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Do promotions affect the quantity of surplus food at retail? Evidence from an Italian case study

Clara Cicatiello [a], Mattias Eriksson [b], Roberta Pietrangeli [a,*], Erik Svensson [b], Christopher Malefors [b], Emanuele Blasi [a]

[a] Department for Innovation in Biological, Agro-Food and Forest Systems, University of Tuscia, Via San Camillo de Lellis snc, 01100, Viterbo, Italy
[b] Department of Energy and Technology, Swedish University of Agricultural Sciences, Box 7032, Uppsala, SE-75007, Sweden

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ABSTRACT

This study explores how promotions affect the food waste at retail stage in Italy. Retail food waste accounts the 7.7% of total food waste in Europe, and fruit and vegetable products are the most wasted. Although retailers contribute with a smaller percentage on generation of waste, they influence the whole chain. This study explores the impact of promotions on the generation of surplus for fruit and vegetable products, using data from two large supermarkets collected from 2016 to 2021. The dataset includes records on purchases, sales, and promotions. In the analysis, products are grouped in families, the surplus rate is calculated as the amount of products that is purchased in excess with respect to sales, expressed in percentage, and it is then compared across promotional and non-promotional weeks. Results show that the relative rate of surplus during non-promotional weeks is 11.3%, while during promotional weeks is 8.3%. During promotional weeks, the surplus increases in absolute terms, while the rate of surplus with respect to purchases decreases, suggesting a positive effect of promotions to reduce generation of surplus. High perishable products see more significant difference between promotional and non-promotional weeks.

1. Introduction and objective of the study

The retail sector generated 7.7% of the total food waste recorded in the year 2023 in the European Union (EU), which corresponds to around 7 million tonnes of fresh food (Eurostat, 2025). At the retail level, the main fraction in terms of wasted mass is fruit and vegetable (FV) (Cicatiello and Franco, 2020; Brancoli et al., 2017; Cicatiello et al., 2017; Lebersorger and Schneider, 2014).

Even if retailers account for a small percentage of the total food waste generate in the food chain, their contribution to addressing the problem of food waste can be crucial, as their strategies impact both customer preferences and suppliers (Cicatiello and Franco, 2020; Cicatiello et al., 2017; Gruber et al., 2016).

Several studies have provided company data about the waste of FV in the retail sector. In Austria, a study involving 612 retail outlets reported that the waste of FV products amounts to 4.2% of sales (Lebersorger and Schneider, 2014). Cicatiello et al. (2017) found that 24 tonnes of FV waste was generated in an Italian supermarket, corresponding to a value of 36,372 €, in one year. In Sweden, a study covering three stores detected 68 tonnes of FV wasted (Mattsson et al., 2018), while Eriksson et al. (2012) found that the rate of waste of FV varied between 2.0% and 4.0% of the 9600 tonnes supplied to six stores, and that returns (pre-store waste) contributed to 67% of the wasted mass (Eriksson et al., 2017).

The main drivers of food waste in the retail sector are linked to both operational and behavioural factors. Inaccurate demand forecasting is one of the primary causes of food waste at the retail level (Mena et al., 2014; Magalhães et al., 2021; De Moraes et al., 2020), because retailers face the challenge to predict the demand of products, thus possibly ordering excess quantities to avoid out of stocks and ensure that shelves are always filled in with products (Evans, 2011). The latter also related to the well-known marketing practice of overfilling shelves, to show abundancy of products and attract consumers. Other causes of retail food waste that are reported in literature, which are particularly relevant for FV, are inefficient stock rotation, poor refrigeration during stocking and lack of shelf-life monitoring (Gruber et al., 2016). The literature also suggests that promotions might be linked to food waste generation at retail stores. According to Wilson et al. (2017), promotions

* Corresponding author.
E-mail address: roberta.pietrangeli@unitus.it (R. Pietrangeli).

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Table 1
Number of weeks analysed across the two stores.

Food categories – families of products	Number of non-promotional weeks	Number of promotional weeks
Apples	158	472
Artichokes & broccoli	388	181
Bananas	327	303
Brassicas	366	264
Cherries	179	44
Grapefruit	581	49
Grapes	417	159
Green beans & fresh legumes	460	170
Kiwis	414	210
Lemons & citrons	327	303
Lettuces	368	262
Mandarin+	290	244
Melons	416	214
Oranges	309	321
Peaches	312	221
Pears	380	250
Peppers	436	194
Pineapples	364	266
Plums	384	149
Potatoes	240	390
Tomatoes	120	510
Watermelon	245	157
Zucchini & aubergines	310	320

may create temporary surges in purchasing, thus concentrating in the store excess quantities of products which, after the promotions, result in surplus food that may be wasted (De Moraes et al., 2020). Moreover, demand forecasting errors can be much more relevant for promotional periods, because predicting consumer response to promotional campaigns may be even more difficult than predicting "normal" daily consumer demand (Mena et al., 2014). At the same time, if well planned, promotions can incentivize immediate consumption and reduce the surplus stocks, thus reducing waste (De Moraes et al., 2020). This can be very useful for highly perishable products such as FV. Date-based promotions are an interesting example to this regard (De Hooge, 2025). These promotions are applied to suboptimal products (that is, products that have cosmetic defects, or are approaching the expiration date; de Hooge et al., 2017) and imply a decrease in their price, usually by 30% or 50%. This strategy is now largely used in the daily retail stores' practice, levering the fact that the acceptance of suboptimal food by consumers increases as their price decreases (Cicatiello et al., 2019; Helmert et al., 2017). These promotions can also be associated to claims against food waste, to make them more attractive for consumers (Aschemann-Witzel et al., 2018).

