



Research Paper

Civic sense and its contribution to recycling activities: Evidence from Italy

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ABSTRACT

This article studies from a conceptual, theoretical and empirical point of view the link between civic sense and recycling activities in Italy related to the years 1998, 2012, 2018, 2019. It establishes a link among the concepts of civic sense, whose essential components are behaviours, attitudes and interactions, with it being a typical traditional theoretical approach with perfectly rational and perfectly informed agents, along with a standard empirical analyses on the determinants of (household) waste recycling. Starting from a game-theoretic model of contribution with particular features related to the objective function of agents and a heterogeneity in their costs, the article aims to highlight how certain theoretical results get together with empirical evidence. In the empirical analysis, using the micro-data of a “Multipurpose Survey on Households” provided by the Italian National Statistical Office and an ordered probit model, the article finds a positive, robust and stable correlation between civic sense and household recycling activities. The findings show that a higher civic sense is related to an increase in household recycling activities, respectively, of 1.2 percentage points in 1998, 4.3 percentage points in 2012, and 3.8 percentage points in both 2018 and 2019.

1. Introduction

The Italian National Statistical Office (ISTAT) defines *civic spirit* or *civic sense* as the set of behaviours and attitudes relating to the respect for other citizens and the rules of life in a community (ISTAT, 2019). This definition is close to the one used in economics for *civic norms*, “rules of behaviour that regulate social dilemma games and help a group to overcome free-rider problems” (de Wit and Lisciandra, 2021, 188; Guiso et al., 2011), which has been used by Owen and Videras (2006) to show how people who are more disposed to act approving civic norms are also more willing to safeguard the public good represented by the natural environment. More recently, Michaeli et al., (2023) define *civicness* as “the willingness to obey mandatory rules concerning contribution to the public good (e.g., paying taxes), even if they are not enforced and are costly to follow.”

In this respect, this paper is concerned with neither the concept of *civic norms* nor *civicness* but rather with certain behaviours that signal the level of *civic sense* within a community. Several essential components can be highlighted in the definition of civic sense. First, the definition considers the behaviour that is not exclusively an economic behaviour such as working, bargaining, buying, gambling, but rather encompasses all the activities performed by individuals within their community.

Secondly, the definition mentions attitude, with this term reinforcing what was emphasised in the description related to behaviour in the definition itself. In this case, attitude does not exclusively refer to the interactions with the economic context but to perceptions of and actions toward all the components of the socio-economic environment. Finally, the importance of the word community must be stressed. Within the community, each agent interacts with the others in the care of the common goods, with the presence of a high civic sense favouring the preservation of common goods such as the environment, the liveability of places and the respect for the rules of coexistence even in the absence of coercion and punishment.

This paper deals with the aspects highlighted above that represent a sub-set of the general concept of *civic norms* and/or *civicness*, and that, regardless of being more circumscribed, can provide a useful aid to the understanding of other virtuous behaviours such as the activities undertaken by citizens to carry out waste recycling. Waste recycling is a time-consuming action that needs an individual effort to sort the household waste and carry it to recycling bins. Nevertheless, it has positive long-term social and environmental externalities, including the conservation of resources, the reduction of both pollution as well as waste management expenditures (Aprile and Fiorillo, 2019). Moreover, waste recycling is a significant indicator of environmental sustainability

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(Argentero et al., 2023). Following Moh and Abd Manaf (2017), this paper considers how recycling is influenced by a mentality towards cleanness and the sense of concern towards waste management. Implicitly, it is possible to assume that civic sense is positively related to recycling activities. Thus, agents decide to respect the norms of civic coexistence, in the same way they might be inclined to respect the natural environment as well as develop any behaviours that limit the pollution and destruction of resources, which could include respecting recycling activity rules.

The aim of this paper is to create a link among the concepts of civic sense, whose essential components are behaviours, attitudes and interactions, with it being a typical traditional theoretical approach with perfectly rational and perfectly informed agents, along with a standard empirical analyses on the determinants of (household) waste recycling.

The research question deals with the concept of civic sense, a game-theoretic model and an empirical investigation of the determinants of waste recycling with which to theoretically underline and empirically corroborate whether and how certain theoretical results get together with empirical evidence.

In the theoretical approach, three basic aspects characterize the model: contributors may have different targets of public goods that could be provided; may have diverse costs in rising the resources required to produce the public good; the agents-contributors are not forced to cooperate. The model assumes the existence of two representative agents, with both having a target level of separate waste collection and their payoffs taking account of a quadratic loss function towards their own recycling target. The model aims to develop a game with simultaneous contributions from the agents in order to reach the same level of recycling.

Data from the 1998, 2012, 2018 and 2019 waves of the Multipurpose Survey of Households (MHS) provided by ISTAT are used in the empirical investigation. Three behaviours kept by citizens in public spaces are considered as *Civic sense*: not throwing paper on the street, not double parking cars and being careful not to adopt noisy driving behaviour. These behaviours are correlated to the separate collection carried out by citizens (*Recycling behaviour*) using an ordered probit model, along with numerous control variables. The key finding shows that *Civic sense* is positively correlated with *Recycling Behaviour*. This result is robust and stable through all the waves analyzed with the marginal effect of *Civic sense* increasing from the 1998 to 2019 waves.

This work adds two new extensions to current theoretical and empirical literature. From a decision theory perspective, the game-theoretic framework of contribution games is used for the first time in decision-making mechanisms regarding waste collection. Citing only the most recent works from a relatively large amount of literature, recycling activity is modeled with game-theoretic frameworks based on the behaviour of consumers, recyclers and public authorities (Ehimwenma et al., 2022) or on non-cooperative game involving municipalities and residents (Cohen et al., 2021). From an empirical point of view, the paper is related to several studies that have highlighted the role of moral and social norms in explaining behaviours in waste recycling (Berglund, 2006; Halvorsen, 2008; Hage et al., 2009; Abbot et al. 2013; Sorkun, 2018; Mintz et al. (2019); Razali et al., 2020; Wang et al., 2020; Liao and Xing, 2023). Despite this increasing amount of literature, to the best of our knowledge, there are no studies that analyse the role played by certain behaviours that denote the presence or absence of civic sense in waste recycling activities.

The paper is structured as follows. Section 2 is a brief review of the related literature. Section 3 develops the theoretical approach. Section 4 discusses the micro-data, reports the descriptive statistics and presents the empirical methodology. Section 5 presents and comments on the results. Section 6 discusses the policy implications and Section 7 makes key conclusions.

2. Related literature

2.1. (Household) waste recycling

Waste recycling at the source has been considered as a feasible choice to address the dilemmas of waste management. Numerous studies around the world have discussed the technological, economic, psychological and social dynamics related to waste sorting (Wang et al., 2020; Yang et al., 2022). Kirakozian (2016a; 2016b), Geiger et al. (2019), Knickmeyer (2020) and Macklin et al. (2023) provide comprehensive reviewer on (household) waste recycling, highlighting terminology, determinants, methodological approaches and main findings. In the discussion below, we highlight determinants and studies of particular relevance for our work.

In the 1990s, an initial analysis of (household) waste recycling considered variables such as: waste disposal fees and recycling programmes (Fullerton and Kinnaman, 1996; Callan and Thomas, 1997; Jenkins et al., 2003); demographic and socio-economic factors (Richardson and Haylicek 1978; Oskamp et al., 1991; Hong et al., 1993); the degree to which the recyclers and non-recyclers required additional information about recycling (De Young, 1988; Hornik et al., 1995; Schultz et al., 1995); the values that affect attitudes, beliefs, and actions regarding specific environmental situations (Vining and Ebreo, 1990; Stern et al., 1993; Stern et al., 1995); the psychological mechanisms that influence people's choices in this type of human activity (Fishbein and Ajzen, 1975; Ajzen, 1991; Stern et al., 1999). The aim of our paper is related to and contributes to the current literature on moral and social norms, intrinsic and extrinsic incentives, social capital and demographic and socio-economic characteristics.

