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How to stimulate environmentally friendly consumption: Evidence from a nationwide social experiment to promote eco-friendly coffee

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Abstract

We investigate the effect of information provision about environmentally friendly coffee on consumers' purchasing behaviors. We use a dataset from a nationwide social experiment in Japan involving over 10,000 vending machines serving brewed coffee. We also provide empirical insights into the mechanisms for stimulating eco-friendly consumption. Our results demonstrate that informing consumers about the product's eco-friendliness significantly increases eco-friendly coffee sales (+7%) only in social spaces (e.g., office buildings) and not in non-social spaces (e.g., shopping malls). Consumers in social spaces might be motivated to purchase eco-friendly coffee to build a "green" reputation among community members after receiving such information.

Keywords: information provision, social experiment, sustainability labels, coffee certification, green reputation

JEL classification codes: Q13, O13, G14, M31, C93

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I. Introduction

Eco-label certification schemes have been increasingly employed for various agricultural goods to promote the consumption and production of environmentally friendly products (hereafter "green products") (Nash, 2009). In these schemes, international non-governmental organizations typically provide certifications to producers that meet certain environmental criteria, allowing these producers to use eco-labels that confirm their products' eco-friendliness. The coffee industry is viewed as a pioneer in eco-label certifications (Reinecke, Manning & Von Hagen, 2012). One particular eco-friendly coffee is shade-grown coffee. Also known as forest coffee, this is grown under a canopy of trees or in forests while maintaining harmonization with other species and conserving soil and water conditions (Takahashi & Todo, 2014).

The sustainability of eco-label certification schemes largely depends on demand for eco-friendly coffee in developed countries, where most such coffee is consumed. Global sales of eco-friendly coffee more than doubled from approximately 410 tons to 840 tons between 2008 and 2012 (Potts et al., 2014). In the United States, sales of eco-friendly coffee in supermarkets grew by 48% between 2010 and 2012, reaching $32 million (International Markets Bureau, 2013).

Providing information about the green characteristics of coffee makes consumers more receptive toward eco-friendly brands (Loureiro & Lotade, 2005). As yet, however, there is no clear evidence that consumers appreciate the eco-friendliness of coffee and that this affects their purchase behavior. In addition, it is still unclear *why* consumers are motivated to purchase eco-friendly coffee after receiving such information. Based on the foregoing, this study examines the impact of information provision about the eco-friendliness of a product on sales of eco-friendly coffee.

A novel aspect of this study is that we conducted a nationwide social experiment in Japan

involving more than 10,000 vending machines serving brewed coffee. In this experiment, we provided information about the green nature of coffee to users of vending machines and examined how information provision affected the actual sales of eco-friendly coffee. There are two advantages of implementing a vending machine experiment in Japan. The first advantage is the low awareness of Japanese consumers. Because the average awareness of eco-friendly coffee is low in Japan, our information provision intervention can generate an awareness gap between consumers with and without the intervention. The second advantage is the availability of non-certified regular coffee. The vending machines used for the experiment also provide non-certified regular coffee at the same price as eco-friendly coffee. Therefore, consumers can choose between eco-friendly coffee and regular coffee in the same vending machine.

This study reveals that in social spaces, namely locations where individual behavior can be observed by community members (e.g., office buildings and factories), sales of eco-friendly coffee rose by approximately 7% when we provided information by displaying a small sticker containing a short statement about the contribution of eco-friendly coffee (hereafter, "the information sticker") compared with machines without the intervention. The impact of information provision in social spaces remained positive after controlling for the demographic characteristics of potential consumers. By contrast, there is no association between information provision and the sales increase in non-social spaces (i.e., locations where individual behavior cannot be observed by community members) such as shopping malls and train stations.

A potential explanation of the sales increase in social spaces is reputation building by consumers. If consumers obtain utility directly from consuming eco-friendly coffee, we should observe a sales increase through information provision regardless to the observability of community members. By contrast, if consumers' motivation for purchasing green products is to obtain a reputation of being concerned about the environment (i.e., a "green" reputation) among peers, they are more likely to purchase eco-friendly coffee only when consumers'

behavior is observable to others in the community. Our estimation results as well as the results of the robustness checks clearly indicate that information provision is associated with sales of eco-friendly coffee only in social spaces, implying the possibility of green reputation building.

This study makes two major contributions. First, to the best of our knowledge, it is the first to implement a nationwide social experiment to investigate the association between purchasing behavior and information provision. An extensive literature in environmental economics and applied microeconomics attempts to understand consumer behavior, particularly whether consumers are willing to purchase green products (Loureiro & Lotade, 2005, Arnot, Boxall & Cash, 2006, Andorfer & Liebe, 2015, Hainmueller, Hiscox & Sequeira, 2015, Van Loo et al., 2015, Takahashi, Todo & Funaki, 2018). However, previous empirical research has relied exclusively on laboratory experiments or small-scale social experiments, with their applicability to more practical situations unclear. This study thus highlights the advantages of the field experimental approach applied to an extensive setting observing the actual sales of eco-friendly coffee. Second, we provide empirical insights into the potential mechanisms for stimulating green consumption. Although we cannot pin down the actual mechanisms of consumers' purchasing behavior, this study still helps narrow the potential explanation of purchasing eco-friendly coffee. Our findings add new evidence to the empirical literature on pro-environmental behavior and provide implications to the theoretical literature on prosocial behavior (Bénabou & Tirole, 2006, Benhabib & Bisin, 2011).

II. Literature Review

The coffee industry is a pioneer in certification schemes and various types of certified coffee are available, such as forest coffee, fair trade coffee, and organic coffee (Ponte, 2004, Stellmacher & Grote, 2011). Although the environmental conditions of production areas are

audited to obtain each certification, the environmental criteria differ by the aims of each certification scheme (Ponte, 2004, Giovannucci & Ponte, 2005, Kolk, 2013, Jha et al., 2014). For example, the main purpose of fair trade certification is to establish a price floor for marginal producers in developing countries (Basu & Hicks, 2008). Organic certification aims to minimize the use of chemical inputs such as chemical fertilizer and pesticide to improve biodiversity and soil activity. By contrast, forest coffee certification focuses primarily on forest conservation and the environmental conditions of production areas. Empirical studies have found that forest coffee certification contributes to environmental conservation in producer countries such as Ethiopia, Colombia, and Costa Rica (Blackman & Naranjo, 2012, Takahashi & Todo, 2013, Takahashi & Todo, 2014, Rueda, Thomas & Lambin, 2015, Ibanez & Blackman, 2016, Takahashi & Todo, 2017). To avoid confusion, we define coffee with forest coffee certification as eco-friendly coffee, while certified coffee indicates coffee that has obtained any type of certification.