In this paper we analyse the link between surplus ordering and promotions at retail stores, with a focus on FV, by analysing the records of two retail stores located in Italy, across six years. The specific research questions this study addresses are: (I) What is the extent of surplus ordering of FV at retail stores? (II) Is the amount of surplus ordering linked to promotions? And if so, how do promotions affect the generation of surplus of FV products, thus possibly impacting the amount of waste? (III) Which groups of FV products are most involved in these dynamics? By answering these questions we aim to clarify the role of promotions in food waste management at retail stores.

2. Methodology

This work is conducted as part of the H2020 project LOWINFOOD, which foresees a package of activities focused on implementing and evaluating the efficacy of innovations against losses and waste of FV, from agricultural production up to retail.

2.1. Data collection

The study is based on data collected at two retail stores (sales area >3500 m^2) located in two different regions of Italy, belonging to the same retail chain, across years 2016-2021. The data refers to individual products in the FV department, identified by the code of the store, the food category and sub-category, and a product unique number. Every time a product is purchased, sold, put on promotion, or wasted a record is generated, resulting in the following list of data.

- purchases, that is the quantity of each product purchased by the store, including the date of purchase and the cost;
- sales, including the date of selling, the quantity of product sold and the selling price;
- promotions, including the period of the promotion and the price applied during the promotion;
- recorded waste, when a product is removed from the shelves and disposed; this record includes the date of waste and the quantity;
- unrecorded waste, estimated by using the shrink records of the stores, corresponding to quantities of products that are missing in the inventory at the monthly recording, assuming that these products (that have been purchased but have never been sold) are removed from shelves and disposed without being recorded as waste (Buzby et al., 2015).

Overall, the data available includes 410 individual FV products. Considering that the above-mentioned information was recorded for two stores and six years, the size of the database was 280,705 datapoints.

2.2. Data treatment

The individual products available in the store records were grouped into 23 families, representing the main types of FV products, and basing on the classification already reported in the store records. This was done under the assumption that items within the same family were similar enough to have a high degree of interchangeability for costumers. For example, all different types of pears were considered together in a single family for the purpose of this study, and so we did for all different types of oranges.

Grouping products into families introduces a methodological challenge, as quantities may not be directly comparable. If one specific product is sold by the unit, and another by the kilogram, adding their quantities together does not represent anything meaningful. There is also a risk that products cannibalize or complement each other within the same family, and that such effects are partially hidden when products are aggregated during promotional periods. The family-level aggregation therefore represents a deliberate trade-off between data consistency and product-level precision. Here we have made a pragmatic choice to prioritise consistent measurement of surplus across products and time, at the expense of capturing SKU-specific dynamics. In practice, the quantity measure had to be normalized between products. For this purpose, the median purchase price was calculated for each product. Then, instead of comparing quantities directly, the total purchasing and sales quantities for the different product families were compared basing on this estimation of their monetary value. The monetary value was calculated using the ordering price rather than the sales price, since ordering price reflects the retailer's actual economic cost of surplus, is consistently recorded in the dataset, and provides a more stable basis for comparison across products and time. In contrast sales prices vary with promotions and margins, making them less suitable for this purpose.

Products with longer shelf life, e.g. nuts and dried fruits, were excluded from the study, since it is easier for the supermarket to absorb any surplus of these products by adjusting future orders and thereby reduce waste caused by promotions or other reasons. For the remaining products, purchase and sales quantities were aggregated weekly,

