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Food waste as a (negative) measure of social capital. A study across Italian Provinces *

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Abstract

Household food waste is a crucial problem in developed countries. Food waste behaviour is the result of complex interactions among economic factors, deeply rooted habits, and social norms. It can thus be considered a measure of the social capital characterizing a community. We test this hypothesis using a national-level dataset on household food-related behaviours and opinions in Italy gathered in 2016. This country is an ideal test bed for a comparative analysis on social capital. We find household food waste measures to be negatively related with the local level of social capital.

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This relationship is mediated by family income, as it becomes weaker for better-off families. Furthermore, we find that behaviours and opinions eliciting status concerns with respect to food, as well as lack of organisational abilities, generate increased food waste. In turn, these behaviours and opinions are more prevalent in areas with low social capital. Our results, captured by a simple model where food waste decisions are considered in the context of a modified public good game, allow to derive several policy implications for the reduction of food waste.

1 Introduction

Waste is a fundamental problem of modern economic systems that pertains to a borderland where the individual domain adjoins the social sphere. Waste behaviour is intrinsically social because of its economic and ethical implications, and its environmental repercussions on common resources, but it also shows distinctive attributes that tend to confine it to the idiosyncratic realm. First, the visibility of waste behaviour is limited to the members of a restricted group, such as one's family, thus it can barely be subject to social monitoring (Ariely et al. 2009). Second, waste 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 last act of a decision-making process focused on individual consumption of goods and services (e.g., water, food and energy). In particular, food waste behaviour is influenced by a chain of choices (Setti et al. 2018), which are, in turn, driven by personal deep-seated beliefs, needs and judgments ('visceral factors', Loewenstein 1996; Ajzen 2015).

Within the general problem of waste, household's food waste stands out as it implies the waste of all the resources necessary to produce food and bring it to households. The importance of social circumstances in shaping households' waste behaviour is still under discussion. Some studies find that social pressure encourages the purchasing of excessive quantities of food leading to unnecessary throwing out of unconsumed goods (Vermeir and Verbeke 2006; Evans 2011, 2012; Farr-Wharton et al. 2014), whereas Quested et al. (2013) argue that food waste-related social norms can barely affect one's individual behaviour due

to the limited visibility of the phenomenon.

A well-established conceptualisation of the relationships between preferences and behaviour is contributed by Benabou and Tirole (2011), according to whom individual decisions can be ascribed to three main determinants: intrinsic and extrinsic motivations, and anticipated reputational effects. This background can account for the conflicting preferences individuals face when dealing with food waste. Intrinsic motivations (e.g., altruism or commitment) and/or extrinsic motivations (e.g., costs saving) can lead to pro-social acts like waste prevention or reduction, whereas alternative intrinsic motivations (e.g., food security, time saving, or self-gratification) or anticipated reputational effects (e.g., status concerns) are antecedents of a-social acts like waste generation. The question remains open on whether any relationship exists between household food waste behaviour and social norms.

The set of social norms 'that guide and/or constrain human behaviour' (Cialdini and Trost 1998, p. 152) is defined as social capital (Putnam et al. 1994; Putnam 2001; Guiso et al. 2004). Previous studies have shown a positive role of social capital in the adoption of cooperative practices in both developed (e.g. Alló et al. 2015) and development economies (e.g. Teklewold et al. 2013). This study contributes to uncover of the relationship between social capital and household food waste behaviour, enquiring whether the latter can be considered a measure of the former. In this endeavour, instead of limiting the analysis to strictly food-related social norms, we consider the relationship between these norms and the more general capacity of a community to 'sustain cooperative behaviour, ..., [and] the provision of public goods' ('community capital', Jackson 2017, pp. 4-5). This capacity of sustaining cooperative behaviour has been convincingly associated in the literature with societal propensity toward (organ and blood) donation and of civic participation (Guiso et al. 2004), among others. The objective of this study is thus to detect possible correlations between pro-social norms accruing to a society and pro-social deeds performed by an individual when the atypical case of food waste behaviour is considered.

When considering food waste behaviour with respect to other measures of social capital a major difference arises. Standard indicators of social capital like participation in associations

or donations imply a so called social dilemma, i.e. a trade-off between investing personal time or effort to the benefit of others instead of one-selves. The costly individual choice contrasts the social beneficial act, which people nonetheless undertake due to social norms. From a strictly individual perspective, pro-social behaviours are anti-economical with respect to the selfish outcome. Food waste does not entail a social dilemma from this strictly economic point of view. Generating food waste implies lowered food surplus causing insecurity and loss of personal time, thus consumers are individually worse-off by producing waste. Conversely, reducing food waste increases social wellness by lowering the costs of waste management for the community, lowering pollution, and increasing the availability of common natural resources. In addition, it implies an indirect economic saving for the individual. Thus if she wastes less food, a consumer is both is pro-social (intrinsic motivation) and saves money (extrinsic motivation). This consideration would imply a convergence of food waste behaviour toward zero. Nevertheless, evidence shows that food waste is a persistent or raising phenomenon (Verplanken et al. 1998; Verplanken and Orbell 2003; Stefan et al. 2013; Graham-Rowe et al. 2015; Stancu et al. 2016; Setti et al. 2018). In this article we argue that the difference derives from the existence of non-economic concerns such as status and organizational concerns.

This study argues that the relationship between social capital and household food waste is affected not only by pro-social norms and cohesiveness of a community (the 'features of a society', Jackson 2017, p. 21), but also by individual conditions shaping one's personal will and capacity to comply with social norms (Loury et al. 1977). From an economic point of view, a key candidate to influence household food waste is the individual income position, of which we assess the impact as a moderator of the relationship between food waste and social capital. The debated role of economic inequalities seems related to a general compression of the involvement in community life and a 'decline of civic trust' (Szreter and Woolcock 2004, p. 3), where the poorer suffer for the lack of social support and opportunities. We adopt a different perspective by focusing on the individual standard of living (i.e., the individual perception of inequality) and measuring if any association with social capital emerges when

food waste behaviour is considered (Setti et al. 2016). It is supposed, paraphrasing Melnyk et al. (2011), that when individuals are under economic pressure, the influence of pressure to conform to social norms increases (Akerlof 1991).

To test these hypotheses, we rely on a national-level dataset of household food-related behaviours in Italy, to which we merge a number of variables eliciting the level of social capital in the Province of residence (blood and organ donations, referendum turnout). Italy is an ideal location for this analysis because of the well-known divide in terms of social capital between the North and the South (Guiso et al. 2004; Bigoni et al. 2016). Moreover, we focus on consumers as they are the main responsible for waste generation along the food value chain (Parfitt et al. 2010; FAO 2011).

We have three main results from our analysis. First, there is a negative relationship between social capital and food waste: more food is wasted where social capital is low. This suggests that food waste is a good indicator of (weakness of) social capital. Second, by exploring the drivers of acquisition of social norms, we find that one's income level mediates the previous relationship. More specifically, low- and middle-income families waste less food where social capital is higher and *vice versa*, while this relationship is non-significant among high-income families. Third, we find that behaviours and opinions eliciting 'status concerns' with respect to food (that lead to overabundance) and the lack of 'organisational abilities' generate increased food waste, and that these behaviours and opinions are more prevalent in areas with low social capital.

The rest of the paper is organised as follows: Section 2 introduces a simple model where an individual chooses food waste in a public good game; Section 3 discusses the data used and the methodology of the empirical analysis; Section 4 presents the results in detail and discusses them; and Section 5 concludes.

2 The model

The social dilemma entailed by pro-social behaviour can be effectively represented by a Public Good Game (PGG) which models the choice of an individual between personal income, and wealth coming from a public project in which to invest at community level. In this game, each individual is given an endowment e, which she can decide to invest totally or partially in a public project. The amount invested in the PGG by each and every participant is multiplied by a factor $\beta > 1$. Each participant decides the amount to invest at the same time, without knowing the amount invested by the other group members. The amounts devoted to the public project are multiplied by the factor β and then divided equally by all participants, independently from their individual contribution: this implies that there is an incentive to free-ride, i.e. to contribute nothing and obtain the equal share of the public project contributed by the other group members. Provided that everyone should expect this behaviour from group participants, the Nash equilibrium of the game predicts a situation in which nobody contributes anything to the public good. This equilibrium is sub-optimal with respect to the social optimum where everybody contributes everything.

Formally, the payoff π of an individual is given by:

$$\pi = e - c_i + \frac{\beta \sum_{i=1}^{n} c_i}{n}, \tag{1}$$

where n is the number of members of the social group and c_i is the amount of personal endowment that the group member contributes to the public good. The payoff structure stresses the dilemma existing between the personal payoff $(e - c_i)$, which is reduced by the contribution to the public good c_i, and the public payoff $\frac{\beta \sum_{i=1}^{n} c_i}{n}$, that increases its value as members contribute. Key to the decision is the marginal per capita return to the game $MPCR = \frac{\beta}{n}$.

As noted in the introduction, however, the case of food waste has a peculiar payoff structure. To model the choice concerned, we modify this traditional game to adapt it to the choice of food waste we intend to study. In our PGG game – that we can call Food Waste Game (FWG from now on) – the individual choice consists of a personal choice to waste

food that residues from the choice of non-wasting. Each individual has an initial endowment that she can decide to save, or turn into food that goes wasted.

