

Article

Investigating Consumers' Perception of Discounted Suboptimal Products at Retail Stores

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Abstract: Following the increasing pressure to reduce food waste at supermarkets, many retailers are starting initiatives to prevent the disposal of food items or to manage the waste produced in a more sustainable way. The practice of applying discounts on close-to-date and other suboptimal products is becoming popular, as reducing price pushes consumers to accept small defects of food products. Here, the attitude of 218 supermarket customers towards these discounts is analysed, basing on a questionnaire survey. Two-thirds of the sample declare to be interested in discounts on close-to-date products; the determinants of this interest are studied through a Generalized Maximum Entropy model against a set of socio-demographic and behavioral factors. Results suggest that the interest towards discounts on close-to-date product is primarily driven by a general attitude to save money in food shopping. However, an interesting positive effect is observed for the use of a shopping list at the supermarket, which may be linked to a greater attention on food planning and, consequently, to a lower production of food waste at home. In conclusion, date-based pricing seems to be an effective strategy to address food waste reduction in a sustainable management perspective, for its attractive capacity on different profiles of consumers.

Keywords: food waste; suboptimal products; close-to-date products; discounts; date-based pricing; supermarket; sustainable retail management; in-store waste; Generalized Maximum Entropy model

1. Introduction

Producing food is one of the human activities that has a higher impact on the environment. In the EU-28, food production processes generated 470.6 million tons of CO₂ equivalent in 2012, corresponding to about 10% of total greenhouse gas emissions [1]. About one-third of the food globally produced is not actually consumed as it gets lost in the first stages of the supply chains, or wasted during commercialization and consumption [2]. This exerts a huge impact on the global environment, as scarce natural resources are used to produce foods that will never get consumed [3]. For this reason, food losses and waste are commonly considered one of the main challenges to the sustainability of food systems [4]. A specific objective to “halve per capita global food waste at the retail and consumer level by 2030” has also been set among the Sustainable Development Goals [5], calling nations and supply chain actors to make a great effort in the prevention and reduction of food losses and waste. In the EU-28, it has been estimated that about 87 million tons of food waste are produced every year [6], out of which more than a half is at the household level.

Retailers are estimated to produce about 5% of the total food waste generated along the supply chain [6]. Albeit this amount seems little, it encompasses 4.4 million tons of food in Europe alone [7]. Although these figures are about tenfold lower than the food waste produced at the household level, retailers are considered key players in the design and implementation of strategies against food waste.

Indeed, besides their interest in reducing food waste to save money, they can influence the purchasing and consumption habits of their customers [8,9].

In retail stores, food waste is generated for several reasons, spanning from technical failures, weak storage methods, overstocking and un-purchased foods due to difficulty in determining sales volumes [10], to spoiled packaging [4], or damaged, crooked and wrong sized products [2,10].

A meaningful share of the products wasted at supermarkets is likely to be perfectly edible when removed from the shelves [8]. These products are often referred as “suboptimal”, to indicate that they deviate from the standard products because of [11]: (i) aesthetical imperfections; (ii) approaching of the expiration (or best before) date; (iii) broken or defective packaging. However, they retain all their intrinsic quality cues and they are still safe for human consumption [12].

Current research on consumer acceptance of suboptimal products suggests that their attitude towards these products is generally negative [11]. In one paper [13] an eye tracking technique was used to measure consumers’ attention to pictures of apples with and without defects, showing that “ugly” apples attracted more attention but were chosen by only 15% of the participants. In general, “ugly” fruits and vegetables are more easily accepted when they show light defects [14], while they tend to be refused when located next to optimal similar products [13]. Besides fruits and vegetables with defects, the literature has also analyzed consumers’ attitude towards products approaching the expiration date. Consumers are quite attentive to expiration date when they go shopping for food, and they mostly choose the items with the longest remaining shelf life [15]; this means that products approaching the expiration date are avoided [11]. Finally, for what concerns items with damaged packaging, there is evidence that they may raise safety risks in the mind of consumers [16].

Different strategies can be applied to influence the value perception of suboptimal products, including changing beliefs about suboptimality and reducing their price [17]. The latter option has been largely investigated, by analyzing consumers’ reaction to discounts on products with defects. In general, the acceptance of suboptimal food increases as their price decreases [18], and discounts may help selling most products showing a defect [11]. When consumers are faced with price-reduced suboptimal food items at the store, they have been found to consider the cues of the products in relation to their possible uses at home [19], with a clear intention of avoiding to waste money. Instead, the presence of a clear message against food waste associated to discounts based on expiration dates may be effective in attracting consumers with a higher socioeconomic status [17].

