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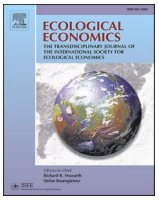

Analysis

Community social capital and status: The social dilemma of food waste☆

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ABSTRACT

In developed countries, the largest share of food is wasted at the household level. Household food waste results from a complex interaction between economic factors, well-established routines, and social norms. To explain this interaction, we propose a simple model of waste behavior where the individual and social economic costs generated by wasting are counterbalanced by the security and status generated through acquiring excess food, thus causing a social dilemma. This trade-off is mediated by social capital, which measures the intensity with which each individual within a community evaluates the negative effects of waste. We test this model's hypotheses using a 2016 dataset of food behaviors and opinions of Italian households, which we merge with variables known to elicit the local level of social capital. We find individual food waste levels to be negatively related with social capital. Contrastingly, status concerns with respect to food and the lack of organizational abilities are both more prevalent in low social capital areas, and are related to increased food waste. This relationship is mediated by income.

1. Introduction

The generation of unnecessary waste is a fundamental problem of modern economic systems that pertains to the borderland where the individual domain adjoins the broader socio-economic sphere. Waste behavior is intrinsically social because of its economic, environmental, as well as ethical implications, but it also has distinctive attributes that tend to confine it to the idiosyncratic realm. First, the visibility of one's waste behavior is limited to the members of a restricted group, such as one's family, so it cannot be subject to social monitoring (Ariely et al., 2009). Second, wasting is a repetitive choice resulting from well-established habits (i.e., one's "automatic responses to certain cues", Verplanken and Orbell, 2003, p. 104). Third, waste is the outcome of a decision-making process focused on the individual consumption of resources (e.g., water, food, and energy).

Within the general problem of waste, food waste stands out as it involves the dissipation of a large amount of resources necessary to produce food. The environmental footprint of food waste in terms of greenhouse gas emissions, soil erosion, and water wastage, among others, has been emphasized in a number of studies (Schanes et al., 2018; Secondi et al., 2015; FAO, 2011; Chapagain and James, 2011; Quested et al., 2011; Parfitt et al., 2010). In developed countries, the largest share of food is wasted by consumers in their homes, not in the upstream phases of the value chain (FAO, 2011; Monier et al., 2010; Parfitt et al., 2010). For example, avoidable consumer food waste is thought to be responsible for 3% of the greenhouse gas emissions and 5% of the water footprint of total consumption (i.e., not only of food) in the U.K. (Chapagain and James, 2011; Quested et al., 2011).

Such high levels of household food waste are not to be understood in isolation, but are rather driven by systemic factors intrinsic to modern industrial food systems that determine over-production, over-abundance, and, eventually, waste. In particular, Colbert et al. Colbert et al. (2017) highlighted the role of power unbalances in food supply chains, with large-scale retail companies able to dictate the way food is "grown,

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harvested, and transported", including the setting of restrictive quality specifications that result in the externalization of waste upstream, to producers, and downstream, to consumers. Other authors (Ghosh and Eriksson, 2019; Piras et al., 2018) focused on the effect of unfair trading practices on food waste, such as the absence of a written contract shifting risk toward weaker supply chain actors, or the arbitrary use of quality specifications and minimum life on receipt criteria. Given these systemic factors, Evans et al. Evans (2011) argued that household food waste cannot be conceptualized as a problem of individual consumers, thus pointing to the need to overcome the current state of the policy debate, which tends to blame them for their lack of responsibility. In contrast, Graham et al. Graham-Rowe et al. (2014) identified "the perception that the responsibility for food waste lays with the food industry and supermarkets rather than the individual" and "the low priority given to [food waste minimization] by some household food purchasers" as two key barriers to waste reduction. Giordano et al. Giordano et al. (2019) found no evidence of a positive relationship between the purchase of discounted food products, which could be seen as a strategy used by supermarkets to externalize their surpluses, and household food waste quantities. Thus, although systemic factors need to be addressed, and most of the environmental impact of thrown-away food is generated upstream in the value chain, consumer food waste, like waste in general, results from complex interactions between the individual sphere and external elements. In developed economies, more responsible food behaviors at the household level would significantly contribute to its reduction (Schanes et al., 2018; Parfitt et al., 2010). In particular, it would be worth investigating whether some social contexts are more prone to the consolidation of wasteful, consumerist behaviors.

Concerning the individual domain, a long and complex chain of choices affects household food waste behavior (Setti et al., 2018), which are in turn driven by personal deep-seated beliefs, needs, wants, and judgments ("visceral factors", Visschers et al., 2016; Ajzen, 2015; Loewenstein, 1996). The importance of social circumstances in shaping household waste behavior is still being discussed. Some studies found that social pressure encourages the purchasing of excessive food quantities, leading to the waste of unconsumed goods (Farr-Wharton et al., 2014; Evans, 2012, 2011; Vermeir and Verbeke, 2006), whereas others argued that social norms barely affect one's food waste behavior due to the limited visibility of the phenomenon (Quested et al., 2013).

According to Benabou et al. Benabou and Tirole (2011), individual decisions can be ascribed to three main determinants: intrinsic and extrinsic motivations, and anticipated reputational effects. This framework provides a conceptualization that accounts for the conflicting preferences faced by individuals when dealing with food waste. Extrinsic motivations (e.g., costs saving) and some intrinsic motivations (e.g., altruism or commitment) can lead to pro-social acts such as waste prevention or reduction, whereas alternative intrinsic motivations (e.g., food security, time saving, and self-gratification) and anticipated reputational effects (e.g., status concerns, including the "good provider identity", Graham-Rowe et al., 2014; Visschers et al., 2016) might be antecedents of waste generation.[1] The question remains open on whether any relationship exists between household food waste behavior and social norms.

In this study, we aim to address this gap by assuming the set of social norms "that guide and/or constrain human behavior" (Cialdini and Trost, 1998, p. 152) to be an important element of social capital (Putnam, 2001, 1995; Putnam et al., 1994). Social capital has been defined as "features of social life—networks, norms, and trust—that enable participants to act together more effectively to pursue shared objectives" (Putnam, 1995, pp. 664–665). Whereas social norms emerge from interactions between individuals and their social groups, they are then internalized and adopted even in the absence of social control (Dreber et al., 2016; Rand et al., 2012; Haidt, 2007). Previous studies have shown a positive role of social capital in the adoption of cooperative practices in both developed (e.g., Farrow et al., 2017; Alló et al., 2015) and developing (e.g., Teklewold et al., 2013) economies. Whether individuals are willing to make resources available to others because they feel a moral obligation to do so or for instrumental reasons does not affect the outcome (Guiso et al., 2004).

Under these assumptions, this study contributes to uncovering the relationship between social capital and household food waste behavior. Instead of limiting the analysis to strictly food-related social norms, we considered the relationship between these norms and the more general capacity of a community to "sustain cooperative behavior, …, [and] the provision of public goods" (known as "community capital", Jackson, 2017, pp. 4–5). In the literature, the ability to sustain cooperative behavior has been convincingly associated with societal propensity toward blood donation and civic participation (Guiso et al., 2004), among others. The objective of this study was thus to detect possible correlations between pro-social norms as an element of social capital accruing to a society, and the atypical phenomenon of individual food waste behavior. To this end, we relied on a national-level dataset of household food behaviors in Italy, with which we merged the above as well as other covariates known to elicit the level of social capital of a community. Italy is an ideal location to study this relationship because of the well-known divide in terms of social capital between the north and south of the country, which has been at the center of the social capital debate in the literature (Bigoni et al., 2016; Guiso et al., 2004; Putnam et al., 1994).

As a proxy of social capital, food waste behavior presents a major difference compared to other proxies of this phenomenon. Standard indicators of social capital, such as participation in associations or donations, imply a social dilemma, i.e., a trade-off between investing personal time or effort to the benefit of others and paying a personal cost. From a strictly individual perspective, pro-social behaviors are anti-economical; nonetheless, people undertake them due to social norms. Food waste does not entail a social dilemma from this strictly economic point of view, as reducing waste delivers both social benefits (e.g., lower negative externalities on the environment) and private gains (e.g., monetary savings). These considerations should imply a convergence of interests toward food waste reduction. However, evidence shows that food waste is persistent or increasing (Setti et al., 2018; Stancu et al., 2016; Graham-Rowe et al., 2015; Stefan et al., 2013; Verplanken and Orbell, 2003; Verplanken et al., 1998). It is thus necessary to investigate how the interaction between economic and non-economic motivations influences the generation of unnecessary food waste. The intrinsic complexity of the concept of social capital as well as data constraints suggest the decisions about food waste generation should be modeled through a simplified model. In particular, in our model, we make simplifying assumptions concerning the function modeled to focus on the key trade-off observed in our data: the trade-off between social capital and status concerns. For instance, we include no external constraints on consumers' purchasing and food management possibilities besides their income and location (which also defines social capital). All assumptions and limitations of the model are detailed in the following section.

