Italian consumers' income and food waste behavior

1. Introduction and theoretical background

One-third of the food produced globally is lost or wasted, which has negative environmental, economic, and social impacts on the overall food value chain and on society (Parfitt et al., 2010; FAO, 2011).

Although literature does not provide neither a shared definition of food waste nor consistent data on the related amount generated in the different phases of the food chain, also due to dissimilar methodologies (Garrone et al., 2014; Møller et al., 2014; Falasconi et al., 2015), the general consensus is that most waste is produced in the downstream stages in developed countries (FAO, 2011; Lipinski et al., 2013; Östergren, K. et al. 2014; Garrone et al., 2014). FAO (2011) estimates the quota of household food waste to be between 33% and 38% of the total. Consumers waste 19% of purchased food in UK (WRAP, 2013), 21% in the USA (Buzby et al., 2014) and 25% in Italy (Waste Watcher, 2014).

The level of household food waste reveals that individuals' related choices tend to diverge from the objective of maximizing the utility function, as the core economic theory states.

On the one hand, consumer's food waste behavior depends on the temporal sequence of the decisions (Read and van Leeuwen, 1998): current state and preferences influence the future choice to dispose food.

On the other hand, socio-economic circumstances, habits, emotions, culture and the variety of the food resources depict complex individuals' food and food waste behaviors (Quested et al., 2013; Parizeau et al., 2015).

According to the literature on behavioral economics, these elements imply that individuals can show time-inconsistency, can under/overweight the available information by resorting to a selecting attention (DellaVigna, 2009), and can be inclined to simplify the choice by using suboptimal heuristics (Lin et al., 2015).

It derives that individuals tend to reduce the complexity of their choices, and that nonstandard decision-making results to be directly influenced by his or her current situation.

With the purpose to understand how the individual's state affects the later choice to discard edible products, the work devotes special attention to the consumer's income condition and its relationship with food waste behavior.

Not only income level is a primary factor of consumers' food choices and of the linked and delayed household food waste behaviors (Brook Lyndhurst, 2007; WRAP, 2014), but also income inequalities suggest that the individuals' decisions deal with different degrees of complexity. Moreover, these dynamics are expected to take on even greater importance following the economic crisis and its impact on consumers' income in some EU countries, including Italy [1].

Nevertheless, the relationship between individual income and household food waste remains largely unexplored. The central claim of the study is to argue that this relation, far from being unique, leads to a differentiated set of behaviors.

Given this research hypothesis and considering the environmental implications of food waste (depletion of water, land, and biodiversity and emission of GHGs: Segrè et al., 2012, 2013; FAO, 2013), the study further analyzes whether, and under which auxiliary conditions, the "individual income–household food waste" function can be described by the environmental Kuznets curve

(EKC) and by the underlying elements of behavioral economics. In this regard, many studies show that the results on the relation between improving income conditions and reducing environmental impacts (Andreoni and Levinson, 2001; Plassmann and Khanna, 2006) do not share a theoretical grounding and indicate conflicting findings. In fact, critical contributions state that the uniqueness of the implied "poverty–pollution" hypothesis is not based on assumptions that are easily generalizable (Levinson, 2002; Stern, 2004, 2014).

Furthermore, they demonstrate that the derived "income–natural resource consumption" (EKC) functions often reveal a too rudimentary cause–effect relation (Galeotti, 2007; Choumert et al., 2013). Moreover, results frequently appear to be influenced by the weak consistency of the adopted methodologies owing to poorly representative case studies and samples (Dinda, 2004; Ma and Stern, 2006) and defective theoretical models.

With regard to this conceptual field, the analysis of the relations between consumers' per capita income and household food waste allows to consider these theoretical and methodological limitations, as well as detect possible anomalies in the EKC framework and/or define ancillary robustness conditions.

Furthermore, the complexity of elected subject gives the opportunity to extend the study to the overall (e.g., behavioral, social, cultural) factors describing the individual's current situation and jointly responsible for generating household food waste (WRAP, 2011; Evans, 2012; Secondi et al., 2015), and to consider both the diversity of individual profiles and behaviors, and the specificity of the wasted resources (five foodstuff typologies).

2. Research methodology

2.1 Sampling and data collection

This study analyzes data on household food waste in Italy, collected using the computer-aided web interviewing (CAWI) technique by the Waste Watcher observatory. The questionnaire was submitted in 2013, during the economic crisis, to a sample of 1,706 consumers. The sample was statistically representative of the Italian population by region of residence, gender, age, demographic categories, and standard of living. The final sample contained 1,403 usable responses. However, the sampling distributions of per capita income and the perception of monetary wealth were still significantly in line with the Italian official 2013 statistics on income conditions [1]. The cleaned data show that 63% of consumers in the southern regions and the 38% of those in the northern regions belong to the lower income bracket (i.e., earn less than 800 €/month). Moreover, 8.2% of the respondents living in the south of Italy and the 4.2% in the north are categorized as living in extreme poverty.

