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On the Perils of Environmentally Friendly Alternatives

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Abstract

Environmentally friendly alternatives are touted as a key component of a transition towards lowering the impact of human activity on the environment. The environmental costs of these technologies are seldom null; they are simply less environmentally damaging than existing options. In this paper, we investigate consumer behavior when an environmentally friendly alternative is introduced under different decision contexts. Using a carefully constructed field experimental design, we look at the use of plastic bags vis-a-vis biodegradable (bio) bags, when the latter are offered for free versus at a price. Moreover, we explore offering costly biodegradable bags as part of the default choice. We find that giving away the bio bags for free results in a large behavioral rebound effect, resulting in a large increase in the total number of bags. Setting a small, rather symbolic price offsets this rebound effect completely. Interestingly, when the bio bag is offered as a default, the behavioral rebound remains. The large behavioral rebound effect leads us to conclude against providing these environmentally friendly alternatives for free, and to caution against the use of subsidies to promote their uptake.

Keywords: biodegradable, plastic bags, behavioral, rebound

JEL Codes: C93, D91, Q53

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On the perils of environmentally friendly alternatives

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Abstract

Environmentally friendly alternatives are touted as a key component of a transition towards lowering the impact of human activity on the environment. The environmental costs of these technologies are seldom null; they are simply less environmentally damaging than existing options. In this paper, we investigate consumer behavior when an environmentally friendly alternative is introduced under different decision contexts. Using a carefully constructed field experimental design, we look at the use of plastic bags vis-a-vis biodegradable (bio) bags, when the latter are offered for free versus at a price. Moreover, we explore offering costly biodegradable bags as part of the default choice. We find that giving away the bio bags for free results in a large behavioral rebound effect, resulting in a large increase in the total number of bags. Setting a small, rather symbolic price offsets this rebound effect completely. Interestingly, when the bio bag is offered as a default, the behavioral rebound remains. The large behavioral rebound effect leads us to conclude against providing these environmentally friendly alternatives for free, and to caution against the use of subsidies to promote their uptake.

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1. Introduction

In an attempt to reduce the environmental footprint on the planet's carrying capacity, consumers are substituting away from goods and services with high environmental impact, to alternatives touted to have a lower impact in the environment (Jones et al. 2020; Latvala et al. 2012; Tobler, Visschers, and Siegrist 2011). Environmentally friendly alternatives are increasingly becoming a frequent sight in the consumption basket of households. This is happening in several areas of consumption, from plug-in hybrid vehicles instead of gasoline cars (Jenn 2020), solar instead of coal or gas to warm our homes (Wilson and Staffell 2018), bags and cutlery that are biodegradable instead of plastic (Song et al. 2009), meat substitutes instead of animal proteins (Reijnders and Soret 2003), and recycled fabrics instead of cotton or wool (Niinimäki et al. 2020).

The popularity of environmentally friendly alternatives should not be surprising, because they allow us to continue our daily lives in, or very near, a business-as-usual scenario, i.e., without really restricting our behavior for the environment's sake. For example, instead of opting for public transportation or reducing our travel, plug-in hybrid vehicles allow us to travel as usual with presumably a lower impact on the environment. Undeniably, the key characteristic of environmentally friendly alternatives is their lower environmental footprint. Still, their environmental footprint is not zero. Most of these technologies require substantial resources for their production, and their increased use might still generate environmental impacts (Luderer et al. 2019; Baroni et al. 2007; Rosi et al. 2017; Larcher and Tarascon 2015). The result of the introduction of an environmentally friendly alternative is therefore not zero environmental impact, even if the old polluting alternative is completely phased out.

In this paper we investigate, using a field experiment, the effects of the introduction of an environmentally friendly alternative. The environmentally friendly alternative we use is biodegradable (bio) plastic bags as an alternative to plastic bags.

If consumers care about the environmental impact of their consumption, an introduction of bio bags should result in a substitution from plastic to bio bags. In addition, the introduction of the more environmentally friendly alternative could convey passive information on the environmental consequences of our actions (i.e., priming of environmental concerns). This information in itself could affect behavior as well (Johe and Bhullar 2016; Jessoe and Rapson 2014; Cohn and Maréchal 2016). In this particular case, it would first of all strengthen the substitution effect, but it could also mean that total use of bags (i.e., of plastic and biodegradable bags) decreases since the environmental impact of the new alternative is not zero.