From our model and data analysis, we derive four main results. First, we identified a negative relationship between food waste and social capital: more food is wasted where social capital is low, suggesting that food waste is a (negative) proxy of the level of social capital. Second, food behaviors and opinions related to status concerns and to poor organizational ability in food management are more prevalent in areas with lower social capital. Third, both status concerns with respect to

[1] While investigating the barriers to household food waste reduction, Graham-Rowe et al. (2014) identified among respondents a "need to feel like a 'good' provider and minimze any feelings of guilt experienced if they failed to meet personal or cultural expectations" (p. 19). This tendency, named the good provider identity, reveals a strong link between concerns for food security and for status vis-à-vis one's children, partner, and especially guests. Its role in food waste generation was also confirmed by Visschers et al. (2016).

food (which lead to overabundance) and poor organization in food management are positively related to food waste. Fourth, the relationship between income, social capital, and food waste is complex. More specifically, in areas where social capital is lower, higher income is related to more food waste; in areas where social capital is higher, higher income is related to lower food waste.

2. The model

To guide the empirical analysis, we developed a simple model of individual behavior concerning the choice to buy excess food that ends up as waste. The individual's choice is modeled with a payoff function that considers the variables that positively and negatively influence the welfare of the individual in terms of this decision. We then built the individual payoff function step-by-step.

From a purely monetary point of view, the payoff π_i of each individual is given by:

$$\pi_i = e_i - w_i, \tag{1}$$

where e_i is one's individual endowment, representing income that can be used to buy food or other products; the subscript $i \in (0, n)$ indicates the decision of the ith individual, who takes this decision in a (large) population of n individuals. Given their endowment, each individual decides their level of waste w_i. This choice reflects that individuals can decide how to spend their food-related income, directing it toward goods and quantities that lead to different levels of waste. Implied by our modelling choice is the hypothesis that individuals are capable of perceiving the amount of food they need and are aware that if they buy more, this food might go to waste. As real-world food decisions are not completely rational but derive from a wealth of visceral factors (Visschers et al., 2016; Ajzen, 2015; Loewenstein, 1996), this simplification helps separate the decision to buy food from the decision of buying food that is then wasted, with the aim of finding a rationale for the latter. The amount of food waste generated w_i enters the function with a negative sign because it is a cost; thus, it reduces the endowment of an individual of the amount chosen for waste. Given that waste is "bad", the decision as presented here has the simple implication that individuals are making an economically irrational choice because they are choosing to invest money in something that actively decreases their own payoff.

Besides the negative impact of one's own food waste, individuals live in communities where others' decisions to waste food further reduce their payoffs. This further negative effect is caused, for example, by the cost of waste collection, dissipation of resources used to produce uneaten food, increased pollution, and so on. To include this additional negative effect of community waste on the payoff of i, we introduce an additional term in the utility function, $E\left[\overline{w}_{j \neq i}\right]$, where E is expectation and $\overline{w}_{j \neq i}$ is the average waste of j individuals in the population.[2] The payoff of agent i becomes:

$$\pi_i = e_i - w_i - \beta E\left[\overline{w}_{j \neq i}\right], \tag{2}$$

where β represents the level of social capital at the community level. We use this parameter as an indicator of social capital, assuming that it influences the perception that individuals in the community have of the detrimental effect of food waste. According to Putnam (2001), social capital refers to "connections among individuals—social networks and the norms of reciprocity and trustworthiness that arise from them. In that sense social capital is closely related to what some have called 'civic virtue' " (p. 19). Social capital, and the norms of trust and trustworthiness that come with it, are pivotal to achieving cooperation and solving collective action problems (Giardini et al., 2020). Consequently, it is the best candidate to favor civic behaviors like the choice to reduce waste of food at the community level.

When β is low, individuals in the community are not particularly concerned about the negative social effects of food waste, so the influence of community waste on their payoff is low. For higher social capital levels, individuals show stronger sensitivity to the problem of food waste; correspondingly, the negative effect of community waste is expected to be perceived more strongly. This parameter is homogenous at the population level as each community shares the same level of social capital and it is measured normally at community level (see for example Guiso et al. (2004)), so no subscript is needed here.

As both individual economic considerations related to the cost of waste and social concerns for aggregate waste negatively affect the payoff function of our decision maker, we should not be observing, in principle, any waste, except the involuntary waste arising as a side effect of a limited organizational ability. However, the latter is unlikely to be the leading cause of the very large amounts of food waste observed in developed economies. Thus, the decision to buy food in excess and then waste it implies some element of choice that positively influences the payoff function of our individuals and leads them to waste large amounts of food, as observed in the empirical literature (Setti et al., 2018; Stancu et al., 2016; Graham-Rowe et al., 2015; Stefan et al., 2013; Verplanken and Orbell, 2003; Verplanken et al., 1998). Among the likely factors that increase individual willingness to waste is the need to acquire more food than necessary with the objective of feeling safe in terms of potential consumption and avoiding potential damage to one's own social status due to the lack of food. This reflects the key role of the "good provider identity" identified by Graham-Rowe et al. (2014) in food waste generation. Correspondingly, we introduce a third term in the payoff function, which represents non-monetary factors influencing the choice to waste. Status is, by definition, assessed relative to others in the community (Anderson et al., 2015); therefore, we assume that exceeding the average level of waste (i.e., acquiring more food than is necessary) provides a positive contribution to one's own utility, while wasting less than the rest of the community has a detrimental effect on one's own utility.

With this idea in mind, the payoff function in Eq. 3 is augmented with a term that indicates the amount of food wasted by an individual compared to the average amount wasted in the community. Higher waste than the community average not only provides security of being a good provider, but also allows to show off food excess, which then goes wasted, with respect to others. With the inclusion of the status effect (whose importance is mediated by the community-level parameter γ[3]), the payoff function of the individual becomes:

$$\pi_i = e_i - w_i - \beta E\left[\overline{w}_j\right] + \gamma\left(w_i - E\left[\overline{w}_j\right]\right) \tag{3}$$

The status effect turns our food waste decisions into a proper social dilemma, i.e., a situation in which everyone would be better off cooperating but they fail to do so because of conflicting individual interests that discourage joint action (Brown et al., 2018; Ostrom, 2008; Kollock, 1998). In our case, if everyone wastes more, the total waste of the community is higher, and this decreases the individual payoff; the reduction of food waste in general would positively affect every individual in the community. On the other hand, the presence of the status effect generates an individual incentive to waste more (i.e., more than

[2] This specification implies that the individual utility is affected only by the average value of waste in the population; the waste at the population level is assumed to impact each agent equally, with each agent receiving an equal share of the negative effects. This assumption is made for simplicity since assuming more complex distributions of waste effects would not qualitatively change the results.

[3] To derive our results, we assume that γ is homogeneous in the local population of interest. Assuming some degree of heterogeneity would make the model more complex, while qualitatively preserving the results.

the average), determining the conflict between individual and social welfare.

To identify the waste level of an individual and comment on the impact of different elements of the decision on the equilibrium outcome, we need to find one's optimal choice, which depends on one's expectations about the behavior of rest of the population. In our simple model, individuals are heterogeneous only in the level of income, which only additively enters the payoff function. For this reason, the best response function of each individual is equal to the one of the rest of the population, i.e., $E\left[\overline{w}_j\right] = w_i, \forall j$. Operating this substitution and solving the best response function of the generic individual for w_i, the equilibrium waste in a population with status concern γ and social capital β is:

$$w_i = \frac{(1-\gamma)}{(\beta-\gamma)}. \tag{4}$$

Simple comparative statics on this result shows the marginal effects of the parameters on individual decisions to waste. In summary:

- For $\gamma < 1$, the individual food waste decreases in the value of β;
- For $\gamma > 1$, the individual food waste increases in the value of β.

$\gamma < 1$ indicates a community with a low level of status concerns. In such a community, food waste decreases as β increases, indicating that the payoff of the individuals is positively affected by the level of social capital—higher social capital reduces the incentives to waste. On the contrary, when $\gamma > 1$, i.e., the community has relatively higher concerns for status, the positive effect of social capital is more than offset by individuals considering obtaining status through waste as important. To summarize, although the status effect makes the decision to waste a social dilemma, social capital counterbalances this effect. We can interpret this result considering how different cultures differently evaluate the importance of different attributes of food (see, for instance, Damen et al. (2020) on differences between northern and southern Italy), including the status they generate. In communities where social capital is high, the community norm suggests a negative perception of food waste, which implies that the behavior of buying in excess is perceived as unacceptable, overcoming status concerns. The opposite is true in societies with low social capital. Relatedly, the higher γ, the stronger its ability to offset the positive effect of social capital on food waste.

Given this theoretical framework, we propose two implications arising directly from the comparative statics:

Hypothesis 1. *Measures of social capital are negatively correlated with food waste levels.*

Hypothesis 2. *Measures of status concerns related to food are negatively correlated with social capital.*

Besides community-level social capital and status concerns (the main focus of our analysis), two other relevant forces could impact individual levels of food waste: organizational abilities and income. Concerning the former, in real-world situations, people do not choose the amount of food to waste but the amount of food to consume, which in turn can end up as waste. Besides status concerns, the simplest explanation to account for the heterogeneity in waste levels within the same community (sharing the same social capital) is the diversity in the ability to appropriately organize and manage one's food, from purchase to consumption, to the reuse of leftovers. This idea, suggested by common sense, implies a positive correlation between organizational ability and food waste, i.e., better organization results in lower food waste. If this correlation is confirmed in the data, we should observe that:

Hypothesis 3. *Poor organizational abilities are correlated with higher levels of food waste.*

Finally, although our model focuses on the social determinants of food waste, it can be used to empirically investigate the impact of household income, thus ensuring that other variables do not improperly account for some of the variance that can be explained by this individual-level variable. However, the direction of the relationship between individual income and food waste is not trivial. For example, in recognizing the complexity of this relationship, Setti et al. Setti et al. (2016) identified a U-shaped relationship between these two variables in Italy. On one hand, higher individual income allows for the acquisition of more food and could lead to increase food waste; on the other hand, the literature suggests that income (or GDP at the aggregate level) is highly correlated with social behavior and social capital (Guiso et al., 2004). For this reason, even if a clear cut hypothesis cannot be formulated ex ante, we also empirically tested the complex relationship between income, food waste, and social capital.