In the literature several studies focus on moral and social norms. Using data from Swedish households, Berglund (2006) finds that individuals who have a strong moral motivation presents lower costs associated with household recycling activities. Similarly, Hage et al. (2009), studying recycling efforts in Swedish households, find that a moral motive is related to household recycling rates while a social norm is not associated. Viscusi et al. (2011), analyzing household data on the United States do not find a significant influence of social norms on the recycling of plastic bottles. In contrast, Halvorsen (2008) with data on Norway shows how the measures of moral and social norms increase household recycling efforts. In the same way, Abbott et al. (2013) utilizing English data find that social norms affect recycling activities. Sorkun (2018) and Liao and Xing (2023) show that social norms affect household recycling behaviour, respectively, of Turkish and Chinese residents, while Razali et al. (2020) and Wang et al. (2020) with data on Malaysian and Chinese populations underline that moral norms influence waste separation behaviour. Instead Mintz et al. (2019) does not find that social norms predict people engagement in recycling activities in Germany, Israel and Japan. Despite the growing amount of literature on the topic, there are no studies which analyze the link between certain behaviours which denote the presence or absence of civic sense and waste recycling activities.

Other studies in current recycling literature distinguish between intrinsic and extrinsic incentives (Cecere et al., 2014; Corrado et al., 2022). The former regard behaviours that are self-rewarding, while the latter are carried out to obtain an external reward (Deci, 1971). Cecere et al. (2014), in examining individual behaviour towards waste reduction using large EU surveys, highlight that this behaviour is typically driven by an intrinsic motivation. Corrado et al. (2022) utilizing Italian data show that both intrinsic and extrinsic motivations are relevant in household waste recycling. Following Aprile and Fiorillo (2019), in this paper we consider an environmental attitude and environmental concerns as intrinsic incentives (Schultz et al., 2005; Bamberg and Möser, 2007; Arbus and Villanúa, 2016; Yokoo et al., 2018; Escario et al., 2020; Yang et al., 2022) and waste disposal fees and recycling programmes (Fullerton and Kinnaman, 1996; Kipperberg, 2007; Abbott et al., 2011; D'Amato et al. 2016; Anderson and Stage 2018; Gilli et al.,

2018; Degli Antoni and Vittucci Marzetti 2019; Zhou et al., 2021) as extrinsic incentives. In summary, current literature highlights the role of both intrinsic and extrinsic incentives in (household) waste recycling. A number of studies have also considered social capital¹ in the form of social interactions as the main driver of recycling behaviour (Videras et al., 2012; Fiorillo, 2013; Crociata et al., 2015; Agovino et al., 2016). More recent investigations corroborate the relationship between social interaction measures and waste recycling (Aprile and Fiorillo, 2019; Fiorillo and Senatore, 2020; Luo et al., 2020; Wang and Zhang, 2022; Argentiero et al., 2023; Odoardi et al., 2023).

Several studies have shown how demographic and socio-economic features, such as gender, age, education, income, homeownership and family size, influence waste recycling. Regarding gender, while some studies underline how this characteristic has no or little effect on recycling behaviour (Sidique et al., 2010; Miliute-Plepiene et al., 2016; Escario et al., 2020), some studies find a higher tendency to recycle among women (Fiorillo, 2013; Babaei et al., 2015), others show the opposite (Crociata et al., 2015; Corrado et al., 2022). The results regarding age and education variables are also questionable (Tadesse et al., 2008; Escario et al., 2020; Romano et al., 2022). Some studies support findings that older people and individuals who are more educated recycle more (Taberero et al., 2015; Crociata et al., 2015; Corrado et al., 2022; Romano et al., 2022). Other papers find no evidence (Miliute-Plepiene et al., 2016; Yokoo et al., 2018), others show that young individuals recycle more (Czaikowski et al., 2014). Others point out that individuals with a lower educational level recycle more (Escario et al., 2020). Considering income, a number of studies show a positive correlation between income and recycling (Czaikowski et al., 2014; Rompf et al. 2018; Romano et al., 2022; Argentiero et al., 2023). The results regarding the relationship among homeownership, family size and recycling are also unambiguous: homeowners and larger families are more likely to be recyclers (Gaeta et al., 2017; Padilla and Trujillo, 2018).

2.2. Theoretical literature on contribution game

As previously discussed in the introduction, our analysis starts from a game-theoretic structure where citizen-players jointly collaborate to provide a public good. After achieving some theoretical results by solving the model, we support them through an empirical investigation. The basic points of reference in the theoretical literature concern the model of contribution game characterized by the production of a continuous public good. The pioneering analyses on the subject were developed by Warr (1982, 1983), with Cornes and Sandler (1984) and Bergstrom et al. (1986) focusing their attention on voluntary contribution games by considering the significant presence of free riding problems and showing how the Nash equilibrium conditions determine that the amount of public good is underprovided. The theoretical model that we use in our analysis is strictly related to the one described by Varian (1994). In Varian's model, two players are considered, who have a payoff function characterized by a quasi-linear utility. They have ordered marginal valuations of the public good that is present in their economic context, and their strategic interactions in the contribution game have been analysed in both a simultaneous and sequential choice context. In each case, there is a natural free riding problem but the public good provided in equilibrium is higher in the simultaneous case. Varian shows that when the agents act simultaneously, whoever has a higher valuation becomes the standalone contributor, while when the agents contribute sequentially the first mover can decide to contribute zero and the second would be the standalone contributor to the amount of public good provided in equilibrium. Starting from this result, many

analyses have made changes to the original structure of the model, developing its aspects from a theoretical, empirical and even experimental point of view (Falkinger et al., 2000; Gächter et al., 2010). Buchholz et al. (1997) modified the Varian model allowing the players to play a sequential contribution game with the possibility to exchange monetary compensations after all the agents involved in the game have made their contribution. The analysis of altruism in the theoretical framework of contribution games has been concretized and developed by Andreoni (1998). However, subsequent studies have focused on the relevance of the information component within the theoretical structure of contribution games. For example, Vesterlund (2003) studied the importance of the informational values that characterize a game of a sequential fund raising, while Bag and Roy (2011) explored the effects of an introduction of incomplete information in contribution games in both a simultaneous and sequential choice framework. Russo and Senatore (2012) introduced a peculiarity that had not been considered in previous studies, i.e., the possibility for the contributors to have personal desired targets associated to the optimal amount of the public good that must be produced. In the case of recycling, the particular game-theoretic structure of contribution game can be useful in interpreting the behaviours of agents who are more or less inclined to separate waste collection. The theoretical framework allows to consider the level of recycling activity as a level of public good achieved within a community.

3. Theoretical framework

This analysis is founded on a theoretical structure of the contribution game with certain characteristics (Russo and Senatore, 2012). Three basic aspects characterize the model: contributors may have different targets of recycling that could be provided; they may face different costs in employing the inputs needed to develop the recycling activity; the agents-contributors are not forced to cooperate. The heterogeneity that characterizes the cost function and the targets of the public good make it possible to identify two generic, but different, types of agents. For one typology, it is more costly to separate waste than for the other; this may be due to a combination of components such as, for example, the closeness to the waste delivery sites, lack of time to separate waste, lack of unambiguous information on waste separation methodology, etc. Regarding different targets, it is possible to state that our theoretical analysis is particularly apt to show how communities can be composed of individuals with a different civic sense that influences their decisions regarding the desired levels of separate waste collection. Our basic assumption is to consider targets as the projection of civic sense on waste recycling actions. The theoretical framework of the contribution games gives the opportunity to describe the behaviour of agents who, in this case, have perfect information about the state of the world and are perfectly rational. It has been assumed that there are only two types of agents; this allows to include in the model a simplified degree of diversity that has its own reflection in reality. The inclusion of the mechanism related to different targets for recycling collection helps to identify an aspect that is frequent in the real world, namely, the fact that every individual has their own target for recycling collection. This target takes into account our own attitude toward respecting the environment but, as in our model, the behaviour of other agents could also influence the achievement of our desired level of separate collection. The target is a faithful mirror of the civic sense present in society but its achievement is also influenced by the interaction among the agents that belong to it.

We assume the existence of two representative agents *A* and *B*, both having a target level of separate waste collection *R* (the variable *R* corresponds to the level of recycled waste achieved after the recycling activity of the two agents). Each agent is involved in reaching the level of recycled waste through the contributions r_A and r_B so the level of recycling will be:

$$R = \bar{R} + d(r_A + r_B) \quad 0 < d < 1 \quad (1)$$

¹ This paper follows Putnam's definition of social capital as "features of social organization such as trust, norms and networks that can improve the efficiency of society by facilitating coordinated actions" (Putnam et al., 1993, 167).

