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Article

Charging-for-Recycling Business Model and Consumer Adoption of Recyclable Electronics

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Abstract High costs of recycling operations have kept recycling rates low for many consumer electronics. Meanwhile, increasing the adoption of more recyclable electronics among consumers remains a challenge. Motivated by Best Buy's decision to charge consumers a flat fee to accept their used TVs/monitors for recycling, we study how charging for recycling would influence consumer adoption of recyclable electronics. Through experimental studies, and building on relevant behavioral insights (*nudging* and the theory of planned behavior), we compare the charging for recycling scenario with free recycling and recycling tax as current baselines. We find that, compared to the baselines, charging for recycling increases the adoption of recyclable electronics as long as consumers are not in emergency purchase situations. Our results suggest a potential alternative to unsuccessful direct green marketing and cast doubt on prohibiting retailers from charging for recycling.

Keywords sustainable business; recycling; circular economy; green marketing; business model

1. Introduction

Waste Electrical and Electronic Equipment (WEEE), also called e-waste, is a complex and fast-growing waste stream. Worldwide, e-waste is growing at an annual rate of 4–5% [1]. Of the various options for managing e-waste, recycling has proven to yield the most environmental benefits [2]. The inherent complexity of e-waste recycling however has been a burden to recycling operations and a discouraging factor to practitioners: "There is almost nothing as hard to recycle as electronics" [3]. Nonetheless, the majority of countries have mandated the collection of e-waste free of charge. While such policies have led to noticeable growth in the collection and recycling of some materials, e.g., steel and ferrous, they have not done the same for others, e.g., plastic and glass. Recycling rates remain low for the latter as recycling costs are relatively higher [2,4]. Overall, the high costs of recycling core materials have kept the recycling of e-waste far below an ideal point [1]. This casts doubt on prohibiting recyclers and retailers from charging for recycling, which can directly assist the operational costs of recycling chains.

Best Buy that operates one of the largest recycling networks for e-waste in the US was the first retailer that implemented a charging for recycling program. Under this new program, consumers need to pay $25 when they bring their used TVs/monitors to Best Buy for recycling, whereas previously Best Buy used to accept all such products for recycling free of charge.[1] Somewhat different from this program, California's Electronic Waste Recycling Act of 2003 charges consumers a small recycling fee, similar to a tax, on each purchase.[2] From the point of assisting with operational costs, charging for recycling can directly help manufacturers and recyclers manage their recycling costs based on their needs and can thus improve recycling rates of collected e-waste. Meanwhile, free recycling[3] (and recycling tax for that matter) hopes to keep the volume of product return at higher levels because charging can deter consumers from returning their products for recycling. Although many countries (including most starts in the US) have enacted bans on landfilling and/or incinerating large e-wastes such as TVs, monitors, and desktops, the main rationale of free recycling is to keep the product return a convenient option for consumers.

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[1] This new recycling program was implemented in all states except Illinois and Pennsylvania, where state laws bar retailers from charging for recycling (Best Buy has shut down its recycling program in these states).
[2] https://www.calrecycle.ca.gov/electronics/retailer
[3] By "free recycling" in this paper, we refer to the recycling that is free of charge for consumers.

From this point of view, Best Buy's charging-for-recycling program is a counterintuitive approach that does not keep the priority on increasing the volume of e-waste return.

In this paper, we explore an overlooked potential benefit of charging for recycling beyond merely assisting with the operational costs. We study whether charging for recycling, compared to free recycling and recycling tax as baselines, can result in higher consumer adoption of recyclable electronics. Increasing the recyclability of consumer electronics is a viable solution to low recycling rates of collected e-waste. For example, EPA's Energy Star Partner of the Year award in the US[4] is to encourage retailers to market and sell more recyclable electronics. However, evidence has shown that direct green marketing to increase consumer adoption of greener products is not a successful strategy in general (see, e.g., [5,6]), and subsequently, retailers do not find investing in green marketing financially attractive [6–8]. Hence, we explore a possible alternative to direct green marking that could potentially increase consumer adoption of green (recyclable)[5] electronics.

What motivates our exploration is two relevant behavioral factors: *nudging*, and the theory of planned behavior. In contrast to free recycling, charging for recycling can nudge consumers' attention towards the fact that recycling is costly, and thus recyclability is a valuable attribute. Furthermore, a definitive recycling fee (like Best Buy's $25) can improve consumers' perceived self-efficacy from taking eco-friendly action and paying more for recyclability. Lack of such self-efficacy has been proven to hinder people's environmental actions including their green purchases (see, e.g., [9–11]). We perform our exploration through controlled experimental studies (see [12] on using experimental methods to get insights on environmental policies). We use a subject-level measure for the adoption of the recyclable ("Green") version over the non-recyclable ("Standard") version in terms of the subject-level percentage of extra willingness to pay (WTP) for the former. In line with previous studies on consumer durables replacements (see [13] for a review) and emergency purchases (see [14]), we study regular (or new) purchase situations and emergency (or replacement) purchase situations separately as they have been proven to have different decision-making dynamics.

We find that, compared to free recycling and recycling tax scenarios as the baseline, charging for recycling increases regular buyers' adoption of recyclable electronics by around 5%. For emergency buyers, the adoption level remains the same as that in the baseline. This is in line with previous findings that emergency buyers' situation hinders them from paying more for environmental attributes [14]. Our findings have clear implications for green marketing and recycling operations. The most promising outcome in direct marketing of energy-efficient products has yielded an effect size of around 5% in consumer adoption while relying on incentives to salespeople and rebates to consumers [6]. Therefore, our observed effect is not negligible, especially because it comes as a byproduct of a recycling program and at no marketing cost. From an operational perspective, our results extend previous research that ties recycling operations to green marketing and contradict the conventional wisdom that favors free/promotional recycling as the beneficial bridge to coordinate the two (see, e.g., [15,16]). Our findings show that charging for recycling not only directly assists retailers with the operational costs of recycling, but can also help enhance the recyclability of products entering the economy in the first place, which is vital to creating an efficient circular economy [17,18].

The remainder of the paper is organized as follows: Section 2 reviews the related literature and builds the hypotheses; Section 3 describes the experimental design; Section 4 presents the results and analyses; and finally, Section 5 makes concluding remarks on the findings.

2. Hypotheses

Based on Best Buy's practice of charging for recycling, i.e., announcing its charging for recycling and its sale of green electronics at the same time, we postulate that charging for recycling at the purchase point would influence consumer purchasing behavior and lead to higher adoption of recyclable versions. We find two behavioral explanations most supportive of this postulation: nudging and the theory of planned behavior.

[4] https://www.epeat.net/resources/criteria-2 and https://www.energystar.gov/about/awards

[5] In general, the criteria of "green" products focuses on three main aspects: products being free of toxic compounds, being energy efficient, and being made of recyclable and renewable materials [19]. In this paper, our focus is on the recyclability aspect and we thus refer to the recyclable version as the green version.

Nudging, i.e., piquing attention through indirect interventions, has been used in many different contexts to lead people's actions in desired directions (see [20–22] for more discussion on *nudge*). The kind of *nudge* that aims to promote environmentally friendly actions is known as the *green nudge* [22]. To discuss nudging in our context, we draw a parallel with previous work on the provision of direct information to increase consumer adoption of green products. The first stream of work uses energy efficiency in green products to motivate consumers via savings in their electricity bills as a win-win benefit in purchasing such products (see, e.g., [23]). However, the work has found that direct provision of information is an unsuccessful marketing strategy to increase the sale of green products. For example, Allcott & Taubinsky (2015) [5] found that a significant portion of the market still preferred incandescent lightbulbs even after being fully informed about benefits of energy-saving lightbulbs, Kallbekken et al. (2013) [24] found that a salesperson's effort had no significant effect on the demand for energy-efficient products, and Allcott & Sweeney (2017) [6] found that incentivizing salespeople to provide consumers with information on the cost savings of energy-efficient water heaters had no effect on consumer demand. In contrast, there are reports of successful uses of *nudges* to reduce energy consumption among consumers. In their studies of comparison-based households' energy bills, Allcott (2011) [25], Ayres et al. (2013) [26], and Allcott & Rogers (2014) [27] found the comparison-based bill to be a successful *nudge* that reduced households' energy consumption. Similarly, Dolan & Metcalfe (2013) [28] found a significant reduction in energy consumption by nudging households to reduce their energy consumption to comply with social norms. In reducing households' water consumption, Ferraro & Price (2013) [29] found messages based on social norms and social comparisons to be more effective than instructive descriptions.

In parallel with the above, we postulate that charging for recycling at the purchase point will nudge consumer with the fact that "recycling is costly" and increase their valuation for recyclability. Consumers might have some knowledge of the expenses/harms that recycling imposes on society and the environment. What nudging does is to draw their attention to this fact at the purchase point, without which this knowledge might never come to the surface or effectively play its role at the decision point. To the best of our knowledge, our study is the first that explores a *green nudge* in the domain of consumer adoption of green products. It is worth noting that the lack of full awareness that sometimes appears in *nudges* and raises criticism of restricting people's autonomy to act upon their own preferences (see, e.g., [30]) does not apply to our context since we do not architect a *nudge* and rather investigate a byproduct of a recycling program as a *nudge*.