3. Data and methods

3.1. The dataset

Our empirical analysis relied on a dataset collected by the Italian National Observatory on Waste, 'Waste Watcher', in 2016 (Last Minute Market and SWG, 2016). The survey was administrated through CAWI (Computer-Aassisted Web Interviewing) on a sample of 1773 households representative at the national level. The questionnaire consisted of around 100 mostly closed-ended questions on family characteristics, food routines, opinions on food waste and related issues, and potential waste prevention policies.[4]

In the Waste Watcher questionnaire, household food waste was measured by means of three closed-ended questions in which respondents had to provide estimates of the frequency, quantity, and monetary value of their own food waste.[5] We used these questions to create three ordered categorical variables with five, six, and nine levels. All three variables present a strong positive skewness, with around half of the respondents selecting the lowest option in the cases of food waste frequency and quantity, and two-thirds in the case of value. Setti et al. Setti et al. (2016) argued that if questionnaires are used, asking for one's food waste frequency is the most suitable strategy to obtain a variable that describes households' actual behavior. Testing three variables increased the robustness of the findings. Since behaviors are self-declared, the results might be affected by idiosyncratic levels of social desirability bias (Cerri et al., 2019; Giordano et al., 2018), as suggested by the skewed distribution of the answers. To control for this possibility, in all the models, we included an ordered categorical variable indicating respondents' self-declared perception about the seriousness of the issue of food waste. Furthermore, the households who declared not to know one of the food waste measures were excluded from the models that use the resulting variable.[6]

Besides food waste measures, we identified questions concerning food behaviors (e.g., the frequency of shopping for food) and opinions

[4] In 2016 in Italy, there were no systematic policies in place that could impact consumer food waste behavior at the local level (Azzurro et al., 2016). First, the only national law addressing this issue was introduced in September 2016, but focused on retailers' food waste. Second, the revenues from the landfill tax (introduced in 1995 and modified in 2015), which could be used by the regions (corresponding to EU NUTS2 units) to encourage waste prevention, tend to be used for other purposes. Third, Italian municipalities rarely adopt pay-as-you-throw schemes as these need to be financed with general taxation. (Regardless, these are aimed at reducing non-recyclable waste rather than food waste). Fourth, the introduction of a tax discount for the households implementing home composting is not compulsory for the municipalities, and has been allowed only since December 2015 (Azzurro et al., 2016).

[5] As of 2019, consumer food waste in Italy has been assessed on a large scale only by means of questionnaires, although there have been attempts to test waste-sorting analysis at the local level (Giordano et al., 2018).

[6] Different from the independent variables described below, we decided not to input these values and to lose observations, deeming that the opposite decision would have represented a too strong assumption.

(e.g., potential solutions to food waste) to be used for generating corresponding variables. We turned non-ordered categorical variables into a series of dummies.[7] For ordered categorical variable, we reverted the direction of the scale when required to increase the intuitiveness of the interpretation of the results (e.g., higher values indicate higher frequency, or stronger agreement), and replaced 'don't know' answers with the mean.[8] We created dummy variables identifying the households providing 'don't know' answers to assess the correlation between having no opinion (i.e., "limited attention", Setti et al., 2018) and wasting food. Overall, we created 71 variables (42 for behaviors and 29 for opinions), plus a dummy for the families without children who could not answer children-related questions. In Section 4, these variables are classified according to the macro-categories discussed in our theoretical model:

1. the search for food security for one's family and for reward by guests and other people in line with the good provider identity (Graham-Rowe et al., 2014) as well as spoiledness with respect to food are considered proxies of the status effect;
2. the behaviors and opinions concerning food management, from its purchase to the use of leftovers, including the time devoted to different activities, are proxies of one's organizational ability;
3. concerns for the environment, for the fairness of food decisions, for the monetary cost of food, for the social consequences of food waste, and for related behaviors are proxies of social capital.[9]

Finally, the Waste Watcher dataset includes information about the age of the respondents, their level of education, their household size, their socio-economic conditions, and their municipality of residence, which we used to create socio-demographic covariates. Socio-economic conditions were measured as self-assessed household income and self-assessed social class (both ordered categorical variables assuming five values, from low to high). Only household size and self-assessed social class (wealth) present some missing values, but these were not imputed.

With the obtained dataset, we merged four variables eliciting the levels of social capital in the provinces of the respondents (corresponding to EU NUTS3 units). The first two variables were those chosen by Guiso et al. (2004) to study the effect of social capital on financial development in Italy: blood donations per capita[10] and average voter turnout at referenda until 1987.[11] The other two variables were calculated for the purpose of this research: share of population giving their consent to organ donation,[12] and average voter turnout at referenda after 1990.[13] The variables used by Guiso et al. (2004) were calculated for the 95 provinces existing in 1991, our variables for the 110 provinces existing in 2015. Similar measures of social capital at the province level in Italy have been convincingly associated to sustainability concerns, namely the value assigned to fair trade products (Bosbach and Maietta, 2019).

Since we assigned to each respondent the values of social capital observed in their province of residence, social capital enters the models as a place-based dimension influencing individual food waste. This approach does not require the assumption that respondents are representative of their own province in terms of food waste or other food behaviors and opinions, and is thus suitable for our sample, which is only representative at the national level.[14] Apart from social capital measures, the size of the municipality of residence and dummies for the households residing in the province capitals were added as location characteristics.

Table 1 reports summary statistics for the variables that appear in Section 4. A complete overview of the variables used in the empirical analysis is provided in Table S1 in Supplementary Material 2, while the English translation of all questions of the Waste Watcher questionnaire used to generate variables, plus the scales used to code the answers, are reported in the Table Questionnaire in Supplementary Material 2.

3.2. The estimation strategy

Since we dealt with dummies or ordered categorical variables and due to the skewed distribution of most of them, which violates the assumption of normality required to run ordinary least squares (OLS), the most appropriate models were logistic and ordered logistic regressions, respectively[15] (Robinson, 2013; Winship and Mare, 1984). All estimates reported in Section 4 were obtained using one of these model typologies. However, for robustness, all models presented were also estimated using OLS, which tends to be preferred in econometric analysis for interpretability reasons (Robinson, 2013; Angrist and Pischke, 2008). The results, reported in Supplementary Material 2, provide qualitatively equivalent results. To enhance interpretability, all tables in Section 4 report the odds ratios (ORs) instead of the coefficients of the logistic models: an OR below one indicates a negative relationship; an OR above one indicates a positive relationship. Since we were interested in the correlation between variables, not in representativeness of the variables at national level, we omitted sample weights from all models.

4. Results

Using the predictions of the model discussed in Section 2 as a guide, we started by exploring whether a negative relationship exists between food waste and social capital, as suggested by Hypothesis 1 (Subsection 4.1). We proceeded by analyzing the relationship between food behaviors and opinions, and social capital to uncover whether status concerns are negatively linked with social capital, as suggested by Hypothesis 2 (Subsection 4.2). To test Hypothesis 3, we investigated the relationship between household food waste and food behaviors and opinions (Subsection 4.3). In Subsection 4.4, we explore the complex relationship between social capital, food waste, and income. Finally, in Subsection 4.5 the results of Subsections 4.2 and 4.3 are provided jointly to show how food behaviors and opinions mediate the relationship between food waste and social capital.

4.1. Food waste and social capital

As a first step to test the relationship between food waste and social capital, we estimated a series of 12 models. Each of the three variables eliciting food waste behavior (frequency, quantity, and value) was

[7] When the respondents could select only one option, we created dummies from all options but one to avoid problems of multicollinearity.

[8] Mean imputation of missing data is a common practice to avoid losing observations and maintain the same sample size despite missing values. We assumed that having no opinion is equivalent to having an average opinion.

[9] To reduce complexity, a principal component analysis was performed on the 71 variables eliciting food behaviors and opinions. However, no relevant reduction of the dimensions could be achieved.

[10] "Number of blood bags … per million inhabitants in the province, collected by AVIS, the Italian association of blood donors, in 1995" (Guiso et al., 2004, p. 554).

[11] "Voter turnout at the province level for all the referenda between 1946 and 1987. For each province, turnout data were averaged across time" (Guiso et al., 2004, p. 554).

[12] Members of the Italian Association of Organ Donors (AIDO) per number of inhabitants in the province (average in the period 2014–2016). In the only case in which AIDO did not have a province-level branch, the same value was assigned to the two provinces managed by the same office.

[13] Average turnout in all the referenda held from 1990 to 2016, excluding constitutional referenda; for the rounds of voting including more than one referendum, the average turnout in that round was considered.