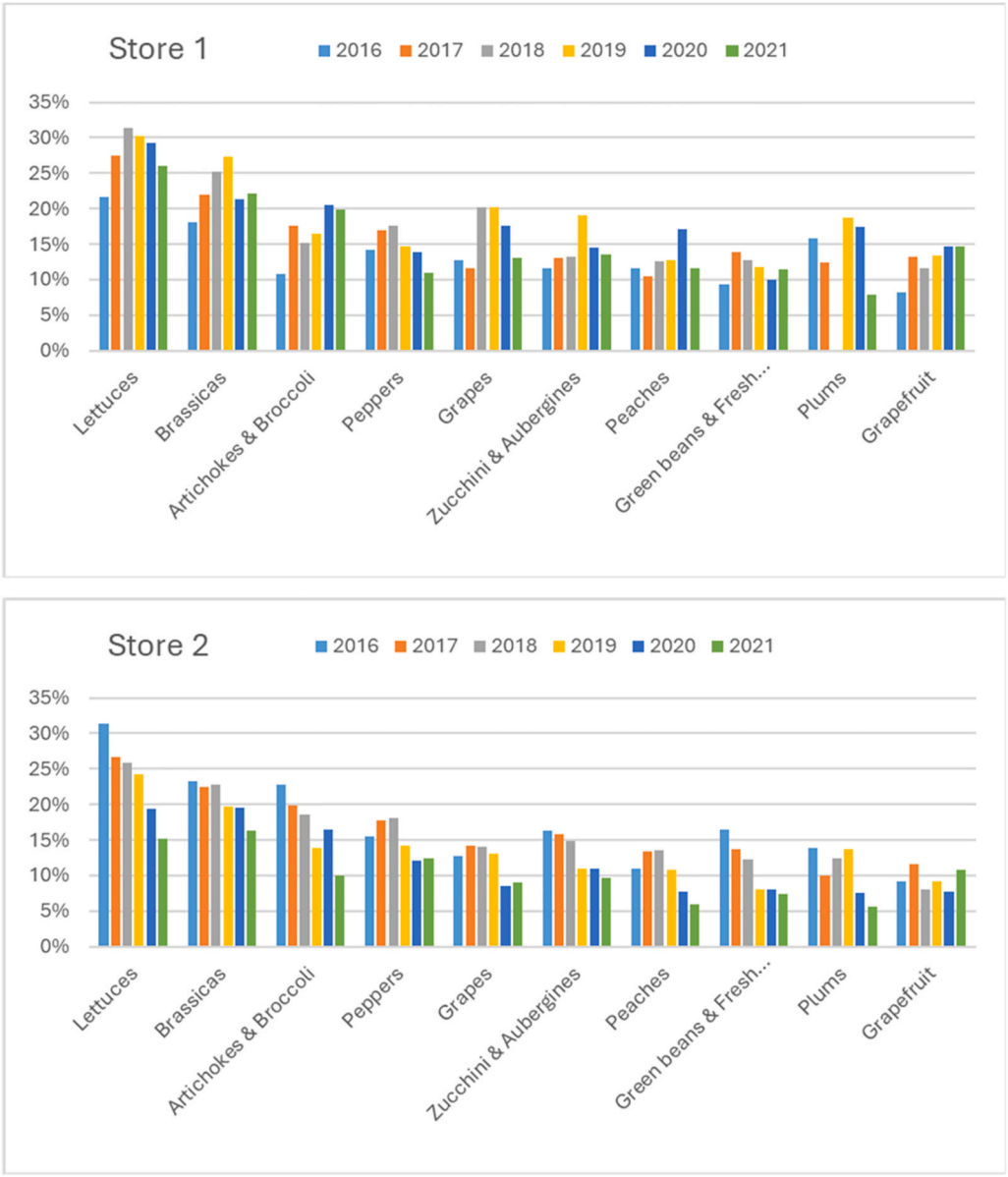

Fig. 1. Rate of SFV in the two stores, per FV family, per year.

because even for products with a shorter shelf life, there is room for the supermarket to compensate for ordering too much one day, by adjusting the next few days.

2.2.1. Indicators of surplus food and food waste

The main focus of the elaborations in this paper is surplus food, defined as the amount of food that is purchased by the store in excess with respect to sales and measured in percentage (%).

For each family of FV products, the rate of surplus was calculated as follows:

$$SFV = \frac{(p - s)}{p} x\ 100$$

where.

- SFV is the rate of surplus for FV products for a given FV family;
- p is the normalized value of purchases, calculated as the normalized quantity of products of a family that is ordered in a given period, multiplied by the median ordering price;
- s is the normalized value of sales, calculated as the quantity of products of the families that is sold in the same period, multiplied by the median ordering price.

The rate of surplus SFV has been calculated both with aggregated values and with mean values, thus generating two different measures: SFV and SFV-rel. The input data for the SFV indicator are recorded daily in the store records, therefore we were able to calculate this indicator at the weekly, yearly and overall levels.

2.3. Elaborations on the link between promotions and food surplus

For each FV family, weeks were categorized as either promotion or non-promotion weeks, based on whether any single product in the family was subject to a promotion that week. Promotions are observed in the store and are based on management store decision that may differ across the two stores. Given the presumed interchangeability of products within each family, it was hypothesized that promotions on one item could significantly affect sales of similar products. Table 1 shows the number of observations analysed as promotional and non-promotional

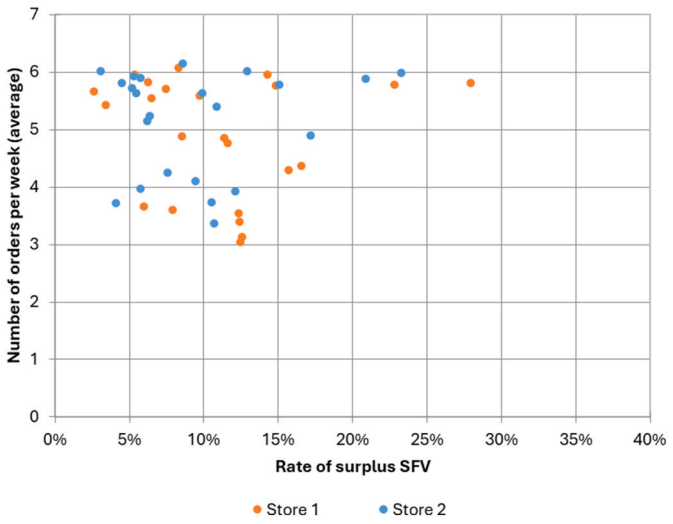

Fig. 2. Rate of SFV (horizontal axis) compared to the number of orders per week (vertical axis). The data points correspond to the position of each FV family with respect to these two variables.

weeks, for each family of FV products.

The surplus ordering SFV was then analysed for both promotional and non-promotional weeks across all product families. The difference between promotional and non-promotional weeks was analysed through a Welch test, considering that the variance of the two samples was not the same. The empirical strategy adopted in this study is descriptive and comparative in nature. The use of Welch tests enables the identification of systematic differences between promotional and non-promotional weeks; however, it does not allow for causal inference. The test captures unconditional mean differences and does not explicitly control for seasonality, which is particularly relevant given the strong seasonal patterns in FV demand.