There are two major certification bodies for eco-friendly coffee, namely the Rainforest Alliance and Bird Friendly provided by the Smithsonian Migratory Bird Center. The production volume of Rainforest Alliance coffee increased from 100 thousand tons in 2008 to 500 thousand tons in 2016 (Figure 1). The sales volume of Rainforest Alliance coffee more than doubled from approximately 62 thousand tons in 2008 to 130 thousand tons in 2011. In addition, according to the Netherlands Ministry of Foreign Affairs, sales of Rainforest Alliance coffee in Europe increased by 19% between 2016 and 2017 (CBI, 2019).

Empirical studies suggest that the majority of consumers are willing to pay more for eco-friendly coffee. For example, Loureiro & Lotade (2005) found that the willingness to pay (WTP) for eco-friendly coffee is 2.5–3.3% higher than that for regular coffee in the United States. Van Loo et al. (2015) confirmed that US consumers are willing to pay an additional $0.84 for eco-friendly coffee. Similarly, average WTP is also increased by introducing other

certification schemes such as fair trade and organic (Basu & Hicks, 2008, Rotaris & Danielis, 2011). For instance, De Pelsmacker, Driesen & Rayp (2005) indicated that average WTP for fair trade coffee is 10% higher in Belgium than in regular coffee. Hence, introducing eco-label certifications has shifted up the demand curve for green products.

However, since WTP is based on hypothetical questions rather than actual purchasing behaviors, its accuracy is often questioned (Cookson, 2003). More importantly, it is unclear how demand for green products can be raised by policy design, including the provision of information on their eco-friendly features. To overcome the shortcomings of WTP analysis, Takahashi, Todo & Funaki (2018) conducted a laboratory experiment in which university students were asked to purchase one of three coffee varieties: one was eco-friendly coffee and the other two were regular coffee. They found that providing information about certification schemes enhanced the purchasing behavior of participants who have previous experience of purchasing eco-friendly coffee. In addition, using a laboratory experiment and interventions in three supermarkets in Germany, Arnot, Boxall & Cash (2006) and Andorfer & Liebe (2015) respectively found that information provision raises demand for fair trade coffee.

However, two shortcomings in the literature persist. First, it is unclear whether the results from laboratory experiments and a small-scale social experiment are applicable to more practical situations. Although Takahashi, Todo & Funaki (2018) captured participants' actual purchasing behavior, all were students from one university. One exception is Hainmueller, Hiscox & Sequeira (2015), who conducted a field experiment in 26 grocery stores in the United States, finding that the introduction of fair trade coffee grew sales by approximately 10%. However, they only investigated the effect of fair trade labeling, which primarily focuses on ethical issues. To the best of our knowledge, no experimental studies have been based on the actual sales of green products including eco-friendly coffee.

Second, the mechanism underlying the shift in demand from introducing eco-friendly

certifications and providing information about a coffee's eco-friendliness remains unknown. For example, consumers may obtain utility directly from consuming green products or indirectly from their green reputation among peers. Whether consumers are driven by their preference for greenness or reputation building has substantial implications for designing policy. In the former case, providing information about products' eco-friendly nature can promote demand under any circumstance. However, in the latter case, information provision alone may be insufficient, with further strategies such as raising the visibility of green product consumption also potentially needed. The experiment we report was designed specifically to overcome these shortcomings and provide new empirical evidence on how information provision about the eco-friendliness of products influences consumers' actual purchasing behavior.

III. Experimental Design and Data Collection

The experiment was conducted by collaborating with a company that provides coffee and other beverages through paper cup-style vending machines (Figure 2). Because the company installs its vending machines in every Japanese prefecture except Okinawa, the experimental scale is nationwide.

The company provides a coffee called "*Brazil*," which contains eco-friendly coffee certified by the Rainforest Alliance: a major US-based certification organization. Products certified by the Rainforest Alliance can be identified by the "green frog" logo. Although the company usually provides both certified and non-certified regular coffee in the same vending machine, they are both sold to consumers at the same price. By collaborating with the company, we could deploy different information provision strategies for the eco-friendly coffee "*Brazil*" and examine how each strategy affected sales of eco-friendly coffee.

A. Intervention: Information Provision Strategies

To provide information about the eco-friendliness of coffee, we devised two types of information provision strategies: a visual provision method and verbal provision method. In the first intervention, we changed the label design for the certified coffee. Before the study, the company adopted a simple green label design for the eco-friendly coffee (picture A in Figure 3), which we designated the "control label." To visually link the eco-friendly coffee with environmental conservation in Brazil, we replaced the green background with a picture of a shade-grown coffee farm, as presented in picture B in Figure 3 (hereafter, the "new label"). Only the background image was changed, meaning that both label designs contained the same information: the product name "*Brazil*," place of origin, and Rainforest Alliance logo. The aim of the new label was to increase consumers' awareness of the coffee's eco-friendliness by showing the image of shade-grown coffee production areas, drawing on the finding of Takahashi, Todo & Funaki (2018) that a label depicting a forest stimulates the purchasing of eco-friendly coffee.

In the second intervention, to provide verbal information about the certification system, we prepared a sticker containing a short statement about the contribution of eco-friendly coffee (hereafter, "the information sticker"). To ensure conciseness and understandability, the statement read as follows: "Environmentally Friendly Coffee: Purchasing coffee certified by the Rainforest Alliance contributes to forest conservation" (Figure 4).

One of the advantages of conducting the experiment in Japan is that consumer awareness about eco-friendly coffee and eco-label certification schemes is limited (Allen, 2000, Takahashi, Todo & Funaki, 2018). According to the Fair Trade Forum Japan, only 3.6% of survey respondents were aware of the Rainforest Alliance in 2015. Therefore, introducing these

information provision strategies is expected to create an awareness gap between the users of treated and non-treated vending machines. In addition, comparing the impacts of each strategy, we can infer the most effective information provision method.

B. Target Area of the Experiment

The collaborating company sells the eco-friendly coffee from 10,475 vending machines throughout Japan. In this study, we chose nine cities as target areas for implementing the above strategies. The selected cities (with their prefecture in parentheses) are Koriyama (Fukushima), Shinagawa (Tokyo), Fuchu (Tokyo), Chiba (Chiba), Atsugi (Kanagawa), Kofu (Yamanashi), Tsu (Mie), Osaka (Osaka), and Hiroshima (Hiroshima). In these nine cities, 1,452 vending machines were installed, as shown by the dark dots in map A in Figure 5; we use these machines as the treatment group. The remaining 9,023 vending machines, illustrated by the light gray dots in map B in Figure 5, are the control group. These vending machines continuously used the control label and did not bear the information sticker during the experimental period.

Although the treated vending machines were widely located across Japan, the nine cities in the treatment group were not randomly selected. The research team first asked the company to pick nine cities (three large, three suburban, and three rural) in which the branch offices were willing to cooperate in the experiment. Among the nine, Shinagawa, Fuchu, and Osaka are considered to be large cities; Chiba, Atsugi, and Hiroshima are suburban cities; and Koriyama, Kofu, and Tsu are rural cities.

