might be a lack of outdoor and indoor storage space.

Perception of community problems matters too. A household head who states that there is no difficulty parking in the area where he/she lives has a higher probability of recycling all five materials. Interestingly, no parking problem is associated with a 4.5% higher probability of recycling glass and a 4.2% higher probability of recycling food waste. This evidence reinforces the results obtained on the difficulty of getting to recycling bins. If recycling bins are in an area where the respondent states there is a parking problem, this perceived problem, together with the high transportation costs of waste materials, discourages household heads from recycling.

Moreover, a household head who states that there is no dirtiness in the area where he/she lives has a higher probability of recycling paper, glass and plastic, whereas a household head who states that there is no pollution in the area where he/she lives has a lower probability of recycling paper, plastic and aluminium. These findings also seem to underline the importance of the respondent's beliefs related to the area where he/she lives. If the respondent perceives the area where he/she lives as being clean, this belief encourages him/her to recycle waste. On the other hand, if the household head perceives the area where he/she lives as being polluted, this opinion dampens his/her effort in recycling waste.

Having problems reaching recycling bins decreases the household's probability of recycling paper by 3.2% and that of recycling glass by 2.5%.

The city size enters the recycling behaviour regressions of glass and plastic negatively and significantly, indicating a non-linear relationship. Household heads living in a municipality with more than 50,000 inhabitants have the lowest recycling probability, followed by individuals living in municipalities with 2000–10,000 inhabitants and by those living close to a metropolis, in the case of glass, and in a metropolis, in the case of plastic.

The regressors also include 18 regional dummies (Val d'Aosta is aggregated with Piedmont), with Lombardy as the reference region, whose marginal effects are shown in Table 6. Household heads living in southern Italy are less likely to recycle all materials. In particular, individuals in Campania have the lowest probability of recycling all materials. Living in Campania is correlated with 51% lower probability of recycling paper, with a 54% lower probability for glass, a 40% lower probability for plastic, 25% for aluminium and 35% lower probability for food waste. Since I controlled for a full set of demographic, social and economic individual variables, a feasible explanation for such findings should be sought in regional economic and institutional factors, comprising economic growth, environmental policy and organised crime.

## 6. Concluding remarks

The paper investigated the determinants of household waste recycling behaviour in Italy on five different materials: paper, glass, plastic, aluminium and food waste. It used survey-based evidence from 47,643 observations from the 1998 and 2000 Italian Multipurpose Household Survey conducted annually by the Italian Central Statistics Office. Its main aim was to explain the likelihood of household recycling behaviour in the absence of monetary incentives and sanctions, and focus on social behaviours. To my knowledge, this is the first empirical study to address such issues at the household level in Italy.

Econometric analysis showed a range of significant determinants of recycling behaviours. Recycling bins increase households' probability of always recycling all five materials. Further, difficulties getting to recycling bins in the area where the household head lives reduce recycling levels for all materials. The magnitude of the marginal effects is quite similar across the materials, with the largest impacts on food waste and plastic. These results suggest that the recycling bin programme has a smaller impact on materials for which there are recycling options, such as newspapers. Furthermore, improving the proximity of recycling bins should reduce household transportation and storage costs which could increase household recycling levels.

Social behaviours matter. Passive and active (unpaid labour supply) membership of non-profit associations have sizeable marginal effects in increasing the probability of always recycling all five materials. These findings seem to indicate that membership of such associations is an important factor in activating moral norms which may positively influence recycling behaviour. Moreover, other social behaviours also constitute major determinants of recycling: church attendance, talking politics on a regular basis and reading newspapers are also significantly positively associated with the probability of always recycling the five materials in question. The former would appear to show that also religious participation has a role in activating pro-recycling moral norms, while the discussion of political interests and reading newspapers emerge as important sources of information about recycling programmes. Investigating the relative importance of such social behaviours across regions (within the same country), and countries, is an interesting direction for future work.