Let us call w_i the individual personal expense in wasted food, which can take values in $\in (0, e)$. Individual income in this modified game is, similarly to the standard PGG, equal to the individual's endowment minus the amount of endowment that she decides to invest in food waste, $e - w_i$. The alternative choice for the individual is, then, to non-waste, which is also a choice beneficial for the group. This choice is beneficial for the group because it reduces the amount of pollution, the costs related to waste collection and the general sustainability level of the community. The more group members individually decide to non-waste, the higher the group benefit. This characteristic of food waste is captured by the second term of Eq. 1 where it is clear that the most important difference with respect to the standard model is that the component w_i influences negatively the total payoff. This term captures the negative effect of waste on the community, and increases as much as each individual decides to spend her endowment on waste. The return to the FWG here is, consequently, the return to non-waste that is achieved by reducing the amount of e devoted to waste. It is also clear from this structure that the social component of waste goes in the same direction of the individual: the higher the individual waste, the higher the social negative effect of wasting, as it is in reality. The two effects both contribute negatively to the individual payoff, which substantiates the following statement:

PROPOSITION **1.** *In the basic FWG there is no social dilemma involved.*

The multiplication factor β plays an important role in this game, because it indicates how strong is the effect of group waste on the individual payoff (and on the payoffs of all group members). This parameter effectively synthesizes the role of social capital, indeed an higher β implies a higher amount of payoff forgone by wasting, in fact:

$$\frac{\partial \pi_i}{\partial_{w_i}} = -1 - \frac{\beta}{n} = -1 - MPCR.$$

The payoff as a function of individual waste is a negative function of β. A higher β implies a higher (negative) impact of waste on the payoff coming from social waste. This

connection identifies a negative relationship between social capital and waste.

Status effect and organizational abilities

Food waste behaviour is not a purely monetary choice. Indeed, it can be influenced by behavioural factors, such are the search for status. When food excess constitutes status, the latter can have a positive effect on amount of food wasted. To take this into account, we modify our model to include this element in the payoff function: the 'status effect' that characterises the choice of wasting food is identified with the parameter γ, and is a positive function of the amount of food wasted individually with respect to the average amount wasted in the community. For levels of individual food waste equal to w_i, the individual payoff function reads

$$\pi_i = e - w_i + \beta \frac{\sum_j (e - w_j)}{n} + \gamma\, e \left(w_i - \frac{\sum_{j \neq i} w_j}{n} \right).$$

The payoff function in this case shows that agents may seek overabundance as the individual perceives the fact of showing off excess of food with respect to the average in her community as individual welfare. For what concerns the individual choice, the optimality condition yields

$$\gamma = \frac{1}{e} \left(1 + \frac{\beta}{n} \right). \tag{2}$$

Equation 2 identifies a complex relationship between social capital, food waste levels and the 'status effect'. The individual payoff increases with the level of food waste when $\gamma > \frac{1}{e_i}\left(1 + \frac{\beta}{n}\right)$. This effect re-introduces a social dilemma in the FWG: the negative individual and social payoff deriving from food waste in the basic game is opposed to the positive individual 'status effect', which leads to the following statement:

PROPOSITION **2.** *The FW game with 'status effect' is a social dilemma.*

It is worth noticing that the net impact of the 'status effect' changes relatively to the level of β, the social capital parameter. The higher the social capital parameter, the higher the 'status effect' needed to create the social dilemma. To say it differently, for very high

levels of β, the 'status effect' may be counterbalanced. On the other hand, the FOC (Eq. 2) indicates that for increasing levels of income a higher level of social capital is necessary to compensate the status effect. At the limit, γ is equal to zero and, consequently, the trade-off between social capital and the 'status effect' disappears.

The last element we introduce in the model is the 'organisational ability' of a household with respect to food management, from purchase to the use of leftovers. The introduction of this factor responds to the evidence shown in studies on the determinants of food waste (Setti et al. 2018). In this case, the payoff becomes

$$\pi_i = e - o_i w_i + \beta \frac{\sum_j (e - o_j w_j)}{n} + \gamma\, e \left(o_i w_i - \frac{\sum_{j \neq i} o_j w_j}{n} \right),$$

where $o_i \geq 1$ is the parameter indicating 'organisational ability'. If a family is perfectly organised, $o_i = 1$; if their organisation is less than optimal, then $o_i \geq 1$. If a family's members are not able to organise their food-related management well, they end up wasting more than they had planned based on their individual, social and status concerns. The optimality condition in this case yields the same result found in Eq. 2.

The relationship between the 'status effect' γ and social capital β does not change: the higher β, the higher the 'status effect' γ needed to create the social dilemma. The 'organisational ability' parameter o_i amplifies the effects of both social capital and status: a well-organised family has a larger benefit from social capital and a lower benefit from status, and *vice versa*. Furthermore, one's 'organisational ability' does not eliminate food waste if the initial food waste target of a family is not zero, but it ensures that the target is met.

This model intends to capture the most important determinants of food waste identified in the literature, and to explore in depth the relationship between food-related behaviours and social norms.

In the next sections we will discuss the methods used to put these hypotheses to test.

3 Methodological approach

Our empirical analysis relies on a dataset collected by the Italian National Observatory on Waste 'Waste Watcher' for the year 2016 (Last Minute Market and SWG Last Minute Market and SWG). The survey, administrated through CAWI on a sample of household representative at national level, has been carried out every year since 2013. The 2016 sample includes 1,773 households. The questionnaire consists of around 100 (mostly) closed-ended questions on family characteristics, food routines, opinions on food waste and related issues, and potential waste prevention policies.

We created ordered categorical variables synthesising household food waste behaviours to assess its different dimensions (quantity, monetary value and frequency). The literature on food waste measurement found that, if questionnaires are used, asking for one's frequency of food waste is the most suitable strategy for obtaining a variable that describes households' actual behaviour (Setti et al. 2016). However, considering three variables increases the robustness of the findings. The value of food waste was detected from the answers to the question 'How much do you think your family's weekly food waste is worth?'. The quantity was detected from the question 'Considering that an apple or a banana weigh around 250 grams, a yogurt 125 grams, and a portion of cooked pasta 250 grams, how much food that could still be consumed do you throw away in a week?'. The frequency was detected from the question 'How often do you throw away leftovers, or food that you do not consider good anymore?'. These behaviours are self-declared, hence we created an ordered categorical variable indicating respondents' perception about the seriousness of the issue of food waste to be used as a control. The households who declared not to know the answer to one of these questions were excluded from the models that make use of the resulting variable.

The 'Waste Watcher' sample is representative at national level, hence for some Provinces only a limited number of households is available. Nevertheless, representativeness at Province level is not an issue, as the units of analysis are the households whose food waste behaviour is supposed to be influenced, among other variables, by the level of social capital in the Province of residence. Maps S1 to S3 (in Supplementary Information) illustrate the values

assumed by food waste variables in the Italian Regions, since the number of observations available at Regional level is substantially larger than at Provincial level.

Within the survey questionnaire, we identified questions concerning food-related behaviours (e.g. the frequency of shopping for food) and opinions (e.g. potential solutions to food waste), and used them to create a corresponding variables. We transformed non-ordered categorical variables into series of dummies (excluding one of the options to avoid problems of multicollinearity). When respondents could select more than one option, we assigned a value of 1 to the dummy for all households who selected the related option, regardless of the order. For ordered categorical variable, the households answering 'I don't know' were imputed the average answer of the others. This is a common practice to avoid losing observations and maintain the same sample size despite missing values. It assumes that having no opinion is equivalent to have an average opinion. Meanwhile, we created dummies identifying these households to assess the correlation between having no opinion (i.e. limited attention) and wasting food. Overall, we created 71 variables : 41 for behaviours, 29 for opinions, and a dummy for the families without children, who could not answer related questions.

We measured social capital at Province level by means of four variables. The first two are those chosen by Guiso et al. (2004) to study the effect of social capital on financial development in Italy: blood donations per capita[1], and the average voter turnout at referenda until 1987[2]. The other two variables were calculated for the purpose of this research: the share of population giving their consent to organ donation [3], and the average voter turnout

[1]'Number of blood bags (each bag contains 16 ounces of blood) per million inhabitants in the Province, collected by AVIS, the Italian association of blood donors, in 1995 among its members' (Guiso et al. 2004, pp. 554).

[2]'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, pp. 554).

[3]Members of AIDO, the Italian association of organ donors, per number of inhabitants in the Province (average in the period 2014-2016). In the only case in which AIDO does not have a Province-level branch, the same value was assigned to the two Provinces managed by the same office.

at referenda after 1990[4]. The variables used by Guiso et al. (2004) were calculated for the 95 Provinces existing in 1991, ours were calculated for the 110 Provinces existing in 2015. We assigned to each household a value of social capital corresponding to her Province of residence. Thus, social capital enters the models as a Province-based covariate influencing household food waste. Maps S4 to S7 (in Supplementary Information) illustrate the values assumed by social capital variables in all Italian Provinces.

Estimation procedure

The core analysis of this paper consists of four steps:

1. assessing the correlation between household food waste and social capital;
2. assessing the effect of household income on the previous relation;
3. identifying the relationship between food-related behaviours and opinions and household food waste;
4. assessing the correlation between relevant behaviours and opinions and social capital.

4 Results

Food waste and social capital

Result **1.** *Food waste is lower in higher social capital Provinces*

As a first step, we explored the correlations between social capital variables and food waste variables. Results are reported in Table 1. They indicate a negative relationship between social capital and the levels of food waste of the households. This holds regardless of the correlation index chosen (Spearman's or Parson's pairwise correlation), and for each

[4]Average turnout in all 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 was considered.

possible pair of social capital and food waste variables. In particular, the correlation is statistically significant (p-values in parenthesis, Table 1) between the turnout before 1990 and all measures of food waste, between the more recent turnout and food waste value and frequency, between the prevalence of organ donors and the value of food waste, and between the incidence of organ donors and food waste quantity and frequency. The highest absolute correlation values are observed between the turnout measures and the value and frequency of food waste. Furthermore, all social capital variables are positively and significantly related among themselves, pointing out to their robustness in measuring the latent phenomenon.

As a second step, we estimated a series of 12 regression models: each of the three variables eliciting food waste behaviour (value, quantity and frequency) was regressed on each of the four variables indicating social capital. Other covariates were the respondents' perception about the seriousness of the issue of food waste, location characteristics (the size of the municipality and a dummy for Province capitals) and, in line with Guiso et al. (2004), households' socio-demographic features. The latter included characteristics that were found to be significantly correlated with household food waste in the literature: family size, age of the household head and its squared value, level of education, and socio-economic status (Barr 2007; Koivupuro et al. 2012; Parizeau et al. 2015; Stancu et al. 2016; Secondi et al. 2015; Setti et al. 2016; Grainger et al. 2017, 2018). The computation of the Variance Inflation Factor (VIF) detected no cases of multicollinearity, apart from between the age and its squared value, which were nevertheless retained.[5] Although no multicollinearity was detected among the 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.[6]

[5]Including the squared value of the age is a common practice in social research, as the relationship between one's age and most social phenomena is not linear. The presence of multicollinearity is thus not an issue in this case.

