



# A study examining the impact of supermarket shopping online vs. In-store on family food waste

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**Abstract:** The purpose of this research is to find out how much food waste families produce as a result of buying for groceries online vs in-store. Understanding how purchase behavior vary across various modes is vital for devising successful food-waste-reduction measures, especially with the rise of digital shopping platforms. Using data from both online and in-store shoppers, the study compares and contrasts important characteristics such shopping frequency, planning behaviors, impulsive purchasing, product visibility, and portion-size selections. The results show that online buyers are more likely to plan ahead, buy fewer impulsive items, and better manage their inventory, all of which lead to less food waste. Store marketing and visual stimulants, on the other hand, drive in-store customers to make more impulsive purchases, which means more wasted perishable goods. Targeted interventions, such as improved digital shopping tools, consumer education, and waste-reduction campaigns led by supermarkets, are needed to promote sustainable home food behaviors, according to the study.

**Keywords:** Online shopping, In-store shopping, Family food waste, Consumer behaviour, Supermarkets, Purchasing patterns, Waste reduction strategies

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## INTRODUCTION

Buying goods and services on the Internet is a new phenomenon. It has now spread to every continent, including India. While awareness of both online and offline shopping, particularly at super and hyper markets, is growing quickly in India, research into the factors impacting Indian consumers' online and offline purchasing habits is lacking. This is especially true in some cities where electronic shopping is still not as common as in other countries. Online purchasing has been the subject of several publications that have examined the aspects that impact it; however, no such study has been carried out in an Indian context.

Most studies of super market and hyper market shopping, whether online or offline, have taken place in countries with individualistic, more independent cultures; in contrast, Indian behaviour is seen as distinctive because of the country's collectivist cultural classification. This study aims to provide light on the purchase intentions of Indian customers. Before making a final purchase decision, the research examines the variables that cause customers to acquire products or services.

The purpose of this study is to add to what is already known about the variables that affect the purchase intentions of Indian consumers, both online and off, and more specifically, consumers in various cities. The results of this study might be useful not only for business leaders and marketers, but also for government organisations, web developers, web designers, and corporate management.

A conceptual model based on the Theory of Planned Behaviour is used in the study. By putting five basic model elements to the test, we can identify the most critical aspects impacting online and offline buying in Delhi NCR and other cities throughout India.

Because to technological advancements, we now have better chances of sellers reaching customers in a quicker, simpler, and more cost-effective manner. The internet now has the market's undivided attention. Online shopping has become the norm. Shopping in supermarkets and hypermarkets, on the other hand, has been steadily rising over the last few years. Many shoppers prefer to peruse products in person before making an online purchase so they can feel the item in their hands as soon as they pay for it. Reliability in today's market is dependent on the capacity to consistently provide customers with quality, value, and happiness. There are those who like to shop online, others who prefer to buy offline, and still others who do both. The data achievement age consumer's preference for online vs brick-and-mortar businesses with relation to mega markets and hypermarkets is the primary subject of the research. People find it simpler to purchase online than in physical stores.

Consumers should be aware of the medium of purchase—whether it be internet buying or offline shopping at a hypermarket or supermarket—before making any purchasing decisions. It is up to the consumer to determine their own needs and goals in order to choose the best solution for them. From a managerial perspective, it is crucial to comprehend how consumers in this little universe may choose the precise medium for their product purchases. (Lai and Laing, 2000). In his opinion, it ranks as the third most important activity, after only accessing the internet for social purposes.

The internet has many uses; it can amuse us, connect us with others, and even help us purchase. However, after demonetization, online shopping and shopping at super and hyper markets have become more popular in India. Online purchasing behaviour or internet shopping is another name for what people do when they purchase online. The term "buying behaviour" refers to the actions of making a purchase using a web browser. Whether a consumer prefers to buy online or at a physical store, there are five universal procedures that apply to both methods. When consumers need a certain product or service, they look for information about it online, according to (Chiang and Dholskia, 2003; Lynch, Kent, and Srinivasan 2001).

However, many of them are actively seeking out comprehensive information; often, details on products that prospective buyers are interested in are what entice them to make a purchase. Online shoppers peruse a plethora of items before settling on the one that's ideal for them. After that, consumers make a purchase, and the site's after-sale services are finished. What matters most when purchasing online is the customer's mindset and actions. The unique selling points of online purchasing items have been the subject of earlier research. When it comes to buying products, most people want to feel and touch them before making a purchase. Unfortunately, online shopping doesn't meet this need.

