The effect of informational nudges to promote voluntary behavior to reduce nonpoint source pollution: A randomized controlled trial in the field

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Abstract

Policy makers often use voluntary programs to control nonpoint source pollution from residential lawns. We run a field experiment to test whether informational nudges can motivate residents to choose green-certified lawn care services voluntarily. We find that the informational nudges spur voluntary behavior conditionally. However, a small financial incentive to encourage behavior does not reinforce the effect of the informational nudges. These findings are potentially important for state and federal agencies as well as advocacy groups interested in promoting best management practices.

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1. Introduction

Nonpoint source (NPS) pollution is recognized as the primary cause of water pollution in the United States [EPA, 2007] and has many adverse environmental effects in other areas such as Europe [EEA, 2007] and China [Sun et al., 2012]. It is hard to control NPS pollution due to its diffuse nature and resulting information asymmetries between an environmental regulator and the agents who contribute to the NPS pollution problem [Xepapadeas, 2011]. To internalize external environmental damages caused by NPS pollution and circumvent the information problems, economists designed "new" standard regulatory policy instruments such as input tax [Griffin and Bromley, 1982], ambient-based instrument [Segerson, 1988] and random punishment [Alpízar et al., 2004]. Theoretically, they are promising to alter behavior that would inhibit water quality. However little progress on NPS pollution regulation has been made, at least in the United States, because of various barriers, including significant political resistance [Craig and Roberts, 2015], few experimental designs and different spatial scales for behaviors and measured outcomes [Rissman and Carpenter, 2015].

Currently, local, state, and federal initiatives in the United States mainly take the voluntary approach to stimulate behavior change to reduce NPS pollution. For example, farmers in the agricultural area are encouraged to adopt pollution control through local, states and federal financial supports [Shortle et al., 2012]; Residents in the urban and suburban area often encounter education campaigns which nudge people to take voluntary behavior to reduce polluted runoff. Appeals such as "water and fertilizer your lawn properly," "leave clips on your lawn" and "use a rain barrel" frequently appear in those programs [e.g., Eisenhauer et al., 2010; Bakacs et al., 2013]. From a broader point of view, policymakers all over the world widely favor the use of voluntary approaches as a way to improve environmental qualities [Segerson, 2013]. Though treated as

second-best instruments, voluntary approaches can be cost-effective in encouraging conservation and environment protection with thoughtful designs. Successful examples of those designs include payments for ecosystem services schemes under which landowners are paid for implementing conservation practices [e.g., Ferraro and Kiss, 2002], or unilateral initiatives under which polluters take voluntary actions to reduce pollution [e.g., Ahmed and Segerson 2011].

Inspired by those voluntary programs, we conduct a randomized controlled field experiment to look into the possibility of using behavioral economic insight, focusing specifically on so-called "green nudges" [Schubert, 2017], to promote voluntary behavior to reduce NPS pollution from residential lawns. A cross-randomized financial incentives treatment is also carried out in this experiment to examine the interaction impacts of the nudges and financial incentives on landowners' lawn management behavior.

About twenty years ago, lawns ranked as the United Sates' fifth largest "crops" [USDA, 1997]. However, according to a recent paper [Milesi et al., 2015] co-authored by NASA scientists, the American lawn is now the largest planted "crop" in the world. As the runoff moves away from the residential area, it carries pollutants, such as excessive nutrients and pesticide from lawns, and deposits them into receiving waterbodies, which represents one of the causes of water quality degradation in many regions [EPA, 2005]. Household lawn fertilization is significant nitrogen inputs in the urban waterways [Hobbie et al., 2016]. With proper lawn care, residents can reduce the negative impact of runoff from lawns, however [Spence et al., 2013]. State and local agencies in the United States have mostly relied on education programs and extension campaigns to send information to homeowners and nudge them to voluntary adopt best management practices (BMPs) on private lawns [e.g., Dietz, 2004; Kelly et al., 2012; Bakacs et al., 2013]. The research questions

of the researchers who scrutinize those programs mainly center on how those programs can increase the supply of BMPs.

To the best of our knowledge, our study is the first to test how information can nudge people to adopt BMP for residential lawn care. One of the key issues in designing such an experiment is the inability of the researchers to observe the subjects' lawn care behavior, such as mowing the lawns high or reducing fertilizer use. To circumvent this problem, we use the discrete choice of whether or not the resident contract with a professional company that can provide BMP lawn care to measure the treatment effects. Contracts are clearly observable. The Rhode Island Department of Environmental Management (RIDEM) has a new program which green-certifies the lawn care businesses that commit to a list of BMPs when they manage their clients' lawns. We seize the opportunity that this new program offers to investigate how the information delivered to homeowners can nudge them into obtaining green–certified lawn care contracts. Moreover, we also test how this type of nudges affects hypothetical willingness to pay (WTP) for contracts with these certified companies. We give real financial incentives randomly to a portion of homeowners by offering rebates for green-certified lawn care contracts. The design gives us a unique opportunity to check whether the financial incentives would backfire the potential positive treatment effect attached to the information.