In this expression \bar{R} describes the pre-existing level of recycling and R is produced using a linear technology. The first part of the expression of the agents' payoffs is represented by a quadratic loss function which specifies the level of recycling achieved after the contribution and the target level of recycling for each agent. We assume that \bar{R} is always less than the targets of the contributors to the public good, i.e. $\bar{R} < R_A^*$, $\bar{R} < R_B^*$. In addition, both agents face costs to achieve their level of separate collection and for agent B it is more costly to contribute to reaching its target of recycling collection. Therefore, we have the following payoff functions:

$$U_i = -\frac{1}{2}(R - R_i^*)^2 - \frac{C_i}{2}r_i^2 \quad A, B; C_A = 1; C_B > 1 \quad (2)$$

(2) can be rewritten as follows:

$$U_i = -\frac{1}{2}(\bar{R} + d(r_A + r_B) - R_i^*)^2 - \frac{C_i}{2}r_i^2 \quad (3)$$

Both contributors play a contribution game choosing their strategies simultaneously thus we obtain the following results in equilibrium:

$$r_A^s = \frac{\Delta A(C_B + d^2)d - d^3 \Delta B}{d^2 + C_B + d^2 C_B}$$

$$r_B^s = \frac{\Delta B(1 + d^2)d - d^3 \Delta A}{d^2 + C_B + d^2 C_B}$$

$$\Delta A \equiv (R_A^* - \bar{R})\Delta B \equiv (R_B^* - \bar{R})$$

At this point, we consider Proposition 1 of the contribution game model analysed in Russo and Senatore (2012) making a slight modification that considers only the case of simultaneous agent contribution.

Proposition 1 (Russo and Senatore, 2012). In the simultaneous case, the individual contributions are both positive if and only if the individual targets are not too different.

Proof

We find the positive values of A's contribution:

$$r_A^s = \frac{\Delta A(C_B + d^2)d - d^3 \Delta B}{d^2 + C_B + d^2 C_B} > 0$$

Solving the inequality:

$$\frac{\Delta A(C_B + d^2)d}{d^2 + C_B + d^2 C_B} > \frac{d^3 \Delta B}{d^2 + C_B + d^2 C_B}$$

After algebraic simplifications:

$$\frac{\Delta A}{\Delta B} > \frac{d^2}{C_B + d^2}$$

We find the positive values of B's contribution:

$$r_B^s = \frac{\Delta B(1 + d^2)d - d^3 \Delta A}{d^2 + C_B + d^2 C_B} > 0$$

Solving the inequality:

$$\frac{\Delta B(1 + d^2)d}{d^2 + C_B + d^2 C_B} > \frac{d^3 \Delta A}{d^2 + C_B + d^2 C_B}$$

After algebraic simplifications:

$$\frac{\Delta A}{\Delta B} < \frac{1 + d^2}{d^2}$$

Therefore, both players contribute positively in the simultaneous case if:

$$\frac{d^2}{C_B + d^2} < \frac{\Delta A}{\Delta B} < \frac{1 + d^2}{d^2}$$

this condition holds when R_A^* is sufficiently close to R_B^* ■.

Looking at the single contributions of the agents, it can be noted that the contribution of A decreases as the value of ΔB increases, and similarly, the contribution of B takes on lower values as the amount of ΔA increases. Furthermore, this implies two possible outcomes of the simultaneous game in equilibria. If B prefers a higher level of recycling respect to A , the second one can decide not to contribute at all since B might contribute enough to satisfy both agents, with the same thing happening in the opposite case. More clearly, one contributor in the simultaneous case could contribute 0 because he is satisfied with the contribution of the other agent. Therefore, the free riding problem in the contribution game is reduced when the individual targets R_A^* and R_B^* are not too different. This theoretical result helps understand some possible scenarios regarding the level of waste separation within a society. If it consists of individuals from the two groups who both have a low recycling target, then since the two targets are similar they both contribute but the level of separate waste collection is low. In case the largest number of individuals belongs to the group that has a low recycling target then, despite the fact that the most virtuous contributors do recycle, the level of recycling waste collection in the society is low since the first ones are free riding. In the opposite case, the free riding problem is reduced and the virtuous contributors determine the level of recycling. Finally, if both groups have high targets R_A^* and R_B^* that are not too different then the free riding problem disappears and the community achieves high peak waste collection rates.

Fundamentally, Proposition 1 shows that the diffusion of civic sense within a society affects the choices of agents. The excessive difference between the targets determines the lack of commitment on the part of those who have the lowest targets in contributing to a cleaner and healthier environment by recycling their waste. This implies the need to spread the culture of recycling as much as possible to avoid any eventual free rider phenomena.

It is also important to identify those who contribute most in this theoretical framework. Through calculations comparing contribution levels, we can state the following Proposition.

Proposition 2 (Russo and Senatore, 2012). In the simultaneous case, player A contributes more than B when $\frac{\Delta A}{\Delta B} > \frac{1+2d^2}{C_B+2d^2}$.

Proof

To compare the contributions, we set $r_A^s \geq r_B^s$:

$$\frac{\Delta A(C_B + d^2)d - d^3 \Delta B}{d^2 + C_B + d^2 C_B} \geq \frac{\Delta B(1 + d^2)d - d^3 \Delta A}{d^2 + C_B + d^2 C_B}$$

Solving the inequality:

$$\Delta A(C_B + d^2) - d^3 \Delta B \geq \Delta B(1 + d^2) - d^3 \Delta A$$

After algebraic simplifications:

$$\frac{\Delta A}{\Delta B} \geq \frac{(1 + 2d^2)}{C_B + 2d^2}$$

the previous condition holds when $\frac{1+2d^2}{C_B+2d^2}$ ■

This result suggests that when the agents A and B face the same costs (i.e., $C_B = 1$), whoever has a higher target contributes more. In this case $C_B > 1$ is sufficiently high, the agent A , who faces lower costs to carry out separate collection, contributes more than B even when $\Delta A < \Delta B$. Although the fact that he has a differential between the achieved level of separate collection and his own target that is lower than that of B , he is willing to support B in achieving a given level of separate collection by contributing more if the latter faces high costs to carry out waste separation activities. He knows that it is less costly for him to contribute, and this can help further raise the level of recycling collection throughout society. This peculiarity can be interpreted as additional evidence of our initial assumption linking civic sense to waste recycling activities. Proposition 2 gives further relevant information: the interaction between the agents, involved in the separate collection action, generates virtuous mechanisms that push the agents who have less difficulty in

carrying out recycling to support those who can carry out it by incurring greater costs. This does not happen because of altruistic mechanisms but, essentially, due to the need of the agents with lower costs to reach the desired targets that allow for the maximization of their well-being. The two propositions fit within the existing literature on two main areas. From a theoretical point of view, the novelty with respect to the literature concerning contribution games is the introduction of a loss function within the agent-maximization process; this modification had already been made by Russo and Senatore (2012) and in this context it is used to describe a contribution to a well-defined public good such as the level of separate collection. Instead, from an application point of view, the two propositions allow us to address for the first time in the literature the issues related to separate collection by applying a particular contribution game which is useful to show that in society there are different types of agents depending on their civic sense and that this, inevitably, influences the desired level of separate collection. The keystone represented by the presence of a loss function allows us to show how the strategic behaviour of agents is also influenced by the degree of heterogeneity that exists in society.

We question at this point, whether the concept of the citizens' recycling collection target, introduced within our model, coincides with their level of civic sense. Empirical analysis can help to interpret in real terms the validity of Propositions 1 and 2 of the model.

Considering the two propositions, the empirical analysis, to confirm the results of the model, should highlight three key aspects. The first is that as the slice of the population with a high target increases, the level of recycling collection also increases. The second is that if both groups of contributors have a high and very similar target of recycling collection, they are induced to always contribute without being free riders. The third is that if one group of contributors knows that the other has to incur higher costs to implement recycling collection then he may decide to contribute more to reach the target of recycling collection desired by the other as well.