The rise of internet shopping and the realisation that it will put pressure on offline shopping are both driven by the fact that people still don't have much time to buy offline, even when the working population is at its peak. In this particular domain, there is a severe lack of research. Some of the most common terms used to describe online stores include virtual store, online storefront, e-web store, e-shop, e-store, internet shop, web-shop, web-store, online store, and online store. Mobile commerce, sometimes known as e-commerce or m-commerce, is a growing industry that takes use of smartphones to facilitate online shopping via

mobile-friendly websites.

## **LITERATURE REVIEW**

Mistry K. (2020) Banks are required to regularly assess customer satisfaction in order to achieve the goal of the research, which is the effective utilisation of E-Banking services. The importance of happy customers cannot be overstated in the service sector, so this is necessary. The purpose of this proposal is to assess the degree of satisfaction among Gujarati residents who use online banking services. Less adoption of e-banking services is attributable, in part, to concerns about transaction security. The two main concerns that financial institutions have when trying to increase the use of electronic banking are security and hidden costs. Customers will have more trust in banks' E-banking services if these issues can be resolved. The results of this research show that different types of banking services are not interchangeable. The majority of respondents are happy with the services provided via ATMs, debit cards, and phone banking. Internet, mobile, and online banking all have reasonable levels of customer happiness, but credit card banking has the lowest degree of satisfaction of all of the E-Banking services.

Senthil Velumurugan M (2019) Consumers' knowledge, gender perceptions, perceived ease of use, perceived danger, and pleasure in the context of mobile phone use are the behavioural purposes that this research elucidated. The study took place in Chennai. In particular, it highlighted the fact that mobile phone apps have flourished in Chennai and that a large number of individuals rely on mobile phone service on a regular basis. Manufacturers of mobile phones would do well to pay close attention to the study's conclusions, which state that mobile phone makers must take into account customer intentions when designing their products. Consumers' behavioural intentions towards the use of information technology in mobile phones are measured on several dimensions, and this research adds to the existing data on these dimensions. Since there was only one dependent variable, five independent factors were examined in this research. The five hypotheses were further evaluated by factor analysis, one-way ANOVA, and a one-sample t-test. Consciousness, gender perception, perceived ease of use, perceived danger, and satisfaction were the five factors that emerged as significant in the findings.

A.F. Salam, Lakshmi Iyer, and Prashant Palvia. (2019) Their study aimed to shed light on the decision-making process behind online shopping by comparing offline and online decision-making and identifying the factors that influence customers' choices between the two. They also sought to understand how consumers gauge channels for their purchases. According to the research, women are more likely to purchase online than men. Due to a general lack of technological literacy, consumers aged 35 and older are less inclined to purchase online.

Ahasanul Haque (2018) examined variables impacting customers' propensity to purchase online, which may constitute a major challenge for the e-commerce and marketing industries. One hundred surveys were sent out to people living in BhilaiDurg (Twin City), namely those who shopped online and used Bhilai-Durg products. In order to assess the study's hypotheses, regression analysis was used to the data. Online buying is strongly correlated with age, income, and education level, according to their research.

Ainin Sulaiman, Noor Ismawati Jaafar and Parveen Kadam. (2018) investigated what elements have affected consumers' intentions to buy online. The researchers looked at the connection between four

independent variables—utilitarian value, hedonic value, security, and privacy—and purchasing intentions (the dependent variable). Using a non-probability sampling strategy, we gathered data from 200 college students who had shopped online at Traveloka.com. Multiple regression analysis was performed on the data. Value for money and safety are two factors that affect consumers' propensity to buy, according to this research. However, considerations of privacy and hedonic value did not influence the decision to buy.

Anthony d. Miyazaki & Ana Fernandez. (2018) investigated the effect of customer demographics on online shopping metrics including happiness with the experience, intent to buy again, frequency of online shopping, quantity of items bought, and total expenditure on online shopping using qualitative and quantitative research methods. The survey found that respondents' perceptions of online buying were favourable, and it also showed that demographic parameters such as age, gender, marital status, family size, and income had a major impact on online purchasing in India.

Aron M. Levin, Irvin P. Levin & Joshua A. Weller (2017). researched the most important aspects of customer behaviour and the connections between them from an e-marketing standpoint. Research on the effect of e-marketing on customers' decision-making processes in Jaipur was carried out. Everyone, regardless of gender or age, uses the internet, according to their research. While there is a correlation between gender and age, there is no correlation between gender and the characteristics of internet trading. The majority of those who took the survey are wary about making purchases on the internet due to safety worries. There was no systematic analysis of the first-time buyer's propensity to continue online shopping or their desire to intensify or pull more of the existing items accessible offline in relation to their influence on purchase intents and adoption phases.