The research focuses on the frequency with which consumers generate food waste as the effect of their income position, food culture and behaviors. This attitudinal dependent/response variable measures the monthly occurrence (never, sometimes, often) of household food waste behaviors. Although the parameter does not quantify the discarded goods and is derived from respondents' self-evaluation, it depicts the major issues in terms of food waste behavior.

In order to consider the complexity of the relations among consumers' waste attitudes and different foods, the study identifies five product typologies (fresh bread, cheeses, yogurt, fresh vegetables, and fruits) and analyzes 20 explanatory variables (Table 1) to select and weigh their association with household waste food according to the following criteria: individual income conditions (per

capita income, monetary wealth perception), social status, food behaviors, and awareness (see Tables 2 to 6).
The food behavioral variables (frequency of purchase, preference for promotional offers, use of a shopping list, frequency of leftover waste) include also the following two (dichotomic) explanatory determinants of household food waste generation:
1) "food purchasing and preparation practices and behavior": excess of food purchase and/or preparation, aversion to risk of insufficient provision, misleading food labels (food behavior, quantitative causes);
and
2) "food storage practices and eating behavior": lack of food conservation skills, products having undesired organoleptic characteristics, food that tastes bad or lacks flavor, not eating leftovers (food behavior, qualitative causes).

2.2 Methodology

In order to identify consumers' income conditions and food behaviors that explain the frequency of household food waste and to measure their complex relations, the study implements specific regression analyses.
Proportional odds models (POMs) are developed and based on the intrinsic (latent and continuous) and extrinsic (ordinal and categorical) characteristics of the response variable (food waste frequency) (McCullagh, 1980; Agresti, 1999, 2010 pp. 44–87). POMs are cumulative logit models, and can be considered an extension of binary logistic systems. Their structure is based on the assumption of "proportionality among the odds".
This means that the logarithms of the odds form an arithmetic sequence, i.e. the value to be added to each of them to obtain the following one is always the same. In this study, if p_{nev}, p_{smt} and p_{oft} are the probabilities of wasting food "never", "sometimes" and "often" (the ordered categories of the dependent variable), the logarithms of the odds are $\log(\frac{p_{nev}}{p_{smt}+p_{oft}})$ for "never", and $\log(\frac{p_{nev}+p_{smt}}{p_{oft}})$ for "never" and "sometimes" (cumulated). The validity of the proportional odds assumption is of paramount importance for the fit of the models.
For each proposed POM (one for each of the five food typologies), a subset of covariates (explanatory variables) is selected by applying classical regression methodologies, such as stepwise procedures (*backward elimination*, *forward selection*, *stepwise regression*), and genetic algorithms (GAs). Stepwise procedures are characterized by different systems of algorithms that iteratively select explanatory variables until they reach statistical robustness and significance. Each model achieves different outputs in terms of the number and order of the selected variables (Derksen and Keselman, 1992).
According to Allison (2012) multicollinearity can safely be ignored:

> The variables with high VIFs (variance inflation factors) are indicator (dummy) variables that represent a categorical variable with three or more categories. If the proportion of cases in the reference category is small, the indicator variables will necessarily have high VIFs, even if the categorical variable is not associated with other variables in the regression model (Allison, 2012).

This approach offers the opportunity to attain comparable solutions among methodologies and among models, enabling the identification of models that best represent the complex relations

between food waste behavior and its determinants and to derive interpretive findings for product combinations. For the same reasons, POMs are developed also through GAs.

GAs use iterative and stochastic algorithms based on the principles of natural selection (Holland, 1975; Goldenberg, 1989) to examine a random sample of strings ("chromosomes"). Then, through heuristic procedures of selection, crossover, and mutation, they generate a new population. In this way, they explore the domain of possible solutions by optimizing a *fitness function*, which measures the quality of the statistical result.

For the purposes of this study, the GAs approach is implemented assuming an initial random population of 50 binary chromosomes, structured in 20 alleles that represent the covariates in the saturated model. The population of chromosomes is iterated for 100 generations through a one-point crossover with probability 0.8, a uniform mutation with probability 0.1, and with elitism set to 1. The Akaike information criterion (AIC) (Akaike, 1973) is adopted to measure the statistical quality of the models based on the stepwise procedures, as well as to estimate the fitness function in the GAs.

In order to prevent *overfitting* in the selection of the subsets of covariates, in a preliminary phase the sample is randomly split into two main sets: a training set (75% of the sample; 1,052 statistical units) and a test set (25%; 351 statistical units). First, the models on food waste frequency are developed based on the training set. Then, their performance is assessed using the test set and McFadden's pseudo-R^2 coefficient of determination (McFadden, 1978, p. 307; Louviere et al., 2000, p. 55).