[14] Maps S1 to S4 in Supplementary Material 1 illustrate the values of social capital in all the Italian provinces.

[15] The latter type of model is built under the proportional odds assumption. Since the Brant tests did not support it in the first set of models, we performed multinomial logistic regressions. As the results did not change significantly, ordered logistic models were preferred as they are much more parsimonious in terms of coefficients, and the interpretation of the results is thus more immediate.

Table 1
Variables appearing in the empirical analysis.

Typology	Variables	N. obs.	Mean	St. dev.	Min.	Max.
Food waste	Frequency (from "almost never" to "almost every day")	1744	1.71	0.90	1.00	5.00
Food waste	Quantity (from "nothing" to "more than 2 kg")	1683	1.80	0.93	1.00	6.00
Food waste	Value (from "less than 5 Euros" to "more than 60 Euros")	1636	1.67	1.24	1.00	9.00
Social capital	Turnout pre-1990	1765	79.84	7.41	62.00	92.00
Social capital	Turnout post-1990	1773	43.53	5.73	27.62	54.98
Social capital	Blood donations	1765	2.26	1.98	0.00	10.52
Social capital	Organ donations	1773	3.13	2.26	0.17	11.21
Socio-demo	Age (years)	1773	47.82	16.33	19.00	91.00
Socio-demo	Family size (members)	1575	3.02	1.01	1.00	7.00
Socio-demo	Education (from "elementary/no schooling" to "PhD")	1773	4.30	1.27	1.00	6.00
Socio-demo	Family income (from "I cannot make end met" to "very comfortably")	1773	3.24	0.85	1.00	5.00
Socio-demo	Family wealth (from "low social class" to "high social class")	1740	2.57	0.76	1.00	5.00
Location	Municipality size (log)	1772	11.12	2.03	5.35	14.78
Location	Province capital (dummy)	1772	0.49	0.50	0.00	1.00
Perception	Perception of food waste (from "not serious at all" to "very serious")	1773	3.41	0.66	1.00	4.00
Behavior	Frequency of shopping (a)	1773	4.96	1.14	1.00	7.00
Behavior	Frequency of buying pre-cooked food (b)	1773	3.02	1.72	1.00	8.00
Behavior	Frequency of buying frozen food (b)	1773	3.76	1.48	1.00	8.00
Behavior	Frequency of buying non-seasonal food (c)	1773	2.48	0.72	1.00	4.00
Behavior	Frequency of buying products from far away (c)	1773	2.49	0.74	1.00	4.00
Behavior	Frequency of making a shopping list (d)	1773	2.42	0.63	1.00	3.00
Behavior	Well-supplied fridge, easy to invite guests (dummy)	1773	0.76	0.42	0.00	1.00
Behavior	Very full fridge, things sometimes get bad (dummy)	1773	0.45	0.50	0.00	1.00
Behavior	Too full fridge, things often get bad (dummy)	1773	0.15	0.35	0.00	1.00
Behavior	Frequency of teaching children not to waste (c)	1773	3.72	0.38	1.00	4.00
Behavior	Frequency of teaching children to use seasonal food (c)	1773	3.48	0.48	1.00	4.00
Behavior	Frequency of teaching children to look for cheap food stores (c)	1773	3.33	0.52	1.00	4.00
Behavior	Shopping: most often from hypermarkets (dummy)	1773	0.31	0.46	0.00	1.00
Behavior	Shopping: most often from small shops (dummy)	1773	0.17	0.37	0.00	1.00
Behavior	Shopping: most often in open-air markets (dummy)	1773	0.16	0.36	0.00	1.00
Behavior	Shopping: most often from ethical purchasing groups (dummy)	1773	0.01	0.11	0.00	1.00
Behavior	Shopping: most often from producers (dummy)	1773	0.04	0.19	0.00	1.00
Behavior	Shopping: most often home delivery (dummy)	1773	0.01	0.07	0.00	1.00
Behavior	Shopping: most often in supermarkets (dummy)	1773	0.76	0.43	0.00	1.00
Behavior	Throws away food past the expiry date (dummy)	1773	0.12	0.32	0.00	1.00
Behavior	Gives expired food as present (dummy)	1773	0.03	0.17	0.00	1.00
Behavior	Uses expired food to feed animals (dummy)	1773	0.02	0.14	0.00	1.00
Behavior	Wastes because: buys too much once a week (dummy)	1773	0.12	0.33	0.00	1.00
Behavior	Wastes because: wrong need calculation (dummy)	1773	0.14	0.35	0.00	1.00
Behavior	Wastes because: fears it is not enough (dummy)	1773	0.07	0.25	0.00	1.00
Behavior	Wastes because: way home without fridge (dummy)	1773	0.34	0.47	0.00	1.00
Behavior	Wastes because: buys too big packages (dummy)	1773	0.08	0.27	0.00	1.00
Behavior	Wastes because: cooks too much food (dummy)	1773	0.11	0.31	0.00	1.00
Behavior	Wastes because: does not like the food (dummy)	1773	0.05	0.21	0.00	1.00
Behavior	Wastes because: food has passed the date (dummy)	1773	0.22	0.42	0.00	1.00
Behavior	Wastes because: food got spoiled (dummy)	1773	0.42	0.49	0.00	1.00
Behavior	Wastes because: has a bad smell or taste (dummy)	1773	0.25	0.43	0.00	1.00
Behavior	Wastes because: buys too much food (dummy)	1773	0.07	0.25	0.00	1.00
Behavior	Usually throws away open packages (dummy)	1773	0.70	0.46	0.00	1.00
Behavior	Usually throws away entire packages (dummy)	1773	0.10	0.30	0.00	1.00
Opinion	Main consequence: harm to the environment (e)	1773	3.09	0.69	1.00	4.00
Opinion	Main consequence: harm to the environment (don't know) (dummy)	1773	0.04	0.19	0.00	1.00
Opinion	People should: cook the right quantity (e)	1773	3.48	0.58	1.00	4.00
Opinion	People should: reuse leftovers (e)	1773	3.33	0.67	1.00	4.00
Opinion	People should: buy fresh food from producers (e)	1773	3.26	0.70	1.00	4.00
Opinion	People should: use doggy bags (e)	1773	3.01	0.80	1.00	4.00
Opinion	People should: check expired food (e)	1773	3.43	0.65	1.00	4.00
Opinion	People should: reuse leftovers (don't know) (dummy)	1773	0.03	0.18	0.00	1.00
Opinion	People should: use doggy bags (don't know) (dummy)	1773	0.07	0.25	0.00	1.00
Opinion	To reduce waste: inform citizens of its consequences (don't know) (dummy)	1773	0.03	0.16	0.00	1.00
Opinion	To reduce waste: educate children in schools (don't know) (dummy)	1773	0.03	0.17	0.00	1.00
Opinion	Main effect: more pollution from disposal (dummy)	1773	0.22	0.42	0.00	1.00
Opinion	Main effect: waste of redistributable food (dummy)	1773	0.64	0.48	0.00	1.00
Opinion	Main effect: waste of resources (dummy)	1773	0.31	0.46	0.00	1.00
Opinion	Main effect: negative influence on the youth (dummy)	1773	0.12	0.33	0.00	1.00
Opinion	Doesn't know her frequency of food waste (dummy)	1773	0.02	0.13	0.00	1.00

Notes: (a) 1 = less than once a month; 7 = daily; (b) 1 = never; 8 = daily; (c) 1 = never; 4 = often; (d) 1 = never; 3 = always; (e) 1 = totally disagree; 4 = totally agree; (dummy) 0 = no/not selected; 1 = yes/selected.

regressed on each of the four variables indicating social capital. In each model, as additional covariates, we included the respondents' perception about the seriousness of the issue of food waste (to control for the social desirability bias), the two variables for location characteristics, and, in line with Guiso et al. (2004), households' socio-demographic characteristics. The latter are characteristics found to be significantly correlated with consumer food waste in the literature: family size, age of the household head, level of education, and socio-economic status (Grainger et al., 018b,a; Setti et al., 2016; Stancu et al., 2016; Parizeau et al., 2015; Secondi et al., 2015; Koivupuro et al., 2012; Barr, 2007).

The computation of the variance inflation factor (VIF) detected no cases of multicollinearity.[16] Estimates obtained with different modelling approaches are reported in Supplementary Material 2.[17]Regardless of the estimation strategy used, the sign and relative size of the coefficients associated with social capital did not differ significantly from the ordered logistic models.[18]

This first set of analyses allowed us to sustain the following result:

Result 1. *Food waste is lower in provinces with higher social capital, i.e., social capital is negatively correlated with food waste.*

As summarized in Result 1 and reported in Table 2, the correlation between food waste and social capital was found to be negative (the ORs are below one) and significant. Therefore, Hypothesis 1 is supported by our data. This result is robust to the chosen measures of food waste and of social capital, with the only exceptions being the models linking the referendum turnout to food waste quantity (Models 5 and 6). The significance level of the correlation was particularly high when food waste was measured by its frequency (Models 1 to 4). As pointed out by Setti et al. Setti et al. (2016), the frequency of food waste "highlights consumers' actions rather than their quantitative effects" (p. 1740), and is thus a better proxy of one's moral and social perception of the problem. Alternative measures of food waste, quantity and value, confirm Result 1, even if the significance level of their relationship with certain measures of social capital is lower. This is probably because these measures of food waste are more affected by socio-demographic variables, primarily family size, than the frequency. Accordingly, our models confirm the finding in literature that larger households tend to waste more food (Grainger et al., 018a,b; Stancu et al., 2016; Secondi et al., 2015).