The theory of planned behavior (TPB) first proposed by Ajzan (1991) [31] has been widely used in studying people's green purchasing behavior (see, e.g., [9–11,32,33]). The main reasoning with TPB is that while one factor of the planned behavior (i.e., attitude) is predominantly in favor of environmentally friendly purchases, the other factor (i.e., perceived behavioral control) is not always realized and thus hinders the final behavior. According to TPB, the nature of the perceived behavioral control is uncertainty about how impactful people think their actions would be on the environment. This concern has been found to be a significant determinant of eco-friendly behavior (see, e.g., [9–11]). We postulate that charging for recycling will induce a belief in consumers that not buying recyclable products imposes equivalent monetary costs to the environment. This monetary and relatable instrument makes it clearer to consumers what impact they are making on the environment by adopting recyclable versions and will thus enhance the perceived behavioral control. The improved self-efficacy in making an eco-friendly action will in turn close the gap in TPB and result in paying more for recyclable versions. Combining the two reasonings above, we summarize our expectations in the following hypothesis:

HYPOTHESIS 1. *Compared to free recycling, charging for recycling will increase the adoption of recyclable versions of products*.

Although compared to free recycling both charging for recycling and a recycling tax collect recycling fees from consumers, there are fundamental differences between them. In contrast to charging for recycling, a recycling tax is reflected as mandatory price inflation at the purchase point. Successful *green nudges* motivate people towards voluntary rather than forcible contributions to environmental protection actions [22]. Being mandatory and tying the *nudge* to purchase costs rather than recycling costs disturbs these dynamics with the recycling tax. Furthermore, one of the main reasons behind the success of nudging households with their neighbors' energy consumption is that the information is delivered to the households together with their energy bills, which makes the information salient and thus works as a *nudge* [22,25,27]. In contrast to charging for recycling that charges the recycling fee explicitly for accepting the product for recycling, the recycling tax charges a fee for selling the product. This does not fit well in tying the information to the right activity and in order to create an informational *nudge*.

From the TPB point of view, by collecting a fee at the purchase point, the recycling tax suggests to consumers that they are already paying their contributions to the environment and will thus leave no room for further pro-environmental actions at the purchase point. In this vein, Merritt et al. (2010) [34] discuss how one act of pro-social behavior can suppress further actions by making people feel as if they have done "enough". With the charging for recycling program, the same pro-environmental action (i.e., paying for recycling) is tied with the recycling action and thus does not interfere with or hinder the other pro-environmental action at the purchase point (i.e., paying more for the recyclable version). These postulations lead us to the following hypothesis:

HYPOTHESIS 2. *Compared to recycling tax, charging for recycling will increase the adoption of recyclable versions of products*.

Bao & Ho (2015) [35] discuss that a *nudge* can have heterogeneous effects on people's decisions depending on the circumstances of the situation they are in. In his study of nudging households with comparison-based energy bills, Allcott (2011) [25] found that households with consumption above average started to decrease their energy usage, while those with consumption below average tended to increase their usage. Similarly, in their study of retirement savings, Beshears et al. (2015) [36] found that peer information increased savings among non-unionized recipients but decreased it among unionized recipients, due to differences in norms between these two groups of workers. In this vein, Bronchetti et al. (2011) [37] segmented people based on their financial limitations and found that opt-in/out defaults had no impact on the saving behavior of low-income tax filers as they had strong intentions to spend their refunds. More related to our study, Samson & Voyer (2014) [14] discuss that emergency purchases, compared to regular purchases, are more prevention-focused, and thus emergency buyers are only willing to spend on necessary attributes and not much on environmental attributes in products.

In a broader view, emergency purchases for consumer electronics can be considered as replacement purchases, for which previous research has found more nuances in behavioral influences compared to new purchase situations [13,38]. Bayus (1991) [39] and Cripps & Meyer (1994) [40] found that purchases due to product failure are based on different decision-making processes than regular purchases. Park & Mowen (2007) [41] found a different behavior in hedonic versus utilitarian replacement purchases. Therefore, we define emergency/replacement buyers as those who are buying a new TV to replace their broken TV, and regular/new buyers as those who are just buying a new TV. Based on the previously established evidence noted above, we postulate that for emergency buyers, the cost-oriented nature of emergency purchases will overshadow the nudging effects of charging for recycling.

HYPOTHESIS 3. *The effect of charging for recycling in increasing the adoption of recyclable versions will be stronger for regular buyers compared to emergency buyers*.

Other consumer heterogeneities in the market that can segment consumers into sub-groups are usually age, gender, education, annual income, etc. Houde (2014) [42] discusses such heterogeneities in consumer adoption of energy-efficient products (in response to direct green marketing) by relating that to consumer sophistication with respect to collecting and processing direct information. One of the main issues widely discussed for direct green marketing of energy-efficient products is consumers' cognitive limitations that can vary with consumer heterogeneities. For instance, direct green marketing urges consumers to evaluate the cost-benefit of paying a higher purchase price for energy-efficient products in exchange for obtaining energy bill savings in the future [43,44]. In contrast, *green nudges*, e.g., nudging households with neighbors' energy consumptions, are found to be successful by going around such cognitive limitations [22,25,27]. Therefore, upon HYPOTHESIS 3 characterizing the main source of difference in consumer behavior, we expect that charging for recycling, as a *green nudge*, will have a homogenous effect across all consumers irrespective of the aforementioned heterogeneities. This expectation is also in line with previous findings in nudging in other contexts. For example, in their study of how students' performance was influenced by learning their relative ranks, Azmat & Iriberri (2010) [45] found a homogeneous nudging effect for both genders after differentiating the effect for the tails of the distribution from middle-rank students. The following hypothesis summarizes:

HYPOTHESIS 4. *The effect of charging for recycling in increasing the adoption of green versions will be robust to consumer heterogeneity*.

3. Experimental Study

3.1. Design

To gain insights on supporting or rejecting our hypotheses, our experimental design is to compare charging for recycling with free recycling and recycling tax for both emergency and regular purchase situations. To keep in line with reality, we choose $25 as the dollar amount of charging for recycling.[6] Since Best Buy only charges this for TVs/monitors, we use a TV as the electronic product in our experiment. With California's Electronic Waste Recycling Act, the fee charged at the purchase point is based on the size of the purchased electronic product, which is $7 for products larger than 35 inches. Hence, we choose $7 as the recycling tax on the purchased TV in our experiment. We use the technical specifications of a real market TV (product specifications are available in the Appendix) and create two identical versions of the TV, Standard and Green, where "designed for increased recyclability"[7] is the only extra attribute in the Green version.

Similar to real market situations, where consumers discover one version of a product first and then find about the other version, participants in our experiment are first offered one version of the TV (Standard or Green)[8] and after indicating their WTPs for that version are offered both versions and asked to indicate their WTPs for both. Participants are allowed to change their starting WTPs for the Standard (or Green) version after being offered the other. We use participants' final WTPs for the Green and Standard versions in the analysis to extract their adoption of the Green version. Realistically, participants' starting WTP might influence their following WTPs for the Green and Standard versions and hence the gap between them by taking effect as an arbitrary anchor [46–48]. However, the measure of adoption we use in our analyses nullifies possible anchoring effects from the starting WTP and enables us to extract the adoption of the Green version free of subject-level factors.

We use the subject-level percentage of extra WTP for the Green version relative to the participant's own WTP for the Standard version as the measure of adoption. We refer to this variable as (extra WTPG)% and compare its average between different experimental groups rather than simply comparing the average of extra WTP for the Green version between different groups. This variable further allows us to investigate both the mere adoption—through (extra WTPG)% > 0—and the intensified adoption—through the value of (extra WTPG)%—in our between-group compositions.

To separate the purchase situations, for emergency/replacement buyers the situation involves participants replacing a broken TV with a new one, and for regular/new buyers the situation involves purchasing a new TV. Together with the two baseline scenarios and the charging for recycling scenario, this creates a 3 × 2 design as summarized in Table 1. We discuss the experimental descriptions in detail in Section 3.3.

Table 1. Experimental framework.

	Regular/New Purchase	Emergency/Replacement Purchase
Free recycling	• Recycling is free of charge • Already have a TV (in good condition) at home, and wanted to buy another one for another room	• Recycling is free of charge • Current TV not working anymore, and need to buy a new one
Recycling tax	• $7 recycling fee on the purchase price • Already have a TV (in good condition) at home, and wanted to buy another one for another room	• $7 recycling fee on the purchase price • Current TV not working anymore, and need to buy a new one
Charging for recycling	• $25 charge for recycling • Already have a TV (in good condition) at home, and wanted to buy another one for another room	• $25 charge for recycling • Current TV not working anymore, and need to buy a new one

[6] $25 was the dollar amount back to when running our experiments, and Best Buy has now increased it to $29.99.
[7] This is the phrase that is being used in the marketing of Green TVs/monitors by Best Buy and is a description of EPEAT-registered electronics as well.
[8] This ordering is counterbalanced in the experiment, and we perform further analyses to ensure that the results are independent of the ordering.

3.2. Incentive Compatibility, Social Desirability and Attention Check

To capture the exact setting and time point of decision making, e.g., deciding to purchase a new TV while already owning a broken one, we use vignette-based experiments and ask participants to indicate their WTPs assuming the described purchase situation. There is ample evidence that if designed properly, respondents' decisions do not differ significantly for vignettes and real situations and the experiment could yield comparable insights (see [49] and references therein). For example, Hardisty & Pfeffer (2017) [50] used vignette-based experiments to study manipulations of hyperbolic discounting where participants chose between current and future payoffs. More similar to our context, Ungemach et al. (2018) [51] used vignette-based experiments to study consumer preference between environmentally friendly and regular cars.