[6]Still in line with Guiso et al. (2004), dummies for North and South, as well as (the logarithm of) the GDP per capita in the Province, were included in the initial models. However, this caused problems of multicollinearity, as in Italy there is a North-South divide in terms of social capital which is in line with the level of economic development. Therefore, these variables were not included in the final models. In turn, the socio-economic status of the households is self-assessed, and is thus more likely to be related to the

Table 1: Pairwise correlation between social capital and food waste variables in Italian Regions.

Variable	Type of correlation	Blood donations	Organ donations	Turnout pre-1990	Turnout post-1990	FW value	FW quantity	FW frequency
Blood donations	Spearman's	1						
	Pearson's	1						
Organ donations	Spearman's	0.7895 (0.0001)	1					
	Pearson's	0.8318 (0.0000)	1					
Turnout pre-1990	Spearman's	0.7000 (0.0008)	0.6965 (0.0009)	1				
	Pearson's	0.7201 (0.0005)	0.7160 (0.0006)	1				
Turnout post-1990	Spearman's	0.6281 (0.0040)	0.6947 (0.0010)	0.9228 (0.0000)	1			
	Pearson's	0.6842 (0.0012)	0.6433 (0.0022)	0.9552 (0.0000)	1			
Food waste value	Spearman's	-0.3053 (0.2038)	-0.3439 (0.1494)	**-0.5895** (0.0079)	**-0.5035** (0.0280)	1		
	Pearson's	-0.3020 (0.2089)	**-0.4848** (0.0303)	**-0.6227** (0.0044)	**-0.4375** (0.0537)	1		
Food waste quantity	Spearman's	**-0.4160** (0.0765)	-0.3308 (0.1665)	**-0.3993** (0.0903)	-0.3554 (0.1354)	0.6468 (0.0028)	1	
	Pearson's	-0.3306 (0.1668)	-0.1610 (0.4978)	**-0.4290** (0.0668)	-0.3406 (0.1417)	0.3575 (0.1217)	1	
Food waste frequency	Spearman's	**-0.4140** (0.0780)	-0.3456 (0.1472)	**-0.6333** (0.0036)	**-0.5684** (0.0111)	0.4456 (0.0559)	0.1141 (0.6419)	1
	Pearson's	-0.3690 (0.1200)	-0.1040 (0.6627)	**-0.5749** (0.0100)	**-0.5139** (0.0204)	0.3133 (0.1785)	0.1790 (0.4503)	1

Due to the ordered categorical nature of the dependent variables, the ordered logit is the most appropriate model typology.[7] The output of the model estimates are reported in Table 2. Since we are interested in assessing the correlation between food waste and social capital, not in representativeness at national level, we omitted the sample weights.[8] For robustness check, we estimated the same models using linear OLS regressions with and without sample weights (Tables S1 and S2 in Supplementary Information) and quantile regressions considering the median (Table S4 in Supplementary Information).

The correlation between food waste and social capital is negative and significant. This result is robust to the measures of food waste and of social capital chosen, with the only exceptions represented by the models linking the referendum turnout before and after 1990 to the quantity of food waste (Models 5 and 6). The largest impact on food waste can be observed when social capital is measured by organ and blood donations (Models 3, 4, 7, 8, 11 and 12). Furthermore, the correlation is particularly significant when food waste is measured by its frequency (Models 1 to 4). As pointed out by (Setti et al., 2016, pp. 1740), the frequency of food waste 'highlights consumers' actions rather than their quantitative effects', and is thus a better proxy of one's moral/social perception of the problem. This may explain the highly significant correlation between this indicator and social capital. On the other hand, the quantity and the value of food waste are less significantly related to social capital because they are influenced by factors other than one's aversion to wasting food (or lack of thereof), primarily family size. Indeed, our models confirm the finding in literature that larger households tend to waste a larger quantity of food (Stancu et al. 2016; Secondi et al. 2015; Grainger et al. 2017, 2018).

households' individual food consumption behaviour than the GDP at Province level.

[7]Since the Brant tests did not support the proportional odds assumption, we performed also multinomial logistic regressions. The signs and the relative sizes of the coefficients were in line with the ordered logistic models. Here we present the latter models, as they are much more parsimonious in terms of coefficients generated, hence the interpretation of the result is more immediate. The estimates of the multinomial logistic models are shown in Table S7 in Supplementary Information

[8]The estimates obtained using sample weights do not differ significantly (Table S3 in Supplementary Information).

As for other covariates, the perception of the seriousness of the food waste problem shows a strong negative correlation with food waste, as expected, with a high level of significance regardless of the measure employed for the latter. This finding is consistent with the hypothesis that the households more concerned about food waste tend to waste less. The level of education is positively correlated with the quantity of food waste regardless of the measure of social capital included in the model. Being an (anti-)ecological behaviour, individual food waste may be subject to underestimation or underreporting due to a social desirability bias (Milfont 2009). This finding may suggest that better-educated households are less affected by this bias, thus reporting higher quantities of food waste. Finally, it is worth noticing that family wealth is positively correlated with food waste, meaning that better-off families tend to waste more, but only in the case of food waste frequency this correlation is significant in all models.

Table 2: Ordered logistic models linking household food waste to social capital.

Indep. \ dep. var.	**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	0.9745***				0.9899				0.9790***			
	(0.0065)				(0.0068)				(0.0073)			
Turnout post-1990		0.9724***				0.9973				0.9770**		
		(0.0085)				(0.0091)				(0.0099)		
Blood donations			0.9287***				0.9501**				0.9322**	
			(0.0233)				(0.0246)				(0.0284)	
Organ donations				0.9195***				0.9545**				0.9300***
				(0.0209)				(0.0217)				(0.0254)
Age	1.0053	1.0063	1.0042	1.0055	1.0085	1.0097	1.0089	1.0103	0.9673	0.9677	0.9671	0.968
	(0.0205)	(0.0205)	(0.0205)	(0.0205)	(0.0191)	(0.0191)	(0.0192)	(0.0192)	(0.0209)	(0.0209)	(0.0208)	(0.021)
Age squared	0.9997	0.9997	0.9997	0.9997	0.9998	0.9998	0.9998	0.9998	1.0002	1.0002	1.0002	1.0002
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Family size	1.0713	1.0792	1.0897	1.0959*	1.2376***	1.2567***	1.2409***	1.2513***	1.2126***	1.2169***	1.2316***	1.2340***
	(0.0574)	(0.0578)	(0.0579)	(0.0582)	(0.0651)	(0.0659)	(0.0639)	(0.0643)	(0.0744)	(0.0745)	(0.0742)	(0.0744)
Education	0.975	0.9777	0.9751	0.9729	1.1083**	1.1097**	1.1065**	1.1045**	1.0813	1.083	1.0835	1.0806
	(0.0423)	(0.0423)	(0.0425)	(0.0421)	(0.0478)	(0.0478)	(0.0478)	(0.0475)	(0.0544)	(0.0544)	(0.0546)	(0.0544)
Wealth	1.1982**	1.1790**	1.1848**	1.1851**	1.1248*	1.1063	1.1249*	1.119	1.0542	1.0464*	1.0448	1.0483
	(0.0875)	(0.0858)	(0.0864)	(0.086)	(0.0788)	(0.0775)	(0.079)	(0.0783)	(0.0866)	(0.0858)	(0.0855)	(0.0852)
Municipality	0.9862	1.0094	0.9715	0.9669	1.0679	1.0687	1.0551	1.0508	1.0474	1.0727	1.0312	1.0361
size (log)	(0.0407)	(0.0415)	(0.0409)	(0.0403)	(0.0451)	(0.045)	(0.0453)	(0.0447)	(0.0501)	(0.0512)	(0.05)	(0.0494)
Province capital	1.2326	1.1771	1.2621	1.2645	0.9294	0.9296	0.9433	0.9487	0.7894	0.7486	0.8087	0.7899
(dummy)	(0.2088)	(0.1988)	(0.2152)	(0.2143)	(0.1533)	(0.1531)	(0.1559)	(0.1562)	(0.1513)	(0.1433)	(0.155)	(0.1508)
Food waste	0.5659***	0.5691***	0.5636***	0.5661***	0.5759***	0.5813***	0.5750***	0.5802***	0.5952***	0.5949***	0.5914***	0.5890***
perception	(0.0454)	(0.0456)	(0.0452)	(0.0451)	(0.0478)	(0.0479)	(0.0476)	(0.0479)	(0.0548)	(0.0546)	(0.0545)	(0.0543)
Observations	1542	1548	1542	1548	1492	1498	1492	1498	1445	1451	1445	1451
Pseudo-R-sq.	0.041	0.039	0.039	0.04	0.039	0.038	0.04	0.039	0.032	0.031	0.031	0.032

Socio-economic condition, food waste and social capital

RESULT **2.** *Social capital is related to lower food waste among poor and middle-income families only.*

To assess the relationship among food waste, social capital and socio-economic conditions, we ran ordered logistic regressions where the dependent variable was again food waste, and the regressor of interest was represented by the interaction between variables eliciting the other two aspects. Out of the various specifications, we present results for the model with self-declared income treated as a factor, and social capital continuous. Self-declared family income is an ordered categorical variable taking five values in the questionnaire, from lower to higher income. Again, we included as covariates the demographic characteristics of the respondent, location variables, and the perception of the seriousness of food waste. We estimated 12 regression models: each variable eliciting household food waste was regressed on the interaction between socio-economic conditions and each of the four variables indicating social capital. [9]

[9]For robustness check, we estimated various sets of models: (1) with the self-declared social class (five levels) as a factor, and social capital continuous; (2) with the GDP per capita in the Province as a factor (respectively five, four or two levels, corresponding to quintiles, quartiles and the median), and social capital continuous; (3) with social capital as a factor (respectively five, four or two levels, corresponding to quintiles, quartiles and the median), and income treated as continuous; (4) with social capital as a factor (again five, four or two levels), and social class treated as continuous; (5) with social capital as a factor (again five, four or two levels), and the GDP per capita in the Province continuous. Self-declared social class is an ordered categorical variable taking five values. All model estimates are coherent in terms of signs and statistical significance of the coefficients. The models (1) with social class as a factor and social capital continuous, and (3) with social capital quintiles as a factor and income treated as continuous are presented in Tables S5 and S6 in Supplementary Information, respectively.