Since food waste in our dataset is self-assessed, it may be underestimated or underreported for social desirability bias (Giordano et al., 2018; Milfont, 2009), especially in low social capital areas, where people might be less willing to take responsibility for social or environmental problems. However, as reported in Table 2, the perception of the seriousness of the food waste problem is strongly negatively related to self-declared food waste with high significance regardless of the model, which is consistent with the hypothesis that households more concerned about food waste tend to waste less. This variable allows us to capture the variability in food waste due to the social desirability bias, reducing the impact of the latter on other coefficients. These considerations confirm the robustness of our findings in this respect.

Regarding control variables, the age of the respondent is negatively related to food waste regardless of the model, confirming the well-established finding that older households tend to waste less food (Grainger et al., 2018b, 2018a; Stancu et al., 2016; Secondi et al., 2015). Instead, the level of education is positively and significantly correlated with the quantity of food waste regardless of the model.[19] Finally, household wealth is positively and significantly correlated with food waste frequency, meaning that wealthier families tend to throw away food more often. We analyze the role of income as a mediator of the relationship between social capital and food waste in more depth in Subsection 4.4.

4.2. Food behaviors and opinions and social capital

As a second step, to test Hypothesis 2, we assessed the correlation between food behaviors and opinions and social capital. Instead of limiting our analysis to behaviors and opinions ascribable to status concerns, we regressed each of the 71 behaviors and opinions on each of the four variables eliciting social capital, for a total of 284 models. In each model, apart from social capital, we included the socio-demographic and location characteristics used in the previous set of models as covariates. Given the nature of the variables concerned, for the 49 behaviors and opinions described by dummies, we used logistic models, whereas for the 22 ordered categorical variables, we used ordered logistic models. In Table 3, we report the ORs only for the food behaviors and opinions significantly correlated with at least one measure of social capital; the full models are reported in Supplementary Material 2.[20] For the behaviors and opinions significantly related with more than one measure of social capital, the direction of the correlation (ORs either above or below one) is robust to the considered measure of social capital. OLS estimates of the same models returned very similar results: only three coefficients that were significant in the logistic models (underlined in Table 3) were not significant in the OLS models.

Based on the results reported in Table 3, we confirm that:

Result 2. *Status concerns are negatively related to social capital*

In line with Hypothesis 2 of our theoretical model, behaviors and opinions eliciting status concerns (overbuying, overcooking, being spoiled with respect to food) are negatively related with social capital, and their absence (reusing food past its best before date if not spoiled) are positively related.

Notably, organizational abilities (making a shopping list, limiting the number of shopping trips, calculating one's need correctly, and purchasing long-lasting frozen products) are stronger where social capital is stronger.[21] In the following subsection, we further examine this relationship.

Finally, for the behaviors and opinions eliciting categories different from status concerns and organizational abilities, the correlation with social capital tends to be weaker.[22]

[16] In preliminary analyses, we included the squared value of the age to test if the relationship between age and food waste was not linear. However, this presented serious problems of multicollinearity, causing related coefficients to become non-significant. Although no multicollinearity was detected between the four variables eliciting social capital, in line with Guiso et al. (2004), they were included in separate regressions, as they measure related aspects of the same phenomenon. Again, in line with Guiso et al. (2004), dummies for north and south as well as the logarithm of the GDP per capita at the province level were initially included. However, they caused problems of multicollinearity too, as in Italy the north–south divide in terms of social capital follows the level of economic development. Therefore, they were excluded from the final models. In turn, we decided to include the socio-economic status of the households being self-assessed and household-specific; this is more likely to be related to the food consumption behavior of individual households than the GDP at the province level.

[17] Multinomial logistic models are reported in Table S2, ordered logistic models with sample weights in Table S3, OLS models in Table S4, OLS models with sample weights in Table S5, and quantile regression models (using either the median or the third quartile, depending on the distribution of the food waste variable) in Table S6.

[18] For a synthesis of the signs assumed by the coefficients in different models, see Table S7 in Supplementary Material 2.

[19] Better-educated households might be less affected by social desirability bias and thus report higher food waste quantities, or confront a higher opportunity cost of time and thus be less likely to use time-demanding food saving behaviors.

[20] The models for the behaviors and opinions described by dummies are reported comparatively for OLS and ordered logistic regressions in Table S8 and those for the behaviors and opinions described by ordered categorical variables in Table S9.

[21] As for the place of shopping, the positive correlation of social capital with shopping from hypermarkets, and the negative correlation with shopping from small shops and open-air markets, are probably due to the different structure of the retail sector in northern and southern Italy.

[22] Some pro-environmental behaviors and opinions, namely teaching children not to waste, shopping from ethical purchasing groups, and linking food waste to the waste of resources, are positively related to social capital, whereas anti-environmental ones like buying non-seasonal products and products from far away show a negative correlation, as expected. The lack of an opinion on the importance of informing citizens about the consequences of food waste and on the importance of educating children is also negatively related with social capital as expected.

Table 2
Models linking household food waste with social capital.

Indep. variable	Food waste frequency				Food waste quantity				Food waste value			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Turnout pre-1990	0.975***				0.989				0.977***			
	(0.007)				(0.007)				(0.007)			
Turnout post-1990		0.974***				0.996				0.974**		
		(0.008)				(0.009)				(0.010)		
Blood donations			0.929***				0.945**				0.929**	
			(0.023)				(0.025)				(0.028)	
Organ donations				0.920***				0.949**				0.927***
				(0.021)				(0.022)				(0.025)
Age	0.980***	0.981***	0.980***	0.980***	0.987***	0.987***	0.987***	0.987***	0.986***	0.987***	0.986***	0.987***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Family size	1.079	1.087	1.096*	1.103*	1.252***	1.271***	1.256***	1.267***	1.206***	1.209***	1.227***	1.230***
	(0.057)	(0.057)	(0.057)	(0.057)	(0.066)	(0.067)	(0.065)	(0.065)	(0.074)	(0.074)	(0.074)	(0.074)
Education	0.983	0.985	0.982	0.980	1.122***	1.124***	1.120***	1.118***	1.070	1.072	1.072	1.070
	(0.043)	(0.043)	(0.043)	(0.042)	(0.048)	(0.048)	(0.048)	(0.047)	(0.053)	(0.053)	(0.053)	(0.053)
Wealth	1.188**	1.168**	1.176**	1.176**	1.119	1.100	1.120	1.114	1.063	1.056	1.053	1.056
	(0.087)	(0.085)	(0.086)	(0.085)	(0.079)	(0.077)	(0.079)	(0.078)	(0.088)	(0.087)	(0.086)	(0.086)
Municipalitysize (log)	0.985	1.008	0.970	0.966	1.074*	1.075*	1.059	1.055	1.046	1.073	1.029	1.034
	(0.041)	(0.042)	(0.041)	(0.041)	(0.046)	(0.046)	(0.046)	(0.045)	(0.051)	(0.052)	(0.050)	(0.050)
Province capital (dummy)	1.253	1.197	1.282	1.284	0.901	0.900	0.916	0.921	0.790	0.747	0.811	0.792
	(0.213)	(0.203)	(0.220)	(0.219)	(0.149)	(0.148)	(0.152)	(0.152)	(0.222)	(0.144)	(0.156)	(0.152)
Food waste perception	0.555***	0.558***	0.553***	0.556***	0.574***	0.580***	0.573***	0.579***	0.602***	0.602***	0.598***	0.596***
	(0.045)	(0.045)	(0.045)	(0.045)	(0.048)	(0.048)	(0.048)	(0.048)	(0.056)	(0.056)	(0.056)	(0.055)
Observations	1523	1529	1523	1529	1477	1483	1477	1483	1430	1436	1430	1436
Pseudo-R-sq.	0.041	0.039	0.040	0.040	0.040	0.038	0.041	0.040	0.032	0.031	0.031	0.031

4.3. Food behaviors and opinions driving food waste

Our Hypothesis 3 surmises that poor organizational abilities are correlated with higher levels of food waste. To test this, we ran ordered logistic regressions with backward selection, where the dependent variables were the three measures of food waste.[23] Instead of limiting our analysis to organizational abilities, we again considered all food behaviors and opinions by including them as covariates together with household and location characteristics, and the perception of the seriousness of the food waste problem. Before running the models, we calculated the VIF to detect cases of multicollinearity, and eliminated the variables presenting this problem.[24] Out of the remaining 70 (or 69) variables, 41 (29 eliciting behaviors and 12 opinions) were retained in at least one of the models after the backward-selection process. We excluded the variables for household and location characteristics and the opinion about the seriousness of the food waste issue from the selection process because they represent intrinsic features of the sample units. Compared to the full models, none of the coefficients changed sign because of the selection procedure, and only 21 coefficients out of 208 switched from being non-significant to significant or vice versa, meaning that our results are robust.[25]

This third set of estimates allows us to support Hypothesis 3:

Result 3. *Poor organizational abilities, as well as the search for status and food security, are related to higher food waste.*

The results are reported in Table 4. The direction of the correlation (ORs either above or below one) is robust to the measure of food waste chosen for all behaviors and opinions.[26]

First, the lack of organizational ability and a need to limit the time devoted to food management (e.g., by purchasing pre-cooked food or relying on home delivery) are associated with higher food waste, and good organization to lower food waste. Organizational ability is exemplified here by the implementation of consistent planning (e.g., making a shopping list, shopping with the right frequency and, in general, correctly calculating one's needs), which cause food to be wasted only when unavoidable (i.e., because it got spoiled). Instead, time-constrained individuals save time at the expense of optimal food management.