Nudge theory prevails after the publishing of the seminal book "*Nudge: Improving decisions about health, wealth, and happiness"* written by Richard H. Thaler and Cass R. Sunstein. In this book, they define the nudges as "*any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives*.". Schubert [2017] raises an idea about "green nudges" and considers it as "*nudges that aim at promoting environmentally benign behavior*.". However, since the exact

definition of nudges is somewhat controversial and there is no strict line between nudges and incentives [Hansen, 2016], we use "informational nudges" and "financial incentives" to differentiate the two kinds of treatments in our study. The first treatment offers information, while the second treatment provides financial incentives to homeowners to nudge the purchasing behavior of green-certified lawn contracts.

Information can affect people's wiliness to pay for market goods. Depositario et al. [2009] find that WTP bids for golden rice are higher under positive information than no information, negative information and two-sided information scenarios. Rousseau and Vranken [2011] demonstrate that the provision of information on the actual environmental and health effects of organic apple production increases consumers' price premium. One study by Aldrovandi et al. [2015] shows that telling people two different types of information about how their consumption is ranking causes an over 30% WTP gap for healthy food. Consumers even react to the information bringing by eco-labeling. For example, Stemle et al. [2016] find that Marine Stewardship Council certification significantly improves ex-vessel prices of some fishes.

Information can also nudge consumers' behavior change. For example, according to the study by Mathios [2000], people significantly consume fewer salad dressings with very high-fat levels after producers were mandatorily required to disclose nutritional content by the Nutrition Labeling and Education Act. Bertrand & Morse [2011] show that information showing the adding-up effect of loan fees over several pay cycles helps people overcome cognitive bias and results in 11% less borrowing in the subsequent four months. There are also a handful of field experiments conducted to test the impact of informational nudges on quantity and quality of people's energy consumption. For instance, Allott [2011] reports that, on average, consumers reduce 2% energy

consumption when nudged by the Home Energy Report letters which display the comparison of their electricity use to that of their neighbors.

Nevertheless, the effect of informational nudges on behavior is highly context-dependent, and the effect of different types of information varies. Fellner et al. [2011] run a field experiment in Austria to test the effectiveness of various normative messages sent to potential evaders of TV license fees. While the "threat" treatment which makes a high detection risk salient is useful, neither appealing to morals nor imparting information about others' behavior induces significant behavior change. Costa & Kahn [2013] find that the informational nudges could have an adverse effect for some political conservatives who may increase their electricity consumption only because they resent the reports that link their behavior to that of their neighbors'.

When the informational nudges are coupled with the financial incentives, the resulting effect is even more complicated. The tension between intrinsic motivation (which can derive from informational nudges) and extrinsic incentives (which might be offered by external agents) is well known in the growing bodies of field experiment literature [e.g. Alpízar and martinsson, 2011; Lacetera et al., 2012;]. The recent research by Pellerano et al., [2016] uses both intrinsic motivation and extrinsic motivation to induce consumers' energy conservation, and they detect a backfire of extrinsic motivation in their experiment. Extrinsic motivation may have a crowing-out effect especially when incentives are small. However, as Gneezy et al. [2011] argue a large incentive may have a stronger price effect than the crowding-out effect so that it can promote conservation in the short run. Our study serves as a field evidence of this argument in NPS pollution voluntary programs settings, and our experiment design can also test for the potential crowding-out effect of financial incentives.

From a theoretical perspective, we test whether informational nudges spur subjects' non-pecuniary motivation such as moral costs [Levitt and List, 2007] in NPS pollution settings and increase their demand for green services. Also, in line with neo-classical economic models to deal with the upfront cost of buying green services, we also impose a cross-randomized treatment in which the respondents receive financial incentives. We postulate that in the field experiment financial incentives also stimulate the demand for green services, but it may crowd out the demand nudged by the information.

We partner with the local green-certified lawn care industry to run the experiment and distribute the survey to the households in the area serviced by these green-certified companies. From the survey, we obtain three indicators to measure the impact of informational nudges and financial incentives on promoting voluntary behavior: (i) homeowners' stated WTP for green-certified lawn contracts;, (ii) reported Likert scale to hire green-certified lawn companies; and (iii) information acquisition requirements which mean the respondents leave their contact details (their names, email addresses, and phone numbers) to the green-certified lawn care companies to get free estimates. Ideally, we can use the uptake of contracts as one indicator. However, at the time of this manuscript, we have not yet concluded the experiment and do not have the full results of the uptake. Therefore, the uptake of contracts is not one of the indicators in this paper. Specifically, we hypothesize that the informational nudges add a premium to the WTP for the green-certified lawn care contracts, increase the stated likelihood to hire a green-certified lawn care companies and incentivize/motivate people to take the first step (towards a more environmentally friendly lawn care contracts). Financial incentives would have a similar effect to the informational nudges on the reported probability to hire and motivating people to take actions. However, when we implement them together, the crowd-out effect may step in.