In addition, there has been a considerable attention on so-called rebound effects of new technology in areas such as energy efficiency (Gillingham, Rapson, and Wagner 2016) and fuel efficiency (Linn 2016). In this context a conventional rebound effect would occur if, for example, the adoption of an improved energy efficiency technology would result in higher energy use than before because of the lower effective price per hour of light or heating. Although the extent of this rebound effect varies considerably across studies (see, e.g., Allcott 2011; Frondel and Vance 2013; Jessoe and Rapson 2014), there is no doubt that it can have a dampening impact on the effect of technological innovation on environmental quality.

In addition to the standard economic rebound effect, there could be a behavioral rebound effect (Dorner 2019). This effect builds on the assumption that individuals care about the environmental impact of their behavior. There could, for example, be a direct altruistic concern, where the consumer cares about the environmental impact of their own consumption on others (Andreoni 1990; Kotchen and Moore 2008), or status concerns to signal pro-environmental behavior (Sexton and Sexton 2014). The implication of this concern is that consumers are potentially willing to make choices to reduce the environmental impact of their behavior (e.g., carrying a reusable bag around in case one visits the supermarket). When the concern is removed because the good is perceived to be environmentally friendly, a non-conventional rebound effect could take place (Dorner 2019). The intuition behind the mechanism is as follows. Suppose a consumer cares about the marginal damage of her consumption and considers this effect when making consumption choices. Now, if the marginal damage for a good is reduced - it could be that a more environmentally friendly bag is introduced or that biofuel is made available for cars – then consumption choices will change as well. In particular, because of this change in marginal damage, consumption of the good will increase. This is what we denote a behavioral rebound effect.

The total effect of a more environmentally friendly alternative on the environment is then unclear and would depend on the direct effect in terms of lower marginal environmental damage and substitutions from the more polluting alternative, and the indirect effect associated with the behavioral rebound effect.

In this paper, we explore the substitution and rebound effects of providing an environmentally friendly alternative (i) at no cost, (ii) at a price, or (iii) at a price and offered as the default alternative. By providing the alternative at no cost, we can isolate a behavioral rebound effect since, as we will explain, the current good is typically also provided for free. This also means that our second treatment allows us to investigate a standard price effect on the use of an environmentally friendly alternative, and how that can counteract a behavioral rebound effect. Finally, in the third treatment we investigate if providing the environmentally friendly alternative as a default has an effect on behavior. Defaults have had very strong impacts on behavior in settings such as choice of energy contract (Pichert and Katsikopoulos 2008), and savings decision (Cronqvist, Thaler, and Yu 2018). In our setting we implement this in a situation where people make frequent decisions and where the decision is rather simple.

We investigate this in a field experimental setting using biodegradable bags as an alternative to plastic bags. Biodegradable bags are regarded by some as a more environmentally friendly alternative to plastic bags, although its environmental impact is far from negligible. In this paper we abstain from discussing the biophysical and chemical properties of the biodegradable versus plastics bags and focus on consumer behavior. We find that the behavioral response to providing an environmentally friendly alternative for free is characterized by a strong behavioral rebound effect, which disappears when the bio bags are priced. Interestingly, when the bio bag is offered as a default, the behavioral rebound remains.

We conclude against environmentally friendly alternatives unless they are properly priced, and caution against the use of subsidies in the promotion of these environmentally friendly alternatives. In our setting, plastic bags were provided for free, precisely because we wanted to explore behavioral responses in relation to the environmentally friendly alternative. A price on plastic bags, in our setting, would simply increase the size of the effect given that reductions in the number of plastic bags are more than compensated by the increase in bio bags. In that sense, a tax on plastic bags should not be accompanied by free or subsidized biodegradable bags. These bags should be priced at, or close to, their shadow price.

The rest of the paper is organized as follows. In section 2 we describe the environmentally friendly alternative, detail the design of the experiment, provide the hypotheses we wish to test with the experiment, and present how the experiment was implemented. In section 3 we outline our empirical approach. Section 4 reports the results, and in section 5 we discuss our findings.

2. Experimental design and procedure

2.1 Environmentally friendly alternatives: biodegradable plastic bags

Biodegradable plastics are materials degraded by the actions of microorganisms in the environment that are finally converted into inorganic substances; that is, the plastic goes through a complete breakdown into CO_2, H_2O and biomass in aerobic settings, and CO_2, CH_4 and biomass in anaerobic settings (Amaral-Zettler, Zettler, and Mincer 2020; Suzuki, Tachibana, and Kasuya 2020; Narancic and O'Connor 2019). In our case, biodegradable light plastic bags are ASTM D6954[1]-certified (ASTM 2013), which means they contain a pro-oxidant additive that promotes their abiotic degradation by the effect of intense sunlight and sustained thermal aging at moderate temperature (Quecholac-Piña et al. 2017). The biodegradable bags used in this experiment comply with the Costa Rican National Strategy to Substitute Single Use Plastic 2017-2021.