Second, the behaviors related to status are associated with higher food waste, and their absence to lower food waste. This result also supports the findings in the previous subsection. In line with the good provider identity (Graham-Rowe et al., 2014), concerns for food security indicate a fear of not being able to feed one's family and guests, which may result in overbuying, overstocking, and overcooking. Spoiledness indicates a refusal to adopt behaviors that could prevent food waste at the price of lowering one's hedonic utility (e.g., trying to reuse expired food).

Third, the relation between food waste and the behaviors being theoretically driven by social capital is rarely (and often only marginally) significant and more complex in terms of direction than the previous ones.

Finally, as expected, monetary concerns showed a negative

[23] We used the backward-selection procedure to discard the variables non-significantly related to food waste. We chose a *p*-value of 0.10 for removal from the model, and a *p*-value of 0.05 for inclusion.

[24] We calculated the VIF after running OLS regressions with all the behaviors and opinions as independent variables. The four dummies indicating different uses of expired products (reusing them, throwing them away, giving them as a present, and feeding domestic animals) yielded values above 4.0 in all the models; the dummy for 'having no opinion on the importance of cooking the right quantity' yielded a value above 4.0 in the model for food waste frequency. After excluding the dummy for 'reusing expired products' from all the models, and for 'cooking the right quantity' from the model for food waste frequency, no multicollinearity was observed.

[25] The OLS and ordered logistic estimates of the full models are compared in Table S10 in Supplementary Material 2, while the OLS and ordered logistic estimates of the stepwise models are compared in Table S11.

[26] OLS stepwise estimates of the same models generate similar results: none of the behaviors and opinions in any of the models present a correlation with food waste that occurs in an opposite direction compared to the ordered logistic model. Only a few behaviors and opinions, whose correlation was often marginally significant and which were often non-significant in the full model, showed a non-significant correlation in the OLS models: these are underlined in Table 4.

Table 3
Significant odds ratios (ORs) in the models linking food behaviors and opinions with social capital.

Type	Category	Behavior/opinion	Turnout pre-1990		Turnout post-1990		Blood donations		Organ donations	
B	Status (food security)	Wastes because: buys too big packages (dummy)	0.999	(0.013)	1.006	(0.017)	0.973	(0.052)	0.901**	(0.041)
B	Status (food security)	Wastes because: cooks too much food (dummy)	0.978**	(0.011)	0.978	(0.015)	0.959	(0.044)	0.977	(0.039)
B	*Status (spoiledness)*	*Checks that food did not get spoiled and possibly re-uses it (dummy) +*	*1.0318***	*(0.0098)*	*1.0454***	*(0.0131)*	*1.0471*	*(0.0408)*	*1.0793***	*(0.0386)*
B	Status (spoiledness)	Throws away food past the expiry date (dummy)	0.963***	(0.011)	0.943***	(0.014)	0.903**	(0.043)	0.906**	(0.039)
O	Status (spoiledness)	People should: check expired food (a)	1.017**	(0.007)	1.024***	(0.009)	1.025	(0.026)	1.030	(0.024)
O	Status (spoiledness)	People should: reuse leftovers (a)	1.013*	(0.007)	1.018*	(0.009)	1.037	(0.027)	1.024	(0.023)
O	Status (spoiledness)	People should: use doggy bags (a)	1.001	(0.007)	1.007	(0.009)	1.045*	(0.026)	1.020	(0.021)
O	Status (spoiledness)	People should: use doggy bags (don't know) (dummy)	0.954***	(0.013)	0.951***	(0.017)	0.886**	(0.052)	0.918	(0.049)
O	*Status (spoiledness)*	*People should: reuse leftovers (don't know) (dummy)*	*0.9518***	*(0.0233)*	*0.9615*	*(0.0315)*	*0.7553***	*(0.0893)*	*0.7680***	*(0.0807)*
B	*Organizational ability*	*Shopping: most often from ethical purchasing groups (dummy)*	*1.0768*	*(0.0508)*	*1.0576*	*(0.0506)*	*1.2873***	*(0.1584)*	*1.3400****	*(0.1178)*
B	*Organizational ability*	*Shopping: most often from hypermarkets (dummy)*	*1.0167***	*(0.0077)*	*1.0243***	*(0.0101)*	*1.0946****	*(0.0308)*	*1.0746****	*(0.0265)*
B	Organizational ability	Shopping: most often from producers (dummy)	1.039*	(0.023)	1.048*	(0.030)	1.043	(0.077)	1.086	(0.065)
B	Organizational ability	Frequency of making a shopping list (b)	1.014**	(0.007)	1.013	(0.009)	1.042	(0.028)	1.063**	(0.025)
B	*Organizational ability*	*Shopping: most often in open-air markets (dummy)*	*0.9749****	*(0.0092)*	*0.9791**	*(0.0121)*	*0.9687*	*(0.0375)*	*0.9285***	*(0.0331)*
B	Organizational ability	Wastes because: wrong need calculation (dummy)	0.988	(0.010)	0.995	(0.014)	0.911**	(0.039)	0.948	(0.034)
B	*Organizational ability*	*Shopping: most often from small shops (dummy)*	*0.9568****	*(0.0085)*	*0.9538****	*(0.0114)*	*0.8425****	*(0.0356)*	*0.8587****	*(0.0322)*
B	Organizational ability	Frequency of shopping (c)	0.952***	(0.006)	0.948***	(0.008)	0.825***	(0.021)	0.857***	(0.019)
B	Organizational ability (time)	Frequency of buying pre-cooked food (d)	1.006	(0.006)	1.010	(0.008)	1.049**	(0.024)	1.050**	(0.020)
B	*Organizational ability (time)*	*Frequency of buying frozen food (d)*	*1.0020*	*(0.0059)*	*1.0039*	*(0.0079)*	*1.0409**	*(0.0245)*	*1.0401***	*(0.0204)*
B	Social capital (environment)	Frequency of teaching children not to waste (e)	1.007	(0.007)	1.010	(0.009)	1.058**	(0.028)	1.047*	(0.025)
O	Social capital (environment)	Main effect: waste of resources (dummy)	1.028***	(0.008)	1.039***	(0.011)	1.039	(0.030)	1.035	(0.026)
O	Social capital (environment)	People should: buy fresh food from producers (a)	0.978***	(0.007)	0.979**	(0.009)	0.928***	(0.025)	0.942***	(0.021)
B	Social capital (environment)	Frequency of buying non-seasonal food (e)	0.989	(0.007)	0.989	(0.009)	0.957*	(0.024)	0.958**	(0.020)
B	*Social capital (environment)*	*Frequency of buying products from far away (e)*	*0.9977*	*(0.0068)*	*0.9978*	*(0.0086)*	*0.9676*	*(0.0235)*	*0.9621**	*(0.0209)*
O	*Social capital (environment)*	*To reduce waste: inform citizens of its consequences (don't know) (dummy)*	*0.9468***	*(0.0235)*	*0.9551*	*(0.0303)*	*0.8710*	*(0.1022)*	*0.9015*	*(0.0925)*
O	*Social capital (society)*	*To reduce waste: educate children in schools (don't know) (dummy)*	*0.9533***	*(0.0210)*	*0.9608*	*(0.0255)*	*0.8198***	*(0.0795)*	*0.8204***	*(0.0773)*

Notes: All regressions include as covariates: age of the household head, household size, level of education, wealth conditions, size of the municipality (logarithm), and dummy for the Province capitals. The behaviors and opinions non-significantly correlated with food waste are in *italics*; the odd ratios (coefficients) non-significant in the OLS models are underlined. B = behavior; O = opinion. (a) 1 = totally disagree; 4 = totally agree; (b) 1 = never; 3 = always; (c) 1 = less than once a month; 7 = daily; (d) 1 = never; 8 = daily; (e) 1 = never; 4 = often. + Not used in the models linking food waste with food behaviors and opinions because of multicollinearity.

correlation with food waste.[27] We explore the complex relationship of food waste with socio-economic conditions and social capital in the next subsection.

4.4. Socio-economic conditions, food waste, and social capital

To assess the relationship between food waste, social capital, and socio-economic conditions, we estimated different sets of 12 models, where each of the variables eliciting food waste was regressed on the interaction between households' socio-economic conditions and each of the variables measuring social capital, separately. Again, we included the households' socio-demographic features, location variables, and the opinion about the seriousness of the food waste issue as covariates. Of the various specifications, Table 5 presents the model with social capital (quintiles) as a factor, and income free to vary because of the interesting dynamics that emerged for different food waste measures.[28]

This last set of models allowed us to conclude that:

[27] For more details on the relationship between behaviors and opinions and food waste, see Supplementary Material 1.