Many differences exist between lawn care contracts and standard market goods such as healthy food, electricity or water even there are markets for lawn care contracts. We do believe those differences affect the outcomes from the survey. For example, households have different sizes of lawns which may result in very different stated WTP for green-certified lawn care; or some households might have a good relationship with lawn care companies they previously contracted with which may affect their decision to switch to a green-certified one. Thus, we also record lawn care practice and individual characteristics in the survey. By controlling those components, we expect to improve the precision of the treatment effect estimation.

Furthermore, we collect two pieces of unique personal information from the respondents echoing the literature that shows the New Ecological Paradigm (NEP) scale and the Self-Report Altruism (SRA) scale are good predictors of pro-social behavior. The NEP Scale is an estimate of endorsement of pro-environmental attitudes [Dunlap et al., 2000] and the SRA Scale is a measure of altruistic personality [Rushton et al., 1981]. In the online survey conducted by Attari et al. [2016], for example, people's pro-social actions have a strong correlative relationship with the NEP Scale. The research by Otto and Bolle [2011] shows that the SRA Scale is related to the charity giving, but not to the blood donation behavior.

We find that in our study, on average, the respondents in the informational nudge treatment group state a significantly larger WTP for green-certified lawn care contracts, but this premium nudging by the information diminishes as the cost of the lawn care increases. When we restrict the samples to those who reported that they are likely to contract with green-certified lawn care companies, the nudging premium is still positive but not statistically significant; the decreasing trend over the cost still exists but not statistically significant either.

We also find that the informational nudges and a high financial incentive significantly increase the reported likelihood to seek a green-certified lawn contract. However, a low financial incentive alone seems to have no effect on the respondents' Likert scales, and it may backfire the positive effect nudging by the information.

The informational nudges have a significant effect of nudging people to take the first step by asking for free estimations from the green-certified lawn care companies. However, after we control the NEP Scale and SRA Scale, the effect is not significant anymore which may indicate the informational nudges only work for a subset of people. Financial incentives are also excellent instruments to create behavior changes, but we find evidence that shows financial incentives crowd out the outcomes of the informational nudges. Only a high financial incentive can induce a significantly greater treatment effect compared to the nudge-only instrument.

We organize the article as follows: Section 2 presents the experiment design and the data collection process. Section 3 formulates the detailed results. Section 4 states our conclusions and recommendations.

2. Experiment design and data collection

2.1 Experiment design

We conduct the research in Rhode Island and neighboring counties in southern Massachusetts and western Connecticut. This area is one of the most densely populated in the United States and has high fractional turfgrass coverage [Milesi et al., 2015]. The urbanization process is still active. When land is transformed for urban and suburban usage, a lawn is often planted as ground cover on open spaces attached to houses and buildings [Jenkins, 2015]. The importance of neighborhood appearance and concern for aesthetics drive residents to water and fertilize lawns frequently and use other practices to care for their lawns [Nielson and Smith, 2005]. Significant NPS pollution is

generated from those lawn care practices, and it is recognized as one of the causes of water quality impairments in some area [e.g., RIDEM, 2015].

In 2015, RIDEM started the program to green-certify lawn care companies who adopt BMPs to reduce their environmental impact when managing residential lawns. The green-certified lawn care companies fulfill a menu of BMPs covering a range of activities focusing on efficient turf management and water conservation. They protect environmental quality by reducing the source of pollution, conserve water and other natural resources and contribute to the sustainability of lawn care. Green-certified lawn care companies need to adopt additional best management practices to get re-certified every two years. Although it is the smallest state in the United States, Rhode Island has about 400 lawn care businesses according to RIDEM. Only ten lawn care companies (about 2.5%) were green-certified as of January 2017.

The green certification program by RIDEM is a good example of the state-level effort to reduce NPS pollution by promoting voluntary "green services" from the supply side. Lawn care companies' behavior varies largely when managing residential lawns [Law et al., 2004]. According to meeting memos with lawn care professionals in Rhode Island, those who pursue this green-certification want to fulfill social responsibility and also hope that the green-certification will bring customers for their business. Apparently, if more customers adopt lawn care contracts because of the green certification, more lawn care companies will react to the signal and minimize their environmental impact. As a side goal, we conduct the experiment to find good ways to endorse and publicize green-certification.

We partner with a state-wide professional landscape association [the Rhode Island Nursery and Landscape Association (RINLA)] and three green-certified landscaping companies to run the experiment. With this collaboration, we integrate BMPs on lawns into green-certified lawn care

contracts. In contrast to measuring homeowners' supply of BMPs as outcomes in regular voluntary programs to control NPS pollution, we estimate their demand side in this study.