From the above theoretical prepositions, we provide the following hypothesize:

H1: If the three aspects are highlighted, exist a positive relationship between civic sense and (household) waste recycling. So we expect to find a positive correlation that supports the conclusions of the adopted theoretical model.

4. Material and methods

4.1. Data

This study uses data from the MHS collected by ISTAT. The MHS is part of an integrated social survey system² and collects essential information on the daily lives of Italian individuals and families. The MHS has been carried out every year since 1993, providing information on several thematic areas concerning school, work, family and social life, leisure time, political and social participation, health, life satisfaction and life styles, economic situation and so on. The survey is carried out on a sample of around 20,000 families and 50,000 individuals.³ The MHS is

² The MHS is included in the National Statistical Plan which collects the statistical surveys necessary for Italy.

³ The MHS interviews all individuals belonging to the families that fall into the sample. The families are randomly extracted from the list of names extracted for the census surveys, according to a sampling strategy aimed at constructing a statistically representative sample of the population resident in Italy. The information is collected using a mixed technique, which makes use of an online questionnaire entirely self-filled by the respondents (CAWI technique, Computer-Assisted Web Interviewing) or a direct interview with both an electronic and paper questionnaire, administered by an interviewer (CAPI technique /PAPI, Computer-Assisted Personal Interviewing and Paper and Pencil Interviewing) (ISTAT, 2023).

not a panel but a cross-sectional dataset as the respondents change every year.

For the aim of this study, the 1998, 2012, 2018 and 2019 waves of the MHS are precious data since they have a thematic area both on environmental problems as well as pro-environmental behaviours including waste recycling behaviours. This piece of information is not simultaneously present in the other MHS waves. This empirical investigation is at the householder head level (aged 18 or over). After removing the missing data on all the variables used in the econometric analysis, the sample size is: 14,893 observations in the 1998 wave; 17,677 observations in the 2012 wave; 18,271 and 18,712 observations, respectively, in the 2018 and 2019 waves. Following the literature on (household) waste recycling reviewed in Section 2.2, Table 1 describes all the covariates used in our empirical analysis. For each year, the final dataset used in the econometric investigation with the weighted summary statistics and correlations are shown in Table 2.

The dependent variable is the household's recycling behaviour that is defined *Recycling behaviour*. In each wave, the head of the household is asked the following question: "Is your family in the habit of collecting the following waste separately using the appropriate waste containers?", with the answers being: "paper, glass, drugs, aluminium, plastic, used batteries, textile, food, others" with the frequency "Yes, always; Yes, sometimes; No." Following the literature reviewed in Section 2.1, we consider the following type of wastes: paper, glass, plastic, aluminium and food. For each material, a dummy variable is built taking value equal to 1 if the head of the householder declares "Yes always" and 0 otherwise. Summing the five dummy variables, one for each material considered, our final dependent variable is a discrete variable which ranges from 0 to 5. In the first case, the head of the householder recycles sometimes or never the five materials; in the last case, he/she recycles all the five materials always. In the middle cases, the head of the household recycles some materials always.⁴

In the paper we have defined civic sense as the set of behaviours and attitudes relating to the respect for other citizens and the rules of life in a community (ISTAT, 2019). To provide a measure of this definition, some environmental issues present in each MHS waves considered are used. We examine three issues: (i) "throwing paper on the street"; (ii) "Double parking the car"; (iii) "Being careful not to adopt noisy driving behaviour". For each issue, a dummy variable is built taking value equal to 1 if the head of the householder declares "never" and 0 otherwise. Hence, we add 1 to *Civic sense* when the head of the householder declares that he/she never does this. Thus, the final key independent variable *Civic sense* is a discrete variable going from 0 to 3, with the highest value indicating that the head of the householder is never engaged in all three behaviours. In our opinion, this variable can capture an individual's respect towards others and towards the rules of life of a community.

We consider several set of control variables according to the review discussed in Section 2.1. The first set of variables regards the intrinsic and extrinsic incentives. We build a variable capturing a general worry for the environment. In every survey analysed, the respondents are asked to declare "The most worrying environmental issue". Thus, *Waste Concern* is a dummy variable equal to 1 if the head of the household affirms that "Waste production and disposal" is the most concerning environmental problem. This variable captures an intrinsic motivation to recycle waste.

The MHS also provides information on the individual's judgment on the tariff for waste disposal and recycling bins. This piece of information is used to build variables capturing extrinsic motivations: external constraints for waste recycling. Thus, "Waste disposal service fee judgement" is a binary variable equal to 1 if the head of the household believes

⁴ Among previous works which use an ordinal variable as measure of (household) waste recycling there are: Kipperberg (2007), Halvorsen (2008), Hage et al. (2009), Agovino et al. (2016), Kirakozian (2016b), Corrado et al. (2022).

Table 1
Description of the variables.

Definition	Description	Variable
<i>Dependent variable</i>		
Recycling behaviour	The head of the household recycles from zero to five types of waste: paper, glass, plastic, aluminum and food	0–5 scale
<i>Key independent variables</i>		
Civic sense	The head of the household declares that he/she is never involved in: (a) “throwing paper on the street; (b) “double parking the car”; and (c) “be careful not to adopt noisy driving behaviour”	0–3 scale
<i>Control variables</i>		
<i>Intrinsic and extrinsic incentives</i>		
Waste concern	The head of the household affirms that waste production and disposal is the most concerning environmental problem	= 1
Waste disposal service fee judgment	The head of the household believes that the waste disposal service fee is high	= 1
Recycling bins	Number of recycling bins in the area where the head of the household lives	0–5 scale
Recycling bins easy to reach	Recycling bins easy to reach in the area where the head of the household lives	=1
<i>Demographic and socio-economic characteristics</i>		
Female	The head of the household is female	= 1
Married	The head of the household is married. Reference group: male	= 1
Age18-30	The head of the household is aged between 18 and 30 years old Reference group: others status	= 1
Age31-45	The head of the household is aged between 31 and 45 years old	= 1
Age46-60	The head of the household is aged between 46 and 60 years old	= 1
Household size	Number of people living in the family	
Children0_5	The head of the household’s children are aged less than 5 years. Reference group: no children	= 1
Children6_12	The head of the household’s children are aged between 6 and 12 years	= 1
Children13_17	The head of the household’s children are aged between 13 and 17 years	= 1
Low education	The head of the household has no education and/or education less than diploma. Reference group	= 1
High school (diploma)	The head of the household has completed high school (13 years)	= 1
Bachelor’s degree	The head of the household is graduated or more (more than 18 years)	= 1
Household economic situation judgment	The head of the household judges the household economic situation in the last year as better or little better	= 1
Household economic resources judgment	The head of the household judges the economic resources of all the household members as adequate	= 1
Unemployed	The head of the household is employed. Reference group: others status	= 1
Retired	The head of the household is retired	= 1
Homeowner	The head of the household owns his/her home outright	= 1
Good health	The head of the household assesses his/her state of perceived health as good and/or very good	= 1
Newspapers	The head of the household reads newspapers every day	= 1
Church attendance	The head of the household goes to church once or more a week	= 1
Talk politics	The head of the household talks about politics every day	1 =
<i>Social capital as social interactions</i>		
Putnam membership	The head of the household participated in meetings of voluntary service,	1

Table 1 (continued)

Definition	Description	Variable
	ecological and cultural organizations in the last twelve months	
Volunteering	The head of the household did unpaid work for voluntary organizations in the last twelve months	= 1
Meeting friends	The head of the household meets friends more than once a week	= 1
<i>Perception of community issues in the area where the respondent lives</i>		
No parking issues	The head of the household declares that there are no parking difficulties	=1
No traffic issues	The head of the household declares that there are no traffic problems	=1
No dirtiness issues	The head of the household declares that there are no dirtiness problems	=1
<i>Municipal variables</i>		
Metropolis	The head of the household lives in a metropolitan area. Reference group: municipality with less than 2,000 residents	=1
Neighbouring metropolis	The head of the household lives in a municipality close to a metropolitan area	=1
Municipality with more than 50,000 residents	The head of the household lives in a municipality with more than 50,000 residents	=1
Municipality with 10,000–50,000 residents	The head of the household lives in a municipality with a population between 10,000 and 50,000 residents	=1
Municipality with 2,000–10,000 residents	The head of the household lives in a municipality with a population between 2,000 and 10,000 residents	=1

that the waste disposal service fee is high. Additionally, the MSH asks individuals the query: “Are there any containers for separate waste collection in the area where your family lives? The possible answers are: 1) “Yes and they are easily accessible”; 2) “Yes but they are difficult to reach”; 3) “no”; 4) “I don’t know”. Response (1) is used to build an ordinal variable labelled “Recycling bins” ranging from 0 (for those who declare that there are no recycling bins for all the selected items or they are difficult to reach) to 5 (for those who declare that there are recycling containers for all the five items and are easy to reach). Finally, the MSH surveys ask the respondent if he/she “has difficulties in reaching the recycling bins”. Thus, a dummy variable equal to 1 if the head of the household declares “no difficulty” is created and labelled “Recycling bins easy to reach”.