[28] OLS estimates of the same model are reported in Table S12 in Supplementary Material 2. Sets of models with (1) self-declared income as a factor and social capital continuous, and (2) self-declared social class as a factor and social capital continuous were estimated as a robustness check. All the model estimates were coherent in terms of signs and statistical significance of the coefficients. The estimates of Models (1) and (2) are reported in Tables S13 and S14, respectively, in Supplementary Material 2.

Table 4
Models linking household food waste to food behaviors and opinions.

Type	Corr.	Category	Behavior / opinion	Food waste frequency		Food waste quantity		Food waste value	
B	+	Status (food security)	Wastes because: cooks too much food (dummy)	2.579***	(0.386)	2.648***	(0.439)	2.934***	(0.470)
B	+	Status (food security)	Very full fridge, things sometimes get bad (dummy)	2.507***	(0.311)	2.166***	(0.255)	1.906***	(0.249)
B	+	Status (spoiledness)	Usually throws away open packages (dummy)	1.979***	(0.349)	2.294***	(0.368)		
B	+	Status (spoiledness)	Throws away food past the expiry date (dummy)	2.074***	(0.384)	1.742***	(0.295)	2.522***	(0.460)
B	+	Status (spoiledness)	Wastes because: does not like the food (dummy)	2.274***	(0.623)	1.740**	(0.464)		
B	+	Status (food security)	Wastes because: buys too much food (dummy)	2.270***	(0.524)	1.606**	(0.335)	1.928***	(0.449)
B	+	Status (food security)	Too full fridge, things often get bad (dummy)	2.267***	(0.362)	1.580***	(0.272)	1.954***	(0.327)
B	+	Status (food security)	Wastes because: buys too big packages (dummy)	1.463*	(0.300)	1.808***	(0.403)	2.028***	(0.457)
B	+	Status (food security)	Wastes because: fears it is not enough (dummy)	1.702***	(0.342)	1.521**	(0.318)	1.661**	(0.357)
B	+	Status (spoiledness)	Wastes because: has a bad smell or taste (dummy)	1.359**	(0.170)	1.258*	(0.160)	1.394**	(0.203)
O	+	Status (spoiledness)	People should: use doggy bags (don't know) (dummy)	1.700**	(0.374)				
O	−	Status (spoiledness)	People should: reuse leftovers (a)			*0.819***	*(0.078)*		
O	−	Status (spoiledness)	People should: use doggy bags (a)					0.809**	(0.071)
O	−	Status (spoiledness)	People should: check expired food (a)	0.758***	(0.069)			*0.821**	*(0.088)*
B	−	Status	Well-supplied fridge, easy to invite guests (dummy)					*0.790**	*(0.111)*
B	+	Organizational ability	Gives expired food as present (dummy)	2.414**	(0.847)	4.949***	(1.723)	5.966***	(1.985)
B	+	Organizational ability	Uses expired food to feed animals (dummy)			3.171**	(1.727)	3.327***	(1.208)
B	+	Organizational ability	Usually throws away entire packages (dummy)	2.084***	(0.508)	2.277***	(0.500)		
B	+	Organizational ability	Wastes because: buys too much once a week (dummy)	2.626***	(0.399)	1.659***	(0.250)	1.779***	(0.315)
B	+	Organizational ability	Wastes because: way home without fridge (dummy)	1.961***	(0.233)	1.885***	(0.213)		
B	+	Organizational ability	Wastes because: wrong need calculation (dummy)	1.779***	(0.279)	1.468**	(0.243)	1.332*	(0.209)
B	+	Organizational ability	Wastes because: food has passed the date (dummy)	1.450***	(0.177)			1.544***	(0.226)
B	+	Organizational ability	Frequency of shopping (b)	1.163***	(0.066)				
B	−	Organizational ability	Frequency of making a shopping list (c)			0.843**	(0.072)		
B	−	Organizational ability	Wastes because: food got spoiled (dummy)			*0.823**	*(0.092)*		
B	−	Organizational ability	Shopping: most often in supermarkets (dummy)					0.739**	(0.106)
B	−	Organizational ability	Shopping: most often from producers (dummy)	*0.622**	*(0.172)*				
O	+	Organizational ability	Doesn't know her frequency of food waste (dummy)	n.a.				7.220**	(5.624)
O	−	Organizational ability	People should: cook the right quantity (a)	n.a.				0.783**	(0.095)
B	+	Organizational ability (time)	Shopping: most often home delivery (dummy)	8.922***	(3.826)	5.707***	(3.648)	13.904**	(15.550)
B	+	Organizational ability (time)	Frequency of buying pre-cooked food (d)	1.171***	(0.044)	*1.137****	*(0.037)*	1.150***	(0.046)
B	+	Social capital (environment)	Frequency of teaching children to use seasonal food (e)					1.374**	(0.183)
B	+	Social capital (environment)	Frequency of buying non-seasonal food (e)	*1.191***	*(0.104)*			1.300***	(0.126)
B	−	Social capital (environment)	Frequency of teaching children not to waste (e)			0.758*	(0.116)		
O	+	Social capital (environment)	People should: buy fresh food from producers (a)			*1.159**	*(0.099)*	*1.205**	*(0.116)*
O	−	Social capital (environment)	Main effect: more pollution from disposal (dummy)	0.771*	(0.110)				
O	−	Social capital (environment)	Main effect: waste of resources (dummy)	0.789*	(0.097)			0.676***	(0.099)
O	−	Social capital (environment)	Main consequence: harm to the environment (don't know) (dummy)					0.357**	(0.184)
O	−	Social capital (fairness)	Main effect: waste of redistributable food (dummy)	0.735**	(0.096)			0.727**	(0.100)
B	−	Social capital (costs)	Frequency of teaching children to look for cheap food stores (e)					*0.809**	*(0.091)*
O	−	Social capital (society)	Main effect: negative influence on the youth (dummy)	0.534***	(0.102)				
Observations				1529		1483		1436	
Pseudo-R-sq.				0.214		0.161		0.178	

Notes: All regressions include as covariates: the age of the household head, the household size, the level of education, the wealth conditions, the size of the municipality (logarithm), the perception of food waste, a dummy for the Province capitals, and the perception of food waste. The odd ratios non-significant in the full models are in *italics*; the odd ratios (coefficients) non-significant in the OLS models are underlined. B = behavior; O = opinion. + = positive correlation; − = negative correlation. (a) 1 = totally disagree; 4 = totally agree; (b) 1 = less than once a month; 7 = daily; (c) 1 = never; 3 = always; (d) 1 = never; 8 = daily; (e) 1 = never; 4 = often.

Result 4. *Where social capital is low, higher household income yields more frequent food waste; where social capital is high, higher income yields lower food waste.*

The relationship between food waste, social capital, and household socio-economic conditions is complex. The correlation between income and the frequency of food waste is significant and positive where the level of social capital is low or mid-to-low (first and second quintiles), and non-significant where social capital is mid-to-high (third to fifth quintiles). The correlation between one's income and the value of food waste is significant and negative for the families residing in provinces with mid-to-high social capital, and non-significant where social capital is mid-to-low or low. Thus, social capital seems to counterbalance the role of one's financial endowment in generating food waste opportunities.

These findings are confirmed for both income and social class if these are treated as factors and social capital as continuous. With income as a factor (Table S13 in Supplementary Material 2), the negative correlation between food waste and social capital is more often significant for low, and especially mid- and mid-to-high-income households, while being barely significant for richer households. With social class as a factor (Table S14 in Supplementary Material 2), the gap between middle- and low-class households (characterized by a negative and mostly significant correlation between food waste and social capital) and upper-class households (for whom this correlation is mostly non-significant, and

Table 5
Models linking household food waste to the interaction between social capital and income.