3. Results

3.1. Rate of surplus FV products at stores

The rate of surplus ordering (SFV) of FV products recorded at the case study stores varied between 3% and 30%, depending on the family of products and the year. Overall, the average SFV across the 23 FV families was 10.4%, considering the aggregate value of all products, for all years. Store 1 showed higher rates of SFV (11.2%) with respect to Store 2 (9.6%).

The rate of surplus ordering was higher for more perishable products, such as lettuces (with most types of fresh salad showing a rate of surplus >15%), while it was lower for products with a longer shelf life like apples, oranges and potatoes. Fig. 1 shows the yearly rates of SFV at the two stores, for the 10 FV families with higher average surplus.

Looking at the figure, SFV appears very similar across the two stores, meaning that it is significantly higher for the same products. A slightly decreasing trend is also visible in both stores across the six years analysed. The number of orders per week was 5 on average, across all stores and FV families. Peaches, plums and watermelon showed the lowest number of orders per week, while potatoes, zucchini and tomatoes are ordered more often, around 6 times per week. However, we detected no correlation between the number of orders per week and the rate of surplus, as shown in Fig. 2.

3.2. Impact of promotions on rate of surplus FV products

There is evidence of systematic differences in surplus outcomes between promotional and non-promotional weeks at the two stores. For individual products as well as entire FV families, the value of surplus increased in absolute terms during weeks of promotion. However, since the amount of sold produce also increased, the rate of surplus SFV, expressed in percentage, generally decreased during promotional periods.

In Store 1, 16 FV families showed a decrease in surplus during promotional weeks, while the surplus increased for 7 FV families. In Store 2, the rate of surplus decrease for 18 FV families during promotional weeks. Figs. 3 and 4 shows the rates of SFV in promotional and non-promotional weeks, for each of the two stores.

A Welch test was conducted to compare the rate of surplus during

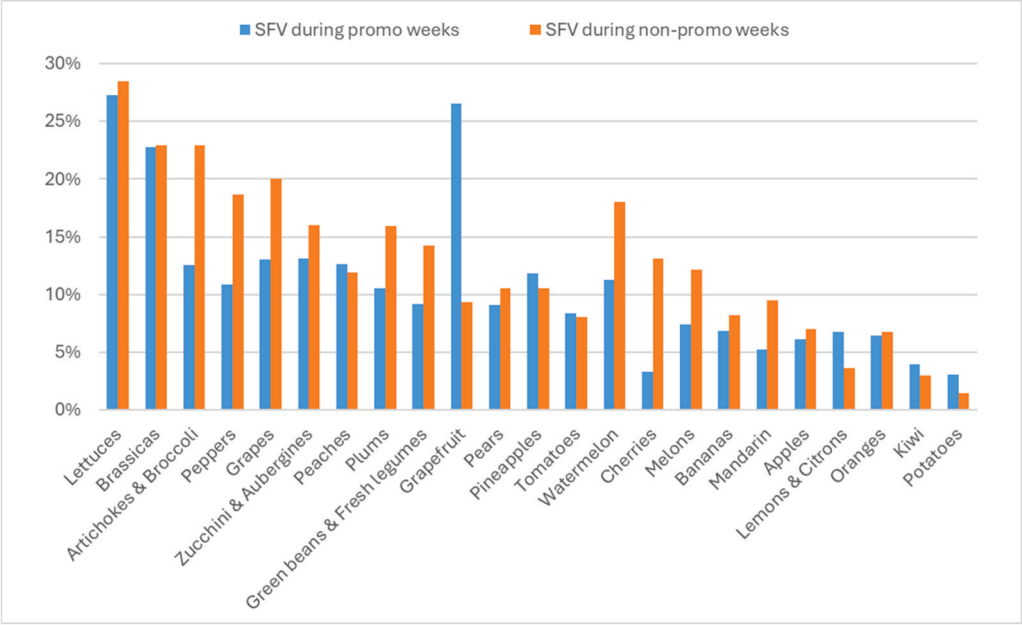

Fig. 3. Rate of SFV at Store 1, broken down by promotional and non-promotional weeks.