Several retailers have identified in these suboptimal products a first target for their strategies against food waste, and the practice of reducing the price of products approaching the expiration date is becoming increasingly common in Europe. Examples are reported in France (“inglorious food” at Intermarché), UK (“Wonky Fresh Produce” at Asda and “Imperfect Picks” at Harris Farms), Germany (“Nonconformist produce” at Rewe and “Nobody is perfect” at Edeka), the Netherlands (sale of suboptimal fruits and vegetables baskets at Albert Heijn), Denmark (price discounts on suboptimal products in several retailers) and Austria (“Wunderlinge”); in two retailers in Sweden (ICA and Coop) meals are prepared at the stores using raw materials that otherwise would be wasted [20,21].

With the aim of contributing to the research on retailers’ strategy to deal with suboptimal products, this paper aims to study consumers’ perception towards expiration date based pricing. Namely, their interest towards this practice is analyzed basing on survey data gathered at two supermarkets in Rome, Italy.

The remainder of the paper is structured as follows. Section 2 reports the structure of the survey and the statistical model used for the analysis of the resulting data. Section 3 reports the results of the survey and of the estimation results, which are later discussed in Section 4.

2. Materials and Methods

2.1. Structure of the Survey

A survey was administered to 218 customers at two supermarkets in Rome, belonging to the same chain, which is a major retailer in Italy. Both supermarkets have a sales area of about 2500 square meters, one located in the center of the city and one in the northern suburbs. The survey was conducted in January and February 2019, across two days (one Wednesday and one Saturday) for each store. Customers were approached at the exit of the store, after having completed their purchases, during the hours of higher frequency (10 a.m.–1 p.m. and 5 p.m.–8 p.m.). Respondents were selected by asking one person out of five getting out of the stores to join the survey. Whenever a customer refused to join the survey, the following one was asked, until an available respondents was found.

Store managers provided data on the number of customers shopping at the stores in the days covered by the survey, summing up to 4848. Therefore, the sample covered 4.5% of the total customers of the stores during the survey period.

2.2. Questionnaire

Participants were asked to self-fill a questionnaire, which was placed on a folder in order to allow them to write while they were standing. Completing the questionnaire took about four minutes per respondent. All participants were informed about the privacy issues in treating the data, namely that questionnaires were anonymous and that they would not be asked to share personal information with the interviewer.

The questionnaire was structured as follows:

- six questions on food consumption habits: frequency of food shopping, household weekly food expenditure, use of the shopping list, planning of meals to be cooked at home, search for discounts at the supermarket, share of food expenditure at the surveyed supermarket;
- five questions based on proxies of environmental awareness: four pictures of apples with defects were proposed, plus one with apple peel, and the respondent was asked whether he/she would throw it out; another question concerned source separation of household wastes;
- four questions about the interest and opinion about expiration date based discounts on food products;
- previous experience on purchase of suboptimal products offered at a discount;
- five demographic variables: age, gender, size of the household, occupation, level of education.

Questions on food consumption and planning routines were inspired by previous studies on household food waste [22,23], while the proxies of environmental awareness were consistent with a previous study on food shoppers' self-perception of food waste [22].

2.3. Methodology and Model Specification

With the aim of identifying the factors which can stimulate customers' interest towards discounted suboptimal products at retail stores, we focused on the question "Some supermarkets sell products close to the expiration date at a reduced price, by applying a percentage discount. Does this initiative seem interesting to you?" and we adopted the segmentation approach based on logit models [24].

The original question in the survey foresaw four categories of responses ("Yes", "More Yes than No", "More No than Yes", "No") while considering its empirical distribution of the responses, we constructed a dichotomous variable to be used for the analysis. The transformed dichotomous variable was equal to 0 if the participant expressed a complete or partial dis-interest towards discounted product (by aggregating the responses to the categories "No" and "More No than Yes") and equal to 1 if the respondent selected the categories "More Yes than No" and "Yes", thus showing interest for these types of products.