Finally, the adherence of the models to the proportional odds assumption is tested. Considering the sparse nature of the analysed data, literature suggests a number of statistical validation methods [2], among which the goodness-of-fit test C_g, developed by Fagerland and Hosmer (2013) is adopted here. This approach adapts the Hosmer-Lemeshow test and, even if less powerful than the other tests, it allows detecting different types of lack of fit, including the violation of the proportionality assumption. In order to perform this test, first, to each observation is assigned a score given by the estimated probabilities; constants are equally-spaced integer weights, which reflect the proportional odds assumption. Second, all observations are partitioned into g groups, based on the value of their score (here, $g = 10$, "deciles of risk"). The test follows a χ^2 distribution with $(g-2)(j-1)+(j-2)$ degrees of freedom, where j is the number of categories of the dependent variable "frequency of food waste" (here, $j = 3$: never, sometimes, often). A (significant) p-value associated with the test C_g smaller than 0.05 implies a lack of fit and a violation of the proportional odds assumption, in which case the related model must be rejected. The five models reach p-values that range from 0.35 ("fresh bread") to 0.69 ("cheeses"), prove statistical significance and cohere with the initial assumption.

3. Findings

Findings reveal that almost all the respondents plan their purchases by preparing a shopping list (92%), and buy foodstuffs mainly when special offers are available (99%).

With regard to consumer awareness, the sample shows a high degree of ethical concern related to food waste (86%), as well as awareness of the environmental repercussions of food disposal (82%).

Similarly, the majority of respondents declared to pay general attention to household food waste issues according to their (self-assessed) orientation to limiting or avoiding waste behaviors [3].

Indeed, many claim not to waste certain products at all: 74% of the sample in the case of yogurt, 68% for fresh bread, and 66% for cheeses. A higher frequency of household food waste is observed for fresh vegetables (53%) and fruits (55%).

The main results on the determinants of consumers' waste behavior for each analyzed food typology are reported in Tables 2 to 6. The tables describe the methodologies adopted to select the explanatory variables (covariates), the respective AIC values, the model parameters of the control tests (C_{10} test values, McFadden's pseudo-R^2), and the odds ratios (exponents of the regression coefficients) [4].

Although the models all significantly represent the relations between food waste frequency and its drivers, some dissimilarities emerge among food typologies (e.g., higher levels for cheeses and fresh bread, lower levels for fresh vegetables and fruits), as shown by the McFadden pseudo-R^2 values.

Of the methodologies used to detect the waste behavior determinants, the stepwise procedures generate similar or identical results for the major part of the modeled food typologies. Furthermore, the implemented GAs confirm the solutions of the classic approaches, although show more significant findings for fruit waste frequency. In this case, the GAs include the variable "perception of monetary wealth" providing a richer set of explanatory variables and returning a model statistically more robust and coherent with the purposes of this study.

With regard to the main determinants of fresh bread waste behavior (Table 2), the odds ratios reveal that, ceteris paribus, consumers belonging to the mid-to-low income bracket (monthly per capita: € 800–1,400) show a limited attitude to waste when compared to the lower income bracket (less than € 800). In general, a higher per capita weekly food expenditure leads to a stronger propensity to waste fresh bread. The only exception to this general trend is within the lower income bracket, where two sub-clusters can be identified: individuals with a weekly food expenditure lower then € 25, and individuals who spend between € 25 and € 50. The first sub-cluster (less than € 25) waste more bread than do the second. Finally it appears that consumers in large household groups (4–6 members) waste fresh bread with a higher frequency than individuals living alone.

With regard to household waste of dairy products (cheeses and yogurt: Tables 3–4), ceteris paribus, food waste is more frequent in the mid-to-low levels of "perception of monetary wealth" (i.e., consumers who have difficulty making ends meet show a greater attitude to waste). Findings also show that "food purchasing and preparation practices and behavior" and "food storage practices and eating behavior" (see 2.1) are significantly related to cheeses waste.

The household fresh vegetables waste model (Table 5) reveals that consumers who usually buy local products tend to significantly limit (up to 90%) the frequency of wasting vegetables. This trend is coherent with the significant role played by both "food purchasing and preparation practices and behavior" and "food storage practices and eating behavior" in influencing the intensity of waste behavior. Furthermore, consumers perceiving monetary wealth difficulties show a higher propensity to waste fresh vegetables, particularly those who state that they occasionally have difficulties reaching payday.