Table 3: Ordered logistic models linking household food waste to the interaction between income and social capital.

Dep. variable	**Food waste frequency**				**Food waste quantity**				**Food waste value**			
Social capital (indep. variable)	Turnout pre-1990	Turnout post-1990	Blood donat.	Organ donat.	Turnout pre-1990	Turnout post-1990	Blood donat.	Organ donat.	Turnout pre-1990	Turnout post-1990	Blood donat.	Organ donat.
Lower income	0.9726***	0.9708***	0.7922**	0.8525*	0.9836**	0.9878	0.8916	0.8893	0.9815**	0.9789*	1.0650	1.0151
	(0.0076)	(0.0110)	(0.0845)	(0.0757)	(0.0081)	(0.0121)	(0.1050)	(0.0967)	(0.0084)	(0.0121)	(0.1001)	(0.0870)
Lower-middle income	0.9716***	0.9682***	0.9167	0.9141	0.9902	0.9985	1.0043	0.9916	0.9849*	0.9867	1.0678	1.0357
	(0.0069)	(0.0092)	(0.0553)	(0.0507)	(0.0076)	(0.0104)	(0.0706)	(0.0656)	(0.0079)	(0.0109)	(0.0678)	(0.0627)
Middle income	0.9742***	0.9723***	0.9428*	0.9222***	0.9909	0.9994	0.9654	0.9624	0.9820**	0.9808*	0.9557	0.9539
	(0.0066)	(0.0087)	(0.0309)	(0.0254)	(0.0070)	(0.0094)	(0.0311)	(0.0249)	(0.0075)	(0.0102)	(0.0383)	(0.0315)
Higher-middle income	0.9743***	0.9723***	0.9179**	0.9177***	0.9896	0.9967	0.9373**	0.9507*	0.9795***	0.9759**	0.8770***	0.8972***
	(0.0065)	(0.0086)	(0.0272)	(0.0239)	(0.0069)	(0.0092)	(0.0283)	(0.0252)	(0.0073)	(0.0098)	(0.0336)	(0.0287)
Higher income	0.9841**	0.9894	11342	10744	0.9912	0.9986	0.9602	0.9747	0.9828**	0.9813	0.9793	0.9403
	(0.0073)	(0.0105)	0.1116)	(0.0716)	(0.0084)	(0.0132)	0.1446)	0.1040)	(0.0085)	(0.0127)	(0.1272)	(0.1008)
Age	1.0051	1.0058	1.0009	1.0021	1.0057	1.0067	1.0062	1.0081	0.9618*	0.9616*	0.9606*	0.9625*
	(0.0207)	(0.0206)	(0.0206)	(0.0207)	(0.0193)	(0.0193)	(0.0193)	(0.0194)	(0.0210)	(0.0209)	(0.0209)	(0.0210)
Age Squared	0.9997	0.9997	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	1.0003	1.0003	1.0003	1.0003
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Family Size	1.0824	1.0897	1.0982*	1.1062*	1.2430***	1.2610***	1.2427***	1.2531***	1.2165***	1.2198***	1.2392***	1.2357***
	(0.0580)	(0.0583)	(0.0583)	(0.0587)	(0.0655)	(0.0663)	(0.0643)	(0.0646)	(0.0751)	(0.0751)	(0.0755)	(0.0751)
Education	0.9867	0.9900	0.9978	0.9931	1.1247***	1.1272***	1.1310***	1.1246***	1.1144**	1.1163**	1.1186**	1.1160**
	(0.0419)	(0.0420)	(0.0420)	(0.0417)	(0.0479)	(0.0480)	(0.0480)	(0.0478)	(0.0554)	(0.0555)	(0.0550)	(0.0550)
Municipality Size (log)	0.9943	10172	0.9721	0.9703	1.0674	1.0673	1.0574	1.0526	1.0477	1.0702	1.0353	1.0392
	(0.0413)	(0.0421)	(0.0410)	(0.0404)	(0.0451)	(0.0449)	(0.0452)	(0.0446)	(0.0499)	(0.0509)	(0.0499)	(0.0494)
Province Capital (dummy)	1.2146	1.1610	1.2608	1.2607	0.9348	0.9359	0.9437	0.9493	0.7900	0.7524	0.8049	0.7882
	(0.2064)	(0.1967)	(0.2148)	(0.2133)	(0.1550)	(0.1550)	(0.1561)	(0.1564)	(0.1519)	(0.1446)	(0.1543)	(0.1507)
Food Waste Perception	0.5649***	0.5675***	0.5611***	0.5623***	0.5754***	0.5799***	0.5709***	0.5763***	0.5867***	0.5863***	0.5862***	0.5822***
	(0.0454)	(0.0455)	(0.0451)	(0.0448)	(0.0481)	(0.0482)	(0.0476)	(0.0480)	(0.0540)	(0.0537)	(0.0540)	(0.0537)
Observations	1542	1548	1542	1548	1492	1498	1492	1498	1445	1451	1445	1451
Pseudo-R-sq.	0.041	0.394	0.040	0.040	0.040	0.039	0.040	0.039	0.034	0.033	0.035	0.034

Table 3 shows the results of the model estimation. The negative correlation between food waste and social capital is confirmed. However, it is more often significant for low, and especially for middle- and higher-middle-income households, while being barely significant for richer households. As for the absolute incidence of social capital on food waste, the odd ratios are particularly low for poorer households when social capital is measured by organ or blood donations and food waste by its frequency. This suggests our second result: poor and average-income families tend to throw away less food (and less often) if there is a higher level of social capital in their area of residence. The correlation is particularly significant when food waste is measured by its frequency, confirming that this is the best proxy of one's food waste behaviour (Setti et al. 2016). Well-off families seem not to be significantly affected by the level of social capital in their Province.

These findings are confirmed if income is replaced by social class as a factor (Table S5 in Supplementary Information), as well as if social capital is treated as a factor and income as continuous (Table S6 in Supplementary Information). [10] In general, the relation between food waste and social capital becomes barely or non-significant for better-off families because,

[10]When income is replaced by social class as a factor, the gap between low-to-middle-class households and higher-class households is even larger than in the previous set of models, with higher-middle-class household aligning with the latter, i.e. showing no significant correlation between food waste and social capital (in one case, this correlation is even positive). The correlation is, again, more significant when food waste is measured by its frequency, and the absolute effect is larger for lower-class families. The self-declared social class depends on one's social, professional and educational background, and is thus a good proxy of households' concern for status: higher-class families evaluate their status more than the benefits of non-wasting food (so that no clear correlation emerges), while low-class families are influenced by social norms, where present.

When social capital is treated as a factor and income as continuous, the dynamics observed are more complex. On the one hand, the correlation between one's income and the *value* of food waste is significant and *negative* for the families residing in the Provinces with middle-to-high social capital, and non-significant where social capital is middle-low or low. On the other hand, the correlation between one's income and the *frequency* of food waste is significant and *positive* where the level of social capital is low or middle-low. These findings confirm, once again, the role of social capital in limiting food waste and the counterbalancing power of income.

as theorised in our model, their higher financial endowment allows them to overcome the negative effect of wasting food, while they are less influenced by the social norms prevailing in their territory (social capital has a lower value for them).

Food-related behaviours and opinions driving food waste

RESULT **3.** *The search for status and food security is related to higher food waste; poor organisational abilities to higher food waste; environmentalism, pro-sociality and fairness to lower food waste.*

To identify the behavioural and motivational mediators of the relationship between food waste and social capital, we ran ordered logistic regressions with backward selection. [11] Our dependent variables were the three measures of food waste, respectively, our regressors food-related behaviours and opinions. The latter were classified according to macro-categories corresponding to the parameters of our theoretical model:

1. the search for food security for one's family, status seeking *vis-á-vis* guests and other people, and spoiledness with respect to food were considered proxies of the 'status effect';

2. the behaviours and opinions concerning the management of food from its purchase to the use of leftovers, including the time devoted to it, were considered proxies of 'organisational abilities';

3. concerns for the environment, for the fairness of food-related decisions, for the monetary cost of food, for the social consequences of food waste, and related behaviours were considered proxies of the 'social capital effect'. [12]

[11] We used the backward-selection procedure to discard the variables non-significantly related to food waste while reducing type I errors. We chose a p-value of 0.10 for removal from the model, and a p-value of 0.05 for addition to it. Forward-selection was also implemented, yielding similar results.

[12] With a view to reducing complexity, a principal component analysis was performed on the 71 variables eliciting food-related behaviours and opinions. However, no relevant reduction of the dimensions could be achieved.

Besides behaviours and opinions, we included the same covariates for family and location characteristics as the previous models, as well as the perception of the seriousness of the food waste problem. We did not subject these covariates to the backward selection process, since they are intrinsic features of the sample units. We used the VIF to detect cases of multicollinearity, and eliminated the variables presenting this problem.[13] Forty-three out of 71 variables – of which 30 eliciting behaviours and 13 opinions – were retained in at least one of the models. Compared to the full models (provided in Table S8 in Supplementary Information[14]), none of the coefficients changed sign because of the stepwise procedure, and only a limited number of coefficients non-significant in the full models became significant (or *vice versa*), meaning that the results are robust.

Table 4 shows the results of model estimation. The direction of the correlation (odd ratios either above or below 1) is robust to the measure of food waste chosen. Three behaviours (using expired food to feed animals, giving it as a present, and relying on home delivery) stand out for their very high odd ratios, likely due to their relative low prevalence in the sample and, thus, in Italy.

First, the behaviours related to the 'status effect' are associated to more food waste, while their absence tends to reduce food waste. Concerns for food security and status indicate a fear not to be able to feed one's family and guests, which may result in overbuying, overstocking and overcooking. Spoiledness indicates a refusal to adopt behaviours that could prevent food waste at the price of a reduction in one's hedonic utility (e.g. trying to reuse expired food).