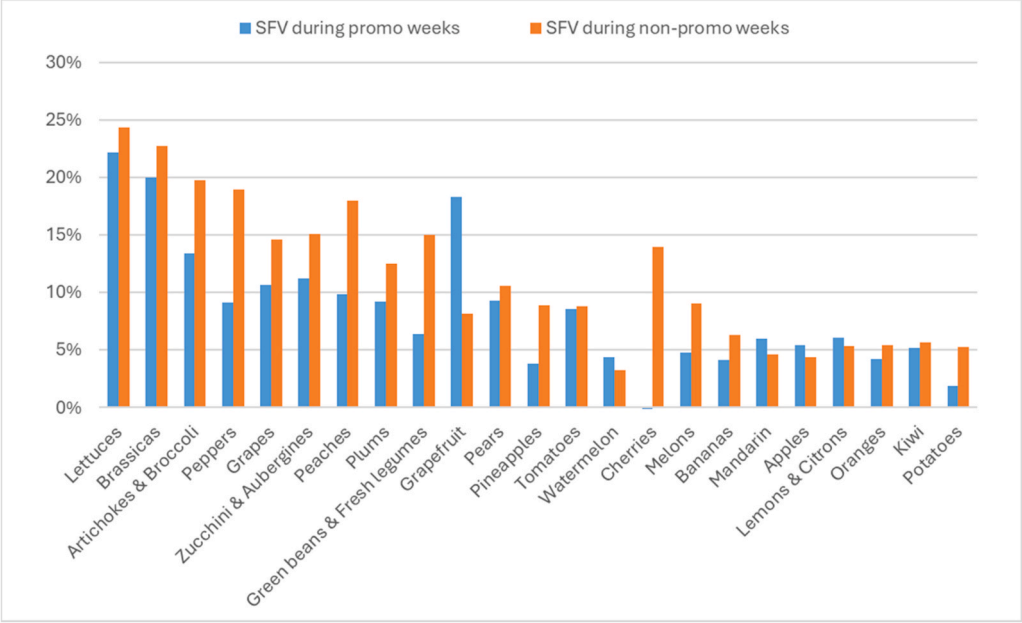

Fig. 4. Rate of SFV at Store 2, broken down by promotional and non-promotional weeks.

promotional and non-promotional weeks, considering the indicator SFV-rel. To test the significance of the test, the t value calculated with the Welch test was compared with threshold values (two-tails). We found 12 cases with significant difference, half of which are significant per $p < 0.05$, as shown in Table 2. In Table 2, the difference is calculated as the SFV in promotional weeks minus SFV in non-promotional week. Therefore, a negative value indicates that surplus rates were lower during promotion weeks (i.e. a beneficial effect of promotions), while a positive value indicates the opposite. Some mean values of SFV-rel are negative, which reflects cases where sales exceeded recorded purchases; this is primarily due to stock being depleted from previous weeks. The Welch tests capture differences in mean relative surplus rates between promotional and non-promotional weeks and do not control for confounding factors or imply causality.

The results show that promotions have a beneficial effect in lowering the rate of surplus especially for peppers, green beans & fresh legumes, which show significant reduction of SFV-rel in both stores. Also in the case of watermelon, zucchini & aubergines, lettuces, grapes, cherries, and bananas a beneficial effect is detected in one of the stores. When considering all product families together, the relative surplus rate is lower on average during promotional weeks (8.3%) than during non-promotional weeks (11.3%). For relatively homogeneous product families, such as bananas and potatoes, the difference between promotional and non-promotional weeks are comparable in magnitude to the overall results. Bananas show consistently lower relative surplus during promotional weeks in both stores while potatoes display a mixed pattern across stores. This supports the interpretation that the main findings are not solely driven by aggregation across heterogeneous product families.

4. Discussion

The rate of surplus and waste detected in this study is slightly higher compared to existing estimates of retail food waste for the FV food category. Lebersorger and Schneider (2014) estimated that the rate of FV waste at Austrian retail was 4.2% of the sales, while Eriksson et al. (2012) calculated a 4.3% rate of waste with respect to deliveries, in six Swedish retail stores. Previous studies conducted in Italy confirm that FV are among the most wasted products in the retail environment, estimating a food waste rate in value of 2.2% for FV products, with respect to sales (Cicatiello and Franco, 2020). The individual FV products that are more wasted such as lettuces and brassicas are in line with findings from Mattsson et al. (2018).

It is important to highlight that, by accessing full detailed records on purchases and sales, this study was able to account for all the surplus generated at store. Other studies, instead, are based on waste records, which may be biased due to unrecorded waste, which is estimated to make up around one-third of total retail food waste (Eriksson et al., 2012; Cicatiello and Franco, 2020) and is considered especially significant for FV (Cicatiello and Franco, 2020).

Studies in literature concerning the role of in-store promotions on retail food waste deliver contrasting results. On the one hand, there is evidence that when promotions are in place retailers may increase stocks of products, possibly resulting in an increase in waste (De Moraes et al., 2020). On the other hand, in the economic and management literature promotions are considered profitable ways for retailers to liquidate surplus stocks (Wu and Honhon, 2023). This study provides evidence that relative surplus rates of FV products are lower during promotional weeks, even if the absolute quantities of surplus increase as a consequence of the general increase of sales induced by promotions. A similar pattern has previously been described for meat and dairy products by Eriksson et al. (2014) and for bread by Brancoli et al. (2019). Both of these studies found that for products with larger sale volumes and consequently faster turnover the relative waste was lower and absolute waste higher in comparison with produces with smaller sales volumes. Since the retailer increases the turnover of specific products during the promotion period, these products temporally fit the pattern of high turnover and low waste products. Therefore, from the perspective of retailers' performance, promotions can be considered an efficient solution to increase turnover and reduce surplus orders, which are the foremost cause of food waste generation at retail stores (Wu and Honhon, 2023).

Another interesting result is that no correlation between the number of orders per week and the rate of surplus is evidenced. This may be due to the fact that the frequency of orders in the FV department is already high (3 times per week or more), given the perishability and the short shelf-life of the products. The amount of surplus seems therefore not linked to more frequent purchases, as it happens in others stages of the supply chain, for example at household (Schrank et al., 2023; Stancu et al., 2016).

This may suggest that the main issue to reduce surplus of FV at retail

Table 2
Results of Welch test on SFV-rel for the two stores and 23 FV families.