Lastly, the POM developed to describe the relationship between covariates and household fruit waste (Table 6) shows that consumers whose monthly per capita income exceeds € 2,500 tend to waste fruits significantly more frequently than do individuals in the lower income bracket. This finding is consistent with the evidence offered by the perception of monetary wealth. Moreover, it emerges that fruit waste frequency is also related to quantitative and qualitative food behaviors.

4. Discussion

This study suggests a diversified set of relationships among consumers' income conditions, food choices and household food waste behaviors. The variety of detected factors, which include a range of economic and social conditions and the number of individual decisions related to the characteristics of the specific food typologies, in accordance with more recent studies (WRAP, 2011; Evans, 2012; Secondi et al., 2015), emphasize how complex and diversified the connections among food waste and its determinants can be.

In all the developed models, these linkages are centered on the explanatory variables "food purchasing and preparation practices and behavior" (food behavior, quantitative causes) and "food storage practices and eating behavior (food behavior, qualitative causes)." These variables identify consumers' decisions on purchasing, managing, and using foodstuffs.

Food behaviors emerge to be closely linked to waste behaviors (frequencies). Note that, on the one hand, respondents pay significant attention to the ethical and environmental implications of food waste. On the other hand, respondents clearly identify their role in generating household food waste. This apparent paradox underlines the knowledge and intentionality gaps between choices made upstream (food purchasing and using decisions) and actions downstream (frequency of household food waste).

Household food waste behavior is not only induced, but is also predefined by consumers' food decisions, which depend on needs (according to heuristic and risk aversion criteria). However, these decisions neglect the effects on waste.

Furthermore, the cognitive problem that influences consumers' behaviors supports the identification of the response variable as the "frequency" of household food waste. In fact, this dependent variable highlights consumers' actions rather than their quantitative effects, allowing analyzing the relations between individual decisions (food behavior) and the attitude to food waste (waste behavior).

Coherent with the objectives of this study, the models all emphasize how individual income/perception of monetary wealth affects consumers' attitude to food waste behavior through food purchasing and handling decisions. On the one hand, this reaffirms the centrality of the relation between food behavior and waste behavior. On the other hand, it highlights the complexity of the food waste domain, which implies the need to avoid generalized analysis approaches.

In this regard, some Authors (Parfitt et al., 2010; Segrè et al., 2014) suggest a connection between income and food waste without analyzing its nature or measuring its intensity, whereas Brook Lyndhurst (2007) shows that "high food wasters are more likely younger of lower social class".

Findings deepen this understanding by revealing a significant diversification of the relations between income levels and household waste behaviors according to the food typology. In particular, for the yogurt, cheeses, and fresh vegetable typologies, consumers in the mid-to-low income/monetary wealth brackets waste food more frequently than those in the lower and higher income brackets do. This appears to be the result of consumers' decisions to renounce specific qualitative elements and services of foodstuffs ("food storage practices and eating behavior") in favor of a relative compensatory increase in purchased quantities ("special offers," "food purchasing and preparation practices and behavior").

Thus, in a situation of budget constraints, consumers tend to replace high value added food (such as dairy products and pre-packed vegetables) with larger amount of products that belong to the same food typology, but with a reduced content of ancillary functions (e.g. pre-packed vegetables replaced by unpacked vegetable). This adaptation strategy (quantity vs. quality) affects the overall

chain of relations between consumers and food (food behavior) and the frequency of household food waste (waste behavior). Cheaper products can be bought in larger quantities (affecting food purchasing and preparation practices and behavior) but, in these circumstances, are often of reduced quality (affecting food storage practices and eating behavior).

In a food typology that includes high value added products, the relation between the level of individual income and the propensity to waste food can be described by an inverse U-shaped curve (the household Food Waste Kuznets Curve - FWKC).

In the case of food groups characterized by a lower value added, findings indicate different relations between per capita income/monetary wealth and waste behavior. In fact, the frequency of fresh bread waste is highest in the higher and lower income classes (an N-shaped pattern): a "dual" attitude that can again be ascribed to the conditioning of food behavior on waste behavior. On the one hand, individuals with low incomes tend to (at least) maintain their level of consumption of fresh bread (a foodstuff characterized by income inelasticity of demand and a high socio-cultural value), even if their income condition implies a reduction in quality. This choice leads to a higher frequency of food waste. On the other hand, consumers in higher income clusters have easier access to fresh bread. This, combined with a greater tendency to dine out, produces a surplus in food availability and, thus, more frequent waste. Furthermore, consumers in extreme poverty (i.e., income < € 800 and weekly food expenditure < € 25) show a very limited tendency to waste fresh bread.

Lastly, findings show a specific configuration of the relation between income and the frequency of household fruit waste. Here, a higher income class tends to mean an increase in waste.

5. Conclusions

The search for the determinants of household food waste reveals a large set of drivers, including consumers' income/monetary wealth condition and their food behaviors.