Second, lack of 'organisational abilities' and a need to limit the time devoted to food management (e.g. by purchasing pre-cooked food) generate more food waste, a good organi-

[13]We calculated the VIF after running OLS regressions with all behaviours and opinions as independent variables. The dummies for reusing expired products after checking them, for throwing them away without checking, for giving them as a present, and for using them to feed domestic animals yielded values above 4.0 in all models; the dummy for having no opinion on the importance of cooking the right quantity yielded this problem in the model with food waste frequency. Once we excluded the dummy for reusing expired products from all models, and the one for cooking the right quantity from the model with food waste frequency, no multicollinearity was observed.

[14]Supplementary material tables are available upon request to the corresponding author.

Table 4: Ordered logistic models linking household food waste to food-related behaviours and opinions.

Type	Corr.	Category	Behaviour/opinion	Food waste value		Food waste quantity		Food waste frequency	
B	+	Social capital (environment)	Frequency of teaching children to use seasonal food (c)	1.3475**	(0.1830)	1.2084*	(0.1351)		
B	+	Social capital (environment)	Frequency of buying non-seasonal food (c)	1.3125***	(0.1246)			1.1958**	(0.1032)
B	+	Social capital (environment)	Frequency of buying products from far away (c)			1.1468*	(0.0900)		
B	−	Social capital (environment)	Frequency of teaching children not to waste (c)			0.7010**	(0.1068)		
O	+	Social capital (environment)	People should: buy fresh food from producers (d)	1.1810*	(0.1144)	1.1608*	(0.0994)		
O	−	Social capital (environment)	Food waste causes water scarcity (don't know) (dummy)	0.7052*	(0.1401)				
O	−	Social capital (environment)	Main effect: waste of resources (dummy)	0.6972**	(0.1019)			0.7416**	(0.0953)
O	−	Social capital (environment)	Main effect: more pollution from disposal (dummy)					0.7500*	(0.1101)
O	−	Social capital (fairness)	Main effect: more cross-country inequality (dummy)					0.7416*	(0.1277)
O	−	Social capital (fairness)	Main effect: waste of redistributable food (dummy)	0.7185**	(0.0968)			0.7151**	(0.0971)
B	−	Social capital (costs)	Frequency of teaching children to save money (c)	0.8071*	(0.1018)				
O	−	Social capital (society)	Main effect: negative influence on the youth (dummy)					0.5138***	(0.1007)
B	+	Organisational ability	Uses expired food to feed animals (dummy)	3.3046***	(1.1156)	2.8487*	(1.5588)	1.7408*	(0.5325)
B	+	Organisational ability	Usually throws away entire packages (dummy)			2.1546***	(0.4746)	2.0537***	(0.5067)
B	+	Organisational ability	Wastes because: buys too much once a week (dummy)	1.8266***	(0.3229)	1.6418***	(0.2483)	2.6553***	(0.4038)
B	+	Organisational ability	Wastes because: way home without fridge (dummy)			1.8663***	(0.2090)	1.9636***	(0.2328)
B	+	Organisational ability	Wastes because: wrong need calculation (dummy)	1.3543*	(0.2116)	1.4182**	(0.2341)	1.8082***	(0.2826)
B	+	Organisational ability	Wastes because: food has passed the date (dummy)	1.5794***	(0.2301)	1.2369*	(0.1552)	1.4568***	(0.1787)
B	+	Organisational ability	Frequency of shopping (a)					1.1586***	(0.0655)
B	−	Organisational ability	Wastes because: food got spoiled (dummy)			0.8282*	(0.0928)		
B	−	Organisational ability	Frequency of making a shopping list (e)			0.8228**	(0.0710)		
B	−	Organisational ability	Shopping: most often in supermarkets (dummy)	0.6950**	(0.0989)				
B	−	Organisational ability	Shopping: most often from producers (dummy)					0.6165*	(0.1719)
O	+	Organisational ability	Doesnt know her frequency of food waste (dummy)	6.4059***	(4.5538)				NA
O	−	Organisational ability	People should: cook the right quantity (d)	0.7984*	(0.0976)				
B	+	Org. ability (time)	Frequency of buying pre-cooked food (b)	1.1401***	(0.0457)	1.1363***	(0.0365)	1.1737***	(0.0443)
B	+	Org. ability (time)	Shopping: most often home delivery (dummy)	15.1022***	(15.4006)	5.5893**	(3.8010)	8.7473***	(3.6833)
B	+	Status (food security)	Wastes because: cooks too much food (dummy)	2.9951***	(0.4892)	2.7021***	(0.4521)	2.5966***	(0.3864)
B	+	Status (food security)	Very full fridge, things sometimes get bad (dummy)	1.9043***	(0.2470)	2.1003***	(0.2462)	2.4279***	(0.2990)
B	+	Status (food security)	Too full fridge, things often get bad (dummy)	1.9832***	(0.3310)	1.5094**	(0.2556)	2.2372***	(0.3578)
B	+	Status (food security)	Wastes because: buys too much food (dummy)	1.9321***	(0.4558)	1.6065**	(0.3215)	2.2118***	(0.5030)
B	+	Status (food security)	Wastes because: buys too big packages (dummy)	1.9891***	(0.4420)	1.7762***	(0.3912)	1.4374*	(0.2966)
B	+	Status (food security)	Wastes because: fears it is not enough (dummy)	1.6124**	(0.3518)	1.4899*	(0.3072)	1.6985***	(0.3424)
B	+	Status (spoiledness)	Throws away food past the expiry date (dummy)	2.5409***	(0.4610)	1.7141***	(0.2815)	2.1164***	(0.3995)
B	+	Status (spoiledness)	Usually throws away open packages (dummy)			2.2181***	(0.3587)	1.9924***	(0.3558)
B	+	Status (spoiledness)	Wastes because: does not like the food (dummy)			1.8377**	(0.4800)	2.1914***	(0.6104)
B	+	Status (spoiledness)	Wastes because: has a bad smell or taste (dummy)	1.3550**	(0.1936)			1.3714**	(0.1709)
O	+	Status (spoiledness)	People should: use doggy bags (dont know) (dummy)					1.7487**	(0.3815)
O	−	Status (spoiledness)	People should: reuse leftovers (d)			0.8087**	(0.0766)		
O	−	Status (spoiledness)	People should: use doggy bags (d)	0.7973**	(0.0697)				
O	−	Status (spoiledness)	People should: check expired food (d)	0.8199*	(0.0868)			0.7562***	(0.0682)
B	−	Status	Well-supplied fridge, easy to invite guests (dummy)	0.7526**	(0.1055)				
B	+	Status	Gives expired food as present (dummy)	5.9262***	(1.9758)	4.7073***	(1.6189)	2.5416***	(0.9005)
Observations				1.451		1.498		1.548	
Pseudo-R-sq.				0,180		0,161		0,214	

Notes: All regressions include as covariates: the age of the household head, its squared value, the household size, the level of education, the wealth conditions, the size of the municipality (logarithm), the perception of food waste and a dummy for the Province capitals. The odd ratios non-significant in the full models are in italics. B = behaviour; O = opinion; + = positive correlation; = negative correlation; (a) 1 = less than once a month; 7 = daily; (b) 1 = never; 8 = daily; (c) 1 = never; 4 = often; (d) 1 = totally disagree; 4 = totally agree; (e) 1 = never; 3 = always; (f) 1 = not useful at all; 10 = very useful.

sation reduces it. Organisational abilities refer to the implementation of consistent planning that results in less food waste (e.g. making a shopping list, shopping with the right frequency and, more in general, calculating correctly one's needs), or to the presence of valorisation opportunities (e.g. feeding animals), so that food is wasted only when unavoidable (i.e. because it got spoiled). Instead, time-concerned individuals save time at the expense of an optimal food consumption.

Third, the correlation between food waste and the behaviours theoretically driven by 'social capital' is less often significant, and more complex. As expected, monetary concerns show a negative correlation with food waste. Pro-environmental behaviours may result in food waste reduction but, surprisingly, also in heightened waste. This is the case of the purchase of seasonal products, which is probably driven by the desire to eat healthily or by the search for status, rather than by intrinsic social values. We call this dynamic the 'hipster factor'.

Opinions represent abstract desiderata or statements of principles implying no commitment, hence their correlation with one's real food waste is less reliable. Concerns for the impact of food waste on the environment and on resource distribution as well as the disapproval for spoiledness and overcooking are related to less food waste. Instead, the households who think that the purchase of fresh food from producers reduces food waste tend to waste more. Probably, this opinion represents a misunderstanding of the consequence of buying fresh food, which is more likely to get spoiled. Like the purchase of seasonal products, shopping from producers is probably driven by the desire of eating healthily or by the search for status. Finally, lacking an opinion on doggy bags and ignoring one's own frequency of food waste are related to heightened food waste, as they probably identify households with limited awareness. [15]

[15] This latter finding supports the choice to include dummies for the households answering 'I do not know' to any of the questions on opinions and behaviours.

Food-related behaviours and opinions and social capital

RESULT **4.** *Status seeing is negatively related to social capital, organisational abilities positively.*

As a fourth step, we assessed the correlation between relevant food-related behaviours and opinions, and social capital. We regressed each behaviour and opinion on each of the variables measuring social capital, for a total of 172 models. [16] In each model, we included the covariates for family and location characteristics mentioned previously, but not the covariate eliciting one's perception of the food waste problem. For the 30 behaviours and opinions described by dummies we used logistic models, for ordered categorical variables ordered logistic models.

[16] With a view to reducing complexity, we performed a principal component analysis on the 43 variables retained after the previous step, but we achieved no relevant reduction of the dimensions.