The estimation of logit model was carried out by referring to the Generalized Maximum Entropy (GME) estimator which provides several advantages in this type of market research [25]. In fact, the GME method firstly avoids specify restrictive distributional assumptions for error components and to use all the data as information in the optimization problem [26,27]. Furthermore, this estimator proved to be particularly suitable for limited and ill-posed samples as well as for data sets characterized by a high level of correlations between variables (the so-called ill-conditioned problems) as underlined by [26] and further described by Corral and Terbish [28].

For the estimation of GME logit model we firstly considered p_{ij} the probability of alternative j for individual i being related to a set of covariates such as:

$$p_{ij} = \text{Prob}(y_{ij} = 1 | x_i, \beta_j) = F(x_i' \beta_j) > 0, \text{ (for } i = 1, 2, \dots, T; j = 1, 2, \dots, J) \quad (1)$$

where β_j is a $(K \times 1)$ vectors of unknowns, x_i' is a $(1 \times K)$ vector of covariates, and $F(\cdot)$ is a function linking the probabilities p_{ij} with the covariates $x_i' \beta_j$, such that $\sum_j F(x_i' \beta_j) = 1$. By including in the above equation an additional noise component leads to:

$$y_{ij} = F(x_i' \beta_j) + e_{ij} = p_{ij} + e_{ij} \quad (2)$$

for which the indirect empirical measurements on the noisy observable y and the known covariates x_i must be used to recover the unknown and unobservable p and e .

The estimation of the model within the GME framework by referring to Shannon's entropy was carried out by re-parameterizing the error terms e by defining the support space $v = (-1/\sqrt{T}, 0, 1/\sqrt{T})$ with corresponding probabilities w_{ij} to be estimated such that $e_{ij} = \sum_m v_{ijm} w_{ijm}$ where $\sum_m w_{ijm} = 1$, while p is already in probability form.

The maximization of the entropy linked to the signal (data) and error terms subject to the data constraints and the normalization constraints enabled us to estimate p_{ij} and w_{ijm} and therefore the $\hat{\beta}_j$ and \hat{e}_{ij} . It is worth noting that the estimation results are reported in terms of Average Marginal Effects (AMEs) which provide information about the impact of each x on the probability of a positive outcome [28].

3. Results

3.1. Descriptive Analysis

Overall, 52.7% of the sample was interviewed on Wednesday, while 47% on Saturday, across the two stores (Table 1).

Two-thirds of the sample was made of women (Table 1), showing that, in Italy, women still have a greater commitment than men in housekeeping, including food shopping. The average age of respondents was 53.78 years old, and most respondents belonged to the 45–65 years old range (Figure 1). The size of households was 2.7 persons (Table 2), quite in line with the national average. University degree holders represented 27.1% of the sample, and 51% declared to have a job; housewives accounted for 17.4% of respondents.

Table 1. Descriptive statistics of the categorical explanatory factors.

Variable	Category	Observations	%
Weekday	Wednesday	115	52.752
	Saturday	103	47.248
Shopping list	Never	99	45.413
	Sometimes	52	23.853
	Often	31	14.220
	Always	36	16.514
Meal planning	Never	152	69.725
	Sometimes	39	17.890
	Often	19	8.716
	Always	8	3.670
Looking for deals	Never	20	9.174
	Sometimes	28	12.844
	Often	77	35.321
	Always	93	42.661
Throwing out apple peel	No	171	78.440
	Yes	47	21.560
Gender	Female	147	67.431
	Male	71	32.569
University degree	No	159	72.936
	Yes	59	27.064
Occupation: housewife	No	180	82.569
	Yes	38	17.431
Occupation: worker	No	105	48.165
	Yes	113	51.835

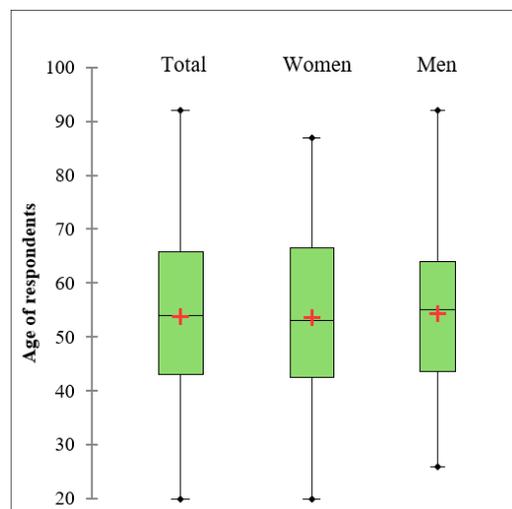


Figure 1. Box plot representing the age of respondents.