Contrary to what one may believe, greater per capita income/monetary wealth relates to a stronger attitude to waste behavior for certain food typologies only. Results show this is significantly the case for product types that do not incorporate services, such as unpacked fruits (Pagani et al., 2015), for which the tendency to waste increases with consumers' income levels.

This kind of relationship does not apply to foodstuffs characterized by a lower income elasticity of demand and distinctive cultural significance (e.g., bread). In this case, findings show that waste behavior is more common for consumers that belong not only to high but also to low per capita income brackets, thus revealing a polarized relation between income and household food waste frequency.

In contrast, when individual income is associated with household waste frequency in high value added food typologies, a stronger incidence of waste behavior is observed in the mid-to-low income/monetary wealth bracket. This is particularly true for dairy products (yogurt and cheeses) and pre-packed vegetables.

This specific relation between the explanatory variable (individual income) and response variable (waste frequency) describes a household FWKC, and highlights two ancillary conditions required to configure this function in a food waste framework: 1) food typologies that include high value added resources; and 2) waste behavior (frequency) greatly affected by consumers' risk averse food choices (food behavior).

Although statistically significant, it is important to consider that the results are derived from respondents' self-assessments and cross-section analyses. Nevertheless, the identification of the FWKC suggests that a prolonged economic crisis, and the consequent growth of the mid-to-low income classes, can generate household food waste.

Therefore, an increase in income inequality and relative poverty can worsen economic disparities because of the higher propensity of consumers in weak conditions to waste food waste ("regressive effect").

Furthermore, while confirming the complex and non-unique relationship between individual income, food behaviors, and household food waste, when high value added food typologies are taken into exam a reduction in consumers' income will affect the following:

1) consumers' food purchasing and preparation practices and behavior: with a reduced budget, consumers tend to buy cheaper products that can be bought in larger quantities, but that can potentially lead to an inflating effect (excess purchases to ensure provision). This is suggesting the need for policy and commercial strategies that are recognizing the value of food including its nutritional, social and environmental implications. On the other hand there is also a clear call for consumers' awareness and education;

2) consumers' eating behavior: cheaper products are often related to reduced quality (i.e. nutritional characteristics, product life), which might increase the amount of wasted food owing to its taste, flavor, or organoleptic attributes. This is also suggesting the need for consumers' awareness and education and, in addition, that organizational and technological solutions aimed at improving the performances of the involved supply chains should explicitly address food waste since their design and conception.

More generally, on the one hand, results identify a large range of factors that contribute to household food waste. These factors require an adequate and diversified set of strategies, including research, investment support, technological and organizational innovation, income equalization, and consumers training. On the other hand, results highlight the need for further research based on appropriate time series to detect causal relationships and on analyses of larger sets of food typologies, social contexts, and consumers' food behaviors.

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Table 1–Investigated determinants of consumer' household waste behavior

COVARIATE	DUMMY
RESIDENCE AREA	Northwest/Northeast/Centre/South/Islands
AWARENESS OF ENVIRONMENTAL ISSUES	From 1 to 10.
FREQUENCY OF PURCHASE (FRESH BREAD, FRESH FRUIT, FRESH VEGETABLES, CHEESES, YOGURT)	Daily/Every 2 days/2-3 times per week/Weekly/Biweekly/Monthly/Occasionally/Never
PURCHASE FREQUENCY OF NOT-SEASONAL PRODUCTS	Often/Sometimes/Rarely/Never
PURCHASE FREQUENCY OF NOT-LOCAL PRODUCTS	Often/Sometimes/Rarely/Never
WEEKLY PER-CAPITA FOOD EXPENDITURE	Less than 25 €/From 25 to 50 €/From 50 to 75 €/More than 75 €
USE OF SHOPPING LIST	Often/Sometimes/Rarely
TAKE ADVANTAGE OF SPECIAL OFFERS	Often/Sometimes/Rarely
FREQUENCY OF LEFTOVER FOOD WASTE	Nearly every day/3-4 times a week/1-2 times a week/Less than once a week/Rarely
FOOD BEHAVIOR - QUANTITATIVE CAUSES (excess of food purchase or preparation/aversion to risk of insufficient provision/misleading food labels)	Yes/No
FOOD BEHAVIOR - QUALITATIVE CAUSES (lack of food conservation skills/products having undesired organoleptic characteristics/food that tastes bad or lacks flavor/not eating leftovers)	Yes/No
FOOD WASTED DAILY	Much/Rather/Not much
READING OF EXPIRATION DATE	Often/Sometimes/Rarely
AWARENESS OF ETHICAL ISSUES	Strongly agree/Tend to agree/Tend to disagree/Strongly disagree
FOOD WASTE CAUSES ENVIRONMENTAL IMPACTS	Strongly agree/Tend to agree/Tend to disagree/Strongly disagree
PERCEPTION OF MONETARY WEALTH	Feeling poor/Many difficulties/Some difficulties/Safely
EDUCATIONAL QUALIFICATION	Primary-Middle-High school diploma/Undergraduate/Bachelor's-Master Degree/PhD
PROFESSIONAL POSITION	Employed/Seeking employment/Housewife/Student/Working student
MEMBERS OF HOUSEHOLD GROUP	Living alone/2-3/4-6/More than 6
MONTHLY PER-CAPITA INCOME	Less than 800 €/From 800 to 1,400 €/From 1,400 to 2,500 €/Over 2,500 €