The second set of control variables regards the demographic and socio-economic characteristics. For each of these features, we build dummy variables (see Table 1). As is standard in this type of literature,⁵ we consider gender (*Female*), marital status (*Married*), age (three dummies: *Age18-30*, *Age31-45*, *Age46-60*), family size (*Household size*), children’s age (three dummies: *Children 0–5*, *Children 6–12*, *Children 13–17*), the level of education (three dummies: *Low education*, *High school*, and *Bachelor’s degree*), household economic conditions (two dummies: *Household economic situation judgment*, *Household economic resources judgment*), employment status (two dummies: *Unemployed*, *Retired*), tenure status (*Homeowner*), self-reported health (*Good health*), the habit of reading newspapers (*Newspapers*), the frequency of going to church or other place of worship (*Church attendance*) and the habit of talking about politics (*Talk politics*).

Moreover, three dummy variables reflecting social interactions as social capital are formed: *Putnam membership*, *Volunteering*, *Meeting friends* (see Table 1 for their description). Furthermore, the perception of community issues where the head of the household lives is also controlled for. Three issues are considered: parking problems, traffic problems and dirtiness problems. Hence, respectively, three dummy variables are built, *No parking issues*, *No traffic issues*, *No dirtiness issues*,

⁵ See reviewer provided by Kirakoian (2016b) and Maklin et al. (2023).

Table 2
Panel A. Weighted descriptive statistics, years 1998, 2012, 2018 and 2019.

	1998		2012		2018		2019	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Recycling behaviour	2.112	1.992	3.780	1.884	4.233	1.444	4.322	1.393
Civic sense	1.802	0.831	1.902	0.854	2.138	0.807	2.156	0.806
Waste concern	0.396	0.489	0.474	0.499	0.465	0.498	0.487	0.500
Waste disposal service fee judgment	0.669	0.470	0.665	0.471	0.681	0.465	0.649	0.477
Recycling bins	2.080	1.925			2.610	2.235	2.690	2.256
Recycling bins easy to reach	0.795	0.403	0.775	0.418	0.698	0.458	0.695	0.460
Female	0.202	0.402	0.316	0.465	0.357	0.479	0.357	0.479
Married	0.716	0.450	0.541	0.498	0.480	0.500	0.486	0.500
Age18-30	0.051	0.220	0.038	0.191	0.033	0.178	0.025	0.155
Age31-45	0.289	0.453	0.265	0.441	0.210	0.407	0.202	0.402
Age46-60	0.320	0.454	0.289	0.453	0.303	0.459	0.317	0.465
Household size	2.883	1.279	2.443	1.283	2.322	1.275	2.364	1.281
Children0_5	0.153	0.426	0.126	0.399	0.105	0.327	0.099	0.357
Children6_12	0.186	0.462	0.177	0.478	0.161	0.466	0.163	0.460
Children13_17	0.156	0.422	0.091	0.316	0.085	0.307	0.088	0.311
High school (diploma)	0.276	0.466	0.325	0.468	0.345	0.475	0.344	0.475
Bachelor's degree	0.093	0.290	0.130	0.335	0.144	0.351	0.157	0.363
Household economic situation judgment	0.621	0.485	0.405	0.490	0.082	0.274	0.090	0.286
Household economic resources judgment	0.644	0.478	0.523	0.499	0.594	0.491	0.638	0.480
Unemployed	0.029	0.168	0.067	0.249	0.076	0.265	0.071	0.257
Retired	0.335	0.472	0.320	0.467	0.323	0.467	0.318	0.465
Homeowner	0.694	0.460	0.738	0.440	0.716	0.451	0.730	0.444
Good health	0.727	0.445	0.614	0.486	0.583	0.493	0.595	0.490
Newspapers	0.313	0.463	0.225	0.418	0.146	0.353	0.141	0.348
Church attendance	0.305	0.460	0.281	0.449	0.242	0.428	0.246	0.431
Talk politics	0.124	0.329	0.133	0.440	0.107	0.309	0.095	0.292
Putnam membership	0.148	0.355	0.148	0.354	0.155	0.362	0.154	0.361
Volunteering	0.086	0.281	0.101	0.301	0.109	0.312	0.104	0.304
Meeting friends	0.269	0.444	0.255	0.435	0.235	0.423	0.225	0.318
No parking issues	0.335	0.472	0.392	0.488	0.364	0.481	0.348	0.476
No traffic issues	0.196	0.397	0.282	0.450	0.249	0.432	0.245	0.430
No dirtiness issues	0.226	0.418	0.310	0.462	0.269	0.443	0.258	0.437
Metropolis	0.244	0.429	0.130	0.336	0.298	0.457	0.301	0.459
Neighbouring metropolis	0.076	0.265	0.085	0.279				
Municipality with more than 50,000 residents	0.148	0.355	0.160	0.366				
Municipality with 10,000–50,000 residents	0.207	0.405	0.269	0.453	0.424	0.494	0.428	0.494
Municipality with 2,000–10,000 residents	0.248	0.432	0.269	0.443	0.275	0.447	0.268	0.443
No. of obs.	14,893		17,677		18,271		18,712	

Panel B. Weighted correlations, year 1998, 2012, 2018 and 2019

	1998	2012	2018	2019
	Recycling behaviour	Recycling behaviour	Recycling behaviour	Recycling behaviour
Civic sense	0.144	0.172*	0.125*	0.095*

Note: * denotes that the coefficient is statistically different from zero at 5% level.

taking the value equal to 1 if the head of the household declares no problems.

Finally, the size of the municipalities and regional dummies are also included to take into account of the great local heterogeneity in Italy.

4.2. Descriptive statistics

Table 2 panel A shows the weighted sample average of recycling behaviour and the civic sense variables in the years analysed. We can observe that both the variables increased. The average of recycling behaviour increased from 2.112 in the year 1998 to 3.780 in the year 2012 to reach the value of 4.322 in the year 2019. In addition, the average of civic sense increased from 1.802 in the year 1998 to 1.902 in the year 2012, to reach the value of 2.156 in the year 2019. Figures 1–4 in Appendix 1 show this trend. Considering the recycling behaviour variable, an important change is observed between 1998 and 2012 years. The former is the year when the separate waste collection began in Italy and although it was mandatory, in practice it was voluntary as failure to comply was rarely sanctioned (see Fiorillo, 2013; Aprile and Fiorillo, 2019). We note the high percentage of respondents who declare that they either do not recycle or recycle sometimes for all the five materials considered (value 0). On the other hand, the latter is the year

in which the percentage of respondents who declares that they always separate waste collection of the five materials increases considerably (value 5). 2018 and 2019 years are the years in which there is a stabilization of the percentages of the respondents who declare that they always recycle (value 5). An explanation for this important increase is linked to the European Union legislation that defined higher percentages of waste recycling at a national level, with a consequent push towards higher separate waste collection by local municipalities (see Agovino et al., 2016; Degli Antoni and Vittucci Marzetti 2019; Romano et al., 2022; Argentiero et al., 2023).⁶ Numerous other factors may have contributed (as reported in Section 2.1) and still contribute, as in the case of civic sense whose role this paper is trying to highlight. For a brief review of the studies that deal with the determinants of waste recycling behaviour in Italy, see Corrado et al. (2022).

Looking at the trend of civic sense variable in the years considered, we observe a less marked increase compared to those of the recycling behaviour variable, nonetheless it is important in relation to the percentage of respondents who declares they are never engaged in all three behaviours (value 3) (almost doubled from 1998 to 2019).