2.2 Experimental design[2]

[1] The ASTM D6954 is the Standard Guide for Exposing and Testing Plastics that Degrade in the Environment by a Combination of Oxidation and Biodegradation.

[2] See Lanza Castillo, Alpizar, and Carlsson (2019) for preregistered experimental design.

The setting of our experiment is wholesale markets in Costa Rica. At these markets vendors sell a variety of fruits and vegetables during Saturdays throughout the year. There is a widespread use of plastic bags at these markets, not the least because customers buy a variety of goods from different vendors. The plastic bags are provided for free by all vendors. There are a number of ways to avoid the use of plastic bags. Foremost, customer might simply reduce the number of bags by rejecting the plastic bags offered to them, and instead place their purchased goods directly in a cloth tote bag or a trolley. This comes potentially at the cost of some damage to delicate fruits and vegetables. Another option is to use an environmentally friendlier option. In this experiment we used a biodegradable bag as a substitute to plastic bags.

In three different treatments we introduced this substitute bag. In Treatment 1 the bio-bag was provided for free. Vendors were instructed to say the following to customers: *"Would you like to reduce pollution in the oceans by using a biodegradable plastic bag for your [name of the fruit/vegetable] instead of a plastic bag?"*[3] In Treatment 2, the bio bag was also introduced, but with a price per bag of 25 colones.[4] Vendors were instructed to say the following to customers: "*Would you like to reduce pollution in the oceans by using a biodegradable plastic bag for your [name of the fruit/vegetable] instead of a plastic bag? It will cost you 25 colones per bag?"* Note that the price per bio bag is rather symbolic. In Treatment 3, we simply changed the default situation. Instead of providing the bio bag as an alternative, vendors packed the fruits in a bio bag and then read the same text as in Treatment 2, including mention of the price per bag. In the Control group, we made sure that no substitute to plastic bags was provided by the vendors. For all four groups we observe the number of plastic bags and bio bags sold before (2 weekends) and after (2 weekends) the introduction of the bio bags.

2.3 Hypotheses

A consumer willing to reduce the environmental impact of her consumption can, simply put, take two, non-mutually exclusive actions: i. consume less, e.g., use fewer or no

[3] Literal translation from original in Spanish.
[4] At the time of the survey 1USD=596 colones, or one bag for about $0.04.

bags and carry other means of transporting and separating purchased goods; ii. opt for a more environmentally friendly alternative if it exists.

Table 1 describes the potential outcomes from introducing an environmentally friendlier alternative to plastic bags. All our treatments offer the opportunity to substitute away from plastic bags by using a bio bag. This allows for a one-to-one substitution between plastic and bio bags. However, the offer of the bio bag and the content of the message might induce subjects to reduce the use of any kind of bag, resulting in a substitution of one plastic bag by less than one bio bag. Finally, since bio bags are touted to be more environmentally friendly, subjects might be tempted to use even more bio bags than plastic bags.

Table 1: Potential effects from introducing an environmentally friendlier alternative

Motivation	Action: Substitution of…	Outcome in our experiment	Environmental outcome
Substitution of polluting technology by a cleaner one	One plastic bag by one bio bag	-Reduction in number of plastic bags -**Unchanged** total number of bags	Reduced environmental impact due to lower impact of bio bags
Priming of environmental concerns	One plastic bag by **less** than one bio bag	-Reduction in number of plastic bags -**Reduction** in total number of bags	Reduced environmental impact due to lower impact of bio bags
Behavioral Rebound effect due to reduced environmental concerns of bio-bags	One plastic bag by **more** than one bio bag	-Reduction in number of plastic bags -**Increase** in total number of bags	Uncertain environmental impact

In all treatments we thus hypothesize a reduction in the use of plastic bags, compared to the control where bio bags are not available, based on the assumption that a non-negligible fraction of the consumers cares about the environmental impact of their behavior (Andreoni 1990; Kotchen and Moore 2008).