## **OBJECTIVES OF THE STUDY**

1. To evaluate the amount of food that goes to waste by comparing households who mostly purchase online with those that shop in-store.
2. To compare and contrast the ways in which online and in-store grocery buyers approach tasks including planning, impulsive shopping, and inventory management.

## **RESEARCH METHODOLOGY**

Together with eight major Swedish supermarkets from two different chains, we carried out the natural field experiment. Following all applicable rules, we were able to get ethics permission from the University of Copenhagen, Department of Economics, Ethics board. In order to proceed with the survey portion, participants' informed agreement was obtained first. For two weeks, from March 8th to the 21st, 2021, we collected sales data. We randomly assigned consumers to one of four experimental settings when purchasing fresh vegetables, with prices held constant (Fig. 1). For the purpose of testing interventions that may reduce over-purchasing, we added two more conditions in addition to the Multi-Unit Promotion (1A; for example, "2 for 30 kr") and the Single-Unit Discount (1B; for example, "1 for 15 kr") conditions. To make the comparative price for buying one unit more noticeable, the Salience condition (1C) used a bigger text size (e.g., "Reg. price: 15.95 kr"). By doing so, the meager 0.95 kr (or around 6% per unit) savings from purchasing two goods rather than one becomes clearly apparent. A little speech bubble in the 1D Prompt condition read: "I am happy to come home with you if you will eat me." The premise here is that

the speech bubble should make people think about whether they'll buy both items in the next days. It subtly suggests that customers should purchase two, which makes them think again about the current situation.

Since fruits and vegetables account for over half of all food waste, we decided to concentrate on them. Six of the shops only had cucumbers in the trial, whereas two of the stores had both cucumbers and broccoli. Reasons for our selection of these two items are as follows. According to a Swedish food waste diary study that was carried out a year before our research, cruciferous vegetables like broccoli ranked first, while cucumbers and broccoli were among the top five fruits and vegetables that were most often discarded in Swedish homes. Based on our statistics, each shop sold an average of 309 units each day, which includes 370 cucumbers and 64 broccoli units, for a grand total of 43,246 goods. Furthermore, we are able to adjust single-unit discounts vs multi-unit offers since both goods are offered per unit, not by weight. Because each item comes in its own packaging, we can easily affix stickers encouraging customers to fill out the follow-up survey. Finally, we can assess food waste since both veggies, cucumber and broccoli, expire within a week and are always or frequently bought fresh, not frozen. Due to their large sales volume, these goods also helped supermarkets avoid in-store food waste by allowing them to swiftly alter stock levels depending on daily sales. The promotion price remained consistent across all situations ( $x$  for two and  $x/2$ ) for one. Cucumbers and broccoli couldn't have uniform pricing at all of the supermarkets due to their dispersed locations around the nation. All we asked was that throughout the two weeks of therapy, the prices remained the same at each retailer. The price for two cucumbers ranged from 28 kr in four shops to 30 kr in three of the eight retailers. Two cucumbers cost 24 kr at one shop. Two heads of broccoli will set you back either 15 or 22 kronor. Since we do not see any statistically significant variations between the two groups, we will just provide the combined findings.

Our primary product, cucumber, was randomly allocated two circumstances each shop, while broccoli, if available, was given two conditions as well. Hence, four different shops were used to examine each intervention. There is a total of 10 store-level trials, with two treatments tested in each. The 14-day test period was split into three periods using an A-B-A design. Each treatment was performed for 7 days in total. This allowed us to control for variations in the quantity of customers and variances in shopping behavior between weekdays and weekends. Throughout the first three days of the trial, the shops implement their primary intervention. The price displays are updated to reflect the second intervention on the fourth day. The first intervention is administered again over the last four days of the trial.

## **RESULT**

There was additional randomization in this treatment plan. The selection was made with an eye toward striking a balance between statistical strength and the practicality of implementation for the store's staff. We first classified the stores according to their sizes before randomly assigning them to treatments. Supermarkets of varying sizes are dispersed around the nation. A total of eight supermarkets, four big and four small, were part in the trial. We requested the stores to make signage that matched their corporate design when we handed them their treatments after randomization. We did this to reduce the possibility of experimenter demand effects and make sure the experiment was as natural as possible, which is essential for external validity. Thus, consumers had no idea an experiment was underway. Before using any signs,

we made sure they were compatible with the therapies by vetting them. We may compare the offers' causal influence on purchase quantity while controlling for store fixed factors using this technique. During the course of the trial, the same consumers may have shopped again at the same retailer. But with eight locations spanning the nation, it's implausible that they shopped at only two of the participating retailers. There was a high degree of statistical insignificance due to the large volume of consumers (350,000+) who shopped at the participating shops during the trial. It is also not apparent how within-shopper spillovers should impact our findings, given that the treatments were time-randomized.