⁶ For an overview of the legislation on separate waste collection see Agovino et al. (2021).

Understanding what factors drove this increase is a direction for future research in this area.

Furthermore, Table 2 panel B shows a positive weighted sample correlation that is statistically significant at 5 % level between recycling behaviour and civic sense variables for each year of analysis. This result indicates that both variables move in the same direction in accordance with our theoretical framework already in a preliminary descriptive analysis.

4.3. Empirical method

The relationship between civic sense and recycling behaviour for individual i at time t is modelled as:

$$RB_{it}^* = \beta CS_{it} + \gamma X_{it} + \epsilon_{it} \tag{4}$$

where RB^* is the latent variable of recycling behaviour, CS is the vector of civic sense; X is the matrix containing all the control variables; β, γ are coefficients to be estimated and ϵ is a random-error term.

In the MHS dataset, the recycling variable is an ordinal variable with the values (0, 1, 2, 3, 4, 5). This means that the regression model suitable to estimate Eq. (4) is an ordered probit model where the random-error term is normally distributed across the observations (Green 2012).⁷

Hence, we do not observe RB^* in the data. Rather, what we observe is.

$$RB = 0 \text{ if } RB^* \leq 0$$

$$RB = 1 \text{ if } 0 < RB^* \leq \mu_1$$

$$RB = 2 \text{ if } \mu_1 < RB^* \leq \mu_2$$

$$RB = 3 \text{ if } \mu_2 < RB^* \leq \mu_3$$

$$RB = 4 \text{ if } \mu_3 < RB^* \leq \mu_4$$

$$RB = 5 \text{ if } \mu_4 \leq RB^*$$

where μ_j , with $j = 0, \dots, 5$, are the unknown parameters to be estimated with β and γ . With ϵ normally distributed and normalizing the mean and the variance to zero and one, we have the following probabilities:

$$\text{Prob}(RB_{it} = 0) = \Phi(-\beta CS_{it} - \gamma X_{it})$$

$$\text{Prob}(RB_{it} = 1) = \Phi(\mu_1 - \beta CS_{it} - \gamma X_{it}) - \Phi(-\beta CS_{it} - \gamma X_{it})$$

$$\text{Prob}(RB_{it} = 2) = \Phi(\mu_2 - \beta CS_{it} - \gamma X_{it}) - \Phi(\mu_1 - \beta CS_{it} - \gamma X_{it})$$

$$\text{Prob}(RB_{it} = J - 1) = \Phi(\mu_j - \beta CS_{it} - \gamma X_{it}) - \Phi(\mu_{j-1} - \beta CS_{it} - \gamma X_{it})$$

$$\text{Prob}(RB_{it} = 5) = 1 - \Phi(\mu_4 - \beta CS_{it} - \gamma X_{it}) \tag{5}$$

where $\Phi(\cdot)$ is the cumulative normal distribution. The model is estimated using a maximum likelihood estimation (MLE). We compute for each variable the average marginal effect.

5. Results and discussion

Tables 3 and 4 display the ordered probit estimates of the outcome (5) “the head of the household recycles all the items always”. The Columns show, respectively, the average marginal effects and the standard errors which are corrected for the heteroskedasticity.

The discussion of the econometric findings is divided in the following. First, the correlation between the civic sense and recycling

⁷ Previous studies which use an ordered probit model to estimate (household) waste recycling are: Kipperberg (2007), Halvorsen (2008), Hage et al. (2009), Agovino et al. (2016), Kirakozian (2016b), Corrado et al. (2022).

Table 3

Ordered probit results years 1998 and 2012. Marginal effects of outcomes (5).

Variable	1998		2012	
	Dy/dx	Std. Err.	Dy/dx	Std. Err.
Civic sense	0.012***	0.002	0.043***	0.004
Waste concern	0.017***	0.003	-0.002	0.008
Waste disposal service fee judgment	-0.001	0.003	-0.003	0.008
Recycling bins	0.031***	0.003		
Recycling bins easy to reach	0.029***	0.003	0.061***	0.008
Putnam membership	0.024***	0.006	0.024*	0.013
Volunteering	0.018**	0.007	0.053***	0.015
Meeting friends	0.001	0.003	0.007	0.008
Female	0.010*	0.005	0.022**	0.010
Married	0.014***	0.005	0.027***	0.011
Age18-30	0.001	0.009	-0.034	0.024
Age31-45	0.011*	0.006	-0.091	0.015
Age46-60	0.011**	0.005	0.008	0.013
Household size	0.005***	0.002	0.015***	0.005
Children0_5	-0.011**	0.005	-0.034***	0.012
Children6_12	-0.001	0.004	-0.010	0.010
Children13_17	-0.001	0.004	-0.005	0.014
High school (diploma)	0.020***	0.004	0.031***	0.009
Bachelor's degree	0.028***	0.006	0.043***	0.012
Household economic situation judgment	-0.003	0.003	-0.029***	0.008
Household economic resources judgment	0.009***	0.003	0.049***	0.009
Unemployed	-0.014*	0.008	-0.028*	0.016
Retired	0.019***	0.005	-0.001	0.012
Homeowner	0.010***	0.003	0.047***	0.009
Good health	0.004	0.003	0.010	0.009
Newspapers	0.007**	0.003	0.037***	0.009
Church attendance	0.016***	0.004	0.021**	0.009
Talk politics	0.017***	0.005	0.037***	0.011
No parking issues	0.012***	0.004	0.036***	0.009
No traffic issues	-0.008*	0.004	-0.026***	0.010
No dirtiness issues	0.009**	0.004	0.046***	0.009
Municipal dummies Yes			Yes	
Regional dummies Yes			Yes	
No. of obs.	14,039		16,155	
Pseudo R2	0.156		0.116	
Log-likelihood	-19,274.99		-18,132.94	

Notes: Covariates' legend: see Table 1. The standard errors are corrected for the heteroskedasticity. Columns report the average marginal effects of outcomes (5) i.e. “the household head recycles all items always”. The symbols ***, **, * denote that the coefficient is statistically different from zero, respectively, at 1, 5 and 10 % level.

behaviour variables is considered. Then, the intrinsic and extrinsic incentive variables are discussed. Third, some key demographic and socio-economic determinants of recycling behaviour are examined. Moreover, the social capital variables are considered. Table 5 shows the sign and significance of the main findings.

Looking at the relationship between the civic sense and recycling behaviour variables in 1998, 2012, 2018 and 2019 years, we observe that *Civic sense* enters in the equations of *Recycling behaviour* with a positive sign which is statistically significant at a 1% level. Considering the marginal effect of the variable for each year, the *Civic sense* is positively correlated with a higher probability of declaring recycling behaviour by 1.2 % in the year 1998. In other words, when waste recycling started in Italy, the head of the household with a higher civic sense had a higher probability of recycling always all the waste materials by 1.2 percentage points. This correlation has increased to 4.2 % in 2012 to remain stable and robust to 3.8 % in 2018 and 2019. In these last years, the head of the household having a higher civic sense presents a higher likelihood to recycles always all the waste materials by 3.8 percentage points. Thus, through the waves analysed, we can observe a positive, robust and stable correlation between the civic sense and recycling behaviour variables in line with our theoretical model.

These findings add new pieces of information to current waste

Table 4
Ordered probit results years 2018 and 2019. Marginal effects of outcomes (5).