As Meloy et al. (2006) [52] discuss, vignette-based designs are of particular importance in environmental studies (e.g., green purchase behavior, environmentally friendly actions, etc.) where incentive-aligned payment often hinders understanding people's intrinsically motivated behaviors. Furthermore, the comparison-based approach of our study together with the nature of the adoption measure we use enable us to go around the need for incentive compatibility to obtain reliable results. In particular, we do not use the raw gap in participants' WTPs for the Green and Standard versions in our analyses and rather utilize participants' extra WTP for the Green version relative to their own WTP for the Standard version. More importantly, we compare participants' adoption of the Green version under the charging for recycling scenario with that under the baseline scenarios. This enables us to isolate and measure the net difference that the charging for recycling scenario makes. Hence, any possible price inflation for the Green version (due to lack of incentive compatibility) is canceled out in extracting the net difference and the results are driven purely by the effect of charging for recycling.

The social desirability effect, or the Experimenter Demand Effect (EDE), is considered as any change in experimental subjects' decisions due to what might constitute appropriate behavior [53]. In other words, subjects may give priority to being "good subjects" and feel committed to making a decision that assists the experimenter. As Zizzo (2010) [53] discusses, this can be an issue in environmental/social studies from two points: first, using an incentive-compatible design and inducing to participants to maximize their monetary benefits may deter them from their environmental/social utilities in honoring the induced, desired performance; second, if the environmentally/socially conscious decision is positively correlated with experimenter demand (i.e., if participants show environmental/social consciousness in their decision because of assuming that it is what the experimenter is looking for), that would lead the results in a biased direction. Our experimental study nullifies the latter by using the comparison-based design as explained above. In comparison-based designs, there are comparable sources of environmental/social desirability in both the treatment and the control (baseline) groups. In our experiment, in both the charging for recycling scenario and the free recycling and recycling tax scenarios, participants have comparable opportunities to show a socially desirable decision (i.e., paying more for the Green version) if they are under the influence of EDE. This neutralizes the effect of EDE and ensures that any net difference in the adoption level is merely driven by the hypothesized effects.

To filter out inattentive respondents and ensure the reliability of the collected responses, we use a strict attention check question at the end of the experiment. Abbey & Meloy (2017) [54] discuss a wide range of attention check questions commonly implemented in vignette-based experimental designs. Our attention check question (available in the Appendix) is designed to test participants' attention to two key points in the descriptions: first, whether the purchase situation was a regular/new purchase or an emergency/replacement purchase; and second, whether the recycling was free or there was a charge associated with it.

3.3. Descriptions

The experimental description includes three main parts: first, a starting description with manipulation on the purchase situation (regular/new vs. emergency/replacement); second, a description for manipulation on the recycling scenario; and third, a description stating the difference between the Standard and Green versions of the TV. Full experimental descriptions are available in the Appendix.

The experimental description starts with telling participants whether the situation is a regular/new or an emergency/replacement purchase. For the former, we ask participants to imagine they *already have an almost-new TV at home and are thinking about buying an extra one for another room*. For the latter, we ask participants to imagine their *TV is not working anymore and that they need to buy a new one*.

The second part of the description creates the treatment effect regarding the recycling scenario. In doing so, we try to match the description with Best Buy's announcement on its charging for recycling program as much as possible. With the free recycling scenario, the description mentions that the retailer *also has a recycling program and accepts broken TVs for recycling free of charge*, in line with Best Buy's previous free recycling program. With the charging for recycling scenario, the description mentions that the retailer *also has a recycling program and, due to the cost of managing TV recycling, charges $25 to accept broken TVs for recycling*. This short description captures Best Buy's announcement about its recycling program together with the reasoning behind it as mentioned in the announcement. We avoid adding any further detailed information in the interest of having the best reflection of reality. For the recycling tax scenario, the description mentions that the retailer *also has a recycling program and, due to the cost of managing TV recycling, charges a $7 recycling fee in addition to the sale price for all TVs, regardless of the brand or technical specifications*. We do not use the word "tax" in the description because the $7 fee associated with California's Electronic Waste Recycling Act of 2003 is not labeled as "tax" in practice. The descriptions use the same wording when describing the recycling scenario for both regular/new and emergency/replacement purchase situations. This leaves the difference between the two purchase situations only to the first part of the experimental description. Using the word "*broken*" in this part ensures aligning the descriptions between the two parts for the emergency/replacement purchase situation in which participants face *broken TVs*.

The experimental descriptions were refined through several pre-runs where participants were asked to provide explanations behind their thinking. This open-ended question similar to the one used by Ball et al. (2001) [55] that "asked subjects to describe their thought process and strategy for participating in the auction" helped us ensure the clarity of the descriptions to participants without having to list further detailed information in the descriptions.

The last part of the experimental description presents the technical specifications of the TV (be it Standard or Green version) alongside the picture of the TV and asks participants about their WTPs for the offered TV. For the Green version, the description clearly states that this version *also is a Green TV, designed for increased recyclability at its end of life*. Upon indicating their WTP for the offered version (be it Standard or Green), participants go to the next stage where they are first reminded about the WTP they indicated for the offered version and then are told to *assume* that they *find there is also a Green [or Standard] version of that TV*, wherein both versions are shown together. The description points out clearly that both versions have *the exact same features* except for *the increased recyclability in the Green version*. Participants are asked that in light of this new information what their WTPs are for each of the TVs. In the recycling tax scenario, participants are asked to indicate their WTP *inclusive of the $7 fee*, in order to capture the final price paid for the TV as in reality.

3.4. Procedure

We recruited a sample of 838 participants (46.5% female, 53.1% male, and 0.4% preferred not to indicate their gender; M_{age} = 39.8 and SD = 12.1) through Amazon Mechanical Turk (AMT) and paid a flat fee for their participation (the same as similar studies in AMT, e.g., [51]). The payment proportionally was over the minimum wage per hour at the time the experiment was run. Participants were eligible to participate if they were at least 18 years old and resided in the US. Upon agreeing to participate in the study, participants were randomly assigned to one of the six experimental groups (see Table 1) and were asked about their WTPs for the Standard and Green TVs in the order explained in the previous section. In all groups, following the main experimental task, participants also provided an explanation of their thinking behind their decision. We also asked participants about the clarity of the descriptions and experimental tasks. The average clarity score on a 1–5 scale (5 being the highest) was 4.5. The experiment ended with the attention check question and demographic questions. A majority of the participants (73.6%) indicated having earned a bachelor's degree or having a college-level credit. The average income level was between $26,000–$75,000, and most of the participants had an income level between $26,000–$50,000.

4. Results and Analyses

Among 838 participants, around 5–7 in each group (36 in total; 4.3%) indicated that WTPs for the Green TV were lower than their WTPs for the Standard TV. Based on their explanations, we call them anti-Green participants, i.e., consumers with strong doubts about green and environmentally friendly products [56]. The exclusion or inclusion of these participants in the sample does not make a difference in the main results and findings, so we keep them in the sample as we do not have a predetermined reason to exclude them. We filter out responses based on the attention check question, which yielded a rejection rate under 22.1%.[9] Finally, we exclude six participants who were not able to enter a valid number as to their WTPs in either/both of the questions.

The focal point of our analyses is on the effect of charging for recycling on the subject-level percentage of extra WTP for the "Green" version, which we have defined as the measure of adoption. We refer to this variable as (extra WTPG)%. In analyzing this variable, our experiment uses a between- and within-subject mixed model design: having three recycling policies as a between-subject manipulation while measuring within-subject WTPs for the Standard and Green versions. In addition, the two purchase situations (regular vs. emergency) and the two orders (Standard first vs. Green first) add to the between-subject manipulation. Hence, in total, our experimental design is a 3 × 2 × 2 × 2 mixed model based on recycling scenario × purchase situation × order × product version. Before going into the details of analyzing our main variable (extra WTPG)% through regressions, it is worth analyzing this mixed model in order to uncover sources of variation in that. We use mixed-model ANOVA, which is the perfect methodology for a mixed between- and within-subject experimental design [57,58].

Table 2 shows that the mixed-model analysis suggests a statistically significant effect from the recycling scenario under some conditions. The first row of Table 2 shows that there is a statistically significant difference between WTPs for the Green and Standard versions. The second row shows that without differentiating the purchase situation, recycling scenario manipulation has no statistically significant effect on the within-subject difference between WTPs for the Green and Standard versions. However, the third row uncovers that depending on the purchase situation, the recycling scenario can indeed increase the within-subject extra WTP for the Green version. Finally, the last row shows that the order in which participants discover the first version has no statistically significant effect on the effect from recycling scenario manipulation.

Table 2. Mixed-model analysis.

	Full Model		
Term	***F***	**Power**	**Effect Size**
version	201.74**	0.241	1.000
version×policy	0.32	0.001	0.100
version×policy×purchase	4.15*	0.013	0.733
version×policy×purchase×order	0.92	0.003	0.210

Note: Effect size is based on partial-eta-squared. Power reflects observed power.
*Significant levels: * = 0.05 and ** = 0.01.*

To further explore whether the observed effect from recycling scenario manipulation is driven by the charging for recycling scenario, the recycling tax scenario, or both, Table 3 repeats the same analysis of Table 2 by contrasting only two of the recycling scenarios (charging for recycling vs. other policies, recycling tax vs. other policies, and free recycling vs. other policies). In this case, the mixed-model design reduces to 2 × 2 × 2 × 2, which allows us to isolate the observed effect for different recycling scenarios. Table 3 shows that it is indeed the charging for recycling scenario that compared to free recycling and recycling tax scenarios makes a statistically significant difference on participants' extra WTP for the Green version.