Individual characteristics matter too. Females always recycle more than males; married individuals always recycle more than singles. Household recycling behaviour is U-shaped in relation to age, while higher household income produces a higher probability of always recycling. Moreover, it was found that the poorly educated are less likely to recycle than an educated household head, and the retired are more likely to recycle than those in employment. Finally, the household head residing in the regions of southern Italy is least likely to recycle. This also suggests a direction for future research.

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## Notes

1. See D. Lgs 156/2006 and Law 292/2006.
2. In Italy, until 1996 the main aim of environmental policy was waste disposal using taxation as a policy instrument to combat waste problems (see DPR 915/1982 and Law 475/1988). In 1997, Legislative Decree 22/1997, called *Decreto Ronchi* (DR), to improve waste management changed the aim of environmental policy, indicating as the main targets the reduction of waste materials sent to landfill and the increase in reuse, recovery and recycling. These targets included: recycling 15% of waste by 1999; 25% by 2001 and 35% by 2003. The Legislative Decree 156/2006 increased these targets to 35% of waste by 2007 and 40% by 2008. Furthermore, the DR replaced taxes with tariffs as policy instruments to cover costs related to waste management.
3. Distributions are available from the author upon request.



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## Appendix

As in Fiorillo (2009), let $A$ be the MSH dataset (the so-called 'base file') collecting information on $X_A$ variables for each of $n_A$ records, and let $B$ be the SHIW dataset (the 'supplemental file') comprising $X_B$ variables for each of $n_B$ records. Let $X = (X_1, \ldots, X_P)$ be the vector of variables measured in both the files, i.e. for each of the units $n_A$ and $n_B$ included in the two datasets. The remaining variables in each of the files will be referred to as $Y = (Y_1, \ldots, Y_Q)$ in file $A$ and as $Z = (Z_1, \ldots, Z_R)$ in file $B$. The statistical matching procedure is aimed at creating a file $C$ collecting all the variables $X$, $Y$, and $Z$ for each of $n_A$ records of the base file. For each unit in file $A$ a similar unit in file $B$ is identified as a function of the $X$ 'common' variables. Then the household income variable collected in the supplemental file $B$ (the SHIW) is imputed to the matching records in the base file $A$ in order to obtain an original dataset $C$ including all the variables of interest for the analysis. The inherent assumption in this procedure is that the random vector $Y$ given $X$ is independent of the random vector $Z$ given $X$. The conditional independence assumption implies that $Y$'s relationship to $Z$ can be totally inferred from $Y$'s relationship to $X$ and $Z$'s relationship to $X$. Thus, the distributions of $X$, $Y$, and $Z$ of the new file $C$ must be identical to the distributions of $X$, $Y$ and $Z$ empirically observed in the original files $A$ and $B$. As a consequence, the best test to evaluate the quality of the statistical matching relies on the marginal distributions of the variables. As stated by Rässler (2002, p. 23): "A statistical match is said to be successful if the marginal and joint empirical distributions of $Z$ and $Y$ as they are observed in the donor samples are nearly the same in the statistically matched file".

The common variables $X = (X_1, \ldots, X_P)$ shared by the original datasets are identified according to the following criteria: (1) they must have been classified and measured in the same (or very similar) way in both of the surveys; (2) they must have been observed for all the individuals included in the samples; (3) they can be assumed as possible determinants of household waste recycling and social behaviours in the base file. Based on results from previous studies, the following variables were chosen: gender, age, education, family size, number of children, region of residence, work status, sector of activity and homeownership. Statistical matching was then performed through a regression imputation with random residuals. In particular, the regression parameters of $Z$ (i.e. the household income) on $X$ were estimated on the SHIW. A random residual was then added to the regression prediction to obtain the imputed value of $z$ for each $a = 1, \ldots, n_A$ record in file $A$. Finally, the quality of the procedure was controlled by comparing the conditional distribution of the household income given $X$ in the new and the original files. The marginal distributions are not found to be statistically different.[3]