Variable	2018		2019	
	Dy/dx	Std. Err.	Dy/dx	Std. Err.
Civic sense	0.038***	0.004	0.038***	0.004
Waste concern	0.019***	0.007	0.008	0.006
Waste disposal service fee judgment	0.011	0.008	-0.014**	0.007
Recycling bins	0.043***	0.002	0.036***	0.002
Recycling bins easy to reach	-0.031***	0.009	-0.011	0.008
Putnam membership	0.014	0.010	0.006	0.010
Volunteering	-0.004	0.012	-0.001	0.011
Meeting friends	-0.000	0.008	0.000	0.008
Female	0.014	0.009	0.024***	0.008
Married	0.031***	0.010	0.031***	0.010
Age18-30	0.004	0.025	0.005	0.025
Age31-45	0.005	0.014	-0.013	0.013
Age46-60	0.009	0.014	0.008	0.011
Household size	-0.001	0.005	-0.002	0.004
Children0_5	-0.015	0.012	0.006	0.011
Children6_12	0.005	0.009	0.008	0.008
Children13_17	0.005	0.013	0.000	0.011
High school (diploma)	0.018**	0.008	0.014*	0.008
Bachelor's degree	0.039***	0.011	-0.003	0.010
Household economic situation judgment	0.035***	0.013	-0.005	0.012
Household economic resources judgment	0.023***	0.008	0.023***	0.007
Unemployed	0.008	0.015	-0.004	0.014
Retired	0.005	0.011	0.006	0.010
Homeowner	0.027***	0.009	0.036***	0.008
Good health	0.023***	0.008	0.009	0.008
Newspapers	0.012	0.010	0.010	0.009
Church attendance	0.014	0.009	-0.011	0.008
Talk politics	0.059***	0.011	0.027**	0.011
No parking issues	0.005	0.008	-0.006	0.008
No traffic issues	-0.020***	0.009	0.007	0.008
No dirtiness issues	0.039***	0.009	0.041***	0.008
Municipal dummies	Yes		Yes	
Regional dummies	Yes		Yes	
No. of obs.	16,166		17,636	
Pseudo R2	0.058		0.035	
Log-likelihood	16,211.46		-16,366.16	

Notes: Covariates' legend: see Table 1. The standard errors are corrected for the heteroskedasticity. Columns report the average marginal effects of outcomes (5) i.e. “the household head recycles all items always”. The symbols ***, **, * denote that the coefficient is statistically different from zero, respectively; at 1, 5 and 10 % level.

recycling and institutional economics literature. With reference to the (household) waste recycling literature, our paper fits into the line of studies that investigated the role of moral and social norms (Berglund, 2006; Halvorsen, 2008; Hage et al., 2009; Abbot et al. 2013; Mintz et al., 2019; Wang et al. 2022) to integrate them with a theoretical and empirical analysis which also emphasizes the role of civic sense (civic norm). In line with most of previous findings, we show that civic sense, our measure of civic norm, is a relevant predictor of (household) waste recycling. Moreover, regarding institutional economic literature, our study adds new evidence to those studies that apply a notion of civic norm and make use of social survey dataset to measure it (Knack and Keefer, 1997; Owen and Videras, 2006; Guiso et al., 2011; de Wit and Lisciandra, 2021).

Secondly, looking at the intrinsic and extrinsic incentives variables, through all the years, the key findings are on the waste concern and recycling bins variables. *Waste concern* is positively associated with a higher probability to recycle all five items in the estimations of 1998 and 2018. In both years, the significance is at a 1 % level, while the marginal effects are, respectively, 1.7 % and 1.9 %. Thus, these results are in line with previous studies on Italy i.e. Aprile and Fiorillo (2019), Fiorillo and Senatore (2020) and Corrado et al. (2022), and with the literature on environmental concern and attitude (intrinsic motivation) reviewed in

Table 5
Key empirical findings.

Variables	Year			
	1998	2012	2018	2019
Civic sense	+ sig.	+ sig.	+ sig.	+ sig.
Waste concern	+ sig.	not. sign.	+ sig.	not. sign.
Waste disposal service fee judgment	not. sign.	not. sign.	not. sign.	-sig.
Recycling bins	+ sig.	+ sig.	+ sig.	+ sig.
Recycling bins easy to reach	+ sig.	+ sig.	-sig.	not. sign.
Putnam membership	+ sig.	+ sig.	not. sign.	not. sign.
Volunteering	+ sig.	+ sig.	not. sign.	not. sign.
Female	+ sig.	+ sig.	not sig.	+ sig.
Age18-30	not sig.	not sig.	not sig.	not sig.
Age 31-45	+ sig.	not sig.	not sig.	not sig.
Age 46-60	+ sig.	not sig.	not sig.	not sig.
High school (diploma)	+ sig.	+ sig.	+ sig.	+ sig.
Bachelor's degree	+ sig.	+ sig.	+ sig.	not. sign.
Household economic resources judgment	+ sig.	+ sig.	+ sig.	+ sig.
Homeowner	+ sig.	+ sig.	+ sig.	+ sig.
Good health	+ sig.	+ sig.	+ sig.	not. sign.
Newspapers	+ sig.	+ sig.	not. sign.	not. sign.
Church attendance	+ sig.	+ sig.	not. sign.	not. sign.
Talk politics	+ sig.	+ sig.	+ sig.	+ sig.
No dirtiness issues	+ sig.	+ sig.	+ sig.	+ sig.

Section 2.1. *Recycling bins* shows a positive sign which is statistically significant at a 1 % level in 1998, 2018 and 2019. The marginal effects are, respectively, 3.1 %, 4.3 % and 3.6 %. These findings highlight the importance of recycling programs in waste management and are consistent with previous worldwide investigations) (Kipperberg, 2007; Abbott et al., 2011; Anderson and Stage 2018; Gilli et al., 2018; Corrado et al., 2022). It is also worth highlighting in recycling behaviour the role played by the ease of access to recycling bins in 1998 and 2012. *Recycling bins easy to reach* is positively related to the recycling behavior variable and statistically significant at a 1 % level in both years. Moreover, *Waste disposal service fee* is not statistically significant except for in 2019. The head of the household who judges the waste disposal service fee to be too high has less probability to recycle all five materials by 1.4 percentage points. In Italy, waste disposal management is the responsibility of the municipalities. In most municipalities, a flat-rate fee related to the number of family components and the house size finances the service. Although we use the head of the household's judgment of this fee and not its amount, this evidence seems to underline that a flat-rate fee system does not constitute an incentive for (household) separate waste collection.⁸

Thirdly, the findings regarding the demographic and socio-economic characteristics are commented according to the review discussed in Section 2.1. In line with some studies (Fiorillo, 2013; Babaei et al., 2015), we find a higher tendency to recycle among female in all the waves except in 2018. In 2019, female show a higher likelihood to recycle all the materials by 2.4 percentage points. The age dummies are not statistically significant (except for in 1998) as in Miliute-Plepiene et al. (2016) and Yakoo et al. (2018). The marginal effect of *High school* and *Bachelor's degree* is positive and statistically significant at a 1 % level in 1998, 2012 and 2018 (except *High school* in 2018 and 2019). The size is, respectively, 2.0 % and 2.8 % in 1998; 3.1 % and 4.3 % in 2012; 1.8 %

⁸ In Buccioli et al. (2015), curbside (door-to-door) collection and “Pay-As-You-Throw” programs are associated with high waste recycling rates.

and 3.9 % in 2018. These findings are consistent with previous studies (Taberero et al., 2015; Crociata et al., 2015; Corrado et al., 2022; Romano et al., 2022) and confirm that waste recycling behaviour increases as the level of education increases. Both *Household economic resources judgment* and *Homeowner* are positive and statistically correlated with *Recycling behaviour* at a 1 % level in all the years analysed. The first evidence is in line with Czaikowski et al. (2014); Rompf et al. (2017); Romano et al. (2022); Argentiero et al. (2023). The latter is consistent with Padilla and Trujillo (2018). Fourthly, the variables which consider social interactions such as membership in Putnam organizations, voluntary work in organizations and meeting friends show mixed results. Both *Putnam membership* and *Volunteering* are positive and statistically significant, at least a 5 % level, but only in the estimates of 1998 and 2012. These last results are in line with Agovino et al. (2016) and Aprile and Fiorillo (2019). The overall findings are interesting since they seem to highlight how participation in associations with altruistic purposes and volunteering have played a relevant role in Italy in the initiation and consolidation of waste recycling behaviour (1998 and 2012 years). Nevertheless, this role seems to have dried up in more recent years (2018 and 2019 years). A possible explanation is linked to the role of active and passive participation in non-profit organizations: providing information and social pressure. After 20 years of mandatory separate waste collection, this role may have weakened because people have internalized the behaviour. The same argument could apply to *Newspapers* and *Church attendance* which are only statistically significant in the equations of 1998 and 2012. Further investigation on social interactions is necessary. Indeed, *Meeting friends* is never statistically significant. However, this finding is in line with Wang and Zhang (2022) but in contrast with Luo et al. (2020).