We studied the data for 43,246 units bought throughout the trial, which is the number of in-store sales, at the daily level, for each shop and circumstance. Using a random effects model that accounts for baseline variables, we calculate the mean treatment effects:

$$\text{UnitsSold}(\log)_{jt} = \alpha + \alpha_1 \text{SingleUnitDiscount}_{jt} + \alpha_2 \text{Salience}_{jt} + \alpha_3 \text{Prompt}_{jt} + \gamma X_{jt} + \mu_j + \varepsilon_{jt} \quad (1)$$

The outcome variable, Units Sold ( $\log$ )<sub>jt</sub>, is defined by store (j) and day (t). The dummy variables, Single Unit Discount, Salience, and Prompt, are set to 1 when supermarket j is in the treatment group and 0 otherwise. X<sub>jt</sub> is a vector of store-specific observables that may be used to predict sales. We start with the Multi-Unit Offer condition. We adjust for the amount of customers and sales data from two weeks before the trial begins. Due to design constraints, we did not account for price variation inside shops throughout the trial. However, we did find that pricing varied between store locations, with urban businesses often charging more than their rural counterparts. We do a random effects regression, where  $\mu_j$  represents the random effect and  $\varepsilon_{jt}$  is the error term, to account for changes that were not detected. Since sales figures varied among shops, absolute figures aren't very instructive, thus we opted for the logarithmic form to make impact sizes in percentage terms easier to understand. The impact sizes from the survey may be more easily compared using the log form as well. At the level of products sold in stores, standard mistakes tend to congregate. Since the trials including cucumbers and broccoli were each randomly assigned, we consider them to be separate observations. It seems unlikely that the thousands of goods and deals shown in the shops would have any effect on one another in a natural field trial. On a daily basis, we track ten different retailers and items for a total of forty-two days. The number of observations for each treatment is purposefully kept almost equal: 35 for multi-unit, 34 for Salience, 35 for Prompt, and 36 for Single-Unit Discount.

The two-item Multi-Unit Offer (i.e., baseline condition) had 19.5% greater sales (measured in units sold) than the Single-Unit Discount condition ( $p < 0.001$ ), as predicted, according to the "Units sold in store" column of Table 1. This suggests that shoppers are swayed by retail promotions and buy 19.5% more food when the deal is offered in multiple units (e.g., "2 for x" instead of "1 for x/2"). After that, we looked at how well the two treatments cut down on unnecessary purchases. The results show that sales were 10.8% lower in the Prompt condition ( $p < 0.001$ ) and 9.1% lower in the Salience condition ( $p < 0.001$ ) when contrasted with the Multi-Unit Offer condition.

**Table 1: Shows the sales data collected in-store, while the second column shows the sales data collected via surveys.**

	Units sold in store relative to multi-unit	Follow-up survey reported purchases relative to multi-unit
Single-Unit Discount	- 0.178***	- 0.176*
	(0.020)	(0.084)
Salience	- 0.095***	- 0.088
	(0.018)	(0.070)
Prompt	- 0.114***	0.071
	(0.027)	(0.064)
Shoppers	0.0005***	
	(0.000)	
Week-2	- 0.0002***	
	(0.000)	
Week-1	0.0004***	
	(0.000)	
Store size		- 0.113
		(0.060)
Constant	3.774***	0.637***
	(0.224)	(0.259)
Observations	140	176
R2	0.837	0.067

Sales in the context of multi-unit offers serve as the benchmark. For column 1, we have 140 observations per shop every day. Two columns of survey replies show a total of 176. A two-week pre-sale window and the total number of shoppers are accounted for in column 1. We account for the size of the shop in column 2. For changes from 0 to 1, the percentage changes for binary predictors were computed as  $[\exp(\beta) - 1]100$ , while for moves from 1 to 0, it was  $[\exp(-\beta) - 1]100$ . Errors standardised in parentheses. With a significance level of \* $p < 0.10$ , \*\* $p < 0.05$ , and \*\*\*  $p < 0.01$ .

As a result, our field trial shows that multi-unit offers increase the amount purchased. While we go into greater depth in the overall subject, we also show two simple ways to cut down on over-purchasing, which might be counterproductive to merchants' goals of maximization of profits. The effect of multi-unit deals on food waste in homes is the subject of our next investigation.