It would have been preferable to randomly assign the interventions to the vending machines in the nine cities, but this was not feasible because it risked causing confusion in the company's logistics system. Therefore, we randomly allocated one city in each of the three categories into three groups. In the first group, called the "new label group," we replaced the

control label with the new label during the experimental period, but the information sticker was not placed on these vending machines. By contrast, in the second group (the "information sticker group"), we used the control label together with the information sticker. Finally, in the third group (the "combination group"), we used the new label and affixed the information sticker on the side or front of the vending machines. Including the combination group allowed us to examine whether the two interventions are complements or substitutes.

C. Social Spaces and Non-social Spaces

To further investigate the impacts of information provision, we divided the 10,475 vending machines into "social spaces" including factories and offices and "non-social spaces" such as shopping malls and train stations. Table 1 presents the observations in social and non-social spaces for each group. Among the 1,452 vending machines in the treatment group, 317 were installed in non-social spaces and 1,135 were in social spaces. To estimate the effect of the information provision strategies in social spaces (7,692 observations) and non-social spaces (2,783 observations), we separately analyzed the observations for each. In particular, we investigate how each strategy affects two sales indicators: cup sales of eco-friendly coffee and total sales of the vending machine. Using Scheffe's multiple comparison test, we compared the means of these sales indicators among the four groups (see Table 1), finding that the mean of the control group in social spaces is significantly different from the means of the other three groups.

D. Experimental Period and Data Collection

The experimental interventions were carried out from June to September 2016. We also

collected data in May 2016 to gauge the sales conditions before the experiment. To estimate changes in sales, we further collected sales data for each vending machine between May and September 2015. The sales data we collected comprise the number of cups of eco-friendly coffee sold and total sales of the vending machine. Although we can capture the number of eco-friendly coffee cups sold, total sales of this coffee for each machine are unclear because we do not know its price, which varies by vending machine. However, we can obtain total sales of the vending machines, which include the sale volumes of eco-friendly coffee and other beverages such as non-certified regular coffee, soft drinks, and soup.

IV. Potential Mechanisms

A. Potential Factors Affecting Consumers' Purchasing Behavior

In this study, we assume six potential explanations of why sales of eco-friendly coffee increased through information provision.

1. Individuals' awareness of eco-friendly coffee

The first explanation is that purchasing behavior for eco-friendly coffee is stimulated by the increase in individuals' awareness of eco-friendly coffee. If consumers gain additional utility from consuming a green product by contributing to environmental protection, purchasing behavior for eco-friendly coffee should be associated with an increase in individuals' awareness through information provision. Asensio & Delmas (2015) indicated that information provision reduces home energy use in the United States by 8%. In addition, Costa & Kahn (2013) and Tanaka et al. (2017) found that green behavior is associated with an increase in individuals' awareness through information provision.

2. Green reputation building

Second, this study proposes green reputation building as the second explanation. Consumers may be motivated to purchase eco-friendly coffee if they can build a good reputation related to pro-environmental behavior among other members in the community. This reputation assumption has been discussed in empirical studies (Carpenter & Myers, 2010, Ekström, 2012). For example, Delmas & Lessem (2014) found that a green reputation leads to decreased energy use in the United States.

There are two essential conditions to observe a green reputation: community awareness of coffee's eco-friendliness and environmental consciousness among community members. If community members know little about the coffee's green nature, consumers are less motivated to purchase eco-friendly coffee simply because they cannot build a green reputation. Therefore, if information provision successfully increases community awareness of eco-friendly coffee, consumers' purchasing motivation is larger. In addition, the environmental consciousness among community members is important for generating a green reputation. If community members do not appreciate pro-environmental behavior because of their low interest in environmental issues, consumers' motivation for purchasing eco-friendly coffee lowers because purchasing eco-friendly coffee does not affect their reputation. Therefore, a certain level of environmental consciousness is necessary to observe a green reputation. Sexton & Sexton (2014) found that the WTP for eco-friendly vehicles in the United States tends to be higher in regions with higher environmental consciousness because the reputational benefits are higher.

3. Demographic characteristics of consumers

Third, purchasing behavior for eco-friendly coffee might be determined by the demographic characteristics of consumers such as education level, income, and employment

status. For example, Loureiro & Lotade (2005) found that survey respondents with a higher education and income are highly receptive toward eco-friendly coffee. Therefore, if eco-friendliness information is given to those with certain demographic characteristics, we may observe a sales increase in eco-friendly coffee through such an information provision.

4. Exposure effect of information provision

Fourth, in social spaces, sales of eco-friendly coffee might increase because of the exposure effect of information provision. According to our definition, consumers in social spaces are regular customers, whereas non-social space consumers are more likely to be one-time opportunistic customers. Therefore, the former may have more opportunity to learn about the eco-friendliness of coffee through information provision than the latter. Because social space consumers are exposed to our intervention, they gradually increase their awareness and increase their motivation to purchase eco-friendly coffee, resulting in a sales increase.

5. Psychological factors except green reputation

Fifth, purchasing behavior may be stimulated through information provision by psychological factors except green reputation. Moral decision-making including eco-friendly consumption has been considered in psychological research (Weber & Ancker, 2005, Weber & Johnson, 2009). Psychological aspects have also been included in economics research, and the recent economic literature in environmental economics focuses on the influence of psychological processes on eco-friendly behavior. Farrow, Grolleau & Ibanez (2017) found that social norms affect a wide range of eco-friendly behaviors such as energy saving, recycling, and green consumption. Therefore, besides green reputation, consumers may decide to purchase eco-friendly coffee after receiving information because of other psychological factors.

6. Collectivist characteristic

Lastly, we may observe a sales increase in eco-friendly coffee through information provision because of Japan's specific characteristics. In particular, we consider the country's collectivist culture that emphasizes belonging to communities (Huff & Kelley, 2003). Therefore, consumers, particularly in social spaces, may purchase eco-friendly coffee because of their collectivist characteristic.

B. Estimation Strategies

Separately estimating the impacts of information provision on sales of eco-friendly coffee for social and non-social spaces, we can empirically examine the effect of individuals' awareness and green reputation building. For vending machines in non-social spaces, we assume that information provision only raises consumers' awareness of eco-friendly coffee and does not lead to sharing information among community members. For example, when information is provided on a vending machine in a train station, an office employee using that station can learn about eco-friendly coffee, but most of his/her colleagues using other stations remain unfamiliar about the green product. However, if a vending machine in that individual's office presents the same information, it likely comes to the attention of most of his/her colleagues. Therefore, providing information in a non-social space does not improve the level of community awareness, whereas doing so in a social space does.