[9] Given its relatively small size (see [54] that discuss data exclusion rates in attention check failures), inclusion of these responses in the analyses did not change the final results nor it influenced the significance levels and only slightly changed the p-values.

Table 3. Mixed-model analysis with charging for recycling scenario *vs* other recycling scenarios.

	(**a**)			(**b**)			(**c**)		
	Full Model			**Full Model**			**Full Model**		
Term	***F***	**Power**	**Effect Size**	***F***	**Power**	**Effect Size**	***F***	**Power**	**Effect Size**
version	190.10**	0.229	1.000	158.74**	0.198	1.000	191.88**	0.230	1.000
version×policy	0.45	0.001	0.102	0.42	0.001	0.099	0.00	0.000	0.050
version×policy×purchase	5.54*	0.009	0.652	0.18	0.000	0.071	7.25**	0.011	0.767
version×policy×purchase×order	0.36	0.001	0.092	0.78	0.001	0.142	1.84	0.003	0.272

Note: Effect size is based on partial-eta-squared. Power reflects observed power.
*Significant levels: * = 0.05 and ** = 0.01.*

The results of the mixed-model ANOVA suggest that it is worth conducting subsequent detailed analyses to further understand the observed effect on (extra WTPG)%. These detailed investigations would determine whether our hypotheses in Section 2 are supported. We structure our subsequent analyses based on analyzing the effect of charging for recycling on the adoption of the Green version for the two purchase situations (Analysis 1), further analyzing the robustness of the effect to common consumer heterogeneities in direct green marketing (Analysis 2), and characterizing the effect in terms of green market expansion and green market intensification (Analysis 3).

4.1. Analysis 1: Charging for Recycling and Adoption of the Green Version in Regular/New and Emergency/Replacement Purchase Situations

The mixed-model ANOVA uncovered what influenced any change in participants' WTPs for the Green and Standard versions. Here, we aim to compare participants' adoption of the Green version in different groups. To do so, we statistically compare the average adoption measure (extra WTPG)% under the charging for recycling scenario with that under free recycling and recycling tax scenarios as the baselines. Given our hypotheses structure and what was uncovered in the mixed-model analysis, we perform this comparison separately for the regular/new and the emergency/replacement purchase situations. Figures 1 and 2 show the average (extra WTPG)% for each experimental group. In the regular/new purchase situation, charging for recycling increases the average of (extra WTPG)% by 4.9 compared to free recycling (t = 2.687, $p < 0.004$) and by 3.4 compared to the recycling tax (t = 1.704, $p < 0.046$). However, it makes no difference for the emergency/replacement purchase situation, compared to free recycling (t = 0.152, $p >$ 0.879) and compared to the recycling tax (t = 0.416, $p > 0.678$).

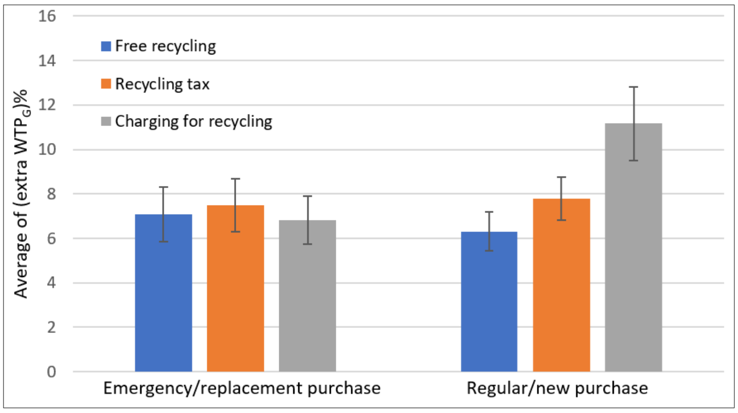
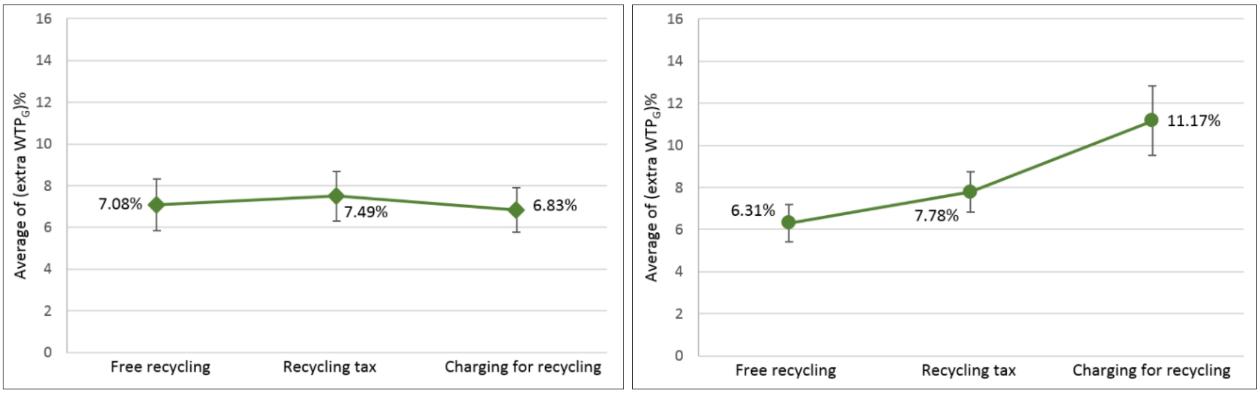


Figure 1. Average of (extra WTP$_G$)% for the two purchase situations with the three recycling policies. Note: Error bars are standard errors of means (SEM).



Emergency/replacement purchase Regular/new purchase

Figure 2. The effect of charging for recycling on the average of (extra WTP_G)% for the two purchase situations. *Note: Error bars are standard errors of means (SEM).*

Our analysis reveals that in line with our expectations in HYPOTHESIS 1 and 2, charging for recycling increases participants' adoption of the Green version through increasing their (extra WTPG)%, compared to both free recycling and recycling tax scenarios. Moreover, the results show that as predicted in HYPOTHESIS 3, the cost-oriented nature of the emergency/replacement purchase situation does not let the effect realize under this purchase situation, hence the adoption remains at the same level as in the baselines. This result also provides supporting evidence for Samson & Voyer's (2014) [14] observation that compared to regular purchase situations, decision-making in emergency purchase situations is more prevention-focused and hinders paying for extra environmental attributes. It is also worth noting that with the adoption level remaining unchanged in all scenarios under the emergency/replacement purchase situation, the results endorse that our experimental design does not fall under issues pertinent to the social desirability effect (see Section 3.2). This ensures the reliability of the extracted difference in the adoption level between the charging for recycling group and the baseline groups for the regular/new purchase situation.

4.2. Analysis 2: Robustness of the Effect to Consumer Heterogeneity beyond the Purchase Situation

Our analysis here aims to explore whether the observed effect is robust to consumer heterogeneity besides the main segmentation considered in Analysis 1. We use participants' demographics, i.e., gender and age, to define consumer heterogeneity, which is a common approach in marketing studies. We separate the participants into young (*ageL*) and senior (*ageH*) based on the cut-off age of 40 which was the average age of participants. In segmenting the participants into male and female groups, we exclude those participants (0.4% of the experimental pool) who did not indicate their gender. We start by repeating the mixed-model analysis of Table 2 considering gender and age extra sources of between-group manipulation. This results in a 3 × 2 × 2 × 2 × 2 × 2 mixed-model. Table 4 shows the results of this analysis. Neither age nor gender has a statistically significant effect on the difference between participants' WTPs for the Green and Standard versions under any of the recycling scenarios or purchase situations.

Table 4. Mixed-model analysis including participants' demographics.

	Full Model		
Term	***F***	**Power**	**Effect Size**
version	203.58**	0.254	1.000
version×policy	0.02	0.000	0.053
version×policy×ageH	0.46	0.002	0.124
version×policy×male	0.07	0.000	0.060
version×policy×ageH×male	0.74	0.002	0.176

Table 4. (*Continued*)

version×policy×purchase	4.24*	0.014	0.742
version×policy×purchase×ageH	0.31	0.001	0.099
version×policy×purchase×male	1.03	0.003	0.231
version×policy×purchase×ageH×male	1.00	0.003	0.225
version×policy×purchase×order	1.22	0.004	0.267
version×policy×purchase×order×ageH	0.18	0.001	0.079
version×policy×purchase×order×male	1.12	0.004	0.248
version×policy×purchase×order×ageH×male	0.92	0.003	0.210

Note: Effect size is based on partial-eta-squared. Power reflects observed power.
*Significant levels: * = 0.05 and ** = 0.01.*

We further perform regression analyses including participants' demographics. We run the following regression that considers dummy variables *ageH* and *male* together with the three recycling scenarios for both the regular/new and the emergency/replacement purchase situations:

$$\begin{aligned}(extra\ WTP_G)\%_i &= \alpha_0 + \alpha_1(ageH)_i + \alpha_2(male)_i + \alpha_3(ageH \times male)_i + \alpha_4(recycling\ tax)_i \\ &+ \alpha_5(recycling\ charge)_i + \alpha_6(recycling\ tax \times ageH)_i + \alpha_7(recycling\ charge \times ageH)_i \\ &+ \alpha_8(recycling\ tax \times male)_i + \alpha_9(recycling\ charge \times male)_i \\ &+ \alpha_6(recycling\ tax \times ageH \times male)_i + \alpha_7(recycling\ charge \times ageH \times male)_i + \varepsilon_i\end{aligned} \tag{1}$$

Table 5 shows the result of this regression and that the observed effect remains statistically independent of participants' demographics.[10]

Table 5. The observed effect in Analysis 1 considering the participants' demographics in the analysis.