### **Follow-up at-home survey**

We postulated that increased food waste in households would result from customers buying more food in the Multi-Unit Offer condition as compared to the other circumstances. A follow-up poll allows us to test this. We requested that grocery stores brand 21,000 veggies with little QR code stickers; this works out to 150 stickers per condition, day, shop, and product type (e.g., broccoli or cucumber). We were able to monitor the condition under which the product was bought without asking responders by using a unique QR code for each retailer, product type, and condition. This allowed us to attract their attention to the treatment. Using the stickers, we were able to encourage people to fill out a short, incentive-filled online survey. The stickers were designed to go in with the store's corporate aesthetic, so they were tiny and unobtrusive. They did not include any references to food waste, which helped prevent customers from accidentally purchasing veggies. By examining images of the screens, we were able to confirm their positioning. Customers were prompted to provide their email address in order to access the survey after they scanned the QR code. There are two reasons to ask for the email address. The first benefit is that we can manage who attempted to participate more than once, which nobody did. Furthermore, participants might be sent the survey link one week after they joined to give themselves plenty of time to eat or dispose of fresh vegetables, such broccoli, which has a shelf life of three to five days in the fridge. After completing the survey, participants were sent a code that could be scanned at checkout, giving them the equivalent of a \$10 (100 kr) voucher to use at the shop chain where they made their purchase. The quantity of things bought and whether or not they had eaten them were both recorded by the participants (a binary variable: Yes or No). (For a complete list of survey topics, see Supplementary Information A.) They were also asked about their purchasing habits and household demographics. Potential problems with survey measurements include desirability bias, respondents' lack of focus, or a misinterpretation of the question's meaning (e.g., "fully consumed" vs. "waste"). Since there is no reason to believe that these biases should differ consistently by condition, we are able to estimate treatment effects using our randomized controlled trial design. This is in contrast to typical consumer surveys, where it might affect the level effects.

The poll was filled out by 178 grocery store customers, which is around 1% of the total, which is normal for marketing studies like these. Two subjects were withdrawn from the research because they claimed to have bought nothing. Every treatment had an equal number of respondents (37 for Multi-Unit Offer, 51 for

Saliency, 38 for Prompt, and 50 for Single-Unit Discount), ruling out treatment-based self-selection in the survey ( $\chi^2(3) = 1.96, p = 0.580$ ).

We started by counting how much cucumbers and broccoli each participant said they bought. We estimate a one-level ordinary least squares regression with store-level standard errors clustered:

$$\text{UnitsPurchased}(\log)_i = \alpha + \alpha_1 \text{SingleUnitDiscount}_i + \alpha_2 \text{Saliency}_i + \alpha_3 \text{Prompt}_i + \gamma \text{StoreSize} + \epsilon \quad (2)$$

Store Size is a dummy variable that is set to 1 if the shop was a big store, Single-Unit Discount, Saliency, and Prompt are the treatment dummies, and  $y$  is the log of goods bought according to the survey. The individual observations are denoted by the subscripts ( $i$ ). In general, we see that the data from the follow-up survey mirrors the data from the in-store data. The results reveal that under the Multi-Unit Offer condition, participants bought 19.2% more units than under the Single-Unit Discount condition, as shown in the "Follow-up survey reported purchases" column of Table 1. To prove that the people who filled out the survey are typical consumers, consider that this figure is quite close to the real rise shown in the in-store sales data. Concurrently, we find that the Prompt condition and the Saliency condition both show a reduction in purchase amount of 7.4% and 8.4%, respectively, when compared to the Multi-Unit Offer condition. Although there is no difference between the in-store and at-home follow-up surveys in terms of point estimates, the Saliency and Prompt condition estimates are not statistically significant at conventional levels, most likely because the sample size was too small.

Then we looked at how many items were really eaten by the consumers. Here, we zero in on the 121 grocery store customers who said they bought two or more goods. Notably, we see that the only condition where all participants claimed to have eaten every last bit of food without any leftovers was the Single-Unit Discount condition. A two-proportion  $z$ -test showed that 12% of participants in the Multi-Unit Offer condition and 0% in the Single-Unit Discount condition did not finish their meal. The statistical analysis was done using  $z = 1.85, p = 0.064$ , and Cohen's  $h = 0.71$ . In addition, there was no statistically significant difference between the Prompt and Saliency conditions with respect to the percentage of participants who reported not finishing their food (Prompt:  $z = 0.345, p = 0.730$ , Cohen's  $h = 0.09$ ; Saliency:  $z = 0.902, p = 0.367$ , Cohen's  $h = 0.23$ ). The findings may be skewed due to the small sample size; so, we also conducted a controlled online survey to supplement the first, as will be detailed in the section below, and found the same thing.