Table 2. Descriptive statistics of the numerical explanatory factors (n = 218).

Variable	Min	Max	Mean	Median	Std. Deviation	CV
Frequency of food shopping	1	7	3.399	3	2.145	0.631
Household’s weekly food expenditure	50	250	100.229	100	47.640	0.475
Age	20	92	53.780	54	15.578	0.290
Size of the household	1	6	2.725	3	1.190	0.437
Share of food expenditure at the store	10	100	59.523	60	24.658	0.414

When asked about the frequency of food shopping, respondents gave quite different answers. The average frequency of 3.4 times per week is the result of a very large number of respondents that are used to shopping for food once or twice a week, compared to another group that buys food every day; indeed, the variation of the data is very high (Table 2). On average, households' expenditure for food was estimated at 100 € per week, 59.5% of which was spent at the store where the respondents were interviewed.

Concerning the food planning habits of the household, 30.7% of respondents declared that they would likely bring a shopping list at the supermarket, while planning what to cook at home was much less frequent, with only 12.3% of the sample declaring that they "often" or "always" plan what to cook in advance. The sample seemed to be made of many deal-prone customers, as 42.6% declared to "always" look for discounts on food products, 35.3% "often" look for discounts, whilst only 9.2% do not look for deals while shopping for food.

The question "Would you throw away the peel of an apple" was used as a proxy to estimate the attitude of respondents towards food waste, showing that 21.6% of respondents would throw away the apple peel.

The key variable of our analysis was the interest of respondents towards the price discount applied on close-to-date products. About 65% of the sample declared to be interested (Table 3), showing a good appreciation of the marketing initiative implemented by the stores. In Section 3.2, the results of the GME logit model are reported, showing the factors exerting an influence over this interest.

Table 3. Descriptive statistics of the dependent variable.

Variable	Category	Observations	%
Interest in discounts on close-to-date products: NO	0	75	34.404
Interest in discounts on close-to-date products: YES	1	143	65.596

3.2. Results of the GME Logit Model

Table 4 shows the estimation results of the GME logit model by reporting the estimated AMEs, the standard errors and the level of significance. The estimation process was carried out using STATA 14.0 software and the tools introduced by Corral and Terbish [28]. When the AMEs are positive (negative), the factor shows a positive (negative) relationship with the probability of observing consumer interest towards close-to-date product, thus increasing (decreasing) the attention over discounts on close-to-date products.

Before analyzing the obtained results, it is important to analyze the goodness of fit of the estimated model through the normalized entropy measure [26] as a measure of uncertainty reduction. For the estimated model, the value of the normalized entropy was equal to 0.792 which indicates a departure from uniform distributions and therefore a reduction in uncertainty due to the selected covariates introduced in the model. Moreover, the Entropy Ratio Statistic equal to 63 (p -value = 0.000) highlights that a good amount of information was explained by the estimated model.

From the analysis of the AMEs we note a negative association between the studied probability (likelihood of observing consumers' interest towards close-to-date products) and age of consumers. In fact, with increasing age, the interest in products discounted and nearing expiration dates decreased (AME = -0.005).

Table 4. Generalized Maximum Entropy logit model: estimation results.

Factors	AME	SE	Significance
Age	−0.005	0.003	**
Size of the household	0.089	0.029	***
Weekday—SATURDAY	0.138	0.060	**
Gender—MALE	−0.040	0.068	
University degree—YES	0.074	0.071	
Occupation: housewife—YES	−0.043	0.093	
Occupation: worker—YES	0.021	0.096	
Household’s weekly food expenditure	−0.001	0.001	*
Shopping list—SOMETIMES	0.153	0.071	**
Shopping list—OFTEN	0.008	0.091	
Shopping list—ALWAYS	0.013	0.086	
Meal planning: sometimes	−0.030	0.079	
Meal planning: often	−0.053	0.107	
Meal planning: always	0.180	0.141	
Looking for deals: sometimes	0.152	0.102	
Looking for deals: often	0.216	0.095	**
Looking for deals: always	0.080	0.098	
Share of food expenditure at the store	−0.002	0.001	
Frequency of food shopping	0.009	0.015	
Throwing out apple peel	−0.170	0.079	**

Notes: level of significance distinguished in three levels: 10% (indicated in Table 4 with *), 5% (**) and 1% (***).