	Regular/New Buyers	**Emergency/Replacement Buyers**
_intercept	6.45** (1.992)	9.47** (2.309)
ageH	1.87 (3.052)	0.09 (3.295)
male	−1.05 (2.577)	−5.94 (3.066)
ageH×male	−1.51 (4.436)	3.28 (4.545)
recycling tax	2.40 (2.950)	3.24 (3.732)
recycling charge	8.60** (3.052)	1.09 (3.266)
recycling tax×ageH	−2.75 (4.432)	−3.88 (5.214)
recycling charge×ageH	−6.17 (4.404)	−3.30 (4.620)
recycling tax×male	−0.35 (4.037)	−0.32 (4.697)
recycling charge×male	−7.28 (4.029)	1.00 (4.377)
recycling tax×ageH×male	1.15 (6.567)	−1.75 (6.912)
recycling charge×ageH×male	8.51 (6.292)	−1.80 (6.410)
R^2	0.05	0.04
Adjusted R^2	0.02	0.01

*Note: Parenthesis includes standard errors. Significant levels: ** = 0.01.*

[10] It is noted that the low R-squares in regression models are due to the nature of the dependent variable (extra WTPG)%, as its value cannot be directly driven by the magnitude of the recycling charge or recycling tax and is rather an indicator of the participants' adoption of the Green version. It is not uncommon to have these levels of R-squares in regressions, considering the nature of dependent or independent variables (see, for example, Allcott & Sweeney's (2017) [6] regression results with low R-squares in the range of 0.01, 0.02, 0.04, 0.05 in a context similar to ours).

It is worth noting that the measure we use for the adoption of the Green version, (extra WTPG)%, isolates the extracted effect from participants' income levels altogether. This was an important consideration because it is plausible that for the same TV, a participant with a high-income level might indicate a higher WTP than a participant with a low-income level. Similarly, it might also be the case that the participants' starting WTPs, taking the role of an arbitrary anchor [46–48], may further influence their extra WTPs for the Green version. However, neither of these will cause issues when using the measure (extra WTPG)% as it rules out the effect of the income level. To further confirm this, we run a linear regression that considers the participant's starting WTP as a potential anchor together with the effect of different recycling policies under the two purchase situations. Since starting WTPs can potentially be higher in the Green-first order compared to the Standard-first order, we further consider an extra interaction term for the Green-first order to capture this possibility:

$$
\begin{aligned}
(extra\ WTP_G)\%_i \\
&= \alpha_0 + \alpha_1(starting\ WTP)_i + \alpha_2(starting\ WTP \times GreenFirst)_i + \alpha_3(recycling\ tax)_i \\
&+ \alpha_4(recycling\ charge)_i + \varepsilon_i
\end{aligned}
\tag{2}
$$

Table 6 shows the result of this regression and that participants' starting WTP has zero effect on their adoption of the Green version irrespective of the recycling scenario and purchase situation.

Table 6. The effect of starting WTP on the adoption of the Green version.

	Regular/New Buyers	**Emergency/Replacement Buyers**
_intercept	6.31** (1.766)	4.75** (1.819)
starting WTP	0.00 (0.003)	0.00 (0.002)
starting WTP×GreenFirst	0.00 (0.003)	0.00 (0.002)
recycling tax	1.50 (1.735)	1.19 (1.713)
recycling charge	4.71** (1.662)	0.16 (1.598)
R^2	0.04	0.03
Adjusted R^2	0.03	0.02

*Note: Parenthesis includes standard errors. Significant levels: ** = 0.01.*

Our analysis above supports our Hypothesis 4 that, apart from the main source of difference considered in Hypothesis 3, the observed effect from charging for recycling is robust to common sources of consumer heterogeneity. This result is in line with previous findings in *nudge*, for example, Azmat & Iriberri's (2010) [45] observation, that while a *nudge* can have heterogeneous effects in the presence of a strong source of change in behavior, it is robust to common sources of consumer heterogeneity.

4.3. Analysis 3: Characterizing the Effect in Terms of Green Market Expansion and Green Market Intensification

Our analysis here explores whether charging for recycling increases the number of participants with (extra WTP)% > 0 or only intensifies the (extra WTP)% among participants. To do so, we first separate the portion of participants with (extra WTP)% > 0 in each group. Figure 3 shows that the size of this portion remains roughly the same across all groups (between 60–70%). Moreover, as Figures 4 and 5 illustrate, we obtain a similar trend for participants with (extra WTP)% > 0 to what we previously observed for all participants in Analysis 1. That is, in the regular/new purchase situation, charging for recycling increases the average of (extra WTPG)% by 6.3 compared to free recycling ($t = 2.964$, $p < 0.002$) and by 5.2 compared to the recycling tax ($t = 2.043$, $p < 0.022$), however, it makes no difference for emergency/replacement purchases compared to free recycling ($t = 0.193$, $p > 0.847$) and compared to the recycling tax ($t = 0.213$, $p > 0.831$). Furthermore, Tables 7–10 show that we obtain similar qualitative results with mixed-model analysis and repeating Analysis 2 on consumer heterogeneity for participants with (extra WTP)% > 0.

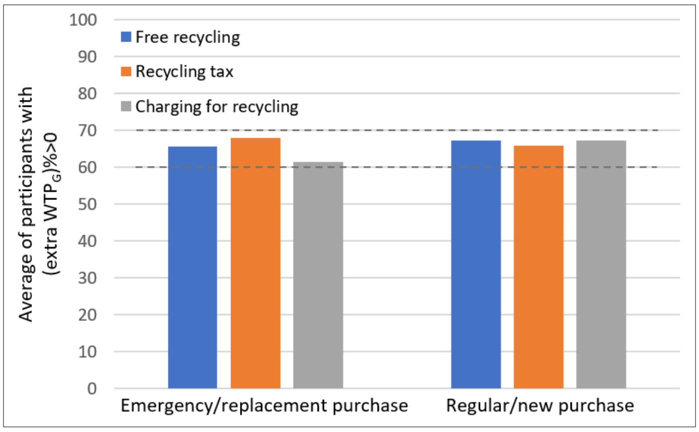


Figure 3. The portion of participants with (extra WTP_G)% > 0 for the two purchase situations with the three recycling policies.

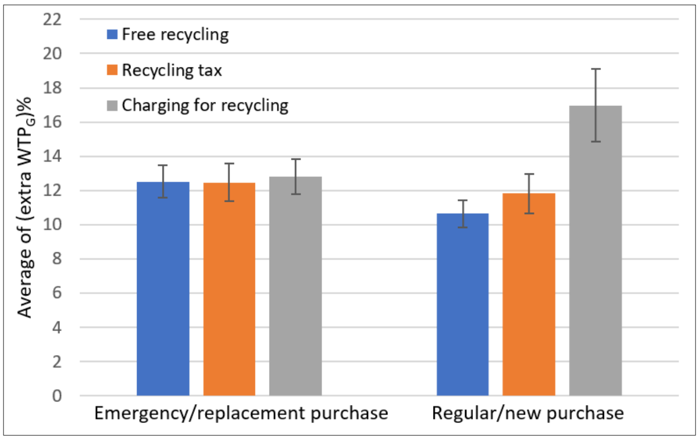
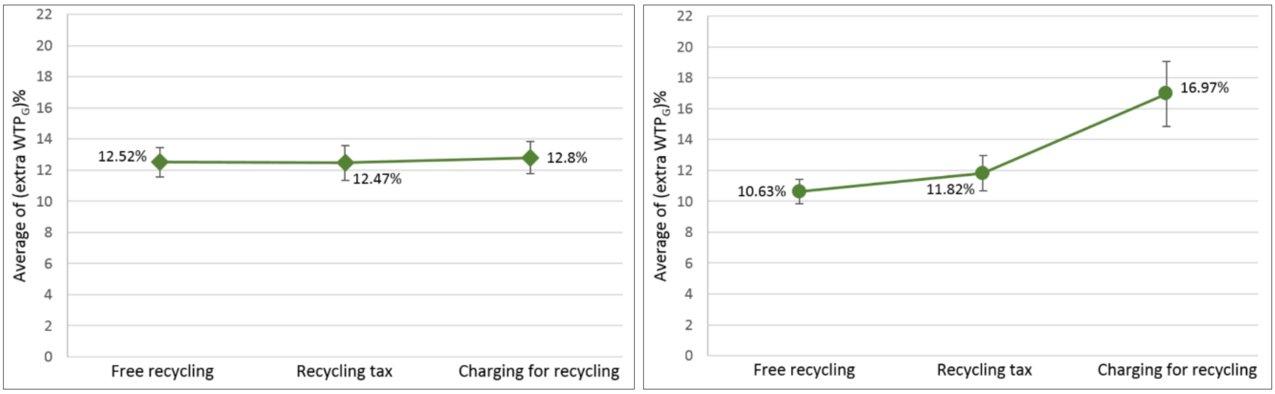


Figure 4. Average of (extra WTP_G)% for the two purchase situations with the three recycling policies for participants with (extra WTP_G)% > 0. *Note: Error bars are standard errors of means (SEM).*



Emergency/replacement purchase Regular/new purchase

Figure 5. The effect of charging for recycling on the average of (extra WTP_G)% for the two purchase situations for participants with (extra WTP_G)% > 0. *Note: Error bars are standard errors of means (SEM).*

Table 7. Mixed-model analysis for participants with (extra WTP_G)% > 0.