The effect on the total number of bags will ultimately depend on the size of the substitution effects and the behavioral rebound effect on bio bags. In Treatment 1, the risk of a behavioral rebound effect is largest, since the bio bags are provided for free. In Treatments 2 and 3, the introduction of a price per bio bag should reduce the behavioral rebound effect. In Treatment 3, the bio bag is offered as a default. Given that the price is rather symbolic, we hypothesize that people will stick to the default alternative leading to a one-to-one substitution of plastic bags.

2.4 Experimental procedure

The experiment follows a between-subject design in a clustered randomized setting. We implemented a cluster sampling, where each wholesale market was considered a cluster. In total, we worked with 12 clusters, distributed equally in two provinces of Costa Rica (see Figure 1). A total of 15 vendors were selected randomly from a list provided by the board administering the wholesale market. The selection was made from fruit and vegetables vendors, which consume the highest volume of ultra-thin plastic bags with very small micron sizes. Vendors of specific products such as processed food (cheese, juices, etc.) were excluded from the experiment. We focused on changes in the consumer demand for plastic bags with the two most commonly used plastic bag size (9x14 and 10x16 inches). We worked with three clusters per treatment (plus a control of three clusters) and 15 vendors per cluster, with a power of 89% anticipating a reduction in the number of plastic bags consumed of 35%. The 35% is conservative considering that the literature reports a reduction of more than 50% when pricing is introduced.

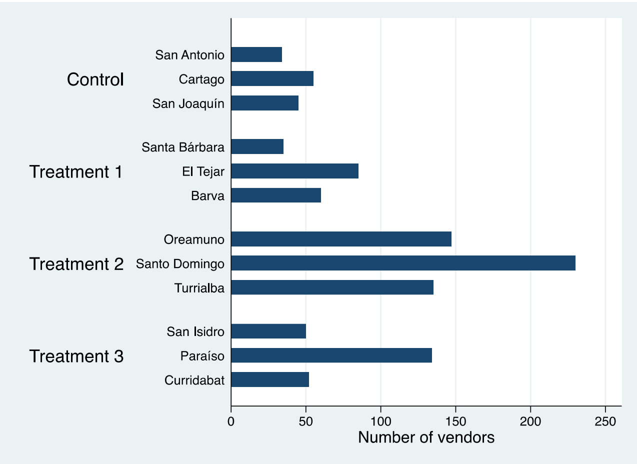

Figure 1. Total number of vendors per location of farmers market under study, and treatment assignment. A total of 15 per market were randomly allocated to our treatments.

The field experiment lasted four weeks, two weeks pre-treatment and two weeks post-treatment. For all treatment groups, each vendor received two 1-kilogram packages:

one of the plastic bags and one of the bio bags at no cost; if the vendor required more plastic or bio bags during the day, the researcher provided additional weighed packages. Research assistants delivered the bags every Saturday before the wholesale market opened (4:00 a.m.) and collected the unused plastic and bio bags packages once the wholesale market closed (1:00 p.m.). After collection, the assistants weighted unused plastic and bio bag packages as a direct measure of consumption. The number of bags consumed was calculated by subtracting the final weight from the initial weight of each package, plastic and bio, separately; the total grams consumed were then divided by the individual weight of a bag, which is 4 grams for a bag 9x16 inches, and 5 grams for a bag of 10x16 inches. Plastic and bio bags have the same density and, therefore, each bag of the same size has the same weight. For the control group, vendors received only plastic bags at no cost; measurement followed the same procedure as in the treatments. The accuracy of the scale was tested before every measurement to ensure precision and correct conversion to the number of bags. Furthermore, for each kilogram of bags, 100 bags were picked randomly and were weighted individually to verify precision. At the end of the two-week treatment period, we applied a survey to the vendors.

Signs about biodegradable bags were located at the entrance of each market for all treatments. In addition, we had set a list of observation criteria that the research assistants had to pay attention to every day of the market in order to control for other external factors, such as weather, any municipal activity in the district, schools' activities, or fairs; see Appendix 2.