We test the effect of two general treatments in the experiment to promote the uptake intention of green-certified lawn care contract: informational nudges and financial incentives. The test treatments are varied between participants in a general two-by-two design (see Table 1) and implemented in a well-structured survey coded in Qualtrics, an online survey software. Respondents of the survey are all exposed to the introduction of green-certified lawn care companies, and two-thirds of them are randomly chosen to receive informational nudges. We introduce a cross-randomized incentive treatment after the first randomization of information. Three-quarters of respondents receive financial incentives randomly, and one-quarter of them receive none. To differentiate the effect of different informational nudges and different level of financial incentives, we implement two types of nudges and two levels of incentives in the experiment (see Table 1 for more details about samples).

Three segments comprise the introduction of green certification programs of RIDEM and green-certified lawn care companies. The first segment introduces the history of the green certification program and some BMPs conducted by lawn care companies using bullet points. The second segment reinforces the contents of bullet points by one infographic. The third segment attaches a few reputable sources about BMPs for lawn care practices from three state universities (the University of Massachusetts, the University of Connecticut and the University of Rhode Island). Based on results of the report about lawn care behavior [Eisenhauer et al., 2010], we design another infographic (Nudge 1) that contains the salient information about the relationship between lawn care practices and water quality. We display Nudge 1 to all the respondents who are in the general informational nudge treatment group. The information such as "Runoff flows into aquatic

habitats, where, just like your lawn, fertilizer makes plants grow. However, too much growth can lead to not enough oxygen in the water, killing fish and other aquatic lives." is shown in the infographic of Nudge 1. We also design another infographic (Nudge 2) that displays the information about how many the respondents' neighbors choose to have green-certified lawn care contracts in 2016 based on statistics we obtain from RINLA. Half of the respondents in the general informational nudge treatment group are exposed to Nudge 2 randomly. (See the attached survey in the appendix for more details about the introduction of the certification programs and green-certified lawn care companies and infographics for informational nudges.)

Two levels of financial incentives are designed and distributed to the respondents randomly. A low financial incentive covers twenty-five percent of a typical green-certified lawn care contract of which the average contract value is $300 according to RINLA, while a high financial incentive covers half of the contract. Due to the limited budget, we cap the low financial incentive to $75 and the high financial incentive to $150. Two-thirds of the respondents who are in the general financial incentive group receive the low financial incentive randomly, and one-third of them are randomly exposed the high financial incentive.

2.2 Survey Design and data collection

The survey contains five parts. The first part of the survey includes screening questions which ensure the respondents are eligible. An eligible respondent must have his or her house properties in Rhode Island and some areas in Massachusetts and Connecticut. We include areas in the other two states because Rhode Island has small geographical area and many lawn care companies have potential customers there. Also, the respondent must be responsible for making decisions on lawn maintenance. We also exclude those households that hired green-certified lawn care companies in 2016 from our survey. The second part begins with a consent form. In the

consent form, we state the affiliation and the purpose of the survey. We include a short description and expected time that the respondents may take to finish all the questions. We embed some clarification requested by the Institutional Review Board (IRB) at the University of Rhode Island in the consent form. If the respondents agree to all the statements in the consent form, they may continue to answer the survey. The rest of part two asks the respondents questions about lawn characteristics and lawn management practices in 2016.

We display the information about green-certified lawn care companies and the informational nudges in the third part of the survey. One-third of the respondents receive Nudge 1 randomly, and another third receive Nudge 1 and Nudge 2 together. We ask the WTP for green-certified lawn care contracts after the nudge randomization is over. The fourth part of the survey is the randomization of giving away incentives. The Likert scale question about their willingness to obtain services from one green-certified lawn care companies is asked based on different combination of the informational nudges and financial incentives. The Likert scale has six levels for this question, from "extremely unlikely" to "extremely likely". At the end of the fourth part, we ask the respondents whether or not they are interested in receiving more information from the three green-certified lawn care companies that collaborate with us. If they are interested, we then ask the respondents for permission to send their contact information to the three green-certified lawn care professionals. Demographic questions including gender, age, education, and income and the question matrices to tease out the respondents' NEP Scale and self-report altruism scale comprise the fifth part of the survey.

The NEP Scale is designed to gauge the environmental concern of people using a survey instrument constructed of fifteen statements. The survey instrument includes the statement such as "*we are approaching the limit of the number of people the earth can support*." or the statement " *if*

things continue on their present course, we will soon experience a major ecological catastrophe.". We ask the respondents whether they agree or disagree those statements, and they answer the questions by choosing from seven levels from "completely disagree" to "completely agree". We assign a value of zero to "completely disagree" and a value of six to "completely agree". The NEP Scale equals the average of the values of the fifteen statement.

The SRA Scale is designed to measure people's altruistic tendency by letting people self-report the frequency with which they engage in 20 altruistic acts primarily toward strangers. Respondents report the frequencies of the acts on a 5-point scale ranging from "never" to "very often". A value of zero is assigned to "never" and a value of 4 for "very often". The SRA Scale equals the summation of the values of the 20 acts.