Food categories/ families of products	Store	Mean relative surplus ordering rate PROMO WEEKS	Mean relative surplus ordering rate NON-PROMO WEEKS	Difference PROMO vs. NON-PROMO weeks	Welch test
Apples	1	6.1%	7.0%	−0.8%	
	2	5.4%	4.4%	1.1%	
Artichokes & broccoli	1	12.5%	22.9%	−10.4%	**
	2	13.4%	19.8%	−6.4%	*
Bananas	1	6.8%	8.2%	−1.3%	
	2	4.1%	6.3%	−2.2%	
Brassicas	1	22.8%	22.9%	−0.1%	
	2	20.0%	22.8%	−2.8%	
Cherries	1	3.3%	13.1%	−9.8%	*
	2	−2.3%	13.9%	−16.2%	**
Grapefruit	1	26.5%	9.3%	17.2%	*
	2	18.3%	8.2%	10.1%	
Grapes	1	13.0%	20.0%	−7.0%	*
	2	10.7%	14.6%	−3.9%	
Green beans & fresh legumes	1	9.2%	14.3%	−5.1%	
	2	6.4%	15.0%	−8.6%	***
Kiwis	1	3.9%	3.0%	0.9%	
	2	5.2%	5.6%	−0.5%	
Lemons & citrons	1	6.8%	3.6%	3.1%	
	2	6.1%	5.4%	0.7%	
Lettuces	1	27.3%	28.5%	−1.2%	
	2	22.2%	24.3%	−2.2%	
Mandarin	1	5.3%	9.5%	−4.2%	
	2	6.0%	4.6%	1.4%	
Melons	1	7.4%	12.1%	−4.8%	
	2	4.8%	9.0%	−4.2%	
Oranges	1	6.4%	6.8%	−0.3%	
	2	4.2%	5.4%	−1.2%	
Peaches	1	12.6%	11.9%	0.7%	
	2	9.9%	18.0%	−8.1%	*
Pears	1	9.1%	10.5%	−1.4%	
	2	9.3%	10.6%	−1.3%	
Peppers	1	10.8%	18.7%	−7.8%	***
	2	9.1%	19.0%	−9.8%	***
Pineapples	1	11.8%	10.5%	1.3%	
	2	3.8%	8.9%	−5.1%	
Plums	1	10.5%	16.0%	−5.4%	
	2	9.2%	12.5%	−3.3%	
Potatoes	1	3.0%	1.5%	1.5%	
	2	1.9%	5.2%	−3.4%	*
Tomatoes	1	8.3%	8.0%	0.3%	
	2	8.5%	8.8%	−0.3%	
Watermelon	1	11.2%	18.0%	−6.8%	
	2	4.3%	3.2%	1.1%	
Zucchini & aubergines	1	13.1%	16.0%	−2.9%	
	2	11.2%	15.1%	−3.8%	**

* significant for $p < 0.10$; ** significant for $p < 0.05$; *** significant for $p < 0.01$.

is rather the ability to accurately forecast consumers' demand (De Moraes et al., 2020). In this regard, several innovations based on artificial intelligence are currently being implemented to improve demand forecasting at large retailers (Priyadarshi et al., 2019), thus exploiting the huge data records that retail stores have available (De Moraes et al., 2020). These results may be generalized to other large retailers in Italy, since in-store dynamics of waste generation are similar; instead; this is likely not possible for small stores and discount retailers given their different patterns of waste generation and promotion strategies. A positive impact of promotions may also be hypothesized for retailers located in developing countries or emerging economies where the use of demand forecasting is still limited.

Beyond the impact of promotions on the amount of surplus food at the retail level, it is also important to examine their effects along the entire fruit and vegetable supply chain. In this context, the impact of retail promotions on suppliers is at the centre of the debate regarding the fairness and quality of commercial relations between retailers and suppliers, particularly FV producers who often have a weaker position in the negotiation. For example, the return of unsold products after promotions, or requiring suppliers to bear promotion costs without prior written agreement, can lead to unfair trading practices (Russo et al., 2023) which hinder the efficiency and sustainability of the supply chain as a whole. These practices are often perceived by FV producers as having a negative impact on their business, resulting from a low-quality commercial relation (Pietrangeli et al., 2025).

For what concerns the impact on consumers, in-store promotions are generally considered to push consumers to buy excessive amounts of perishable products, which may be discarded at home (Calvo-Porral et al., 2017; Gravert and Mormann, 2025). This argument is supported by evidence that promotions – particularly buy-one-get-one-free offers - induce households to overbuy and overstock products beyond their actual needs (Ganglbauer et al., 2013; Ponis et al., 2017), thereby potentially increasing household food waste and shifting consumer priorities away from food waste prevention (Aschemann-Witzel et al., 2016). Other studies, instead, argue that promotions do not necessarily increase household food waste, providing evidence that households that buy promotional items do not waste more than others. Environmentally conscious households or households who buy more on discount, tend to be more aware of food waste related issue, and produce less waste at home (Tsalis et al., 2024). Especially multi-unit promotions may induce situational consumption that leads to higher levels of food waste, which in turn can motivate consumers to adopt waste-prevention actions (Van Lin et al., 2023). Additionally, Van Lin et al. (2023) investigated that households who buy products on promotion, either single units or multiple offers, do not report more waste at home than those who buy full-price, thus supporting the idea that promotions do not increase food waste at the consumer level.

Of course, the surplus FV detected in this study, both during promotional and non-promotional weeks, do not necessarily end up as waste. In this study, it was not possible to detect the final destination of surplus FV. In general, surplus FV may be reprocessed – for example, in stores that prepare ready-to-eat meals – or donated to charities; these options that are largely used by retailers, and they are considered effective strategies to reduce food waste (Huang et al., 2021).