As indicated in Table 2, we conclude by looking at the impact of demographics and purchasing behavior on our outcome variables. Not unexpectedly, the number of people living in a home was the most important factor in determining the total amount bought (refer to the "Units purchased" column in Table 2), with a 15.8% increase for every extra person living in the family. Upon adjusting for the size of the household, no other factor influenced the total amount spent. A larger household appears to consume all of the products to a slightly lesser extent when it comes to food waste (see the "Fully consumed" column in Table 2), but the effect is small and only marginally significant. Curiously, neither the quantity bought nor the amount of waste is altered by consumers' expectations that they are influenced by marketing methods, their frequency of overbuying, nor their tendency to make impulsive purchases.

**Table 2. Factors that influence the purchase, use, and anticipated consumption of units.**

	<b>Units purchased</b>	<b>Fully consumed</b>	<b>Consumption expectations</b>
Household size	0.147*	- 0.054*	- 1.807
	(0.054)	(0.021)	(1.122)
Nr. of kids	- 0.048	0.055*	1.966
	(0.049)	(0.062)	(0.852)
Shopping frequency	- 0.023	0.009	- 0.097
	(0.054)	(0.026)	(6.331)
Buy too much	- 0.007	- 0.069	- 2.626
	(0.009)	(0.030)	(1.533)
Buy unplanned	0.010	0.003	- 0.077
	(0.016)	(0.025)	(0.768)
Influenced by marketing	- 0.018	- 0.016	0.709
	(0.010)	(0.017)	(0.967)
Constant	0.276*	1.215***	95.642**
	(0.095)	(0.132)	(26.960)
Observations	175	175	175
R2	0.116	0.087	0.027

The quantity of broccoli or cucumbers bought is the quantity indicated as units purchased. This is a binary variable that takes the value 0 if all of the goods were eaten within a week after purchase. At the moment of purchase, consumers' expectations about the consumption of all items are measured on a consumption expectations scale that ranges from 0 to 100. Size of the household and the number of children are

continuous variables. On a scale from 1 to 7, with 7 indicating the most agreement, we assess shopping frequency (daily to weekly), purchase too much (unplanned), and marketing impact (influenced by marketing). Clustered by therapy, standard errors are shown in parentheses. This study highlights the need of conducting a natural field experiment to determine the impacts of offers on consumption and food waste (\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ ).

Taken together, the field trial and follow-up survey findings indicate that, in comparison to single-unit discounts, multi-unit in-store promotions impact purchase amount and result in higher home food waste.

The outdoor experiment has a few restrictions. Although we found a medium impact size for our primary treatment, our small sample size hampered statistical power. This was despite the fact that retailers put 21,000 stickers on vegetables to attract survey participants, which assured realism and generalizability. Furthermore, as previously stated, it is challenging to quantify real quantities of food waste in households as it is not feasible to monitor actual trash in consumers' homes. We finally gave in and started asking them whether they've eaten all the stuff they bought. We held off on asking participants specific questions like "what percentage of the edible part of the cucumber have you consumed?" since people's opinions on whether the cucumber's peel or the end of a broccoli stem are edible can differ. We may concentrate on the treatments' causal influence on our outcome variables in this randomized controlled trial since any biases or misconceptions should be equal across treatment groups. So that consumers would have to choose between increasing consumption or throwing away excess food, we chose cucumbers and broccoli, two foods that are either not often bought fresh and subsequently frozen or cannot be frozen. In line with this reasoning, studies have shown that people are more prone to discard perishable food that has been sitting in their fridge for a time, even when it hasn't really gone bad or expired. However, we cannot say for sure that consumers have discarded the food since our measure does not capture this data. A supplementary controlled online survey was subsequently administered in an effort to rectify a portion of these deficiencies. The poll has a high-power level, so we can confidently test our primary hypothesis: that multi-unit offers make household food waste more likely. The field trial and the controlled experiment together provide a strong test of how multi-unit offers affect food waste in households, albeit the former does give up some realism.