Table 5: Significant coefficients associated with social capital variables in the models linking food-related behaviours or opinions to social capital. Full model estimates are provided in Tables S9 (logistic models) and S10 (ordered logistic models) in Supplementary Information

Type	Category	Behaviour/opinion	Turnout pre-1990		Turnout post-1990		Blood donations		Organ donations	
B	Social capital (environment)	Freq. of buying non-seasonal food (c)	0,9909	(0.0069)	0,9918	(0.0089)	0,9605	(0.0235)	**0.9639***	(0.0204)
B	Social capital (environment)	Freq. of teaching children not to waste (c)	1.0060	(0.0067)	1.0079	(0.0089)	**1.0538****	(0.0271)	**1.0411***	(0.0238)
O	Social capital (environment)	People should: buy fresh food from producers (d)	**0.9765*****	(0.0067)	**0.9767*****	(0.0088)	**0.9282*****	(0.0250)	**0.9390*****	(0.0211)
O	Social capital (environment)	Main effect: waste of resources (dummy)	**1.0259*****	(0.0080)	**1.0362*****	(0.0104)	1.0300	(0.0292)	1.0279	(0.0258)
O	Social capital (fairness)	Main effect: waste of redistributable food (dummy)	0.9953	(0.0073)	0.9947	(0.0095)	**0.9516***	(0.0262)	0.9875	(0.0239)
B	Organisational ability	Freq. of making a shopping list (e)	**1.0128***	(0.0069)	1.0105	(0.0089)	1.0288	(0.0272)	**1.0539****	(0.0250)
B	Organisational ability	Freq. of shopping (a)	**0.9534*****	(0.0062)	**0.9497*****	(0.0079)	**0.8330*****	(0.0210)	**0.8647*****	(0.0187)
B	Organisational ability	Shopping: most often from producers (dummy)	**1.0379***	(0.0219)	**1.0471***	(0.0289)	1.0452	(0.0743)	1.0773	(0.0637)
B	Organisational ability	Wastes because: wrong need calculation (dummy)	0.9874	(0.0101)	0.9936	(0.0134)	**0.9044****	(0.0381)	0.9456	(0.0337)
B	Org. ability (time)	Freq. of buying pre-cooked food (b)	1.0061	(0.0061)	1.0095	(0.0081)	**1.0501****	(0.0241)	**1.0515*****	(0.0200)
B	Status (food security)	Wastes because: buys too big packages (dummy)	1.0026	(0.0128)	1.0110	(0.0169)	0.9875	(0.0517)	**0.9160***	(0.0412)
B	Status (food security)	Wastes because: cooks too much food (dummy)	**0.9792***	(0.0111)	0.9801	(0.0146)	0.9660	(0.0440)	0.9838	(0.0394)
B	Status (spoiledness)	Throws away food past the expiry date (dummy)	**0.9641*****	(0.0105)	**0.9448*****	(0.0134)	**0.9141***	(0.0423)	**0.9144****	(0.0379)
O	Status (spoiledness)	People should: check expired food (d)	**1.0147****	(0.0068)	**1.0203****	(0.0090)	1.0179	(0.0257)	1.0221	(0.0233)
O	Status (spoiledness)	People should: use doggy bags (d)	0.9986	(0.0065)	1.0041	(0.0084)	**1.0410***	(0.0251)	1.0147	(0.0209)
O	Status (spoiledness)	People should: use doggy bags (don't know) (dummy)	**0.9556*****	(0.0126)	**0.9532*****	(0.0166)	**0.9094***	(0.0505)	0.9301	(0.0464)

Notes: All regressions include as covariates: the age of the household head. its squared value, the household size, the level of education, the wealth conditions, the size of the municipality (logarithm) and a dummy for the Province capitals. B = behaviour; O = opinion; Significant odd ratios are in bold. (a) 1 = less than once a month; 7 = daily; (b) 1 = never; 8 = daily; (c) 1 = never; 4 = often; (d) 1 = totally disagree; 4 = totally agree; (e) 1 = never; 3 = always.

Table 5 reports the odd ratios associated to a unit change of social capital for the models for which the correlation proved to be significant. The direction of the correlation (odd ratios either above or below 1) is robust to the measure of social capital chosen. In line with our theoretical model, the behaviours and opinions eliciting the 'status effect' (overbuying, overcooking, being spoiled with respect to food) are negatively related with social capital, their absence positively. 'Organisational abilities' (making a shopping list, limiting the number of shopping trips, calculating one's need correctly) are also more prevalent where social capital is stronger. Some pro-environmental behaviours and opinions, like teaching children not to waste or linking food waste to the waste of resources, are positively related to social capital, but the relationship between this group of variables and social capital is more complex.

Reading the results of the previous steps jointly may help draw further conclusions on the complex relationship among social capital, food waste and food-related behaviours and opinions. As expected, most behaviours and opinions significantly correlated with social capital present also a relationship with food waste coherent with the hypothesis that higher social capital yield lower food waste.

Two behaviours are significantly related to all measures of social capital: shopping frequently, and throwing away food past its expiry date without checking it. Both are more common where social capital is low and are linked to heightened food waste. The *opinion* that one should buy fresh food from producers is also negatively related to all measures of social capital and positively related to the *quantity* and the *value* of food waste. This is an opinion, hence it does not imply a commitment to act, but its negative correlation with social capital supports our previous remark on misunderstanding the consequences of buying fresh food and, thus, the existence of an 'hipster factor' mediating pro-environmental behaviours. Interestingly, the *action* of buying from producers is correlated positively with social capital, and negatively with food waste frequency.

Almost all the behaviours and opinions related to at least one measure of social capital show a correlation with food waste coherent with our hypotheses. On the one hand, higher social capital yields a higher frequency of teaching children not to waste and of making a

shopping list which, in turn, yield lower food waste. A similar (positive) role is played by the opinions that food waste is primarily a waste of resources and that people should use doggy bags and check expired food products before throwing them away. On the other hand, lower social capital yields a higher frequency of buying non-seasonal food, and causes households to buy too big packages, cook too much and miscalculate their needs which, in turn, increase food waste. A similar (negative) role is played by 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 in all phases of food management, from purchasing to cooking. Further, organisational abilities are poorer where social capital is weak, leading to more food waste. Instead, environmental concerns are linked to lower food waste only when they are not driven by the search for status.

One behaviour and one opinion present an overall relationship non-consistent with our hypotheses. First, the purchase of pre-cooked food is positively related with both food waste and social capital. Probably, this happens because the Provinces with higher social capital are also richer and with increased economic activity. The higher opportunity cost of time induces more need for pre-cooked food and, thus, more waste, since the management of resulting leftovers is also time-consuming. This confirms the mediating role of income identified by Result 2. [17] Second, the opinion that the main effect of waste is the loss of redistributable food is negatively related with both food waste and social capital. This finding suggests that linking food waste to 'charity' (poverty alleviation through redistribution) – rather than to accountability towards one's society – *is* associated to lower individual waste but implies also a paternalistic approach typical of low-social-capital areas.

[17] As a robustness check, we run a nonparametric equality-of-median test after dividing the sample across the median GDP per capita at Province level (p-value = 0.039) and a regression of the frequency of buying pre-cooked food on the GDP per capita, including covariates for family and location characteristics. The GDP yielded a positive coefficient (p-value = 0.013).

5 Conclusions

Our work shows the existence of a complex relationship between social capital and decisions concerning the use of resources, even when these decisions are private and result from well-established routines, such as household food waste behaviour. In particular, social capital is associated with food waste behaviour among families in low- and middle-income positions. When these households belong to a community endowed with a high social capital, their food waste is lower, and *vice versa*. Instead, the relationship between social capital and food waste becomes non-significant among richer families. This result points to the role of budget constraint considerations in food waste decisions, with food waste having lower economic impact for richer families. Noteworthy, all 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 in itself, given its negative social externalities. Hence, food waste can be considered another (negative) measure of social capital, and *vice versa*.

Our empirical results are coherent with the indications of the simple theoretical model proposed, emphasising the multidimensional nature of the relationship between social capital and food waste. Behaviours and opinions eliciting the 'status effect' in relation to food are linked negatively to social capital, and positively to food waste. 'Organisational abilities' are stronger where social capital is higher, and yield lower food waste. Pro-environmental behaviours and opinions are also stronger where social capital is higher and lead to lower food waste, but only if they are not driven by status concerns. Such a framework suggests that the use of other social capital measures can help policymakers design better-targeted interventions to address the hard-to-measure phenomenon of food waste and, in general, resource waste.

Our results suggest also important policy implications. The interventions aimed at reducing food waste should be prioritised towards areas with weak social capital and low-income families, and should involve social rather than individual incentives. Indeed, while individual-level incentives would make reducing waste less salient, a social incentive leveraging social

capital would reduce the attractiveness of a high-waste behaviour.

Further, interventions should be tailored around the level of social capital of an area. Where social capital is *low*, policymakers should prioritize the diffusion of awareness, the provision of common resources, and the promotion of social responsibility. Indeed, enhanced community capital ('a feature of a society', Jackson 2017, p. 21) represents an enabling condition for waste prevention (e.g., social reward or sanctions). Awareness and educational initiatives might contribute to increase consciousness over the economic, environmental and social implications of food waste, while the promotion of the dialogue between the local community, firms, and other stakeholders of the food value chain could increase public interest towards the problem of food waste. Where social capital is *high*, policymakers can build on existing individual skills and social networks to stabilise the behaviours negatively related to food waste. They may introduce more advanced measures, such as partnerships and agreements among stakeholders of the food supply chain, or socially and environmentally responsible practices. High social capital communities represent an ideal setting for the promotion of social innovation initiatives addressing food waste, e.g. social supermarkets. Social innovations have socially-recognised goals, are focused on people, and are built on relationships; therefore, they represent a way to take advantage of social capital for overcoming resource over-availability and overuse (Habisch and Adaui 2013).

In areas with low social capital, low income implies individual uncertainty and a need to achieve legitimation *vis-à-vis* the members of one's close network which, in turn, lead to overbuying and overcooking. Instead, in higher social capital communities, a low-income condition does not generate status concerns because social legitimation comes from other aspects of social life, such as sharing post-materialist values and interests. Economic measures supporting individual incomes could reduce uncertainty, thus favouring the internalisation of social norms against food waste (Thøgersen 2006). However, such individual measures should be coupled with social incentives and suasive interventions (nudging) like those mentioned above, especially where social capital is low. Finally, it must be taken into account that the internalisation of virtuous social norms takes place only in the long-term.