Based on these assumptions, a positive impact of information provision on sales of eco-friendly coffee in non-social spaces implies the effects of individuals' awareness. By contrast, since information provision to social spaces increases both individuals' and the community awareness, the positive association between information provision and sales of eco-friendly coffee in social spaces may indicate the combined impacts of individuals' awareness and green

reputation building. Therefore, we can identify the impact of green reputation by comparing the results of social and non-social spaces. However, without considering other potential factors such as the demographic characteristics of consumers, exposure effect, psychological factors except green reputation, and collectivist characteristic of Japan, we cannot narrow the potential explanations of the sales increase.

First, to show the possibility of individuals' awareness and green reputation, it is essential to consider the association between demographic characteristics and information provision. Unfortunately, since the data used in this study are at the vending machine level, we cannot directly observe the demographic characteristics of consumers. To capture the demographic characteristics of consumers as much as possible, we obtained social demographic data at the municipality or prefecture level from the "System of social and demographic statistics" provided by the Ministry of Internal Affairs and Communications (MIAC), including the share of highly educated residents (i.e., university graduates) at the prefecture level in 2010, average annual income per taxpayer at the municipality level in 2016, average unemployment rate at the municipality level in 2015, and average recycling rate at the municipality level in 2015. In addition, we estimated the changes in each indicator between the two years as follows: the changes in the share of highly educated residents between 2000 and 2010, changes in average annual income between 2013 and 2016, changes in the average unemployment rate between 2010 and 2015, and changes in the average recycling rate between 2013 and 2015. Since the social demographic data show the average socioeconomic characteristics of residents, they do not necessarily represent the demographic characteristics of consumers. Indeed, especially in social spaces, workers are more likely to live in another municipality. However, the MIAC's demographic dataset is the most reliable, as it covers nationwide demographic statistics.

Table 2 shows the summary statistics of the demographic characteristics. The average share of highly educated residents in the treatment group tends to be higher than that in the

control group by approximately 4.5 percentage points. In addition, average annual income per taxpayer in the treatment group is higher than that in the control group. The difference in average annual income between the treatment and control groups is approximately 0.3 million Japanese yen ($2,700). Moreover, although we find slight differences in the other demographic indicators between the two groups, the gaps are not as large as in the above two indicators.

We include the demographic indicators in our estimation models. To empirically show the possibility of individuals' awareness and green reputation, the significant impacts of information provision on sales of eco-friendly coffee are essential conditions even after reducing the correlation between the demographic factors and information provision.

Second, to investigate the exposure effect of information provision in social spaces, we separately estimate the impacts of information provision in social spaces by month. Point-of-sale or daily sales data are preferred to analyze the exposure effect. Unfortunately, no real-time dynamic data are available. Hence, we examine the sales change through the information provision in social spaces in our survey period to confirm whether the exposure effect is observable at the monthly level.

Third, besides green reputation, other psychological factors such as social norms and social pressure might affect consumers' motivation to purchase eco-friendly coffee. As we cannot obtain related psychological data to clarify the psychological motivation of consumers, to indirectly examine which explanation seems most feasible, we use pro-environmental behavior as a proxy for environmental consciousness among community members. Dividing the observations in social spaces based on pro-environmental behavior, we separately estimate the impacts of information provision on sales. If other psychological factors are the major determinants of the sales increase through information provision, the significant impacts of information provision should be observed regardless of pro-environmental behavior. By contrast, because the motivation of cultivating a green reputation is determined by the

environmental consciousness of community members (Sexton & Sexton, 2014), compared with consumers that have lower environmental consciousness, consumers higher in environmental consciousness are more motivated to purchase eco-friendly coffee to gain a greater green reputation. Therefore, it is reasonable to expect larger impacts of information provision in higher environmental consciousness regions than in lower concern regions.

Moreover, we use the average recycling rate as an indicator of pro-environmental behavior. We define the top quarter percentile as higher environmental consciousness, where the average recycling rate is approximately 31.8%, whereas the bottom quarter percentile is lower environmental consciousness (average rate 11.7%). If we observe the larger impacts of information provision in the former regions than in the latter regions, the possibility of green reputation building is more feasible than that of other psychological factors such as social norms and social pressure.

Lastly, regarding the collectivist characteristic, even if we observe the significant impacts of information provision, such impacts may not be unique to Japan. Indeed, the effect of information provision in social spaces may be observed in individualistic countries, too. For example, Sexton & Sexton (2014) and Delmas & Lessem (2014) found that eco-friendly behavior is influenced by people's motivation to build a reputation among other community members. Hence, although the impacts of information provision in social spaces may be overestimated because of the collectivist characteristic, it does not necessary mean that this is a country-specific trend.

V. Estimation Methodology

A. Benchmark Estimations

To investigate the determinants of purchasing behavior for eco-friendly coffee, we

estimate panel data regressions of the impact of each information provision strategy. Following Gibson & McKenzie (2014), we begin with the following difference-in-difference (DID) specification:

$$\Delta Y_{im} = \alpha + \beta_1 Label_{im} + \beta_2 Sticker_{im} + \beta_3 Comb_{im} + \varphi Treat_i + \sum_{m=6}^{9} \tau_m + \varepsilon_{im} \quad (1)$$

where ΔY_{im} is the change in the outcome of interest (i.e., the natural logarithm of cup sales of eco-friendly coffee or total sales of the vending machine) for vending machine *i* from month *m* in 2015 to month *m* in 2016. $Label_{im}$, $Sticker_{im}$, and $Comb_{im}$ are dummy variables that take 1 if vending machine *i* receives, respectively, the treatment of a new label, the information sticker, or combined interventions in month *m*. $Treat_i$ denotes whether vending machine *i* received any intervention during the experimental period and τ_m are monthly dummies for months other than May. Standard errors are clustered at the city level to account for autocorrelation in the error term ε_{im}.

By employing the DID method, we can control for any baseline-level differences in the outcome *Y* at the group level. In addition to equation (1), we estimate a prefecture-level fixed effects model as a robustness check, which is specified as follows:

$$\Delta Y_{im} = \rho_i + \beta_1 Label_{im} + \beta_2 Sticker_{im} + \beta_3 Comb_{im} + \sum_{m=6}^{9} \tau_m + \varepsilon_{im} \quad (2)$$

where ρ_i is the prefecture-specific fixed effects for vending machine *i*, which reduces the unobserved time-invariant differences between prefectures.

In both equations, β_1, β_2, and β_3 measure the average impact of each information provision strategy on outcome *Y*. Separately estimating the βs for social and non-social spaces, we can identify the mechanism underlying the shift in demand for eco-friendly coffee and most

effective information provision strategy. If individuals' increased awareness is the key trigger for consuming eco-friendly coffee, we should observe a positive impact of information provision in both spaces. By contrast, if increased community awareness, or green reputation, is the major driver of increased consumption of eco-friendly coffee, the information provision dummies should be significantly positive only in social spaces.