3. Empirical strategy

As mentioned above, there are two primary outcome variables of interest. The first is the number of plastic bags sold per week and vendor, and the second is the total number of bags (plastic and bio bags) sold per week and vendor. For both of these outcomes we estimate the average treatment effect. Although the markets were randomized into treatment and control, there were few markets and as such there could be pre-treatment differences in number of plastic bags per vendor. In order to take this into consideration we estimate a three-level random effects model. Following the model specification of Baltagi, Heun Song, and Cheol Jung (2001), observations are clustered at the market level; thus the model is organized as a series of M independent groups or clusters, at the wholesale market.

$$\boldsymbol{y_{ijt} = \beta_{1T} Treat_T + \beta_2 After + \beta_{3T} (Treat_T \text{After}) + u_{ijt}},$$

where y_{ijt} denotes the number of plastic bags (or total bags) of the ith vendor in the jth wholesale market in weekend t. *After* is a dummy variable equal to 1 for the two weeks after the treatments were implemented. $Treat_T$ is a vector of dummy variables that indicates if a farmers market was assigned to a particular treatment group [T=1, 2, 3]. The disturbance term is specified as

$$\boldsymbol{u_{ijt} = u_j + v_{ij} + \varepsilon_{ijt}}$$

where u_j denotes the jth unobservable wholesale market effect, which is assumed to be i.i.d. $(0, \sigma_\mu{}^2)$, v_{ij} denotes the nested effect of the ith vendor within the jth wholesale market which is assumed to be i.i.d. $(0, \sigma_v{}^2)$, and i.i.d. ε_{ijt} denotes the reminder disturbance which is also assumed to be i.i.d. $(0, \sigma_\varepsilon{}^2)$. The $u_i's, v_{ij}'s$, and ε_{ijt}'s are independent of each other and among themselves.

Our coefficients of interest are $\beta_{3\text{T}}$. Since there are three treatment groups, we estimate three treatment effects, relying on regressions where we pool all treatments and the control group. This model is estimated with a mixed effects maximum likelihood regression in Stata. As a robustness check we also estimate a model with vendor fixed effects instead.

4. Results

4.1 Descriptive results

We begin with presenting the average number of plastic bags and the total average number of bags sold before and after the treatment in the four groups in Figure 2; detailed results are reported in Table A1 in Appendix 1.

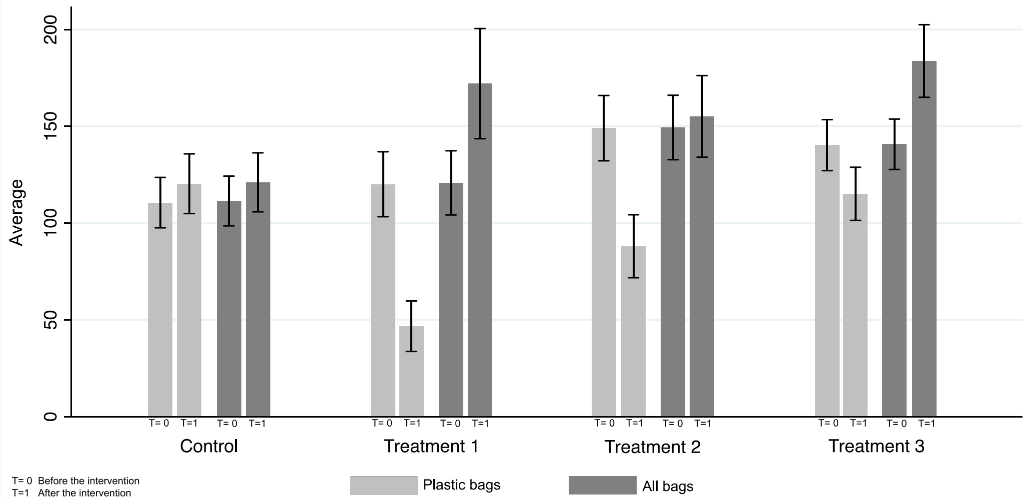

Figure 2. Average number of bags sold before and after the intervention.

Note that there are differences in the number of bags sold in the pre-treatment weeks among the four groups. The average number of bags among vendors in Treatment 2 is almost 150 bags per week, while the average number of bags among vendors in the Control group is 111 bags. More important, though, is the observation that, while the number of plastic bags is roughly the same before and after in the Control group, they are considerably lower in Treatments 1 and 2. There is also a drop in the number of plastic bags among vendors in Treatment 3, but not as sizeable as in the other treatments. Thus, the descriptive statistics suggest that the treatments did, as intended, result in a decrease in the number of plastic bags. If we then look at the total number of bags sold, we observe that there is actually a sizeable increase in the total number of bags in Treatments 1 and Treatment 3, while it is roughly unchanged in the Control group and in Treatment 2. Thus, there is, first of all, a behavioral rebound effect. Second, in Treatment 2, where there is a price for the bio bag, the behavioral rebound effect observed is offset. As a next step we estimate treatment effects using a regression model in order to control for vendor and market characteristics.