We conducted four sessions of focus groups to make sure the respondents understand our survey questions. Group participants were recruited from Craigslist and compensated with $40 for their time. Eligible participants were those who were over 18 years of age, had a lawn and were responsible for its maintenance. We conducted all focus groups at the Robert L. Carothers Library of the University of Rhode Island. During the focus groups, the participants were asked to take the survey first and then provide us with their feedback. On average, the participants spent 19 minutes to finish the survey. Questions such as "Are there any questions that are not clear?" or "What is the message of this infographic?" were asked in the guided feedback session following the completion of the survey. Participants 'comments and suggestions were then used to improve the survey, whenever appropriate. We also sent the survey to outreach personnel at University of Rhode Island and lawn care professionals for further opinions. The survey was officially distributed to the respondents at the end of February 2017, and was supposed to end the last day

of March 2017. However, due to inclement weather and the subsequent delay of lawn care season, we extended the survey closing date until April 15th.

As previously stated, the survey was coded in Qualtrics and distributed online. The survey respondents were recruited through two channels: Qualtrics panel and local organizations' email listserv. Qualtrics use by the invitation-only online panel recruitment methods to avoid self-selection and professional survey takers. Thus many researchers utilize it to recruit subjects for their surveys. Our survey was also distributed to the respondents by local schools, environmental organizations and local newspapers. We reached out to school district superintendents, school principals, directors of environmental organizations and newspapers and representatives of city governments to communicate the availability to distribute the survey to their email listserv. Five schools, twelve environmental organizations, one local online newspaper and one city hall agreed and managed to post our survey on their newsletters sending it to their audiences routinely. The research team created advertisements for recruiting respondents and made minor changes according to volunteer organizations' requests. We offered a $2 Amazon gift card to any respondent who finished our survey as a small thank-you gift. The respondents could obtain the gift cards by signing their names and leaving email addresses. They could also choose to donate the gift cards to the organization that sent them our survey. (We attach a full list of those organizations in the appendix. We also include one example advertisement in the appendix.)

The survey procedure, focus group and all related materials that were shown to the respondents, including the survey itself, were approved by the IRB at the University of Rhode Island. Survey data were downloaded from Qualtrics and updated in our internal database twice per week (Monday and Thursday) during the survey period. The research team routinely checked the data, sent out the Amazon gift cards and interested respondents' information to lawn care

companies. We collected 1,736 answered surveys in total, 1,000 of these from the Qualtrics panel and 736 from schools and local organizations' email listservs. It is worth mentioning that the 1,736 completed surveys may not contain all the variables in this study. This is due to URI IRB regulation that requests that all questions except the screening questions are optional in the survey and the respondents may skip any questions they want.

3. Results

We use three outcome variables to measure the impact of informational nudges and financial incentives on nudging behavior: WTP for green-certified lawn care contracts, Likert scale to hire one green-certified lawn care companies and choices to leave information to the three green-certified lawn care companies. Control variables include household lawn care characteristics and respondents' individual characteristics. Table 2 lists the descriptive statistics of key variables of this study. We start by reporting the results of the respondents' stated WTP.

The average WTP (Median = $200, Mean = $423.92, N = 1030) stated by the respondents in the informational nudges treatment group is higher than the average (Median = $200, Mean = $416.61, N = 522) in the control group. However, the Student t-Test (p = 0.88) does not reject the null hypothesis that the two means are indifferent with each other and Wilcoxon rank-sum test (p = 0.36) does not reject its null hypothesis either. However, since many factors can affect the WTP, such as lawn acreages or lawn management efforts, which may confound the treatment effect, we specify four additional regression models to control those potential factors and identify confounders if any.

Looking into the data, we find that lawn care spending is a good predictor of the stated WTP. Also, we observe zero WTP values for a significant fraction (17.43% in the control group, 15.34% in the informational nudge treatment group). Thus, we first set up a TOBIT regression

model, with the cost in 2016 and experimental design variables as independent variables. An interaction term between the cost variable and the nudge dummy variable is also included to check whether the hypothesized WTP premium nudging by the salient information is affixed to the previous year's lawn care spending. The first column of Table 3 presents the results of the TOBIT model. It seems informational nudges can increase the WTP significantly (p <10%) when spending on lawn care is not too high on the lawn care. However, the statistically significant negative slope for the interaction term indicates that this premium diminishes as the spending increases. The effect of the informational nudges could be negative when the spending is high enough. The NEP Scale and the SRA Scale is added to the TOBIT model to check whether the two individual characteristics well predict the WTP. We do not find that the two variables statistically significantly change the WTP. The effect of informational nudges on the WTP still holds, even in the third model in which we add more lawn characteristics and individual characteristics as explanatory variables.