However, we cannot simply estimate equations (1) and (2) because of endogeneity problems (Imbens & Wooldridge, 2009), as the nine cities of the treatment group were not randomly selected. Therefore, because the assignment of each information provision strategy is endogenously determined, the results of equations (1) and (2) are likely to be subject to selection bias.

To reduce selection bias when evaluating impacts, one of the major analytical approaches is the propensity score matching (PSM) method (Caliendo & Kopeinig, 2008, Blackman & Naranjo, 2012, Takahashi & Todo, 2013, Takahashi & Otsuka, 2016, Takahashi & Todo, 2017). However, King and Nielsen (2016) King & Nielsen (2019) argued that PSM increases imbalance in the empirical distribution compared with the original data, thereby generating statistical bias. Therefore, we follow the prescreening regression approach suggested by Crump et al. (2009) as a benchmark estimation model and provide estimation results based on the ordinary PSM as a robustness check.

In the prescreening approach, we estimate a propensity score and drop observations with estimated propensity scores outside the range [0.1, 0.9]. This prescreening procedure ensures that the regression is estimated for a sample in which the covariate distribution overlaps for the treated and non-treated vending machines. The prescreening approach works well in estimating treatment effects (Angrist & Pischke, 2008, Gibson & McKenzie, 2014). To obtain the propensity scores, we use a probit model that includes the 10 independent variables: total sales of each vending machine and number of cups of eco-friendly coffee sold in each month

between May and September 2015 (the year before the experiment). These variables allow us to control for differences related to the initial sales levels of each vending machine.

Although we try to alleviate selection bias using the prescreening approach, the estimated treatment effect may nonetheless be biased by unobserved factors. To investigate this possibility, we perform the sensitivity analysis developed by Oster (2019) adopted in many recent empirical studies (Baranov, Bennett & Kohler, 2015, González & Miguel, 2015, Agüero, 2017). In this analysis, we test whether unobservable factors might explain the results under the assumption that the selection on observables and unobservables is proportional. Oster (2019) derived the coefficient of proportionality, specified in this study as γ, which is necessary to cause the observed treatment effect to be spurious. A large value of γ suggests that a high degree of correlated unobservable selection would be necessary to explain away the observed estimate, thus indicating that the results are robust. The benchmark coefficient is one (i.e., $\gamma = 1$), meaning that the observables and unobservables are equally correlated with the treatment (Altonji, Elder & Taber, 2005, Oster, 2019). By contrast, $\gamma = 2$ would indicate that the unobservables must be twice as important as the observables to generate a treatment effect of zero. In this study, we calculate the value of γ that negates the observed treatment effect.

In addition to the benchmark estimation, we present the results based on the ordinary PSM as a robustness check. Instead of eliminating observations with propensity scores outside the range [0.1, 0.9], we use the nearest-neighbor one-to-one matching method and pair observations between the treatment and control groups based on the propensity scores.

As mentioned previously, we control for differences in the initial sales levels of each vending machine by including the sales indicators in the probit estimation. However, if we simply match the observations based on propensity scores, we may match observations from different sales environments, potentially causing bias. For example, if their estimated propensity scores are similar, a vending machine in a factory break room is matched with a

machine in a hospital break room despite the different characteristics of their respective consumers (factory workers vs. nurses and doctors).

To control for the ex-ante sales environment of the vending machines, we match observations in each locational category. All vending machines are assigned a location code by the beverage company, categorized into eight groups: manufacturing companies, non-manufacturing companies, service companies, public offices, schools, service stations on freeways, hospitals, and amusement areas. The first three columns in Table 2 show the numbers of observations for each category before matching. Since we could not treat any of the vending machines located in service stations on freeways for administrative reasons, the number of treated observations for the freeway category is zero. After the matching procedure, we employ the same estimation model presented in equations (1) and (2) to examine the effects of the information provision strategies on sales of eco-friendly coffee.

B. Robustness Checks for Unbalanced Characteristics

Although we employ the prescreening regression approach to reduce selection bias related to the ex-ante sales environment for eco-friendly coffee, concerns about the unbalanced characteristics of consumers remain. In particular, the demographic characteristics of consumers, such as education level, income, and employment status, may differ between the treatment and control groups because of the non-random assignment of the treatment. Hence, we must compare consumers' characteristics between the treatment and control groups. However, owing to the lack of demographic data, we cannot statistically test the balance between the two groups. Therefore, this study performs a subsample analysis as a robustness check.

In this robustness check, the prescreening regression estimations are conducted using the

two types of subsample groups, which may have similar demographic characteristics between the treatment and control groups. The first subsample group is the observations within the eight treatment prefectures. Because the information interventions were implemented to one or two cities from each treatment prefecture, the vending machines with and without interventions existed in the same treatment prefecture. Assuming that consumers' demographic characteristics are similar within a prefecture, we conduct the regression analysis using the observations located in the eight treatment prefectures.

The second subsample group is the observations in cities with similar demographic characteristics. To identify observations in the control group that have similar demographic characteristics to the treated observations, we employ the PSM method with one-to-one matching. We calculate the propensity scores using the level and trend of the demographic indicators in Table 2.

Table 3 presents the summary statistics of the demographic indicators for each subsample group, with columns 1 and 2 showing the summary of the first subgroup and columns 3 and 4 for the second subsample group. Although the observations of the first subgroup are from the same treated prefectures, we found a statistical difference between the treatment and control groups for annual income, changes in annual income, the unemployment rate, and changes in the recycling rate. By contrast, all the demographic indicators are insignificant between the treatment and control groups in the second subsample group shown. Hence, using these subsample groups, we can conduct robustness tests for the unbalanced demographic characteristics of consumers.

C. Robustness Checks for Other Explanations

Because the demographic characteristics of consumers are not incorporated into the

benchmark estimations, the estimated parameters of information provision may be biased by unobserved factors. We are particularly concerned about the correlation between the demographic characteristics of consumers and information provision. If information provision and consumers' demographic characteristics are correlated (e.g., higher income consumers respond more to information provision), it would cause omitted variable bias. There are two potential types of omitted variables in our analysis. The first is the demographic level just before the treatment and the second is the demographic trend over the past few years. For example, income may be systematically higher in the treatment group than in the control group, or it might have increased systematically more in the treatment group than in the control group over the past three years. In either case, the estimated effect of information provision could be contaminated by an income effect unless we control for the level/trend of the demographic characteristics in the estimation.

To incorporate the omitted variable bias caused by the demographic characteristics of consumers, we conduct a robustness check by estimating the following DID and fixed effects models:

$$\Delta Y_{im} = \alpha + \beta_1 Label_{im} + \beta_2 Sticker_{im} + \beta_3 Comb_{im} + \gamma Chara_i + \delta CharaXInfo_{im} + \varphi Treat_i + \sum_{m=6}^{9} \tau_m + \varepsilon_{im} \quad (3)$$

$$\Delta Y_{im} = \rho_i + \beta_1 Label_{im} + \beta_2 Sticker_{im} + \beta_3 Comb_{im} + \gamma Chara_i + \delta CharaXInfo_{im} + \sum_{m=6}^{9} \tau_m + \varepsilon_{im} \quad (4)$$

where *Chara* denotes the level or trend of the demographic characteristics of the located municipality. In addition, *CharaXInfo* indicates a set of interaction terms between the information provision dummy and each level of demographic variable. Including the additional

variables related to the demographic characteristics of consumers, we can indirectly reduce omitted variable bias.