	Full Model		
Term	***F***	**Power**	**Effect Size**
version	298.92**	0.419	1.000
version×olicy	1.06	0.005	0.235
version×policy×purchase	4.06*	0.019	0.721
version×policy×purchase×order	0.23	0.001	0.086

Note: Effect size is based on partial-eta-squared. Power reflects observed power.
*Significant levels: * = 0.05 and ** = 0.01.*

Table 8. Mixed-model analysis including participants' demographics for participants with (extra WTP_G)% > 0.

Term	Full Model		
	F	**Power**	**Effect Size**
version	279.61**	0.425	1.000
version×olic	0.42	0.002	0.117
version×polic×ageH	0.56	0.003	0.143
version×polic×male	0.59	0.003	0.149
version×polic×ageH×male	0.81	0.004	0.189
version×policy×purchase	3.29*	0.017	0.623
version×policy×purchase×ageH	0.74	0.004	0.175
version×policy×purchase×male	1.24	0.007	0.270
version×policy×purchase×ageH×male	1.16	0.006	0.254
version×policy×purchase×order	0.10	0.001	0.065
version×policy×purchase×order×ageH	0.62	0.003	0.154
version×policy×purchase×order×male	1.85	0.010	0.384
version×policy×purchase×order×ageH×male	0.49	0.003	0.130

Note: Effect size is based on partial-eta-squared. Power reflects observed power.
*Significant levels: * = 0.05 and ** = 0.01.*

Table 9. The observed effect in Analysis 1 considering participants' demographics for participants with (extra WTP_G)% > 0.

	Regular/New Buyers	**Emergency/Replacement Buyers**
_intercept	11.27** (2.212)	13.52** (1.931)
ageH	0.69 (3.409)	0.33 (2.764)
male	−1.68 (5.893)	−2.90 (2.644)
ageH×male	−0.04 (5.202)	1.48 (4.015)
recycling tax	4.07 (3.474)	2.84 (3.053)
recycling charge	7.96* (3.298)	1.80 (2.764)
recycling tax×ageH	−4.31 (5.097)	−2.94 (4.388)
recycling charge×ageH	−5.22 (4.824)	−2.18 (4.020)
recycling tax×male	−3.32 (4.640)	−1.69 (3.964)
recycling charge×male	−3.77 (4.591)	−2.07 (3.782)
recycling tax×ageH×male	2.627 (7.627)	−1.47 (5.980)
recycling charge×ageH×male	5.59 (7.289)	2.45 (5.767)
R^2	0.07	0.05
Adjusted R^2	0.02	0.00

*Note: Parenthesis includes standard errors. Significant levels: * = 0.05 and ** = 0.01.*

Table 10. The effect of starting WTP on the adoption of the Green version for participants with (extra WTP_G)% > 0.

	Regular/New Buyers	Emergency/Replacement Buyers
_intercept	12.96** (2.061)	13.56** (1.652)
starting WTP	0.00 (0.004)	0.00 (0.002)
starting WTP×GreenFirst	0.00 (0.003)	0.00 (0.002)
recycling tax	0.60 (2.071)	−0.10 (1.501)
recycling charge	5.98** (1.968)	0.05 (1.448)
R^2	0.07	0.02
Adjusted R^2	0.05	0.00

*Note: Parenthesis includes standard errors. Significant levels: ** = 0.01.*

Our analysis shows that charging for recycling shows its effect through intensifying the adoption of the Green version among the participants with (extra WTP)% > 0 rather than increasing the number of such participants. In other words, charging for recycling influences those participants with slight intentions to pay for environmentally friendly and green attributes. This is in line with Bao & Ho's (2015) [35] observation that informational *nudges* in the domain of environmentalism have stronger effects on people with slight pro-social intentions. This further supports our general expectation in HYPOTHESES 1 and 2 that charging for recycling will improve self-efficacy in the consumer side to act upon their pre-existing environmental intentions. Nonetheless, the analysis shows that our expectation in HYPOTHESIS 3 that the cost-oriented nature of the emergency/replacement purchase situations will hinder such effects still applies.

5. Discussion and Conclusions

5.1. Theoretical Implications

In this paper, we examined the effect of charging for recycling on consumer adoption of recyclable electronics. Our experimental findings showed that compared to free recycling and recycling tax scenarios, charging for recycling enhances the adoption of recyclable version by around 5%. This finding is rewarding from the green marketing point of view given that costly direct green marketing strategies have been unsuccessful in increasing consumer adoption of energy-efficient products [6–8]. Comparing it to one of the most promising findings in this area, which has found a 5% increase in the adoption of energy-efficient products by incentivizing salespeople and rebating consumers [6], the observed effect here has merits as an alternative green marketing strategy.

As an indirect *nudge*, charging for recycling can also avoid the green marketing myopia that occurs with some green advertisements [59]. It can go around cognitive limitations such as hyperbolic discounting that deter consumers from paying more for energy efficiency [43,44] and can be immune to common consumer heterogeneity issues in direct green marketing [42]. In addition, direct green marketing mostly focuses on energy efficiency by highlighting the pecuniary benefits to consumers from saving energy, which limits its application to products with high energy consumption such as air conditioners, refrigerators, washing machines, and dryers [60]. Charging for recycling, however, uses the recyclability aspect which applies to a wider range of all consumer electronics irrespective of their energy consumption level.

Moreover, based on previous studies on the strong positive correlation between green purchasing behavior and recycling behavior [61], one can also hope that consumer adoption of recyclable products will also result in a higher willingness to recycle at the recycling point. As Merritt et al. (2010) [34] discuss, a pro-social behavior of adopting a recyclable version may induce more pro-social behavior such as commitment to recycling at the end of the product life, in line with the abundant evidence that inducing commitment can make a significant long-term effect on recycling behavior (see, e.g., [62–65] for a review).

5.2. Practical Implications

The observed effect in this paper was merely a byproduct of a recycling program that primarily aims to assist retailers with the operational costs of recycling. Therefore, any positive impact though small is an extra benefit for retailers and the environment. One can make the most of this positive impact by adjusting the recycling charge such that it maximizes the overall impact in terms of both assisting with the operational costs and increasing the sales of recyclable products. Through this multi-objective approach, charging for recycling can thus go beyond being a simple *nudge* and become a well-adjusted leverage to control the scale of the *nudge* it provides, as the ultimate use of *nudge* [66].

Our findings also suggest that prohibiting retailers from charging for recycling may be counterproductive from a circular economy perspective. Free recycling that has been widely pursued in many countries primarily aims to increase the number of products returned for recycling in the economy as the initial step in creating a circular economy (see [67,68] for a conceptual framework, and [69] for a thorough review). However, it may fail to achieve its objective for two reasons: first, retailers may be forced to leave the recycling business if they cannot manage its operational costs; and second, free recycling fails to lead consumer attention to recyclable products at the point of purchase. Without entering recyclable products into the economy in the first place, merely increasing the volume of product returns cannot translate into more recycling towards a circular economy. Our findings suggest that charging for recycling can be an effective solution to both.

5.3. Limitations

Similar to any research, our study has limitations. Firstly, our study was conducted within a vignette-based experimental setup. Although, as discussed in Section 3.2, such a setting best serves our study's objectives, it remains crucial to assess the impact within real market conditions. Secondly, imposing charges for recycling could dissuade customers from returning their broken/old TVs for recycling, potentially leading them to opt for disposal instead. Hence, in regions where discarding broken TVs is not prohibited charging for recycling might diminish customers' willingness to recycle. Thirdly, our study was limited solely to TVs. Therefore, the generalizability of our findings to all consumer electronics is not assured. It is plausible that variations in product type and size could potentially influence the outcomes. For example, customer behavior might differ for products like cellphones, which are easier to discard, compared to TVs, which are not easily abandoned or disposed of in regular waste.

Data Availability

The data are available from the author on request.

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Conflicts of Interest

The author has no conflict of interest to declare.