A limitation of this work lies in the fact that food waste measures in the 'Waste Watcher' dataset are self-assessed; hence, they might be subject to misestimation, underestimation or underreporting for social desirability concerns. These biases are likely to be larger for food waste quantity and value, due to the difficulty of estimating one's own figures. We mitigate this issue by considering also food waste frequency (which is arguably easier to recall for most individuals), and by including the individual perception about the seriousness of the issue of food waste 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. Researchers could build on the results of this work to analyse waste dynamics within specific groups and across territories. In particular, they could enquire the causal relationship between social norms and food waste behaviour also by relying on panel datasets.

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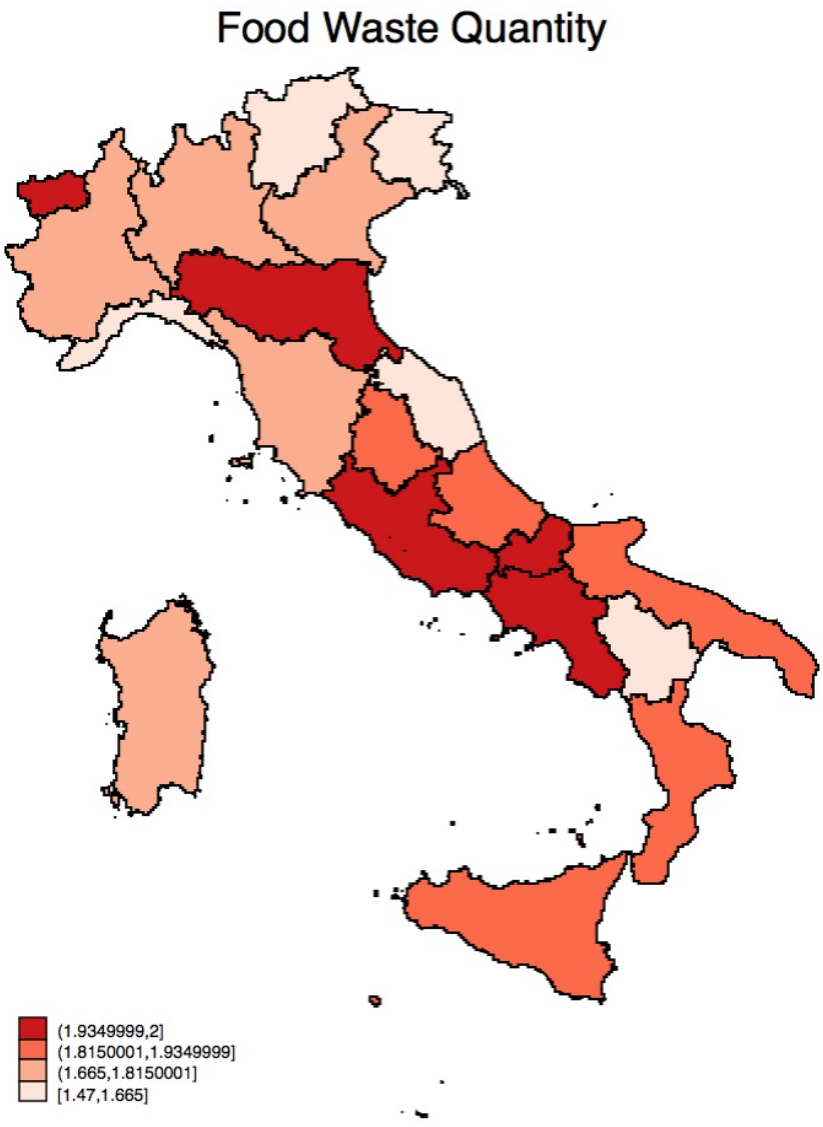
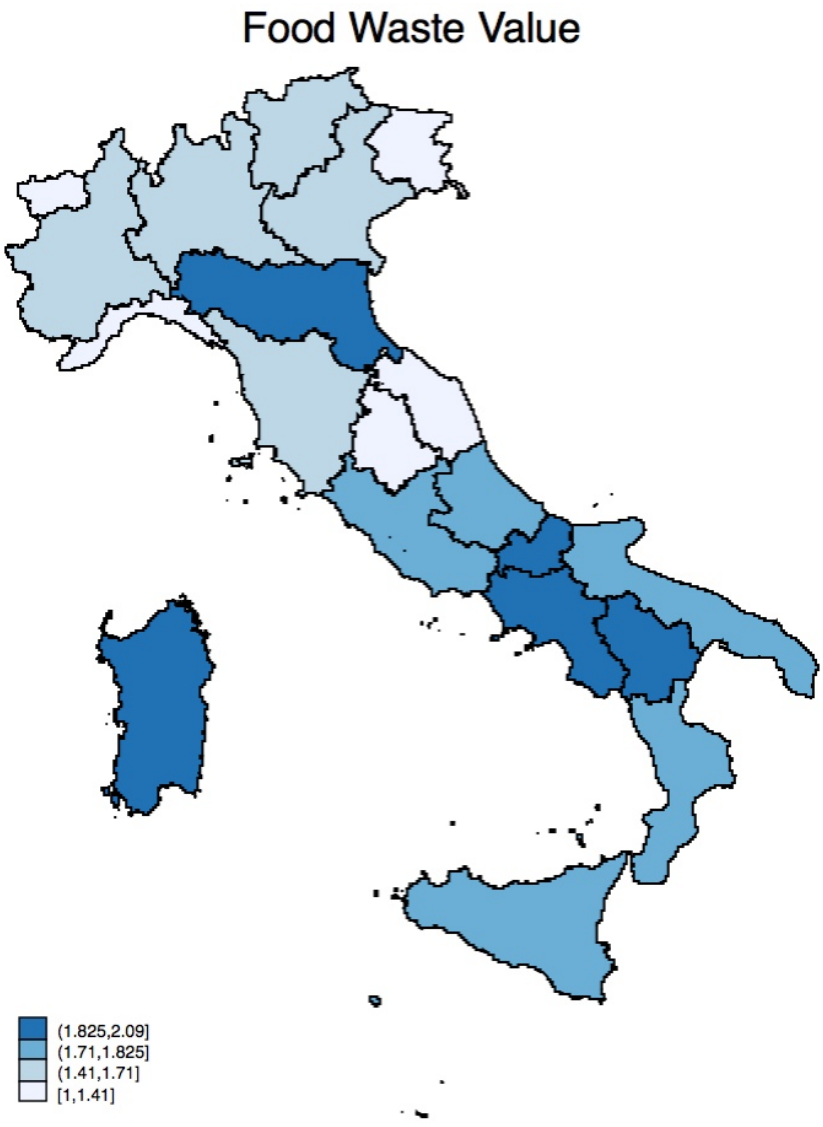
Food waste as a (negative) measure of social capital. A study across Italian Provinces

Supplementary Information

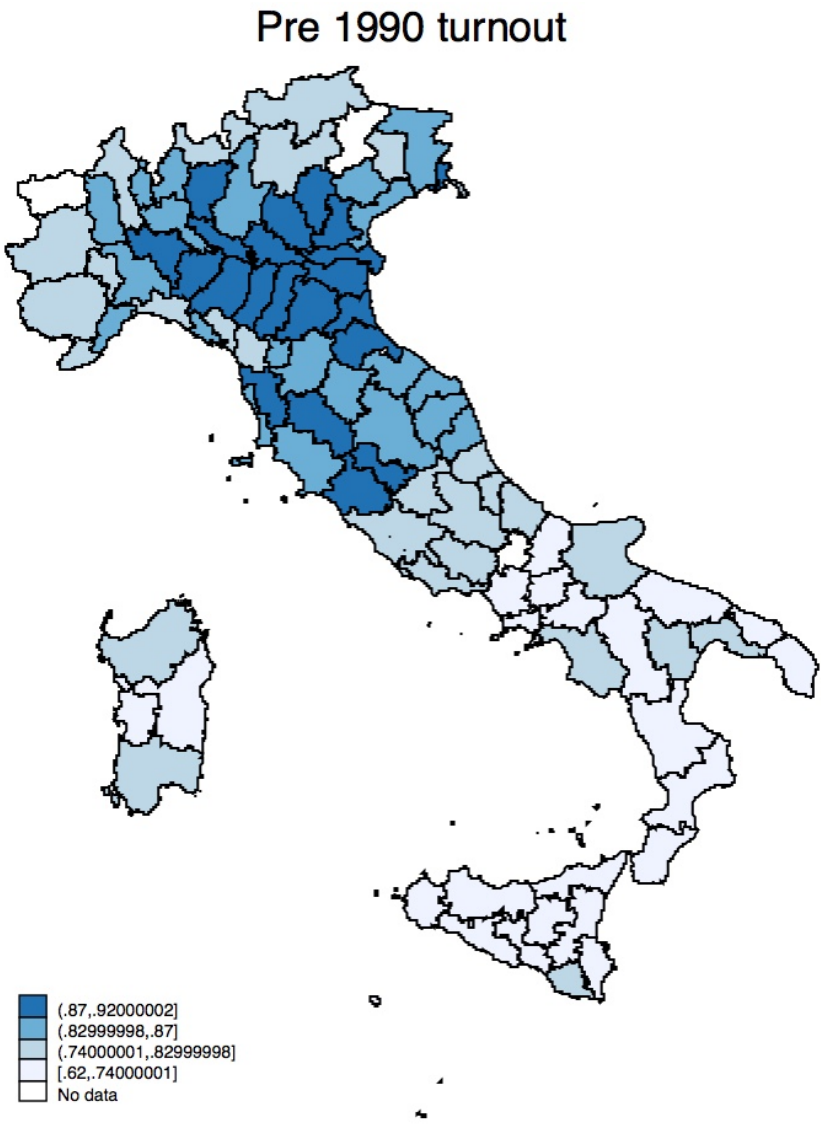
Map S1: Average frequency of wasting food (from 1 = 'almost never', to 9 = 'almost every day'), by Region. Data from Last Minute Market and SWG (2016).