In addition, to consider the possibility of individuals' awareness and green reputation, we conduct a robustness check using pooled data. The estimation models for the DID and fixed effects estimations are

$$\Delta Y_{im} = \alpha + \beta_1 Label_{im} + \beta_2 Sticker_{im} + \beta_3 Comb_{im} + \beta_4 Social_{im} + \theta SocialXInfo_{im} + \gamma Chara_i + \delta CharaXInfo_{im} + \varphi Treat_i + \sum_{m=6}^{9} \tau_m + \varepsilon_{im} \quad (5)$$

$$\Delta Y_{im} = \rho_i + \beta_1 Label_{im} + \beta_2 Sticker_{im} + \beta_3 Comb_{im} + \beta_4 Social_{im} + \theta SocialXInfo_{im} + \gamma Chara_i + \delta CharaXInfo_{im} + \sum_{m=6}^{9} \tau_m + \varepsilon_{im} \quad (6)$$

where *Social* denotes a dummy variable taking one if vending machine *i* is installed in social spaces. The social space dummy controls for the specific trend in social spaces. *SocialXInfo* indicates a set of three interaction terms between the social space dummy and each information provision dummy (i.e., *Label*, *Sticker*, and *Comb* in the model).

In the pooled data analysis, the three information provision dummies (i.e., *Label*, *Sticker*, and *Comb*) capture the impacts of information provision coming from individuals' awareness, while the three interaction terms (i.e., *SocialXInfo*) show the possibility of green reputation building in social spaces.

To investigate the exposure effect of information provision in social spaces, we separately estimate the impact of information provision by month. If we observe a gradual increase in the impact of information provision, the exposure effect is a more feasible explanation than others. Lastly, although we hypothesize that building a green reputation is one explanation of the sales increase in social spaces, psychological factors other than green reputation could play a role.

Hence, we separately estimate equations (3) and (4) based on the recycling rate in the located municipality.

VI. Estimation Results

A. Results from the Matching Procedures

After estimating the propensity scores from the probit estimation, we dropped observations with propensity scores outside the range [0.1, 0.9]. In total, 821 observations were dropped from the prescreening procedure (39 treated and 782 non-treated vending machines). Hence, the number of vending machines used for the prescreening regression was 9,654: 7,550 in social spaces and 2,104 in non-social spaces. Figure 6 shows the distribution of propensity scores between the treatment and control groups: the left charts (A) show the distributions before prescreening, while the right charts (B) show the distributions after this procedure. As presented in the figure, observations with propensity scores under 0.1 were dropped, and the distributions of propensity scores between treated and control vending machines were similar after the prescreening procedure.

In addition to the benchmark estimations, we conducted ordinary PSM estimations and matched observations between the treatment and control groups within each locational category. As shown by the last three columns in Table 4, the total numbers of treated vending machines decreased from 1,452 to 1,376 after the matching procedure.

To check the characteristics of the treatment and matched control groups, we conducted a balancing test by comparing the mean of each covariate between the two groups. The first column in Table 5 shows the mean difference between the treatment and control groups for each covariate before matching. Using a *t*-test, we found that the mean differences of several covariates were significantly different from zero. However, the differences in the covariates

before matching were insignificant after the matching procedure presented in the second column in Table 5. The balancing test thus confirmed no systematic difference between the treatment and matched control groups.

B. Comparison between Social and Non-social Spaces

The first four columns of Table 6 show the effect of the information provision strategies on cup sales of eco-friendly coffee and total sales of vending machines in non-social spaces. Columns 1 and 3 show the results of the DID model, while columns 2 and 4 present the prefecture fixed effect model results. We expected the information provision strategies to positively affect sales from vending machines in non-social spaces because of the increased awareness of consumers. However, the estimation results for the amount of eco-friendly coffee sold (columns 1 to 4) show that none of the information provision dummies had an effect significantly different from zero. We also found that the three information provision dummies insignificantly impacted total sales of the vending machines in non-social spaces (columns 5 to 8).

Table 7 presents the results for the vending machines in social spaces. In contrast to the results for machines in non-social spaces, we found that the sticker and combination dummies had a significantly positive impact on the amount of eco-friendly coffee sold, whereas the new label dummy produced no significant change (columns 1 to 4). The value of the coefficient indicates that providing information by affixing a small sticker increased sales of eco-friendly coffee by approximately 7%.

Moreover, the sticker and combination dummies also positively and significantly affected total sales of vending machines (columns 5 to 8). Although the sticker dummy's coefficient was higher than that of the combination dummy, there was no significant difference between

these two variables. These results indicate that information provision through the sticker is positively associated with total sales from vending machines.

Finally, we checked the sensitivity of the results by estimating the proportional selection γ. Since the results for non-social spaces were insignificant, we only estimated the values for machines in social spaces. The results in Table 8 indicate that the estimated values of γ for the sticker and combination dummies were negative for all the estimations in social spaces. Negative values of γ mean that negative selection on unobservables would be needed to eliminate the effect. Because positively correlated unobservables are the main threat to identification, the negative γs suggest that the estimated treatment effects were robust to omitted variable bias.

C. Results of the Subsample Analysis

Columns 1 to 4 of Table 9 show the prescreening estimation results for social spaces using the observations in the eight treatment prefectures. Consistent with the benchmark estimations, we found that the sticker and combination dummies had significantly positive impacts on cup sales of eco-friendly coffee and total sales of vending machines, but not in the label dummy. In addition, columns 5 to 8 indicate the results of the estimation model using observations in cities with similar demographic characteristics. Except the combination dummy in column 8, significantly positive impacts were observed from the sticker and combination dummies. These results of subsample analysis indicate that the positive effects of the verbal information provision on sales of eco-friendly coffee are robust even after controlling for the unbalanced characteristics between the two groups.

D. Results of the Robustness Checks for the Other Explanations

To further investigate the green reputation explanation in social spaces, we perform robustness checks for the other explanations such as the demographic factors, the exposure effect, and other psychological factors. First, we conducted the estimation models including the level or trend of the demographic factors and interaction terms between the information provision and demographic factors. Columns 1 to 4 and columns 5 to 8 of Table 10 show the results of the robustness checks using the level and trend of the demographic factors, respectively. Unlike the earlier results, the combination dummy turned insignificant in all the estimation models. By contrast, although we could not find significant impacts in the DID estimations with the level of the demographic factors, we found positive impacts of the sticker dummy in most estimation models.