Focusing on the household weekly expenditure for food, we found that as the amount spent increased, the interest towards close-to-date products decreased, even if slightly (AME = −0.001).

On the other hand, a positive relationship emerged with family size (AME = 0.089) and for those who, in the context of our survey, were interviewed on Saturday (AME = 0.138) rather than during the week. Again, making the shopping list sometimes (compared to never doing it, which is the reference category) was associated with the interest shown towards discounting strategies applied to close-to-date products (AME = 0.153).

Furthermore, we found significant and positive association between interest towards discounted products and looking often for deals (AME = 0.216). Lastly, individuals who would throw away the apple peel, appeared to be less interested towards discounted suboptimal products (AME = −0.170).

It is important to note that the structure of our data enabled us to provide information about association between variables, while causal relationships cannot be extrapolated from the estimation results.

4. Discussion and Conclusions

Reducing price on suboptimal products is increasingly regarded by retailers as a strategy to reduce the amount of in-store food waste. Previous research suggests that customers’ approach to these marketing initiatives may be quite different with respect to “normal” discounts, possibly leading to a negative effect on brand quality perception, especially among loyal consumers [29]. In this study, when asked about discounts on close-to-date products, 65.6% of the sample declared to be interested. To some extent, this interest was influenced by the socio-demographic features of the respondents. Younger consumers and respondents belonging to large households were more likely interested; as both categories have been found to have a low attention towards food waste at home [30], their attitude towards these discounts may be due to money constraints rather than to environmental concerns. It may also be argued that buying discounted close-to-date products may result in a greater amount of food waste at home for these categories of customers, thus neutralizing the effectiveness of the initiative. However, this was not the case when this issue was specifically addressed [19,31].

Other factors increasing the interest towards discounted close-to-date products were the attention to offers and discounts in general. Looking often for deals was a significant factor of the model,

suggesting that deal-prone customers are more likely to be attracted by these marketing strategies. This in spite of the fact that discounts on close-to-date products have quite a different objective with respect to “normal” deals. Instead, a higher expenditure for food provision at the household level decreased the attention of respondents, probably because of a lower general attention on offers and discounts.

As far as these first results are concerned, it seems that the interest towards discounts on close-to-date product is mostly driven by a more general attitude to save money in food shopping, resulting in a greater attention to offers and discounts in general. However, the picture changes as the effect of using a shopping list is analysed. Customers that “sometimes” bring a shopping list at the supermarket showed a greater interest in discounts on close-to-date products. This is a very interesting effect as regularly compiling a shopping list has been associated to a lower production of food waste at home [23,32], thus suggesting that a certain attention over the issue of food waste may be detected in customers showing an interest towards these discounts. Instead, differently to the study by Stefan et al. [23], the parameters were not significant for meal planning. Another sign that customers who are interested in date-based pricing may be more concerned by the food waste issue is the parameter for the apple peel; throwing away apples with defects has been associated with a wasteful behavior at home [22], and here it has a negative effect on the interest towards discounts on close-to-date products.

Discounts on close-to-date products represent, from a managerial point of view, a preventive measure against food waste, therefore its application to the larger extent possible shall be highly recommended. In line with the priorities set by the food waste hierarchy [33], prevention should always be regarded as a first objective in managing the food waste challenge, also at the retail level. However, this strategy may concern only a relatively small share of the total food waste produced at supermarkets. Other actions that can be implemented for the remaining products may concern surplus food redistribution [34,35], which also entails a great social value as the surplus food is usually made available for poor people, thus increasing their food security.

As is already happening in the food manufacturing sector [36,37], retailers will be increasingly called to act against food waste, and to show their responsibility towards the great environmental and social challenges of our times. New business models of retailing are emerging, drawing from the sharing economy principles, and putting a great amount of attention into improving the environmental and social impact of food commercialization [38]. Although they do not represent challenging competitors for mainstream retailers yet, consumers’ awareness towards these issues is increasing, and the major companies of the food sector are moving to make their businesses more sustainable. In this context, several strategies at different levels of retailing operations should be tested, including technological innovations to avoid the generation of food waste at stores, marketing initiatives on suboptimal and surplus products, and new forms of communication with consumers. These trajectories represent promising topics for research in the field of sustainable management.

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