Dep. variable	Food waste frequency				Food waste quantity				Food waste value			
Indep. variable	Turnout pre-1990	Turnout post-1990	Blood donations	Organ donations	Turnout pre-1990	Turnout post-1990	Blood donations	Organ donations	Turnout pre-1990	Turnout post-1990	Blood donations	Organ donations
Low social capital (dummy) x Income	1.189** (0.085)	1.203** (0.087)	1.112 (0.078)	1.133* (0.079)	1.102 (0.079)	1.069 (0.075)	1.077 (0.075)	1.069 (0.074)	0.969 (0.075)	0.963 (0.075)	0.926 (0.071)	0.930 (0.071)
Low-middle social capital (dummy) x Income	1.144* (0.085)	1.095 (0.080)	1.178* (0.088)	1.218** (0.095)	1.053 (0.078)	1.033 (0.077)	1.050 (0.076)	1.095 (0.085)	0.960 (0.076)	0.986 (0.078)	0.953 (0.075)	1.016 (0.084)
Middle social capital (dummy) x Income	1.086 (0.078)	1.036 (0.071)	1.085 (0.080)	1.094 (0.080)	1.040 (0.073)	1.047 (0.067)	0.965 (0.076)	1.048 (0.075)	0.873* (0.071)	0.842** (0.063)	0.896 (0.071)	0.910 (0.070)
High-middle social capital (dummy) x Income	1.015 (0.071)	1.010 (0.071)	1.073 (0.075)	1.012 (0.070)	0.968 (0.066)	0.982 (0.067)	1.039 (0.069)	0.994 (0.067)	0.797*** (0.062)	0.787*** (0.061)	0.842** (0.064)	0.816*** (0.062)
High social capital (dummy) x Income	1.031 (0.071)	1.081 (0.075)	0.982 (0.068)	1.005 (0.068)	1.041 (0.070)	1.077 (0.074)	0.957 (0.067)	0.986 0.067)	0.872* (0.066)	0.919 (0.070)	0.830** (0.064)	0.849** (0.062)
Age	0.980*** (0.003)	0.981*** (0.003)	0.980*** (0.003)	0.980*** (0.003)	0.987*** (0.003)	0.988*** (0.003)	0.987*** (0.003)	0.987*** (0.003)	0.987*** (0.004)	0.987*** (0.004)	0.987*** (0.004)	0.987*** (0.004)
Family size	1.094* (0.058)	1.094* (0.058)	1.104* (0.058)	1.103* (0.058)	1.247*** (0.065)	1.258*** (0.066)	1.255*** (0.065)	1.255*** (0.065)	1.207*** (0.073)	1.197*** (0.073)	1.219*** (0.073)	1.210*** (0.073)
Education	0.996 (0.042)	1.003 (0.042)	0.997 (0.042)	0.991 (0.042)	1.126*** (0.047)	1.135*** (0.047)	1.128*** (0.047)	1.125*** (0.047)	1.096* (0.054)	1.107** (0.054)	1.102** (0.054)	1.095* (0.053)
Municipality size (log)	0.984 (0.042)	1.014 (0.042)	0.973 (0.043)	0.998 (0.043)	1.080* (0.047)	1.080* (0.046)	1.046 (0.048)	1.065 (0.046)	1.034 (0.052)	1.094 (0.054)	1.035 (0.052)	1.070 (0.053)
Province capital (dummy)	1.230 (0.213)	1.178 (0.199)	1.259 (0.219)	1.152 (0.199)	0.887 (0.150)	0.913 (0.151)	0.960 (0.163)	0.907 (0.151)	0.797 (0.157)	0.729 (0.140)	0.804 (0.156)	0.723* (0.141)
Food waste perception	0.569*** (0.046)	0.573*** (0.045)	0.563*** (0.045)	0.569*** (0.046)	0.577*** (0.048)	0.581*** (0.048)	0.573*** (0.047)	0.581*** (0.048)	0.596*** (0.056)	0.593*** (0.055)	0.589*** (0.055)	0.590*** (0.055)
Observations	1542	1548	1542	1548	1492	1498	1492	1498	1445	1451	1445	1451
Pseudo-R-sq.	0.040	0.040	0.040	0.041	0.040	0.039	0.040	0.039	0.036	0.037	0.033	0.036

in some cases even positive) is even larger. In both models, the ORs of a unit increase in social capital are particularly low (below one) for poor households when social capital is measured by organ or blood donations.

A household's income is a proxy of the opportunity cost of the time spent managing food, primarily leftovers, and is thus likely to be positively related to food waste, whereas one's self-declared social class depends on their social, professional, and educational background, and is thus a good proxy of their concern for status. Upper-class families evaluate their status more than on the benefits of not wasting food.

In all the models, the correlation is highly significant when food waste is measured by its frequency; that according to Setti et al. Setti et al. (2016) is the best proxy of one's actual food waste behavior.

In general, as theorized in our model, higher financial endowment allows households to overcome the negative financial impact of wasting food, so that they are less concerned about the social norms prevailing in their community. It might also be that social norms are income-specific: among low-income households, they are centered on food abundance; among well-off households, environmental concerns tend to prevail. Therefore, with higher social capital, social norms play a stronger role, but their influence occurs in opposite directions depending on income.

4.5. Social capital, food behaviors and opinions, and food waste

Jointly considering the results of Subsections 4.2 and 4.3 may help draw further conclusions on the complex relationship between social capital, food behaviors and opinions, and food waste. As expected, almost all the behaviors and opinions that are significantly and *positively* related to social capital in Table 3 present a *negative* relationship with food waste, while those *negatively* related to social capital tend to be *positively* related to food waste. This confirms our Hypothesis 1 that higher social capital yields lower food waste.

As for behaviors, higher social capital yields a higher frequency of shopping from producers, teaching children not to waste, and making a shopping list, which in turn are weakly negatively correlated with food waste. A similar dynamic—positive correlation with social capital and negative with food waste—was observed for the opinions that food waste is primarily a waste of resources and that people should reuse leftovers, use doggy bags, and check expired food products before throwing them away. Social capital is negatively related to behaviors such as shopping more frequently, throwing away expired food without checking its reusability, purchasing non-seasonal food or too big packages, cooking too much, and miscalculating one's needs, which are all related to higher food waste. A similar dynamic was observed for the opinion that people should buy fresh food from producers and the lack of opinions on the use of doggy bags. Thus, the relationship between social capital and food waste is mediated by the search for status through food, which leads to overabundance, and by poor organizational abilities in all phases of food management, which cause more food waste. Environmental concerns are linked to lower food waste only when they are not related to the search for status.

Only one behavior (the purchase of pre-cooked food) presents an overall relationship inconsistent with our hypotheses, being positively related with both food waste and social capital. This probably happens

because the provinces with higher social capital are also richer and have increased economic activity, so that the higher opportunity cost of time induces a greater need for pre-cooked food and a lower propensity to use the resulting leftovers.

5. Conclusions

Our analysis unveiled the existence of a complex relationship between the level of social capital in a territory and the use of resources by its inhabitants, even when individual decisions are private and driven by well-established routines, as is food waste behavior. In particular, Italian households appear to waste more food in low social capital areas. Second, behaviors and opinions eliciting status concerns in relation to food are negatively linked to social capital and positively to food waste. Third, organizational abilities are stronger where social capital is stronger, and are related to lower food waste. These empirical results are coherent with the proposed theoretical model.

We found that social capital tends to mediate the relationship between a family's financial endowment and their food waste level, with households in low social capital areas throwing away food more often if their are better-off—a relation that disappears where social capital is high. Pro-environmental behaviors and opinions are also stronger where social capital is higher, but are related to lower food waste only if they are not driven by status concerns. Notably, all these correlations are stronger when food waste is measured by its frequency rather than by its quantity or value, suggesting that higher social capital generates aversion to the act of wasting. Therefore, food waste can be considered a (negative) proxy of social capital and vice versa.

These findings have important policy implications. First, decision-makers could use classical social capital indicators to identify territories where to implement interventions against hard-to-measure food waste and, in general, resource waste. In areas with low social capital, individuals cannot rely on functioning social institutions; hence, they need to achieve acceptance through the members of their close network to reduce uncertainty. In Italy, this often happens through showing food overabundance (i.e., overbuying, overcooking, over-serving, etc.). However, this is possible only when one's financial endowment is sufficiently high. For this reason, our findings suggest that in low social capital areas, educational initiatives should be implemented alongside income-support interventions to mitigate the misuse of resources. Decision-makers should prioritize the diffusion of awareness and the promotion of social responsibility, which are conditions enabling waste prevention. Awareness and educational initiatives might contribute to increasing consciousness over the economic, environmental, and social implications of food waste, whereas promotion of a dialogue between local communities, firms, and other stakeholders of the food value chain could increase public interest in this problem. However, the internalization of virtuous social norms can be achieved only in the long-term.

Instead, where social capital is high, social acceptance is driven by other elements, such as shared post-materialist values and interests, or abiding by social norms. In these areas, decision-makers can build on existing individual skills and social networks to reinforce waste preventing behaviors. High social capital communities represent an ideal setting for the promotion of social innovation initiatives against food waste, e.g., social supermarkets (Schneider et al., 2015). Such entities have widely-recognized goals, are focused on people, and built on relationships; therefore, they can be used to leverage social capital for overcoming resource over-availability and overuse (Habisch and Adaui, 2013). Nevertheless, social supermarkets reduce food waste at earlier supply chain stages rather than at household level. Moreover, they represent an ex post solution to food waste as they reuse existing surpluses rather than preventing their creation, and are thus negatively affected by a reduction in these surpluses. For such reasons, social supermarkets can only be a temporary solution and cannot substitute the need for more systemic interventions.

While we recognize the role of systemic factors intrinsic to modern food systems in the promotion of wasteful behaviors (Colbert et al., 2017; Ghosh and Eriksson, 2019; Piras et al., 2018), and thus that we cannot exclusively blame consumers for food waste generation (Evans, 2011), we argue that the contribution of individual behaviors embedded in a specific social context should not be overlooked. We have shown that food waste and related food behaviors are more likely to be displayed where social capital, and thus commitment to public good, is weaker.

A limitation of this work is that food waste in our dataset was self-assessed. Hence, it might be subject to misestimation, underestimation, or underreporting for social desirability concerns (Giordano et al., 2018). Biases are likely to be larger for food waste quantity and value due to the difficulty of estimating one's own figures. We mitigated this issue by also considering food waste frequency (which is arguably easier to recall for most individuals) and using one's opinion about the seriousness of the food waste problem as a control.

To check the robustness of our findings, further studies could rely on alternative measurement strategies, like diaries for registering the frequency of waste acts on a per-meal basis. Furthermore, researchers could build on the results of this work to assess waste dynamics within specific groups and across territories, possibly extending the analysis to a supranational level.

Declaration of Competing Interest

None.

A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecolecon.2021.106954.

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