Table 11 shows the results of the pooled data analysis, with columns 1 to 4 and columns 5 to 8 showing the results using the level and trend of the demographic characteristics, respectively. As indicated, the three intervention dummies represent the general impact of information provision. The results show that none of the intervention dummies had a significant impact on cup sales or total sales. By contrast, consistent with the previous results, the interaction term between the sticker dummy and social space dummy was significantly positive in most models, except for the results of the fixed effects model for cup sales in columns 2 and 6. The results in Tables 10 and 11 thus confirm that even after indirectly reducing the effects of the demographic factors of consumers, we found an association between the verbal information provision and sales of eco-friendly coffee, implying the possibility of green reputation building.

Next, we examine the possibility of the exposure effect of information provision in social spaces by estimating the impact of information provision by month. Figures 7(A) and 7(B) illustrate the results for cup sales of eco-friendly coffee and total sales in non-social spaces, respectively. We found significant impacts of information provision in non-social spaces for

two cases (sticker dummy in August and combination dummy in June) in the total sales estimation. However, in most cases, there was no significant association between information provision and the sales indicators.

Figures 7(C) and 7(D) show the results for social spaces. Except the sticker dummy in July and the combination dummy in June in the total sales estimation, we found significant impacts of the sticker and combination dummies in our experimental period, such as between June and September. The label dummy in social spaces was continuously insignificant during our survey period. The assumption of the exposure effect is that information provision gradually increases sales of eco-friendly coffee in social spaces. However, as the figures show, we could not observe a stepwise increment in eco-friendly sales. Instead, the increased impacts of the sticker and combination dummies are stable during the experimental period. Therefore, the exposure effect might not be a feasible explanation for the sales increase in social spaces.

Lastly, to indirectly examine the psychological aspects of consumers, we compared the impacts of information provision between regions with higher and lower recycling rates, a proxy for the environmental consciousness of consumers. The results for cup sales of eco-friendly coffee in Table 12 indicate that the sticker dummy was significantly associated with cup sales in high recycling rate regions (columns 1 to 4), while the sticker dummy becomes insignificant for the estimation of low recycling rate regions shown in columns 5 to 8. These results indicate that information provision through sticker usage is positively associated with sales of eco-friendly coffee only in high recycling rate regions, with limited effects in low recycling rate regions. By contrast, Table 13 shows the results of total sales from vending machines. Unlike the earlier results, we found no significant impact from the intervention dummies including the explanation sticker for either high or low recycling rate regions.

Overall, these robustness checks suggest that although we cannot reject the possibility of other psychological factors, the effect of green reputation building is a more plausible

explanation behind the sales increase in eco-friendly coffee through information provision in social spaces.

VII. Discussion

For vending machines of eco-friendly coffee in non-social spaces, we found that neither replacing the label with the visual depiction nor presenting information about the coffee's eco-friendliness stimulated purchases. The robustness checks also suggested that the effect of information provision is continuously insignificant. These findings suggest that individuals' awareness has a limited effect on the consumption of eco-friendly coffee, consistent with prior research findings (Takahashi, Todo & Funaki, 2018). For example, Ito, Ida & Tanaka (2018) found that sending a text message on in-home displays to conserve energy during peak demand reduces consumers' usage by 8%, but that reduction was short-lived and significantly smaller than that produced using an economic incentive (14–18% less energy usage). Regarding the insignificant effects of the interventions in non-social spaces, some may argue that vending machine users are typically in a hurry to purchase and thus pay less attention to the label or sticker. However, in a field experiment using beverage vending machines on train station platforms in Japan, Kawaguchi, Uetake & Watanabe (2018) found that presenting small advertising pop-ups on machines significantly affects consumers' choice. Therefore, our results also suggest that machine users in non-social spaces paid attention to our interventions, which increased their awareness but did not motivate them to purchase eco-friendly coffee.

By contrast, for the vending machines in social spaces, information provision through the sticker with a short statement successfully stimulated the purchase of eco-friendly coffee. The significantly positive association between the verbal information provision and sales of eco-friendly coffee implies the probability of green reputation building. These results are consistent

studies finding an association between green behavior and building a green reputation (Ekström, 2012, Kimura et al., 2012, Delmas & Lessem, 2014, Sexton & Sexton, 2014).

We also found that information provision in social spaces increased vending machines' total sales. This may be due to the acquisition of new customers, since solely persuading existing customers to change from non-certified regular coffee to eco-friendly coffee from the same vending machine would not change total sales from that machine. In a social space, displaying an environmental message through a sticker may thus attract the attention of non-customers before the experiment and enhance their motivation to build a green reputation by purchasing eco-friendly coffee.

Based on this analysis, we discuss policy implications. First, to enhance purchases of eco-friendly coffee in social spaces, the verbal information provision method (i.e., the small sticker) is an effective strategy. Conflicting with the results of Takahashi, Todo & Funaki (2018), our findings suggest that the verbal method of information provision is more effective than visually depicting the product's eco-friendly contribution. One reason for this inconsistency may be the respective studies' different experimental settings. In that prior laboratory study, participants may have paid more attention to the coffee label presented on the desktop screen, causing the effect of the visual information provision method to be overestimated.

Second, it is necessary to raise the environmental consciousness of consumers to maximize the effect of green reputation building on sales of eco-friendly coffee in social spaces. In general, the evidence on the association between consumers' environmental consciousness and eco-friendly behavior is somewhat mixed. While some studies indicate that consumers' environmental consciousness is a good predictor of eco-friendly purchases (Schlegelmilch, Bohlen & Diamantopoulos, 1996, Mainieri et al., 1997, Akehurst, Afonso & Martins Gonçalves, 2012), other work shows no correlation between these two factors (Alsmadi, 2007, Kriwy & Mecking, 2012, Takahashi, Todo & Funaki, 2018). Previous studies may therefore have

overlooked consumers' motivation to gain a green reputation within the community. The results of the robustness checks for other psychological factors in social spaces indicate the larger impact of information provision in regions with high environmental consciousness, while in non-social spaces, there is no association between the information provision and purchasing behavior. These results suggest that increasing the environmental consciousness of consumers may stimulate the purchase of eco-friendly coffee only in social spaces where the expectation of gaining a green reputation is high. Therefore, to stimulate the consumption of eco-friendly coffee in social spaces, it is important to implement policy interventions that promote the environmental consciousness of consumers.

VIII. Conclusion

Examining the impact of information provision about the eco-friendliness of a product on sales of eco-friendly coffee, we found that both cup sales of eco-friendly coffee and total sales increased from vending machines in social spaces such as office buildings and factories when a small sticker verbally emphasizing the coffee's eco-friendliness was affixed. Using Oster's (2017) sensitivity analysis, we confirmed that the estimated results are robust. In addition, the results of the robustness checks indicate the significant impact of the verbal information provision method. By contrast, for vending machines in non-social spaces accessible to the wider public such as shopping malls and train stations, none of our intervention strategies significantly affected eco-friendly coffee sales or total sales. These results indicate that general publicity is not an effective strategy for promoting green product consumption. However, in social spaces, information provision may increase community awareness and enhance the influence of building green reputation, resulting in the increased consumption of eco-friendly coffee.