Some limitations of the study shall also be mentioned. First, while the amount of data gathered is very wide, both in terms of number of products and number of years, data only comes from two specific stores located in Italy. Seasonal demand patterns may partly influence the association between promotional activity and surplus rates, and this should be taken into account when interpreting the observed differences. Therefore, the absolute quantities and rates of food surplus shall be interpreted with caution, whereas the findings concerning the relation between rates of surplus and promotions can be considered more robust. Anyhow, considering the different results obtained in other studies, these findings should be interpreted as associational rather than causal. Second, the raw data about individual products showed several inconsistencies with respect to the quantity purchased, sold and wasted, which sometimes did not add up precisely; the methodological choice to overcome this issue was to consider the families of FV products – meaning, not the individual apple as a reference, but all the apples of the same type, even if they have different identifiers in the stores' records – instead of individual products. Of course, this choice brings some shortcomings, for example that we are not able to detect the impact of the promotion of an individual product on the other products of the same family. Moreover, aggregation at the family level necessarily masks differences between individual products within the same family, such as variation in shelf life, demand patterns, or consumer preferences between for instance different apple varieties. As a result, the analysis reflects average family-level inventory dynamics rather than product-specific responses to promotions. Finally, it should be remarked that we could not distinguish different types of promotions in the analysis, that is planned promotions vs. short-term promotions specifically

intended to push the sales of products with surplus stocks. This might be taken into account in further studies on this topic.

5. Conclusions

This study shows that lower relative surplus rates are observed during promotional weeks for retail fresh FV. While lower relative surplus rates are observed during promotional weeks, the analysis does not provide econometric evidence of a causal effect. The average surplus was 10.4% in value terms, ranging from 10 to 30% depending on product family. The highest surplus levels were observed for highly perishable items such as lettuces, consistently exceeding 15%. During promotion weeks, the relative surplus rate decreased on average from 11.3% to 8.3%, even though absolute surplus volumes rose with higher sales. Significant reductions were observed in several highly perishable product families, such as lettuces, grapes, and green beans, with decreases of more than 2 percentage points. These findings underline that promotions, when strategically applied to short shelf-life products, can accelerate turnover and help address overordering, the main driver of food waste. Of course, the use of promotions as a strategy to reduce surplus does not imply that overordering should not be addressed as a primary cause, for example through more accurate demand forecasting. Although limited to two stores and without distinguishing between promotion types, the evidence provided in this paper suggests that well-designed promotions represent a practical and scalable tool for preventing waste at the retail level, in line with the food waste hierarchy's top priority, especially where the rate of surplus is higher.

CRediT authorship contribution statement

Clara Cicatiello: Writing – original draft, Methodology, Formal analysis, Data curation. **Mattias Eriksson:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization. **Roberta Pietrangeli:** Writing – original draft, Methodology, Formal analysis. **Erik Svensson:** Writing – review & editing, Software, Formal analysis, Data curation. **Christopher Malefors:** Writing – review & editing, Formal analysis, Data curation. **Emanuele Blasi:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization.

Declaration of competing interest

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

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Data availability

The authors do not have permission to share data.

References

Aschemann-Witzel, J., de Hooge, I., Normann, A., 2016. Consumer-related food waste: role of food marketing and retailers and potential for action. J. Int. Food Agribus. Mark. 28 (3), 271–285. https://doi.org/10.1080/08974438.2015.1110549.

Aschemann-Witzel, J., 2018. Helping you to waste less? Consumer acceptance of food marketing offers targeted to food-related lifestyle segments of consumers. J. Food Prod. Market. 24 (5), 522–538.

Brancoli, P., Lundin, M., Bolton, K., Eriksson, M., 2019. Bread loss rates at the supplier-retailer interface–analysis of risk factors to support waste prevention measures. Resour. Conserv. Recycl. 147, 128–136.

Brancoli, P., Rousta, K., Bolton, K., 2017. Life cycle assessment of supermarket food waste. Resour. Conserv. Recycl. 118, 39–46.

Buzby, J.C., Bentley, J.T., Padera, B., Ammon, C., Campuzano, J., 2015. Estimated fresh produce shrink and food loss in US supermarkets. Agriculture 5 (3), 626–648.

Calvo-Porral, C., Medín, A.F., Losada-López, C., 2017. Can marketing help in tackling food waste?: proposals in developed countries. J. Food Prod. Market. 23 (1), 42–60.

Cicatiello, C., Franco, S., Pancino, B., Blasi, E., Falasconi, L., 2017. The dark side of retail food waste: evidences from in-store data. Resour. Conserv. Recycl. 125, 273–281.

Cicatiello, C., Secondi, L., Principato, L., 2019. Investigating consumers' perception of discounted suboptimal products at retail stores. Resources 8 (3), 129.

Cicatiello, C., Franco, S., 2020. Disclosure and assessment of unrecorded food waste at retail stores. J. Retailing Consum. Serv. 52, 101932.

De Hooge, I.E., 2025. Increasing the purchase intentions for suboptimal products: comparing potential marketing strategies. Food Qual. Prefer. 123, 105314.

De Hooge, I.E., Oostindjer, M., Aschemann-Witzel, J., Normann, A., Loose, S.M., Almli, V.L., 2017. This apple is too ugly for me!: consumer preferences for suboptimal food products in the supermarket and at home. Food Qual. Prefer. 56, 80–92.