4.2 Regression results

Our main specification is a three-level random effects model, where we estimate treatment effects for plastic bags and for the total number of bags. Full results are reported in Table A2; below in Figure 3 we report coefficient plots for the treatment effects.[5]

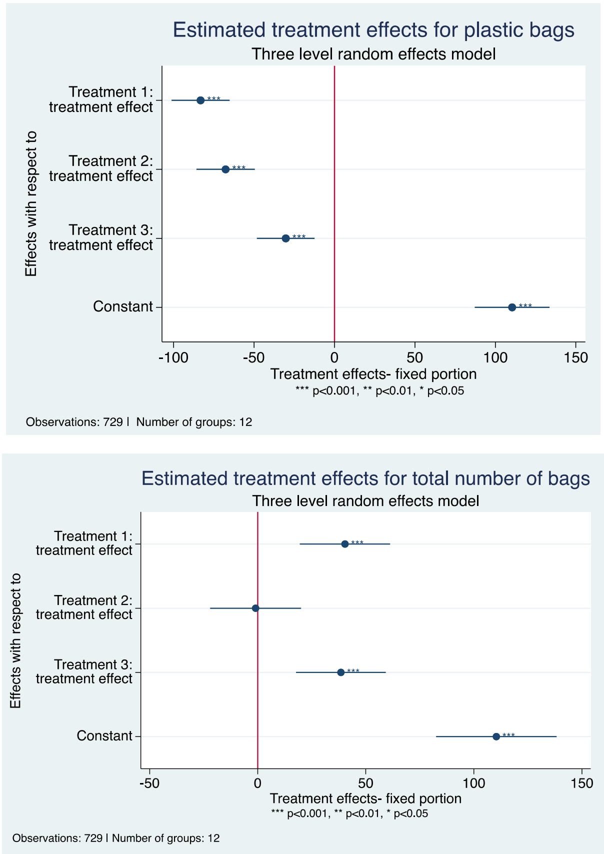

Figure 3. Treatment effects for plastic bags and total number of bags

As expected, all three treatments have a sizeable and statistically significant negative effect on the number of plastic bags. In Treatment 1, the average number of plastic bags is reduced by 64% (from 130 to 83) bags per vendor and week. This is a sizeable effect. The estimated effect in Treatment 2 is somewhat smaller, and the difference between the two treatments is statistically significant; tests of difference in treatment effects are reported in Table 2. Thus, setting a small price on the bio bag partially offsets the reduction of plastic bags. There is a sizeable treatment effect on the number of plastic bags in Treatment 3 as well, but it is considerably lower than in the two other

[5] Results from the corresponding fixed-effects model with vendor fixed effects is presented in Table A3 in the appendix. Estimated treatment effects are very similar. Using a Hausman test we cannot reject a random effects model for plastic bags (p-value = 0.075) or the total number of bags (p-value = 0.302)

treatments, and the differences in treatment effects compared with Treatments 1 and 2 are statistically significant. Consequently, the reduction in plastic bag use is considerably smaller if a bio bag is given as a default but at a price.

Table 2. Test of difference in treatment effects

	T1-T2	T2-T3	T1-T3
Reduction of plastic bags	15.55*	37.38***	52.94***
	(9.33)	(9.28)	(9.22)
Increase in total number of bags	41.36***	-39.47***	1.88
	(10.80)	(10.74)	(10.68)

Note: Standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05

We next turn to the total number of bags. In Treatment 1 where the bio bag is provided for free, there is a substantial increase in the total number of bags compared with the control group. Thus, despite a sizeable reduction in the number of plastic bags, the increase in demand for bio bags is so large that it more than offsets the reduction in plastic bags. Note that, in both Treatment 1 and the control group, all bags are provided for free. This suggest that there is a behavioral rebound effect for the total number of bags by the introduction of a more environmentally friendly alternative. We will return to the environmental implications of this later. For Treatment 2, there is no statistically significant treatment effect on the total number of bags. Thus, the rebound effect we observed in Treatment 1 disappears completely if the bio bag is sold at a small price. In Treatment 3, there is also a sizeable increase in the total number of bags. Thus, despite a smaller reduction in the number of plastic bags, there is still an offsetting rebound effect.

4.3 The required environmental improvement of bio bags

Establishing the exact environmental impact of a bio bag in comparison to a plastic bag is not easy and lies outside the focus of this paper and our expertise. Still, we can use our results to calculate the required difference in environmental impact between a plastic bag and bio bag, such that the provision of this environmentally friendly alternative results in positive overall outcomes, given the results of the different treatments. Results are presented in Table 3.