### **Online experiment**

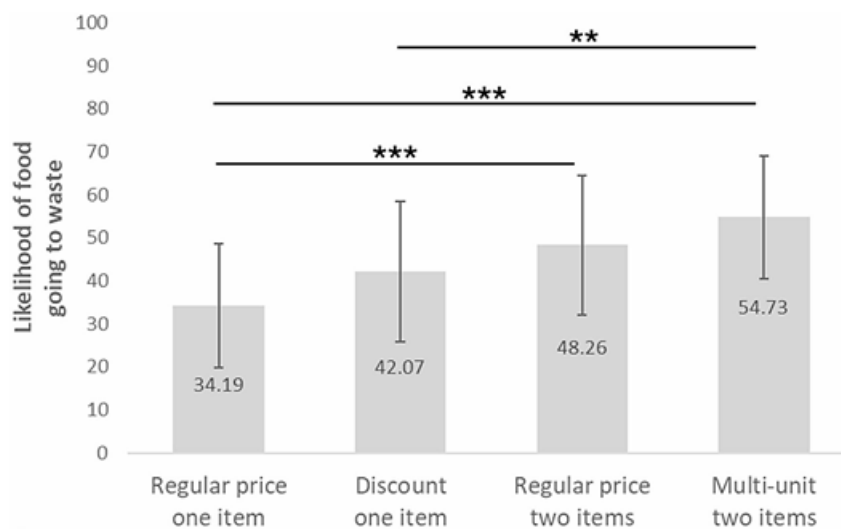
To test the hypothesis that multi-unit promotions increase household food waste, an online experiment was conducted. The study was preregistered as planned, and ethical approval was obtained from the Southern Methodist University Institutional Review Board. All procedures adhered to the required research guidelines. A sample size of 100 participants per condition was targeted, resulting in statistical power of 99%, which exceeds the commonly recommended threshold of 80%.

The final sample consisted of 397 participants from the United States, of whom 51% were female, with an average age of 42.58 years ( $SD = 12.22$ ). Data collection was carried out using Cloud Research. The experimental design followed an approach adapted from prior work by van Lin and colleagues.

Participants were asked to imagine a grocery shopping scenario in which they were purchasing ingredients for several meals, including fresh broccoli. They were randomly assigned to one of four conditions:

purchasing one bunch at regular price, purchasing two bunches at regular price, purchasing one bunch at a 50% discount, or purchasing two bunches for the price of one (multi-unit promotion). In conditions involving a promotion, participants were also shown a corresponding in-store display with a visual cue of the product.

After reading the scenario, participants rated the likelihood that some of the broccoli would spoil within the next few days. Responses were recorded on a scale ranging from 0 (very unlikely) to 100 (certain to occur). An attention check required participants to move a slider to a specified position. Based on preregistered criteria, 8 participants were excluded for failing this check. Additionally, 64 individuals were screened out before participation due to failing a preliminary two-question attention test.



**Figure 1. Impact of multi-unit offer on food waste in households. Standard deviation is shown by the bars.  $p < 0.10$ ,  $**p < 0.05$ , and  $***p < 0.01$  Other than that, there were no notable changes.**

Waste underwent a one-way analysis of variance. The mean values for all conditions are presented in Figure 2. Across conditions, food waste differed significantly ( $F(3, 385) = 8.01, p < 0.001, \eta^2 = 0.59$ ). Results from the Tukey post-hoc analysis indicate that participants who purchased multiple units reported higher levels of food waste ( $M = 54.73, SD = 28.75$ ) compared to those who bought a single item with a 50% discount ( $M = 42.07, SD = 32.50; p = 0.021$ ) and those who purchased one item at the regular price ( $M = 34.19, SD = 28.68; p < 0.001$ ). Furthermore, individuals who bought two items at full price ( $M = 48.26, SD = 32.45$ ) also reported significantly greater food waste than those who purchased a single item at full price ( $M = 34.19, SD = 28.68; p = 0.009$ ). These findings provide additional support for the idea that purchasing larger quantities leads to increased food waste at home. Apart from these differences, no other significant effects were observed. Overall, the results align with the field study and reinforce the hypothesis that multi-unit promotions contribute to higher levels of household food waste.

## DISCUSSION

Food waste is a global problem that significantly contributes to both hunger and environmental degradation. One important driver of this issue is retail promotion strategies. In particular, multi-unit offers—such as

“buy one get one free” or discounted bundles—encourage consumers to purchase greater quantities of food compared to single-item discounts. Evidence from field studies, household surveys, and online experiments consistently shows that these promotions not only increase purchase volume but also lead to higher levels of food waste at home.

These findings add to existing research on consumer behavior, retail promotions, and food waste. Consumers frequently make routine, low-effort purchasing decisions during everyday shopping, often without carefully evaluating actual needs. When stores present larger quantities as the default option through bundled offers, shoppers may unintentionally buy more than they can consume. While earlier research suggests that increased purchasing can lead to higher consumption rates, this study highlights an additional consequence: excess food is more likely to be discarded.