References

1. Baldé, C. P., Wang, F., Kuehr, R., & Huisman, J. (2015). *The global e-waste monitor-2014*. United Nations University, IAS–SCYCLE.
2. Demeester, L., Qi, M., & Van Wassenhove, L. N. (2013). Plant networks for processing recyclable materials. *Manufacturing & Service Operations Management*, *15*(4), 670–688. https://doi.org/10.1287/msom.2013.0437
3. Securis. (2017). *America's Electronic Waste Problem*. http://www.securis.com/lets-talk-about-americas-electronic-waste-problem (accessed 15 November 2023).
4. US EPA. (2016). *Advancing sustainable materials management: 2014 fact sheet*. U.S. Environmental Protection Agency, Office of Resource Conservation and Recovery. http://www.epa.gov/sites/production/files/2016-11/documents/2014_smmfactsheet_508.pdf (accessed 15 November 2023).
5. Allcott, H., & Taubinsky, D. (2015). Evaluating behaviorally motivated policy: experimental evidence from the lightbulb market. *The American Economic Review*, *105*(8), 2501–2538. https://doi.org/10.1257/aer.20131564
6. Allcott, H., & Sweeney, R. L. (2017). The role of sales agents in information disclosure: evidence from a field experiment. *Management Science*, *63*(1), 21–39. https://doi.org/10.3386/w20048
7. Deutsch, M. (2010). Life cycle cost disclosure, consumer behavior, and business implications. *Journal of Industrial Ecology*, *14*(1), 103–120. https://doi.org/10.1111/j.1530-9290.2009.00201.x

8. Deutsch, M. (2010). The effect of life-cycle cost disclosure on consumer behavior: Evidence from a field experiment with cooling appliances. *Energy Efficiency*, *3*(4), 303–315. https://doi.org/10.1007/s12053-010-9076-4
9. Ellen, P. S., Wiener, J. L., & Cobb-Walgren, C. (1991). The role of perceived consumer effectiveness in motivating environmentally conscious behaviors. *Journal of Public Policy & Marketing*, *10*(2), 102–117.
10. Berger, I. E., & Corbin, R. M. (1992). Perceived consumer effectiveness and faith in others as moderators of environmentally responsible behaviors. *Journal of Public Policy & Marketing*, *11*(2), 79–89.
11. Rice, G., Wongtada, N., & Leelakulthanit, O. (1996). An investigation of self-efficacy and environmentally concerned behavior of Thai consumers. *Journal of International Consumer Marketing*, *9*(2), 1–19. https://doi.org/10.1300/J046v09n02_01
12. Shogren, J. F. (2002). Micromotives in global environmental policy. *Interfaces*, *32*(5), 47–61.
13. Guiltinan, J. (2010). Consumer durables replacement decision-making: An overview and research agenda. *Marketing Letters*, *21*(2), 163–174. https://doi.org/10.1007/s11002-009-9085-2
14. Samson, A., & Voyer, B. G. (2014). Emergency Purchasing Situations: Implications for Consumer Decision Making. *Journal of Economic Psychology*, *44*, 21–33. https://doi.org/10.1016/j.joep.2014.05.004
15. Westley, F., & Vredenburg, H. (1991). Strategic bridging: The collaboration between environmentalists and business in the marketing of green products. *The Journal of Applied Behavioral Science*, *27*(1), 65–90. https://doi.org/10.1177/0021886391271004
16. Shrum, L. J., Lowrey, T. M., & McCarty, J. A. (1994). Recycling as a marketing problem: a framework for strategy development. *Psychology & Marketing*, *11*(4), 393–416. https://doi.org/10.1002/mar.4220110407
17. Geyer, R., Kuczenski, B., Zink, T., & Henderson, A. (2015). Common misconceptions about recycling. *Journal of Industrial Ecology*, *20*(5), 1010–1017. https://doi.org/10.1111/jiec.12355
18. Zink, T., & Geyer, R. (2017). Circular economy rebound. *Journal of Industrial Ecology*, *21*(3), 593–602. https://doi.org/10.1111/jiec.12545
19. Speer, M. (2011). *What is a Green Product?* http://www.isustainableearth.com/green-products/what-is-a-green-product (accessed 15 November 2023).
20. Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving Decisions about Health*. Yale University Press.
21. Leonard, T. C. (2008). Richard H. Thaler, Cass R. Sunstein, Nudge: Improving decisions about health, wealth, and happiness. *Constitutional Political Economy*, *19*(4), 356–360. https://doi.org/10.1007/s10602-008-9056-2
22. Schubert, C. (2017). Green nudges: Do they work? Are they ethical? *Ecological Economics*, *132*, 329–342. https://doi.org/10.1016/j.ecolecon.2016.11.009
23. Allcott, H., & Greenstone, M. (2012). Is there an energy efficiency gap? *The Journal of Economic Perspectives*, *26*(1), 3–28. https://doi.org/10.1257/jep.26.1.3
24. Kallbekken, S., Sælen, H., & Hermansen, E. A. (2013). Bridging the energy efficiency gap: A field experiment on lifetime energy costs and household appliances. *Journal of Consumer Policy*, *36*, 1–16. https://doi.org/10.1007/s10603-012-9211-z
25. Allcott, H. (2011). Social norms and energy conservation. *Journal of Public Economics*, *95*(9), 1082–1095. https://doi.org/10.1016/j.jpubeco.2011.03.003
26. Ayres, I., Raseman, S., & Shih, A. (2013). Evidence from two large field experiments that peer comparison feedback can reduce residential energy usage. *The Journal of Law, Economics, and Organization*, *29*(5), 992–1022. https://doi.org/10.3386/w15386
27. Allcott, H., & Rogers, T. (2014). The short-run and long-run effects of behavioral interventions: Experimental evidence from energy conservation. *The American Economic Review*, *104*(10), 3003–3037. https://doi.org/10.1257/aer.104.10.3003
28. Dolan, P., & Metcalfe, R. (2013). *Neighbors, knowledge, and nuggets: Two natural field experiments on the role of incentives on energy conservation* (CEP Discussion Paper No. 1222). London School of Economics and Political Science.
29. Ferraro, P. J., & Price, M. K. (2013). Using nonpecuniary strategies to influence behavior: evidence from a large-scale field experiment. *The Review of Economics and Statistics*, *95*(1), 64–73. https://doi.org/10.1162/REST_a_00344
30. Hausman, D. M., & Welch, B. (2010). Debate: To nudge or not to nudge. *Journal of Political Philosophy*, *18*(1), 123–136. https://doi.org/10.1111/j.1467-9760.2009.00351.x
31. Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T
32. Kalafatis, S. P., Pollard, M., East, R., & Tsogas, M. H. (1999). Green marketing and Ajzen's theory of planned behaviour: a cross-market examination. *Journal of Consumer Marketing*, *16*(5), 441–460. https://doi.org/10.1108/07363769910289550
33. Chan, R. Y. K., & Lau, L. B. (2002). Explaining green purchasing behavior: A cross-cultural study on American and Chinese consumers. *Journal of International Consumer Marketing*, *14*(2–3), 9–40. https://doi.org/10.1300/J046v14n02_02
34. Merritt, A. C., Effron, D. A., & Monin, B. (2010). Moral self-licensing: When being good frees us to be bad. *Social and Personality Psychology Compass*, *4*(5), 344–357. https://doi.org/10.1111/j.1751-9004.2010.00263.x
35. Bao, J., & Ho, B. (2015). Heterogeneous effects of informational nudges on pro-social behavior. *The B.E. Journal of Economic Analysis & Policy*, *15*(4), 1619–1655. https://doi.org/10.1515/bejeap-2014-0125
36. Beshears, J., Choi, J. J., Laibson, D., Madrian, B. C., & Milkman, K. L. (2015). The effect of providing peer information on retirement savings decisions. *The Journal of Finance*, *70*(3), 1161–1201. https://doi.org/10.1111/jofi.12258
37. Bronchetti, E. T., Dee, T. S., Huffman, D. B., & Magenheim, E. (2011). *When a nudge isn't enough: defaults and saving among low-income tax filers* (Paper No. 1688). National Bureau of Economic Research.
38. Fernandez, V. P. (2000). Decisions to replace consumer durables goods: An econometric application of wiener and renewal processes. *The Review of Economics and Statistics*, *82*(3), 452–461.
39. Bayus, B. L. (1991). The consumer durable replacement buyer. *The Journal of Marketing*, *55*(1), 42–51.
40. Cripps, J. D., & Meyer, R. J. (1994). Heuristics and biases in timing the replacement of durable products. *Journal of Consumer Research*, *21*(2), 304–318.
41. Park, S., & Mowen, J. C. (2007). Replacement purchase decisions: on the effects of trade-ins, hedonic versus utilitarian usage goal, and tightwadism. *Journal of Consumer Behaviour*, *6*(2–3), 123–131. https://doi.org/10.1002/cb.212
42. Houde, S. (2014). *How consumers respond to environmental certification and the value of energy information* (Paper No. 20019). National Bureau of Economic Research.