Nevertheless, the informational nudges do not affect the WTP statistically significantly after we restrict the observations to a portion of the sample. In the fourth regression model (N = 675), we drop the WTP observations if the respondents state that they are slightly unlikely, moderately unlikely or extremely unlikely to hire green-certified lawn care companies. From the fourth column of Table 2, we can observe that informational nudges still have a positive effect and their interaction with the cost slopes down, but the coefficients of the two variables are not significant anymore. It suggests that some respondents might be nudged to state high WTPs even they are not likely to obtain contracts. It also indicates that the hypothetical WTP premium for informational nudges in our survey may have a gap between the actual one.

Taken together, we find that the informational nudges can increase people's WTP to for green-certified lawn care contract. However, the effect of the nudges might be different from person to person. Evidence even shows that the informational nudges might lower people's WTP when their lawn care bill is supposed to be high. We apply the same analysis to the figure out the possible different treatment effects between offering Nudge 1 only and offering Nudge 1 and Nudge 2 together. However, no significant differences are detected.

The Likert scales to hire the green-certified lawn care companies are used to measure the effect of informational nudges and financial incentives together. As stated before, we asked the Likert scales question after the respondents randomly received the financial incentives. The Likert scales have six levels, and we assign value one to the Likert scales if they state that they are extremely unlikely to hire one green-certified lawn care companies, and value six for extremely likely.

We first run a Pearson's Chi-square test the independence between informational nudges and the Likert scales. The result rejects the hypothesis that the two variables are independent of each other at 10% level (χ^2= 11.02, p = 0.051). Surprisingly, the Chi-Square test for the independence between financial incentives (= 1 if any incentives are given) and the Likert scales do not reject the null hypothesis (χ^2= 1.99, p = 0.85). We further replace the financial incentives variable with another categorical one, which assigns value zero to the no incentive group, value one to low incentive group and value two to high incentive group, in the test. Its result reject the hypothesis at 10% level (χ^2= 16.79, p = 0.08), however. We conjecture that the two types of financial incentives may have different effects in the stated Likert Scales. Thus, in the following regression analysis, we differentiate the financial incentives as the low financial incentive and the high financial incentive.

We use ordered logistic regressions (OLOGIT) to estimate the treatment effect of the informational nudges and the financial incentives since our dependent variables are ordered categorical variables and our data meet all the assumptions of ordered logistic models. We first run the regression with the design variables, including the interaction terms of the two treatment variables and the variable defining the recruitment channels. The results of the first model (column 1, Table 4) indicates the stated likelihood to hire a green-certified lawn care companies is statistically significantly higher ($p < 0.01$) in the groups presented with the high financial incentive, the informational nudges, and the interaction of informational nudge and the high financial incentive than in the group with no financial incentives and no nudges. However, presenting the low financial incentive alone does not change the likelihood statistically significant. The coefficient of the interaction term of the low financial incentive and the informational nudges is only significant at 10% level ($p = 0.051$), which indicates that the low financial incentive may crowd out the likelihood crowded in by the informational nudges. Interestingly, it seems the stated likelihood from the respondents recruited from the Qualtrics panel is higher than that reported by the respondents recruited from the local organizations' email listserv.

We further added the NEP Scale and the SRA Scale into the second model as explanatory variables. Both variables have statistically significant effects ($p < 0.01$, column 2, Table 4) on the stated likelihood. The results are robust when we add lawn care characteristics and the other individual characteristics into the third and fourth models (column 3 and column 4, Table 4). The effects of high incentive and the informational nudges also persist with more independent variables according to Table 4.

Based on the results of Table 4, we conclude that the informational nudges and the financial incentives increase the respondents' stated likelihood to hire green-certified lawn care companies.

However, the size of the financial incentives matter. People who are more environmentally friendly and altruistic are more likely to show interests in the green-certified lawn care companies. Nevertheless, will they act? The following part analyzes the determinants of the information acquisition requirements variables.

Table 5 summarize the rate of the respondents who want the green-certified lawn care companies to contact them and give more information. It seems the informational nudges increases the action rate no matter there are incentives. However, based on to Chi-square tests (Column 3, Table 5), the action rate is dependent on the nudge treatment at 10% level, not in the cases when we give incentives to the respondents. It suggests that the informational nudges and incentives may substitute each other when nudging the respondents to act to obtain a green-certified lawn care contract.

We further use binomial logistic regression (LOGIT) models to identify the treatment effects. The experiment design variables are predictors of the probability of actions in the first model (χ^2= 12.93, p = 0.04). The results (Column 1, Table 6) show that both informational nudges and financial incentives statistically significantly increase the log odds ratio of taking the first step to having green-certified lawn care contracts. For example, the first cell of column 1 indicates that a low incentive can increase the log odds ratio of actions by 0.924 at 10% level. Surprisingly, the last cell of column 1 points out that the respondents from Qualtrics Panel are less likely to act even they stated that they are more likely to hire a green-certified lawn care contract.