Table 3. Required environmental impact of bio bags in order for treatment to have a positive environment impact (based on results in Table A2)

	Treatment 1	Treatment 2	Treatment 3
Reduction of plastic bags	75%	61%	27%
Increase in total number of bags	37%	0%	35%
Required relative environmental impact of bio bags	0.67	1	0.43

Let us begin with Treatment 2, where the number of plastic bags is reduced, and the total number of bags remain unchanged. In this case, one plastic bag is substituted for one bio bag. As a result, even a slightly smaller environmental impact of bio bags compared with plastic bags would result in an improved environmental outcome.

When bio bags are introduced for free (Treatment 1), we observe a strong behavioral rebound effect. Each reduced plastic bag is substituted by 1.49 biodegradable bags. For this to result in an environmentally positive outcome, the impact on the environment of each biodegradable bag should at most be 67% that of a regular plastic bag.

The situation is more extreme in Treatment 3, where providing the bio bag as a default alternative backfires. Each reduced plastic bag is substituted by 2.29 bio bags. This result is driven by the rather small reduction in plastic bags. Again, the environmental impact of bio bags would have to be 44% that of a regular plastic bag for this pattern to result in positive environmental outcomes.

5. Discussion

As Table 1 showed, the overall effect on the total number of bags will depend on which of the following three effects will prevail: i. a substitution effect that leads to one-to-one substitution, leaving the total number of bags unaltered; ii. a priming effect in which the total number of bags is expected to be lower, or iii. a behavioral rebound effect, observable as an increase in the total number of bags.

Our results show no evidence of a reduction in the total number of bags, despite the strong reduction of plastic bags in all three treatments. Reducing the total number of bags is as simple as carefully placing fruits and vegetables in a tote bag, yet we do not see that happening in our experiment. The results from Treatment 1 are quite extreme. Despite the strong reduction in the use of plastic bags, each of those bags is substituted by much more than one bio bag, an extreme example of a rebound effect. We call this a behavioral rebound effect because the effective price of packing produce remains at zero with plastic and also biodegradable bags. Even more interestingly, we find that charging a small, rather symbolic price for the more environmentally friendly alternative (Treatment 2) completely takes away the behavioral rebound effect, and we observe a one-to-one substitution. Under this scenario, even slightly better biodegradable bags would render positive environmental outcomes.

In Treatment 3, we provided the bio bags as the default alternative, albeit still at a symbolic price. Our expectation was that providing the bio bag as a default would serve as a signal of the appropriate behavior, and it would result in increased moral costs of switching back from the default bio-bag to a plastic bag. In essence, we expected that the strength of the default option would prevail over the rather symbolic price signal. Our result is not in line with what we expected. We believe that the provision of a bio bag at a cost seems to create a sense of entitlement. As such, we believe that customers seem to have accepted the default bio bags at a price but requested additional plastic bags to further separate their fruits and vegetables. As a whole, the environmental impact of a bio bag should be less than half that of a plastic bag for this treatment to result in positive environmental outcomes.

Previous experience does reveal a considerable variation in the size of the default effect. In a meta-analysis, Jachimowicz et al. (2019) identify two important factors that account for the variability in defaults' effectiveness. The first is that defaults tend to be more effective in the consumer domain than in the environmental domain. The second is that defaults are more effective when they are seen as endorsing the appropriate behavior. The default in our case is endorsing the appropriate behavior in the environmental domain. What could explain our result is the interaction between the environmental domain and the role of endorsement. Environmentally friendly behavior is probably explained by both direct concerns for the environment, but also self-image and signaling concerns (Bénabou and Tirole 2006; Venhoeven, Bolderdijk, and Steg 2016). The self-image concern could be negatively affected or eliminated if, as in our case, the environmentally friendly behavior is to some extent provided as a default (Venhoeven, Bolderdijk, and Steg 2016).

6. Conclusion

In this paper we have explored the consequences of introducing an environmentally friendly alternative that in principle allows consumers to continue their business as usual by substituting away from the more polluting base option. To reduce the environmental impact of their actions, consumers could opt for environmentally friendlier options or simply reduce consumption. In our experiment, these actions entail opting for biodegradable bags, or simply rejecting the use of plastic bags in favor of tote bags.

We do not find any indication of subjects' willingness to reduce the use of bags, not even when primed by the setting of our experiment, in which plastic bags were mentioned in the context of ocean pollution. Although the number of plastic bags decreases significantly in all treatments, there is, at best, a one-to-one substitution towards bio bags, leaving the total number of bags unaltered.