Buying food on sale results in reduced food waste compared to buying it at full price, according to two recent empirical studies. The conclusions of the present study vary from those of these two investigations; why is this? Customers could consciously seek out multi-unit discounts in both tests; that is, they could choose to shop at shops that offered multi-unit discounts for certain goods. According to previous research, price-conscious customers waste less food than their less price-conscious counterparts. This suggests that price-conscious consumers may actively seek out multi-unit deals to save food for later use. Our field trial, on the other hand, randomly subjects participants to in-store offers, ruling out the prospect that budget-conscious buyers might actively seek out discounts. We found that in our field trial, buying in bulk only resulted in average savings of around 6% of the purchase price, or less than 2 kr, or \$0.18. That these sales help those on a tight budget doesn't seem like a very compelling argument when you include in the money that will go to waste from wasted food. Instead, our online trial shows that single-unit discounts reduce food waste compared to multi-unit reductions, so shops may assist price-sensitive buyers out.

Additionally, we show two simple in-store interventions that help cut down on impulse buys. These outcomes did not achieve statistical significance, perhaps because of the small sample size, even though lowering over-purchasing should also minimize domestic food waste by causing customers to carry less unexpected product into their homes. We are unaware of any randomized controlled studies that have investigated the efficacy of treatments to decrease food waste in households, however there is little evidence that behavioral interventions may be used to decrease food waste in restaurants. Consistent with previous research on behavioral interventions, our results show that most nudges lead to modest to medium changes in behaviors like making better meal choices. This is particularly true in the food domain.

There are a number of significant policy implications offered by the present study. Reducing retail and home food waste worldwide by half is the target of United Nations Sustainable Development Goal 12.3. Implementing many legislative recommendations, such educating consumers about food waste via information campaigns or decreasing container size, may be a lengthy and complex process with questionable results. Contrarily, stores might instantly institute a policy of not offering multi-unit deals for very perishable veggies. More strict government control on food waste, including government regulation of multi-unit offers, would ideally be a beneficial byproduct of such a voluntary business effort. Customers would also have less work to do in attempting to absorb the informational barrage of in-store offers if this systematic adjustment were implemented. Given the perceived impracticality or political infeasibility of a

multi-unit price restriction, we provide two simple in-store interventions that may mitigate over-purchasing. In an effort to get people to think about their purchases more, both treatments tried to get them to switch off their automated "default" mode. Proposals to use dynamic pricing on perishable goods that are nearing their expiry date and would otherwise result in food waste in storage do not clash with our policy recommendations. These sales are usually for single units, and it's clear why they're on sale and that you should eat them right away.

Of all, most merchants' short-term profit-maximizing goals are at odds with the suggestions made above, which might explain the prevalence of multi-unit deals. While perishable goods like vegetables, bread, and dairy comprise a small percentage of most shops' product offerings, they are responsible for a disproportionately significant amount of food waste in households. As a result, these items might be the first to be regulated in relation to multi-unit offers. Therefore, the present study contributes to our understanding of the difficulties retailers have in juggling profit maximization with CSR initiatives including sustainability, governance, and environmental protection.

## **CONCLUSION**

The current study's findings give strong evidence that multi-unit promotional offers in stores greatly boost food purchases and, by extension, food waste in households. Consumers unwittingly purchase more than necessary when exposed to multi-unit offers, which are often shown as default options during regular, low-involvement shopping, according to results from a field trial, an at-home follow-up survey, and supplementary online research. Especially for perishable goods, this increase in purchasing quantity does not lead to increased consumption but rather increases unnecessary food waste in the home.

Crucially, this study elucidates the rationale for previous empirical investigations that concluded less food is wasted when prices are reduced: in those instances, buyers acted strategically by actively seeking out sales on multiple units, often storing or conserving what they had bought. We found that regular shoppers particularly those who aren't actively looking for sales are more likely to accidentally overbuy when given multi-unit offers, as our field study's randomized exposure prevented such self-selection. It is often believed that multi-unit offers are beneficial for low-income families. However, the monetary and environmental costs of the resultant food waste outweigh the marginal economic benefit of these promotions, which is around 6% of the product price.

Two easy, scalable in-store treatments that may assist reduce over-purchasing by influencing customers' subconscious decision-making processes are also identified in the research. These treatments show potential and are in line with the larger literature on behavioral nudges, which often result in modest but significant changes in food-related decisions; nonetheless, the reductions in food waste did not achieve statistical significance owing to sample size limits. Finally, this study adds to our knowledge of the ways in which advertising campaigns affect both consumer actions and the results of food waste. Academic literature and real-world attempts to construct more sustainable, food-secure systems are both enhanced by the research, which sheds insight on the unintended implications of multi-unit offers and proposes practical solutions.

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