We add the NEP Scale and the SRA Scale in the second model and find that they both increase the probability to take the first step. Financial incentives and their interactions with the informational nudges still have significant effects in this model, but without financial incentives, the informational nudges have a limited effect. It may suggest that the informational nudges can

only spur those people with high NEP Scales and high SRA Scales to act. The above results hold when we add lawn care characteristics and other individual characteristics as explanatory variables. Worth to mention, we cannot differentiate the effect of presenting Nudge 1 and Nudge 2 together on the action from the effect of showing Nudge 1 alone.

The answer to the question "will they act?" is definitely "Yes.". Both the informational nudges and financial incentives can nudge people to act. However, they substitute each other when implemented together. Evidence also shows that the informational nudges may work only for a particular group of individuals with higher NEP Scales and SRA Scales. More testing on differences between coefficients of interaction variables shows that only the high financial incentive interacted with the informational nudges induces a statistically significantly higher probability to act than the informational nudge-only treatment. This result seems to support the argument by Gneezy et al. [2011] in our setting that the high financial incentive may have a big price effect so that it can offset the crowding-out effect and increases the action to obtain green-certified lawn care contracts.

4. Conclusion

This study empirically investigates the impact of the informational nudges on promoting voluntary behavior from the demand side to reduce NPS pollution in a lawn care market setting. The green certification program by RIDEM integrates BMPs, a list of environmental goods, into the lawn care contracts which are market goods. In collaboration with the local lawn care industry in Rhode Island, we conduct a field experiment and obtain two types of outcomes to measure the residents' demand for the green certification. The first type belongs to the stated preferences family. It includes the measure of people's WTP for and the reported likelihood to obtain the green-certified

lawn care contracts. The second type is one kind of revealed preferences, and it captures whether individuals act to secure the green-certified lawn care contracts.

Both types of outcomes indicate that the salient information can nudge the demand. Specifically, the respondents report a WTP premium and higher likelihood to sign a contract when we present them the informational nudges. The information nudges also induce more respondents to take the first step to contract. However, when we show the informational nudges and financial incentives together, we detect the crowding-out effects especially when the financial incentives are small.

Our findings also suggest that the effect of the informational nudges are different from person to person. The WTP premium diminishes as the spending on the lawn care increase; the informational nudges may work mostly for people with higher NEP Scales and SRA scales.

Results show that the financial incentives can nudge the pro-social behavior to some extent, particularly when the incentives are significant. However, when dealing with NPS pollution from the lawns, an environmental regulator has to face many small private landowners. It makes the financial incentives unfeasible under a limited budget. When incentives substitute the effect of the informational nudges and the significant incentives are unfeasible, the voluntary programs to reduce NPS pollution should opt to and focus on the nudging strategies by more efficient education programs and offering more environmentally friendly choices to the public.

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Table 1: Informational nudges and financial incentives interacted-treatments Table

Treatment	Description	Portion of N	Subgroup	Description	Portion of N
Baseline treatment	No nudges + No incentives	1/12	Baseline treatment	No nudges + No incentives	1/12
Treatment group 1	Nudges + No incentives	1/6	Subgroup 1	Nudge1	1/12
			Subgroup 2	Nudge1 + Nudge 2	1/12
Treatment group 2	No nudges + Incentives	1/4	Subgroup 1	Incentive 1	1/6
			Subgroup 2	Incentive 2	1/12
Treatment group 3	Nudges + Incentives	1/2	Subgroup 1	Nudge 1 + Incentive 1	1/6
			Subgroup 2	Nudge 1 + Incentive 2	1/12
			Subgroup 3	Nudge 1 + Nudge 2 + Incentive 1	1/6
			Subgroup 4	Nudge 1 + Nudge 2 + Incentive 2	1/12

Table 2: Descriptive statistics

Variables	Description	N	Median	Mean	Std. Dev
Panel A. Main outcome variables					
WTP	Willingness to pay ($) for green-certified lawn contracts	1552	200	421.5	910.75
Likert Scale	Likert scale to hire a green-certified lawn care companies (1 = extremely unlikely, 6 = extremely likely)	1591	3	3.11	1.69
Act	Request contact from green-certified lawn care companies	1277	0	0.12	0.32
Panel B. Experiment design variables					
Nudge 1	Informational nudge 1 (dummy, = 1 if provided)	1657	1	0.67	0.47
Nudge 1 only	Informational nudge 1 only (dummy, = 1 if provided)	1657	0	0.33	0.47
Nudges 1&2	Informational nudges 1 and 2 (dummy, = 1 if provided))	1657	0	0.34	0.47
Incentives	Incentives (dummy, = 1 if any provided)	1603	1	0.75	0.43
Low incentive	Incentive 1 (dummy, = 1 if provided)	1603	1	0.5	0.5
High incentive	Incentive 2 (dummy, = 1 if provided)	1603	0	0.25	0.43
Panel	Panel (dummy, = 1 if respondents comes from Panel)	1736	1	0.58	0.49
Panel C. Household lawn care characteristics					
Hire	Had a lawn contract in 2016 (dummy, = 1 if had one)	1736	0	0.15	0.35
Cost in 2016	Lawn care spending in 2016	1641	140	367.66	820.72
Acreage	Lawn acreage	1648	0.5	0.7	1.22
# Practices	Number of practices to manage lawns in 2016	1716	4	3.87	2.15
# BMPs	Number of known BMPs applied to lawns in 2016	1628	3	3.47	1.58
Panel D. Respondents' individual characteristics					
NEP Scale	New Ecological Paradigm scale	1534	3.53	3.58	0.56
SRA Scale	Self-Report Altruism Scale	1512	39	39.36	12.17
Belief Scale	Number of BMPs that is recognized as effective	1616	4	3.56	2.05
Gender	Gender (dummy, =1 if female)	1545	1	0.65	0.48
Age	Age (categorical variable)	1567	4	4	1.55
Education	Education (categorical variable)	1569	6	5.25	1.62
Income	Income (categorical variable)	1492	4	4.4	1.8