Table 2–Model *"Fresh bread:"* Determinants of consumers' household waste behavior (year 2013)

Selected covariates	Odds ratios (CI 95%)	qualitative explanatory variables	
		dummy	vs. dummy reference
FREQUENCY OF PURCHASE: FRESH BREAD	*1.05* (0.71–1.55)	every 2 days	**vs.** daily
	1.10 (0.74–1.62)	2/3 times per week	
	1.12 (0.73–1.69)	weekly	
	1.47 (0.57–3.53)	biweekly	
	0.59 (0.12–2.16)	monthly	
	0.69 (0.34–1.34)	occasionally	
	0.06 (0. 01–0.31)	never	
WEEKLY PER-CAPITA FOOD EXPENDITURE	***1.75*** (1.11–2.78)	from 25 to 50 €	**vs.** less than 25 €
	1.62 (0.98–2.71)	from 50 to 75 €	
	2.35 (1.19–4.59)	more than 75 €	
USE OF SHOPPING LIST	***0.59*** (0.36–0.96)	yes	**vs.** no
AWARENESS OF ENVIRONMENTAL ISSUES	***0.92*** (0.86–0.99)		
FREQUENCY OF LEFTOVER FOOD WASTE	*0.87* (0.26–2.99)	3/4 times a week	**vs.** nearly every day
	1.09 (0.34–3.56)	1/2 times a week	
	0.64 (0.21–2.02)	less than once a week	
	0.31 (0.10–0.98)	rarely	
FOOD BEHAVIOR - QUANTITATIVE CAUSES	***1.77*** (1.30–2.39)	yes	**vs.** no
FOOD BEHAVIOR - QUALITATIVE CAUSES	*1.43* (0.98–2.09)	yes	**vs.** no
AWARENESS OF ETHICAL ISSUES	***1.51*** (1.11–2.04)	tend to agree	**vs.** strongly agree
	1.28 (0.77–2.08)	tend to disagree	
	1.91 (0.91–3.86)	strongly disagree	
MONTHLY PER-CAPITA INCOME	***0.65*** (0.46–0.91)	from 800 to 1,400 €	**vs.** less than 800 €
	0.85 (0.57–1.26)	from 1,400 to 2,500 €	
	1.08 (0.46–2.41)	over 2,500 €	
MEMBERS OF HOUSEHOLD GROUP	*1.12* (0.65–1.96)	2–3	**vs.** living alone
	1.96 (1.05–3.71)	4–6	
	0.17 (0.01–1.13)	more than 6	

(Intercepts: never | sometimes: value = 0.17; std. error = 0.80; sometimes | often: value = 2.92; std. error = 0.81)

AIC = 1471.69; $Pseudo - R^2\ McFadden$ = 0.188; C_{10} = 18.62; *p-value* = 0.35.

Odds ratio parameters in bold are statistically significant at the 5% level.

Methodology: Forward selection, stepwise regression, and genetic algorithms.

Table 3–Model "*Cheeses:*" Determinants of consumers' household waste behavior (year 2013)

Selected covariates	Odds ratios (CI 95%)	qualitative explanatory variables	
		dummy	vs. dummy reference
FREQUENCY OF PURCHASE: CHEESES	*0.64* (0.15–3.15)	every 2 days	**vs.** daily
	1.13 (0.29–5.16)	2/3 times per week	
	1.43 (0.38–6.46)	weekly	
	1.52 (0.39–6.98)	biweekly	
	0.64 (0.14–3.21)	monthly	
	0.67 (0.12–3.91)	occasionally	
	0.00 $(-\infty - 0.00)$	never	
TAKE ADVANTAGE OF SPECIAL OFFERS	*1.02* (0.67–1.52)	sometimes	**vs.** often
	0.11 (0.01–0.61)	rarely	
AWARENESS OF ENVIRONMENTAL ISSUES	***0.90*** (0.84–0.97)		
FREQUENCY OF LEFTOVER FOOD WASTE	*1.50* (0.44–5.19)	3/4 times a week	**vs.** nearly every day
	1.29 (0.40–4.26)	1/2 times a week	
	0.62 (0.20–1.98)	less than once a week	
	0.19 (0.06–0.59)	rarely	
FOOD BEHAVIOR - QUANTITATIVE CAUSES	***1.86*** (1.37–2.51)	yes	**vs.** no
FOOD BEHAVIOR - QUALITATIVE CAUSES	***1.60*** (1.09–2.39)	yes	**vs.** no
PERCEPTION OF MONETARY WEALTH	***3.32*** (1.60–7.26)	many difficulties	**vs.** feeling poor
	2.44 (1.25–5.07)	some difficulties	
	2.54 (1.30–5.30)	safely	
FOOD WASTE CAUSES ENVIRONMENTAL IMPACTS	*0.86* (0.62–1.21)	tend to agree	**vs.** strongly agree
	1.38 (0.89–2.14)	tend to disagree	
	1.31 (0.42–3.98)	strongly disagree	