43. Anderson, C. D., & Claxton, J. D. (1982). Barriers to consumer choice of energy efficient products. *Journal of Consumer Research*, *9*(2), 163–170.
44. Newell, R. G., & Siikamäki, J. (2014). Nudging energy efficiency behavior: The role of information labels. *Journal of the Association of Environmental and Resource Economists*, *1*(4), 555–598. https://doi.org/10.3386/w19224
45. Azmat, G., & Iriberri, N. (2010). The importance of relative performance feedback information: Evidence from a natural experiment using high school students. *Journal of Public Economics*, *94*(7–8), 435–452. https://doi.org/10.1016/j.jpubeco.2010.04.001
46. Ariely, D., Loewenstein, G., & Prelec, D. (2003). "Coherent arbitrariness": Stable demand curves without stable preferences. *The Quarterly Journal of Economics*, *118*(1), 73–106. https://doi.org/10.1162/00335530360535153
47. Levav, J., Heitmann, M., Herrmann, A., & Iyengar, S. S. (2010). Order in product customization decisions: Evidence from field experiments. *Journal of Political Economy*, *118*(2), 274–299.
48. Levav, J., Reinholtz, N., & Lin, C. (2012). The effect of ordering decisions by choice-set size on consumer search. *Journal of Consumer Research*, *39*(3), 585–599. https://doi.org/10.1086/664498
49. Carmon, Z., & Ariely, D. (2000). Focusing on the forgone: How value can appear so different to buyers and sellers. *Journal of Consumer Research*, *27*(3), 360–370. https://doi.org/10.1086/317590
50. Hardisty, D. J., & Pfeffer, J. (2017). Intertemporal uncertainty avoidance: When the future is uncertain, people prefer the present, and when the present is uncertain, people prefer the future. *Management Science*, *63*(2), 519–527. https://doi.org/10.1287/mnsc.2015.2349
51. Ungemach, C., Camilleri, A. R., Johnson, E. J., Larrick, R. P., & Weber, E. U. (2018). Translated Attributes as Choice Architecture: Aligning Objectives and Choices Through Decision Signposts. *Management Science*, *64*(5), 2445–2459. https://doi.org/10.1287/mnsc.2016.2703
52. Meloy, M. G., Russo, J. E., & Miller, E. G. (2006). Monetary incentives and mood. *Journal of Marketing Research*, *43*(2), 267–275. https://doi.org/10.1509/jmkr.43.2.267
53. Zizzo, D. J. (2010). Experimenter demand effects in economic experiments. *Experimental Economics*, *13*, 75–98. https://doi.org/10.1007/s10683-009-9230-z
54. Abbey, J. D., & Meloy, M. G. (2017). Attention by design: Using attention checks to detect inattentive respondents and improve data quality. *Journal of Operations Management*, *53–56*, 63–70. https://doi.org/10.1016/j.jom.2017.06.001
55. Ball, S., Eckel, C., Grossman, P. J., & Zame, W. (2001). Status in markets. *The Quarterly Journal of Economics*, *116*(1), 161–188. https://doi.org/10.1162/003355301556374
56. Ginsberg, J. M., & Bloom, P. N. (2004). Choosing the right green-marketing strategy. *MIT Sloan Management Review*, *46*(1), 79–84.
57. McGrath, J. E. (1981). Dilemmatics: The study of research choices and dilemmas. *American Behavioral Scientist*, *25*(2), 179–210. https://doi.org/10.1177/000276428102500205
58. Abbey, J. D., Blackburn, J. D., & Guide, V. D. R., Jr. (2015). Optimal pricing for new and remanufactured products. *Journal of Operations Management*, *36*, 130–146. https://doi.org/10.1016/j.jom.2015.03.007
59. Ottman, J. A., Stafford, E. R., & Hartman, C. L. (2006). Avoiding green marketing myopia: Ways to improve consumer appeal for environmentally preferable products. *Environment: Science and Policy for Sustainable Development*, *48*(5), 22–36. https://doi.org/10.3200/ENVT.48.5.22-36
60. Ward, D. O., Clark, C. D., Jensen, K. L., Yen, S. T., & Russell, C. S. (2011). Factors influencing willingness-to-pay for the ENERGY STAR® label. *Energy Policy*, *39*(3), 1450–1458. https://doi.org/10.1016/j.enpol.2010.12.017
61. Biswas, A., Licata, J. W., McKee, D., Pullig, C., & Daughtridge, C. (2000). The recycling cycle: An empirical examination of consumer waste recycling and recycling shopping behaviors. *Journal of Public Policy & Marketing*, *19*(1), 93–105. https://doi.org/10.1509/jppm.19.1.93.16950
62. Wang, T. H., & Katzev, R. D. (1990). Group commitment and resource conservation: Two field experiments on promoting recycling. *Journal of Applied Social Psychology*, *20*(4), 265–275. https://doi.org/10.1111/j.1559-1816.1990.tb00411.x
63. Werner, C. M., Turner, J., Shipman, K., Twitchell, F. S., Dickson, B. R., Bruschke, G. V., et al. (1995). Commitment, behavior, and attitude change: An analysis of voluntary recycling. *Journal of Environmental Psychology*, *15*(3), 197–208. https://doi.org/10.1016/0272-4944(95)90003-9
64. Lokhorst, A. M., Werner, C., Staats, H., van Dijk, E., & Gale, J. L. (2013). Commitment and behavior change: A meta-analysis and critical review of commitment-making strategies in environmental research. *Environment and Behavior*, *45*(1), 3–34. https://doi.org/10.1177/0013916511411477
65. Osbaldiston, R., & Schott, J. P. (2012). Environmental sustainability and behavioral science: Meta-analysis of proenvironmental behavior experiments. *Environment and Behavior*, *44*(2), 257–299. https://doi.org/10.1177/0013916511402673
66. Johnson, E. J., Shu, S. B., Dellaert, B. G., Fox, C., Goldstein, D. G., Häubl, G., et al. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters*, *23*(2), 487–504. https://doi.org/10.1007/s11002-012-9186-1
67. Ellen MacArthur Foundation. (2015). *Towards a Circular Economy: Business Rationale for an Accelerated Transition.* https://www.ellenmacarthurfoundation.org/towards-a-circular-economy-business-rationale-for-an-accelerated-transition (accessed 15 November 2023).
68. Lewandowski, M. (2016). Designing the business models for circular economy—Towards the conceptual framework. *Sustainability*, *8*(1), 43. https://doi.org/10.3390/su8010043
69. Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: a comprehensive review in context of manufacturing industry. *Journal of Cleaner Production*, *115*, 36–51. https://doi.org/10.1016/j.jclepro.2015.12.042

Appendix A

Below are the experimental descriptions for Standard-first order. For Green-first order, Question 1 starts with the Green TV.

Question 1

[*for regular/new buyers*] Imagine you already have an almost-new TV at home. You are thinking about buying an extra one for another room.
[*for emergency/replacement buyers*] Imagine your TV is not working anymore, and you need to buy a new one.
[*with free recycling*] One of the largest electronic retailers would be a good place to shop. This retailer also has a recycling program and accepts broken TVs for recycling free of charge.
[*with $7 recycling tax*] One of the largest electronic retailers would be a good place to shop. This retailer also has a recycling program and, due to the cost of managing TV recycling, charges a $7 recycling fee in addition to the sale price for all TVs, regardless of the brand or technical specifications.
[*with $25 charge for recycling*] One of the largest electronic retailers would be a good place to shop. This retailer also has a recycling program and, due to the cost of managing TV recycling, charges $25 to accept broken TVs for recycling.
[*with free recycling and $25 charge for recycling*] Assume that the technical specifications of the TV below meet your basic criteria. How much (in dollars) would you be willing to pay for this TV?
[*with $7 recycling tax*] Assume that the technical specifications of the TV below meet your basic criteria. How much (in dollars) would you be willing to pay for this TV (inclusive of the $7 fee)?

- 48.5" LED screen
- Chromecast Built-in
- Google Home and Google Assistant
- 2160p resolution and ultra HD-level quality
- Wireless Connectivity
- Two 12W speakers, DTS Studio Sound
- 3 HDMI inputs and 1 USB input

Price: ------

Question 2

You indicated that you would pay $[price indicated in Question 1] for the TV you were shown. Assume you find there is also a Green version of that TV (as shown below). It has the exact same features as the standard one, while it is also designed for increased recyclability at its end-of-life.
[*with free recycling and $25 charge for recycling*] In light of this new information, how much (in dollar) would you be willing to pay for each of these TVs?
[with $7 recycling tax] In light of this new information, how much (in dollar) would you be willing to pay for each of these TVs (inclusive of the $7 fee)?

Standard Version
- 48.5" LED screen
- Chromecast Built-in
- Google Home and Google Assistant
- 2160p resolution and ultra HD-level quality
- Wireless Connectivity
- Two 12W speakers, DTS Studio Sound
- 3 HDMI inputs and 1 USB input

Green Version
- 48.5" LED screen
- Chromecast Built-in
- Google Home and Google Assistant
- 2160p resolution and ultra HD-level quality
- Wireless Connectivity
- Two 12W speakers, DTS Studio Sound
- 3 HDMI inputs and 1 USB input
- Increased Recyclability

Price for the Standard version: ------
Price for the Green version: ------

Attention Check Question

Please indicate which of the below statements is in line with the situation you just read about?

[*for regular/new buyers with free recycling*]

- ■ Your current TV was fine and almost new, and you were thinking about buying an extra one for another room.
- □ The retailer charged $25 to accept broken TVs for recycling.
- □ Both
- □ Neither

[*for emergency/replacement buyers with free recycling*]

- □ Your current TV was fine and almost new, and you were thinking about buying an extra one for another room.
- □ The retailer charged $25 to accept broken TVs for recycling.
- □ Both
- ■ Neither

[*for regular/new buyers with $25 charge for recycling*]

Please indicate which of the below statements is in line with the situation you just read about?

- □ Your current TV was fine and almost new, and you were thinking about buying an extra one for another room.
- □ The retailer charged $25 to accept broken TVs for recycling.
- ■ Both
- □ Neither

[*for emergency/replacement buyers with $25 charge for recycling*]

Please indicate which of the below statements is in line with the situation you just read about?

- □ Your current TV was fine and almost new, and you were thinking about buying an extra one for another room.
- ■ The retailer charged $25 to accept broken TVs for recycling.
- □ Both
- □ Neither

[*for regular/new buyers with $7 recycling tax*]

Please indicate which of the below statements is in line with the situation you just read about?

- □ Your current TV was fine and almost new, and you were thinking about buying an extra one for another room.
- □ The retailer charged a recycling fee for all TVs.
- ■ Both
- □ Neither

[*for emergency/replacement buyers with $7 recycling tax*]

Please indicate which of the below statements is in line with the situation you just read about?

- □ Your current TV was fine and almost new, and you were thinking about buying an extra one for another room.
- ■ The retailer charged a recycling fee for all TVs.
- □ Both
- □ Neither