Importantly, when the bio bags are provided for free, we observe a strong behavioral rebound effect. We conclude against providing these so-called environmentally friendly alternatives for free or in a subsidized way. Moreover, a tax on plastic bags, if accompanied by free or subsidized biodegradable bags, would simply exacerbate the behavioral rebound effect. Bio bags should be priced at, or close to their shadow price.

Finally, we find puzzling results from our treatment in which the bio bags were provided as the default alternative, albeit at a price. Our results seem to indicate that subjects indeed accepted the bio bags, but still requested additional plastic bags for free. Further research is needed to understand the effect of using the default alternative when paying its price might result in a sense of entitlement by the subjects.

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Appendix 1

Table A1. Average number of bags used per week and vendor, before and after the intervention. Standard deviations in parentheses.

	Plastic bags		All bags	
	Before	*After*	*Before*	*After*
Control	111	121	111	121
	(63)	(74)	(63)	(74)
Treatment 1	121	48	121	172
	(81)	(62)	(81)	(137)
Treatment 2	149	89	149	155
	(80)	(77)	(80)	(101)
Treatment 3	141	116	141	184
	(64)	(66)	(65)	(91)

Table A2. Estimated treatment effects, random effects regression

	(1) Plastic bags	(2) Total number of bags
Treatment 1: treatment effect	-83.23***	40.38***
	(9.21)	(10.67)
Treatment 2: treatment effect	-67.67***	-0.98
	(9.27)	(10.73)
Treatment 3: treatment effect	-30.28***	38.49***
	(9.16)	(10.61)
Post treatment	8.47	8.43
	(6.47)	(7.49)
Treatment 1: pre-treatment	9.10	8.84
	(16.77)	(20.13)
Treatment 2: pre-treatment	39.36*	38.32
	(16.80)	(20.16)
Treatment 3: pre-treatment	29.63	29.31
	(16.71)	(20.05)
Constant	110.42***	110.42***
	(11.85)	(14.23)
Observations	729	729
Number of groups	12	12

Standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05

Table A3. Fixed effects regression

	(1) Plastic bags	(2) Total number of bags
Treatment 1: treatment effect	-83.76***	39.91***
	(9.25)	(10.72)
Treatment 2: treatment effect	-67.15***	-0.40
	(9.30)	(10.78)
Treatment 3: treatment effect	-29.20**	39.49***
	(9.20)	(10.66)
Post treatment	8.25	8.25
	(6.49)	(7.51)
Constant	130.40***	130.20***
	(2.30)	(2.66)
Observations	729	729
R-squared	0.292	0.133
Number of groups	189	189

Standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05

Appendix 2. Observation Criteria – Wholesale market

1. Location of the farmer's fair:

Dropdown menu with the list of wholesale markets - (Select your answer)

2. Name of Collaborator (a):

(Select your answer)

3. General Observation Criteria

3.1 According to what has been observed, considering the period between the fair's start time and 8:00 a.m., what type of population, according to age range, predominates among the fair's clients?
o Young people
o Adults
o Seniors
Other observations: ____

3.2 According to what has been observed, considering the period between 8:00 a.m. and 10:00 a.m., what type of population, according to age range, predominates among the fair's customers?
o Young people
o Adults
o Seniors
Other observations: ____

3.3 According to what has been observed, considering the period between 10:00 a.m. and 12:00 a.m., what type of population, according to age range, predominates among the fair's customers?
o Young people
o Adults
o Seniors
Other observations: ____

3.4 The prevailing weather condition during the day of the fair is:
o Sunny
o Cloudy
o Rainy
Other observations: ____

3.5 Is there any eventuality or activity that modifies the usual dynamics of the farmer's fair?
o YES
o NO
Please specify: ____

3.6 Do most of the clients of the farmer's fair carry shopping carts, reusable bags or other means of storing the products purchased?
o Always
o Almost always
o Sometimes
o Almost never
o Never

3.7 According to what you observed, do most of the fair's customers use plastic bags even if they carry shopping carts, reusable bags, or other means to store the products purchased?
o YES
o NO

3.8 Do vendors generally give plastic bags to customers, even if they do not ask for them?
o YES
o NO

3.9 According to your perception, does the vendor influence the consumption of plastic bags by customers?
o YES
o NO

3.10 Including the registered producer, for the most part, what is the average number of people counted working in the stalls? ____________________

3.11 If necessary, please note any additional observations or comments.
____
____