(Intercepts: never | sometimes: value = 0.64; std. error = 1.00; sometimes | often: value = 1.02; std. error = 1.02)

AIC = 1385.80; $Pseudo - R^2\ McFadden$ = 0.191; C_{10} = 13.60; *p-value* = 0.69.

Odds ratio parameters in bold are statistically significant at the 5% level.

Methodology: Backward elimination, forward selection, stepwise regression, and genetic algorithms.

Table 4–Model **"***Yogurt:"* Determinants of consumers' household waste behavior (year 2013)

Selected covariates	Odds ratios (CI 95%)	qualitative explanatory variables	
		dummy	**vs. dummy reference**
FOOD WASTE CAUSES ENVIRONMENTAL IMPACTS	***1.61*** (1.13–2.34)	tend to agree	**vs.** strongly agree
	1.91 (1.22–3.00)	tend to disagree	
	4.57 (1.40–13.83)	strongly disagree	
TAKE ADVANTAGE OF SPECIAL OFFERS	*0.90* (0.57–1.39)	sometimes	**vs.** often
	0.00 (−∞–0.00)	rarely	
FREQUENCY OF LEFTOVER FOOD WASTE	*2.36* (0.71–8.25)	3/4 times a week	**vs.** nearly every day
	0.94 (0.29–3.13)	1/2 times a week	
	0.30 (0.09–0.98)	less than once a week	
	0.18 (0.06–0.59)	rarely	
FOOD BEHAVIOR - QUANTITATIVE CAUSES	***2.02*** (1.46–2.79)	yes	**vs.** no
FOOD BEHAVIOR - QUALITATIVE CAUSES	***1.73*** (1.16–2.64)	yes	**vs.** no
PERCEPTION OF MONETARY WEALTH	***3.13*** (1.40–7.55)	many difficulties	**vs.** feeling poor
	2.35 (1.12–5.40)	some difficulties	
	2.34 (1.11–5.39)	safely	
MEMBERS OF HOUSEHOLD GROUP	*0.93* (0.55–1.66)	2–3	**vs.** living alone
	1.97 (1.13–3.54)	4–6	
	2.01 (0.47–8.09)	more than 6	

(Intercepts: never | sometimes: value = 2.01; std. error = 0.73; sometimes | often: value = 4.60; std. error = 0.61)

AIC = 1281.04; $Pseudo - R^2\ McFadden$ = 0.123; C_{10} = 14.14; *p-value* = 0.66.

Odds ratio parameters in bold are statistically significant at the 5% level.

Methodology: Backward elimination, forward selection, stepwise regression, and genetic algorithms.

Table 5–Model *"Fresh vegetables:"* Determinants of consumers' household waste behavior (year 2013)

Selected covariates	Odds ratios (CI 95%)	qualitative explanatory variables	
		dummy	**vs. dummy reference**
PURCHASE FREQUENCY OF NOT-LOCAL PRODUCTS	*0.80* (0.46–1.39)	sometimes	**vs** often
	0.58 (0.33–1.01)	rarely	
	0.61 (0.29–1.26)	never	
AWARENESS OF ETHICAL ISSUES	*1.16* (0.87–1.55)	tend to agree	**vs.** strongly agree
	2.12 (1.45–3.11)	tend to disagree	
	1.23 (0.41–3.63)	strongly disagree	
FREQUENCY OF LEFTOVER FOOD WASTE	*0.81* (0.21–3.01)	3/4 times a week	**vs.** nearly every day
	1.14 (0.32–3.98)	1/2 times a week	
	0.40 (0.12–1.35)	less than once a week	
	0.22 (0.06–0.72)	rarely	
FOOD BEHAVIOR - QUANTITATIVE CAUSES	***1.65*** (1.24–2.18)	yes	**vs.** no
FOOD BEHAVIOR - QUALITATIVE CAUSES	***2.20*** (1.57–3.12)	yes	**vs.** no
PERCEPTION OF MONETARY WEALTH	*1.12* (0.61–2.07)	many difficulties	**vs.** feeling poor
	1.66 (0.96–2.89)	some difficulties	
	1.27 (0.73–2.24)	safely	
RESIDENCE AREA	*1.44* (0.99–2.09)	northeast	**vs.** northwest
	0.85 (0.59–1.22)	center	
	0.86 (0.60–1.24)	south	
	0.86 (0.56–1.32)	islands	