De Moraes, C.C., de Oliveira Costa, F.H., Pereira, C.R., Da Silva, A.L., Delai, I., 2020. Retail food waste: mapping causes and reduction practices. J. Clean. Prod. 256, 120124.

Eriksson, M., Strid, I., Hansson, P.A., 2014. Waste of organic and conventional meat and dairy products—A case study from Swedish retail. Resour. Conserv. Recycl. 83, 44–52.

Eriksson, M., Strid, I., Hansson, P.A., 2012. Food losses in six Swedish retail stores: wastage of fruit and vegetables in relation to quantities delivered. Resour. Conserv. Recycl. 68, 14–20.

Eriksson, M., Ghosh, R., Mattsson, L., Ismatov, A., 2017. Take-back agreements in the perspective of food waste generation at the supplier-retailer interface. Resour. Conserv. Recycl. 122, 83–93.

Eurostat, 2025. Food waste and food waste prevention – estimates - year 2023. Available online at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Food_waste_and_food_waste_prevention_-_estimates. Accessed on 13 March 2026.

Evans, J.R., 2011. Retailing in perspective: the past is a prologue to the future. Int. Rev. Retail Distrib. Consum. Res. 21 (1), 1–31.

Ganglbauer, E., Fitzpatrick, G., Comber, R., 2013. Negotiating food waste: using a practice lens to inform design. ACM Trans. Comput. Hum. Interact. 20 (2), 1–25.

Gravert, C., Mormann, M., 2025. In-store food promotions increase sales as well as household food waste. Sci. Rep. 15 (1), 1–10.

Gruber, V., Holweg, C., Teller, C., 2016. What a waste! exploring the human reality of food waste from the store manager's perspective. J. Publ. Pol. Market. 35 (1), 3–25.

Helmert, J.R., Symmank, C., Pannasch, S., Rohm, H., 2017. Have an eye on the buckled cucumber: an eye tracking study on visually suboptimal foods. Food Qual. Prefer. 60, 40–47.

Huang, I.Y., Manning, L., James, K.L., Grigoriadis, V., Millington, A., Wood, V., Ward, S., 2021. Food waste management: a review of retailers' business practices and their implications for sustainable value. J. Clean. Prod. 285, 125484.

Lebersorger, S., Schneider, F., 2014. Food loss rates at the food retail, influencing factors and reasons as a basis for waste prevention measures. Waste Manag. 34 (11), 1911–1919.

Magalhães, V.S., Ferreira, L.M.D., Silva, C., 2021. Using a methodological approach to model causes of food loss and waste in fruit and vegetable supply chains. J. Clean. Prod. 283, 124574.

Mattsson, L., Williams, H., Berghel, J., 2018. Waste of fresh fruit and vegetables at retailers in Sweden–Measuring and calculation of mass, economic cost and climate impact. Resour. Conserv. Recycl. 130, 118–126.

Mena, C., Terry, L.A., Williams, A., Ellram, L., 2014. Causes of waste across multi-tier supply networks: cases in the UK food sector. Int. J. Prod. Econ. 152, 144–158.

Pietrangeli, R., Cicatiello, C., Galli, F., Carbone, A., Cacchiarelli, L., Sorrentino, A., Russo, C., 2025. Exploring the quality of commercial relations between producers and buyers in the fruit and vegetable supply chain. Sustainability 17 (6), 2641.

Priyadarshi, R., Panigrahi, A., Routroy, S., Garg, G.K., 2019. Demand forecasting at retail stage for selected vegetables: a performance analysis. J. Model. Manag. 14 (4), 1042–1063.

Ponis, S.T., Papanikolaou, P.A., Katimertzoglou, P., Ntalla, A.C., Xenos, K.I., 2017. Household food waste in Greece: a questionnaire survey. J. Clean. Prod. 149, 1268–1277.

Russo, C., Di Marcantonio, F., Cacchiarelli, L., Menapace, L., Sorrentino, A., 2023. Unfair trading practices and countervailing power. Food Policy 119, 102521.

Schrank, J., Hanchai, A., Thongsalab, S., Sawaddee, N., Chanrattanagorn, K., Ketkaew, C., 2023. Factors of food waste reduction underlying the extended theory of planned behavior: a study of consumer behavior towards the intention to reduce food waste. Resources 12 (8), 93.

Stancu, V., Haugaard, P., Lähteenmäki, L., 2016. Determinants of consumer food waste behaviour: two routes to food waste. Appetite 96, 7–17.

Tsalis, G., Jensen, B.B., Aschemann-Witzel, J., 2024. The relationship between retail price promotions and household-level food waste: busting the myth with behavioural data? Waste Manag. 173, 29–39.

Van Lin, A., Aydinli, A., Bertini, M., Van Herpen, E., Von Schuckmann, J., 2023. Does cash really mean trash? An empirical investigation into the effect of retailer price promotions on household food waste. J. Consum. Res. 50 (4), 663–682.

Wilson, N.L., Rickard, B.J., Saputo, R., Ho, S.T., 2017. Food waste: the role of date labels, package size, and product category. Food Qual. Prefer. 55, 35–44.

Wu, Q., Honhon, D., 2023. Don't waste that free lettuce! impact of BOGOF promotions on retail profit and food waste. Prod. Oper. Manag. 32 (2), 501–523.