Table 3: Estimation results of the TOBIT models

VARIABLES	(1) WTP	(2) WTP	(3) WTP	(4) WTP
Cost in 2016	0.957***	0.955***	0.844***	0.848***
	(0.0715)	(0.0726)	(0.0870)	(0.100)
Nudge 1	125.7*	134.9*	138.5**	91.84
	(67.87)	(69.99)	(67.83)	(64.07)
Nudge 1 # Cost in 2016	-0.343**	-0.346**	-0.347**	-0.249
	(0.171)	(0.174)	(0.161)	(0.185)
Panel	78.75	64.39	58.42	17.16
	(52.21)	(58.66)	(46.46)	(42.31)
NEP Scale		47.70	38.64	-62.69
		(39.84)	(40.11)	(38.84)
SRA Scale		0.181	-0.329	1.711
		(1.865)	(2.077)	(1.464)
Other lawn care characteristics			✓	✓
Other individual characteristics			✓	✓
N	1,544	1,462	1,348	675

*Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

Table 4: Estimation results of the OLOGIT models

VARIABLES	(1) Likelihood	(2) Likelihood	(3) Likelihood	(4) Likelihood
No nudges # Low incentive	0.296	0.335*	0.256	0.359*
	(0.194)	(0.199)	(0.197)	(0.205)
No nudges # High incentive	0.786***	0.778***	0.758***	0.827***
	(0.226)	(0.234)	(0.228)	(0.244)
Nudge 1 # No incentive	0.525***	0.462**	0.377*	0.397*
	(0.196)	(0.205)	(0.201)	(0.210)
Nudge 1 # Low incentive	0.324*	0.345*	0.297	0.381**
	(0.182)	(0.189)	(0.186)	(0.194)
Nudge 1 # High incentive	0.677***	0.652***	0.645***	0.627***
	(0.200)	(0.205)	(0.202)	(0.214)
Panel	0.464***	0.445***	0.403***	0.452***
	(0.0986)	(0.110)	(0.110)	(0.127)
NEP Scale		0.773***	0.822***	0.713***
		(0.0987)	(0.101)	(0.103)
SRA Scale		0.0167***	0.0139***	0.0176***
		(0.00445)	(0.00454)	(0.00469)
Lawn care characteristics			✓	✓
Other individual characteristics				✓
Observations	1,590	1,501	1,484	1,412

Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 5: Action rate by treatments

	No Nudges	Nudges	Nudge 1 vs. Act (p-value)
No Incentives	4.76%	10.67%	$\chi^2 = 3.19$, $p = 0.07$
Low Incentives	11.11%	12.13%	$\chi^2 = 0.14$, $p = 0.70$
High Incentives	14.00%	16.67%	$\chi^2 = 0.36$, $p = 0.54$

Table 6: Estimation results of the LOGIT models

VARIABLES	(1) Act	(2) Act	(3) Act	(4) Act
No nudges # Low incentive	0.924*	0.904*	0.916*	0.906*
	(0.509)	(0.518)	(0.522)	(0.536)
No nudges # High incentive	1.181**	1.120**	1.043*	1.040*
	(0.544)	(0.557)	(0.557)	(0.577)
Nudge 1 # No incentive	0.875*	0.778	0.793	0.769
	(0.510)	(0.522)	(0.526)	(0.540)
Nudge 1 # Low incentive	1.009**	0.984**	0.993**	0.970*
	(0.486)	(0.494)	(0.500)	(0.511)
Nudge 1 # High incentive	1.385***	1.396***	1.418***	1.156**
	(0.497)	(0.505)	(0.510)	(0.526)
Panel	-0.350**	-0.541***	-0.580***	-0.516**
	(0.174)	(0.192)	(0.197)	(0.233)
NEP Scale		0.692***	0.661***	0.648***
		(0.163)	(0.173)	(0.187)
SRA Scale		0.0165**	0.0142*	0.0144*
		(0.00726)	(0.00754)	(0.00813)
Lawn care characteristics			✓	✓
Other individual characteristics				✓
Observations	1,276	1,200	1,184	1,112

Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$