(Intercepts: never | sometimes: value = -0.38; std. error = 0.71; sometimes | often: value = 3.01; std. error = 0.72)

AIC = 1696.08; $Pseudo - R^2\ McFadden$ = 0.121; C_{10} = 13.87; *p-value* = 0.68

Odds ratio parameters in bold are statistically significant at the 5% level.

The underlined parameters odds ratios are statistically significant at the 10% level.

Methodology: Backward elimination, forward selection, stepwise regression, and genetic algorithms.

Table 6–Model "*Fruit:"* Determinants of consumers' household waste behavior (year 2013)

Selected covariates	Odds ratios (CI 95%)	qualitative explanatory variables	
		dummy	vs. dummy reference
PURCHASE FREQUENCY OF NOT-SEASONAL PRODUCTS	*1.27* (0.71–2.26)	sometimes	**vs.** often
	0.87 (0.49–1.55)	rarely	
	1.26 (0.61–2.60)	never	
FREQUENCY OF LEFTOVER FOOD WASTE	*1.21* (0.30–4.72)	3/4 times a week	**vs.** nearly every day
	1.33 (0.35–4.95)	1/2 times a week	
	0.67 (0.18–2.37)	less than once a week	
	0.22 (0.06–0.79)	rarely	
FOOD BEHAVIOR - QUANTITATIVE CAUSES	***1.74*** (1.31–2.32)	yes	**vs.** no
FOOD BEHAVIOR - QUALITATIVE CAUSES	***2.11*** (1.50–2.99)	yes	**vs.** no
MONTHLY PER-CAPITA INCOME	*1.19* (0.87–1.62)	from 800 to 1,400 €	**vs.** less than 800 €
	1.34 (0.94–1.91)	from 1,400 to 2,500 €	
	2.63 (1.24–5.63)	over 2,500 €	
PERCEPTION OF MONETARY WEALTH	*1.50* (0.80–2.81)	many difficulties	**vs.** feeling poor
	1.94 (1.10–3.48)	some difficulties	
	1.81 (1.01–3.27)	safely	
WEEKLY PER-CAPITA FOOD EXPENDITURE	*0.99* (0.67–1.45)	from 25 to 50 €	**vs.** less than 25 €
	0.67 (0.45–1.00)	from 50 to 75 €	
	0.65 (0.36–1.18)	more than 75 €	
(Intercepts: never | sometimes: value = 0.14; std. error = 0.74; sometimes | often: value = 3.64; std. error = 0.76)			
AIC = 1667.67; $Pseudo - R^2\ McFadden$ = 0.092; C_{10} = 15.01; *p-value* = 0.59			
Odds ratio parameters in bold are statistically significant at the 5% level.			
Methodology: Genetic algorithms.			

Notes:

[1] The Italian National Institute of Statistics (ISTAT) rates as absolute poor the 9.9% of the Italian population (14.8% in the south), and as relatively poor the 16.6% (2013).

[2] The test developed by Pulkstenis and Robinson (2004) is used for assessing the goodness-of-fit for models that include both discrete and continuous covariates; since here the covariates are mainly categorical, the approach cannot be adopted. As for the goodness-of-fit test proposed by Lipsitz et al. (1996), although based on the Hosmer–Lemeshow approach (Hosmer and Lemeshow, 1980), it doesn't provide any contingency table of the observed and estimated frequencies, and it's unsuitable for the verification of the elected assumption.

[3] The relation between "food waste awareness" and "monthly frequency of household food waste" shows a statistical significance level of 5%, and 10% in the case of the "fresh bread" and "yogurt" typologies (fresh bread: *X-squared = 5.49, df = 2, p-value = 0.06;* cheeses*: X-squared = 16.08, df = 2, p-value =< 0.001;* yogurt*: X-squared = 5.60, df = 2, p-value = 0.06;* fresh vegetables*: X-squared = 18.63, df = 2, p-value =< 0.001;* fruits*: X-squared = 8.69, df = 2, p-value = 0.013*).

[4] An odds ratio values less than one indicates that the associated class of explanatory variable shows a frequency of household food waste that is lower than that of the class adopted as a (dummy) reference.