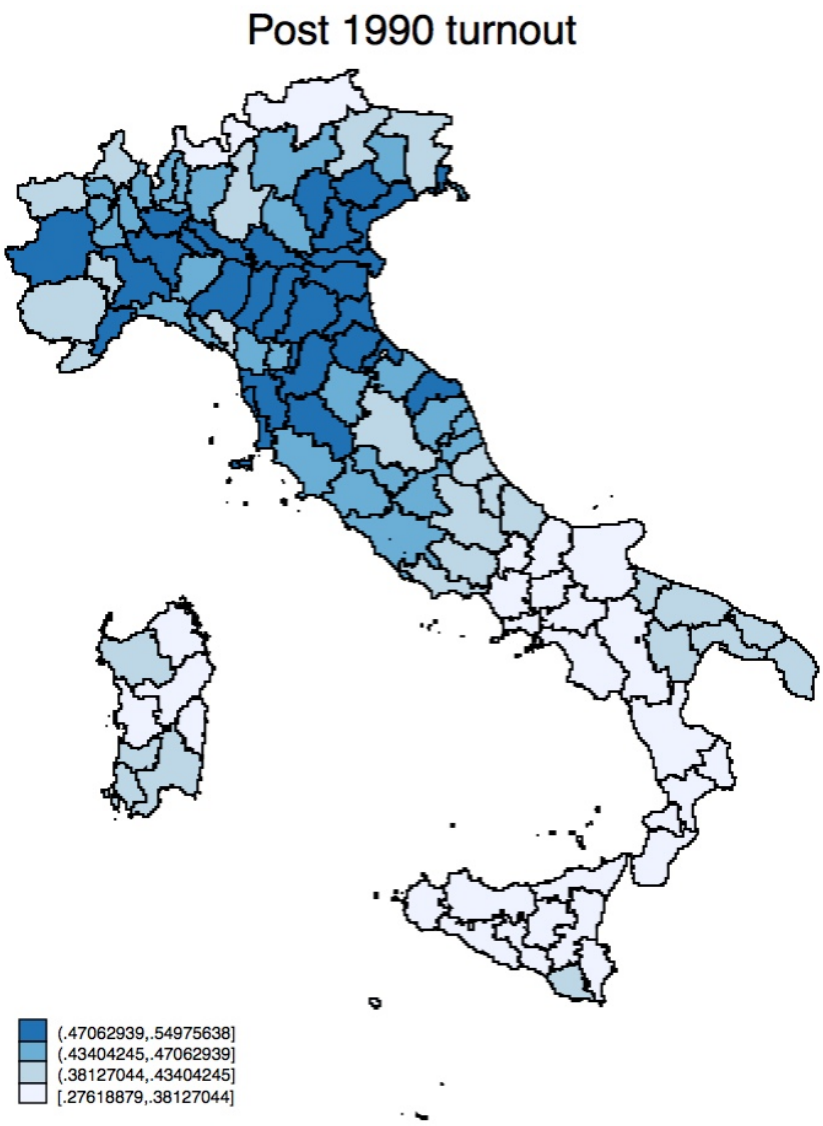
Map S2: Average weekly quantity of household food waste (from 1 = 'nothing', to 9 = 'more than 2 kg'), by Region. Data from Last Minute Market and SWG (2016).



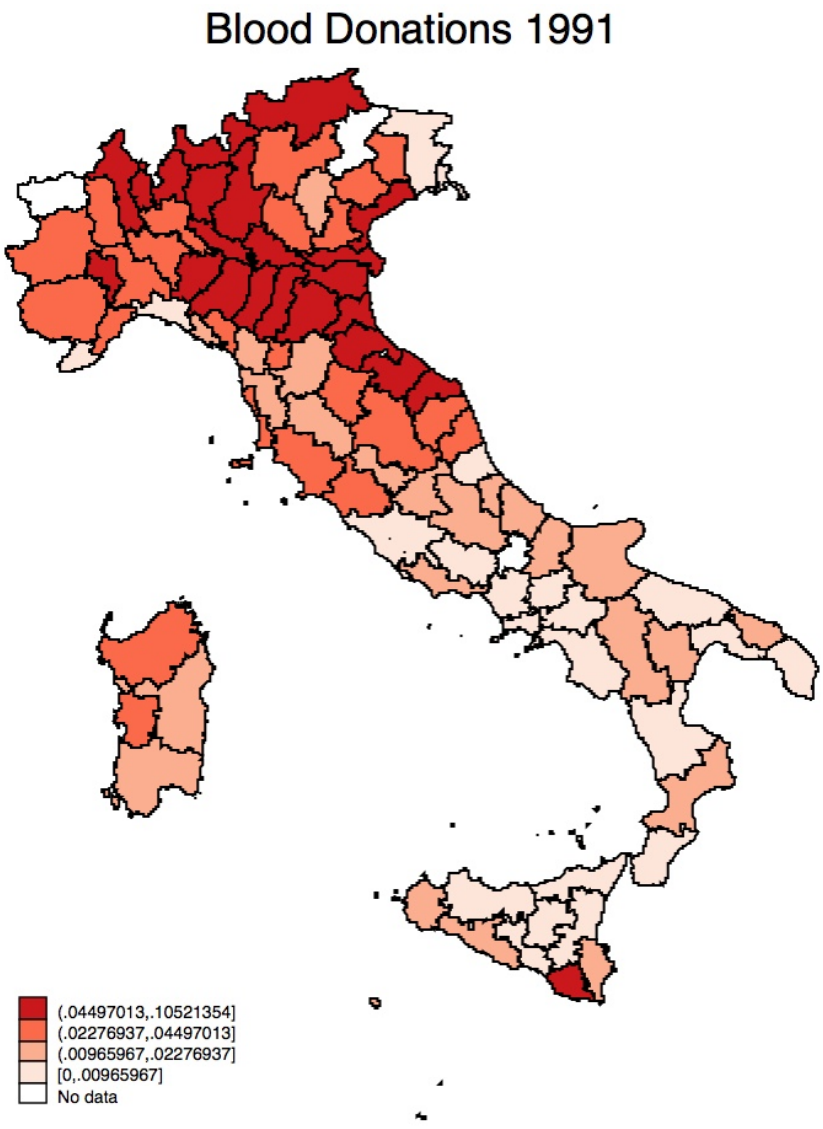
Map S3: Average weekly value of household food waste (from 1 = 'less than five Euros', to 9 = 'more than 60 Euros'), by Region. Data from Last Minute Market and SWG (2016).



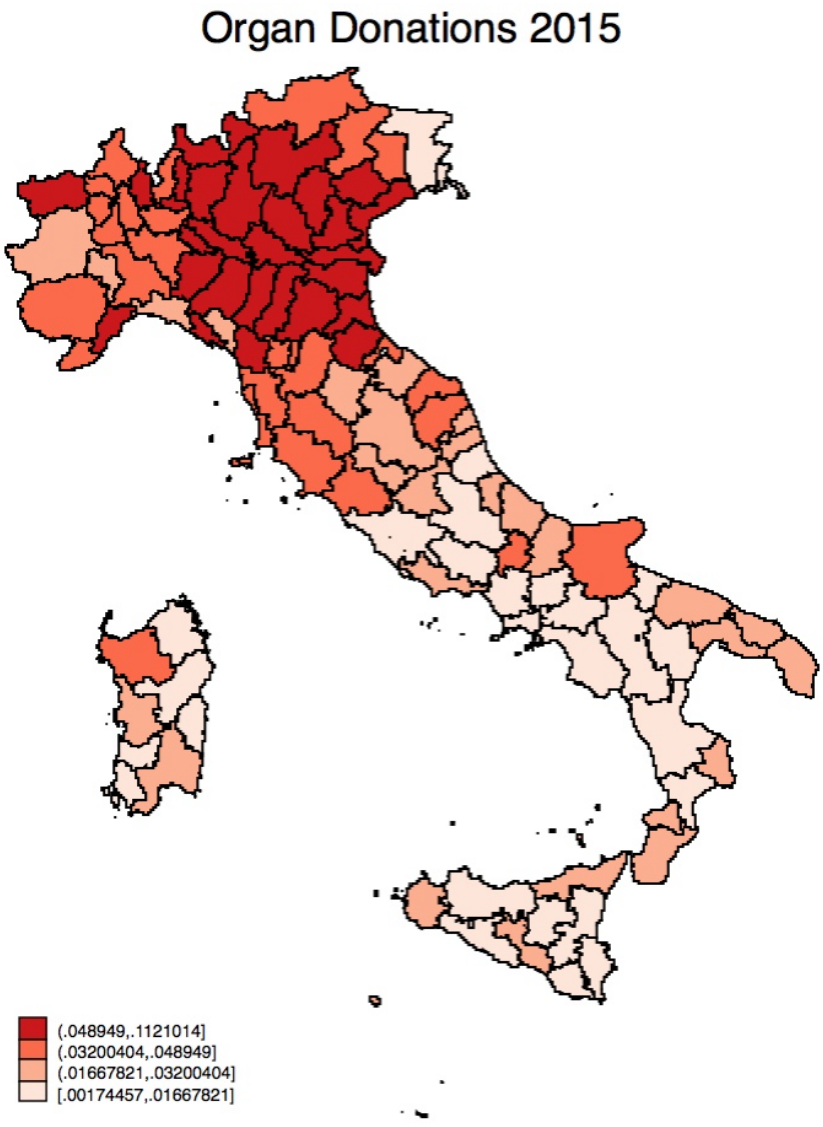
Map S4: Voter turnout in referenda between 1946 and 1987, by Province. Values are averaged across time. Data from Guiso et al. (2004)



Map S5: Voter turnout in referenda between 1990 and 2016, by Province. Values are averaged across time. Data from Ministero dell'Interno, Dipartimento per gli Affari Interni e Territoriali (2018)



Map S6: Blood donation (number of blood bags per million inhabitants) collected by AVIS (Italian association of blood donors) in 1995, by Province. Data from Guiso et al. (2004).



Map S7: Members of AIDO (Italian association of organ donors) per number of inhabitants (average in the period 2014-2016), by Province. Data provided by AIDO in 2017.

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