Finally, among the perception of community issues where the head of the household lives, it is worth commenting on the *No dirtiness issues* which is positively associated with recycling behaviour at a 1 % level. Corrado et al (2022), using the MHS dataset for 2012, find a negative relationship between the dirtiness variable (dummy equal to 1 if the respondent perceives to live in a dirty area; 0 otherwise) and the recycling behaviour variable (the respondent recycles always paper, bottles, food, and glass). Our results confirm the finding of Corrado and co-authors (2022) and extends it to 1998, 2018 and 2019.

6. Policy implications

In terms of policy choices, the control and coercion of agents in order to force them to separate collection is very difficult and costly. Government authorities have often developed environmental protection programs that have been demonstrated ineffective. The inability to inexpensively and effectively control the habits of billions of citizens is the Achilles' heel of these strategies planned to protect the environment and, in particular, to increase recycling.

Once again, looking the key findings of our empirical analysis, it becomes essential to consider and organize actions aimed at stimulating the diffusion of civic sense and the accumulation of human capital in communities, and think about recycling programs. The first two aspects could be achieved by activating and funding projects within schools and communities that can prioritize training and education to respect the rules of civic behaviours with the aims to strengthen cooperation among citizens and to reduce free riding behaviours. In the same direction it could be helpful developing functional policy and regulatory choices to stimulate cooperation and sensitivity to the care and preservation of the common good. Moreover, ensuring economic and social policies for the less affluent, who are often confined to urban areas where inequalities are higher, could also be the right policy to foster the social cohesion and, hence, the civic sense and behaviours toward recycling activities. The centrality of concepts such as horizontal subsidiarity, aimed at stimulating cooperation between citizens and government authorities, and the creation of horizontal social networks must be a priority goal to encourage waste collection through the civic sense. Looking to

subsidiarity and horizontal social networks, the Third Sector has a key role in Italy (Salvatori et al., 2023).⁹ As shown in this paper, civic membership and volunteering performed in non-profit organizations were a driver of waste recycling behaviour when it started at the end of 1990 years. Moreover, they also played a role in consolidating this behaviour in 2012. In the recent years, it is possible that the Third Sector still has an important role in waste recycling behaviour fostering civic sense (*civiness*) according to the theoretical explanation of Putnam et al. (1993). For Putnam and colleagues, social interactions within non-profit organizations generate social trust in the communities, as they strengthen informal sanctioning mechanisms; they strengthen the civiness and help reputation mechanisms that can be used for future cooperation. Under this scenario, policies oriented to the Third Sector could have a role in supporting waste recycling behaviour over civic sense.

The creation of contexts that foster civic sense and, in particular, programs for separate waste collection also depends on policy decisions that influence the production structures of industries and the logistics of waste collection. The creation of a new business culture that encourages the production of goods that are already born with the peculiarity of being easily recycled is a fundamental step for the spread of civic sense among producers and consumers. A manufacturing sector permeated by a civic drive to produce highly recyclable goods, could also push consumers to implement actions that can facilitate the concretization of their civic sense in recycling activities. Making recycling easier is an objective that can be pursued by incentivising businesses and subsequently saving money by obtaining less waste sent to landfills or incinerators. Investing in the training of an entrepreneurial class that considers civic sense significantly characterized by useful pro-environmental productions could be a strategic policy objective. On the other hand, investing in the optimal location of separate waste collection systems and in the construction of an efficient logistics network for moving waste would reduce the difficulties in carrying out separate waste collection which burden both the production system and consumers. In this regards curbside (door to door) collection programs could have a major role in increasing civic sense and waste recycling behaviour (Buccioli et al., 2015; Degli Antoni and Vittucci Marzetti 2019). All these actions are suggested by the theoretical and empirical analysis present in this article. Furthermore, facilitating behaviours characterized by civic sense determines a diffusion effect of them and a mechanism of imitation among the members of a society becoming convenient and natural.

7. Conclusions

Our analysis takes an important step by introducing the vision of recycling collection as a public good that benefits the whole community. It is no longer exclusively the result of strategic interactions among public authorities, producing companies, recycling companies, and consumers. We went to consciously investigate an aspect of the recycling process that is based on consumer behaviour. The protagonists of our analysis are exclusively the citizens and their families who must choose

⁹ The Third Sector reform in 2016 (law n. 106/2016) define formally the Third Sector as “the complex of private entities constituted for the pursuit of non-profit, civic, solidarity and social utility purposes and which, in pursuance of the principle of subsidiarity and under their respective statutes or constitutive acts, promote and carry out activities of general interest employing voluntary and free forms of action, mutuality or production/exchange of goods or services”. A key point of the reform deals with recognizing the Third Sector as a key actor for the entire society. The Third Sector organisations support not only the most disadvantaged groups of the population, with a wide range of interventions in the socio-assistance, socio-health and educational fields, but not-profit organizations play a cross-cutting and functional role in delivering services to the entire society: from urban regeneration to environmental education, from cultural activities to territorial public health services (Salvatori et al. 2023).

to cooperate in order to achieve a level of separate collection that is as close as possible to their goal. The theoretical prediction tells us that a community composed of individuals with the same goal regarding the level of separate collection achieves the goal more easily since everyone is driven to contribute and cooperate. Even those who face more onerous difficulties in carrying out their separate collection can count on the help of those who are more facilitated in implementing it. All these characteristics lead to identifying a strong correlation between civic sense and separating waste. It is worth recalling that we do not consider any level of coercion or any system of incentives or taxation; in our analysis, the centrality is reserved for the attitude of citizens to respect the rules and the extrusion of civic sense exclusively related to widespread values in the community. This approach represents a preliminary analysis preparatory to the empirical evidence emerging from the ordered probit model used to analyse the data coming from the MHS collected by ISTAT. The assembling of the data in this case generates a set of variables, all of which describe the degree of civic sense present in a community. This methodology constructs a scenario essentially focused on human behaviour independent of sanctioning or coercive mechanisms. The results obtained from the empirical analysis highlight a correlation between civic sense and recycling behaviour robust to the intrinsic and extrinsic motivations of the agents. The correlation between civic sense and recycling behaviour can generate significant implications for both theory and practice. From the theoretical point of view, understanding human behaviour beyond just external incentives or penalties, can allow to define intrinsic factors, such as civic sense or social norms, which play a crucial role in shaping individuals' recycling behaviour. In addition, our results give a relevant value to social influence and community norms in driving sustainable behaviours. Still from a theoretical point of view, we highlight that motivation for sustainable behaviours may be driven by a combination of intrinsic factors such as personal values and social norms and extrinsic factors represented by incentives or penalties optimally planned. Consequently, the practical implications could be articulated on different planes of action. Activities aimed at encouraging recycling and focused on fostering a sense of community and collective responsibility may be promoted. The main goal should be to create a culture where recycling is seen as a shared responsibility by developing social marketing initiatives, community-based campaigns and educational programs. Building social marketing strategies could be launched ideas to encourage civic pride, community identity, and social norms related to recycling. The design of interventions not only characterized by punitive measures it is also crucial. Policymakers can stimulate the importance of civic responsibility and community engagement by planning incentives for community-based recycling initiatives, recognition programs for recycling champions, and support for grassroots efforts to promote recycling. Finally, important practical implications could be the adoption of measures, which ensure that recycling infrastructures are accessible and convenient for all members of the community. The existence of easy access to recycling bins, clear guidelines for waste delivery, and efficient collection systems could facilitate recycling behaviour and reinforce positive social norms.

Further research could investigate the aspects concerning the causality between the variables considered in the empirical analysis as well as if extrinsic motivations, such as curbside collection and fee programs crowd out (in) intrinsic motivations as civic sense and civic participations in social groups. Variations regarding the information set of the contributing agents and the Government intervention within the contribution scheme could be introduced into the theoretical structure. Furthermore, it might also be relevant to analyze in which way the pandemic experience of COVID-19 influenced the correlation between civic sense and recycling collection. In this case, to have more reliable results, it might be useful to wait for a reasonably large period after the end of the pandemic, which occurred during 2023. These theoretical and empirical developments would represent further and valid insights.

CRediT authorship contribution statement

Damiano Fiorillo: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Luigi Senatore:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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Appendix A. Supplementary data

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