This study's results could provide useful information for environmental organizations and governmental institutions. Because the promotion of eco-label certification schemes could achieve environmental conservation and enhance producers' income generation (Blackman & Naranjo, 2012, Takahashi & Todo, 2013, Takahashi & Todo, 2014, Rueda, Thomas & Lambin, 2015, Ibanez & Blackman, 2016, Takahashi & Todo, 2017), the expansion of markets for green products is essential. In this respect, there are great opportunities in Asian markets in which the market share of green products is low and has potential for considerable growth (Giovannucci & Koekoek, 2003, Yang et al., 2012). The estimation results indicate that purchases of green products may be stimulated by increasing community awareness and developing the environmental consciousness of consumers.

However, this study has several limitations. First, although we carefully estimated the impact of the information provision strategies on eco-friendly coffee sales, the study's experimental design was not fully randomized. A randomized experiment would have the advantage of capturing the effectiveness of each intervention and should be free of selection bias. Empirical evidence based on a randomized experiment is therefore needed.

Second, although we suggested the effects of building a green reputation on eco-friendly consumption in social spaces, this study cannot pin down the exact mechanisms of the sales increase through information provision because of data constraints. In particular, to incorporate demographic factors and psychological aspects, detailed consumer-level data are essential.

Third, this study investigated the short-term impact of information provision, and the long-term impact remains unclear since the interventions were implemented for only four months. In particular, it is important to investigate whether the consumption of eco-friendly coffee becomes a habit for consumers in social spaces through information provision.

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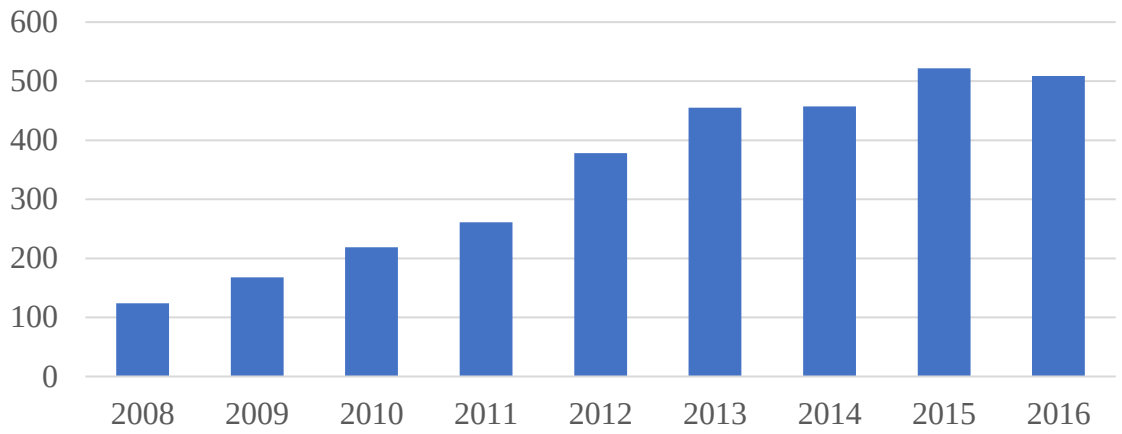
Figure 1: Production volume of eco-friendly coffee certified by the Rainforest Alliance (thousands of tons)



Note: Data are obtained from the "State of Sustainable Markets in 2018" by the International Trade Centre

Figure 2: A paper cup-style vending machine operated by the collaborating company

Figure 3: Labels for the eco-friendly coffee used in the experiment: (A) the original (control) label; (B) the new label, depicting a shade-grown coffee plantation

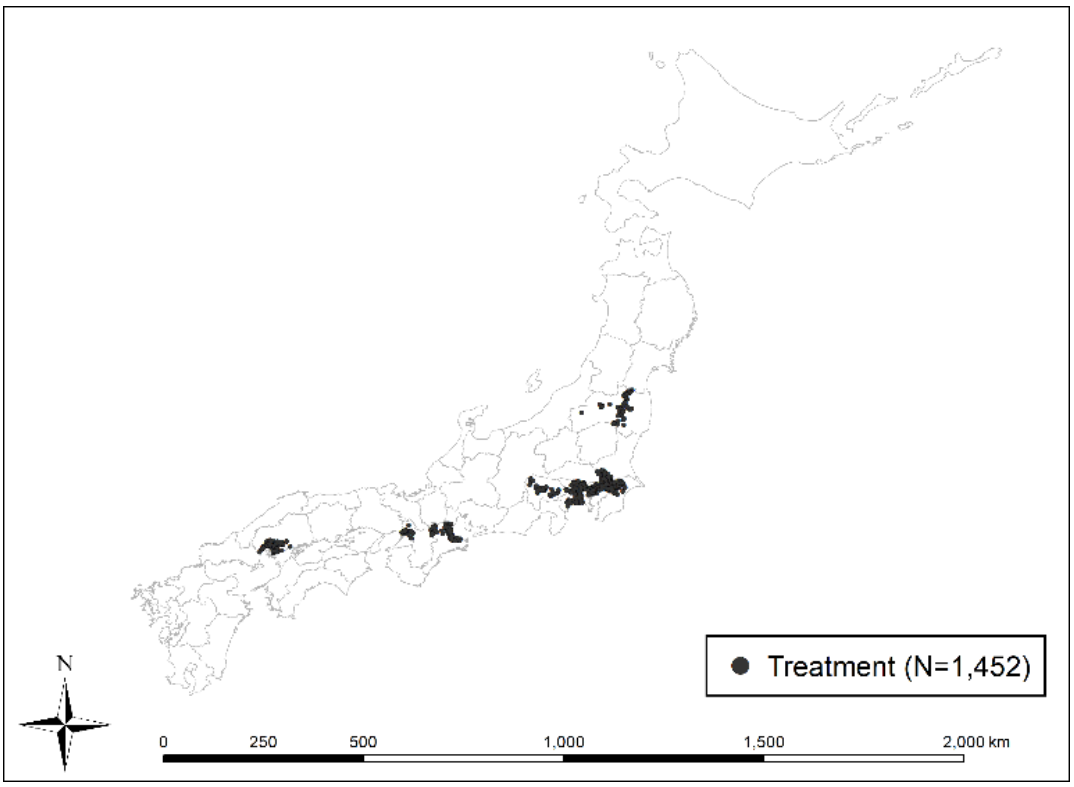
(A) (B)

Note: Other than the background image, both label designs include the same information.

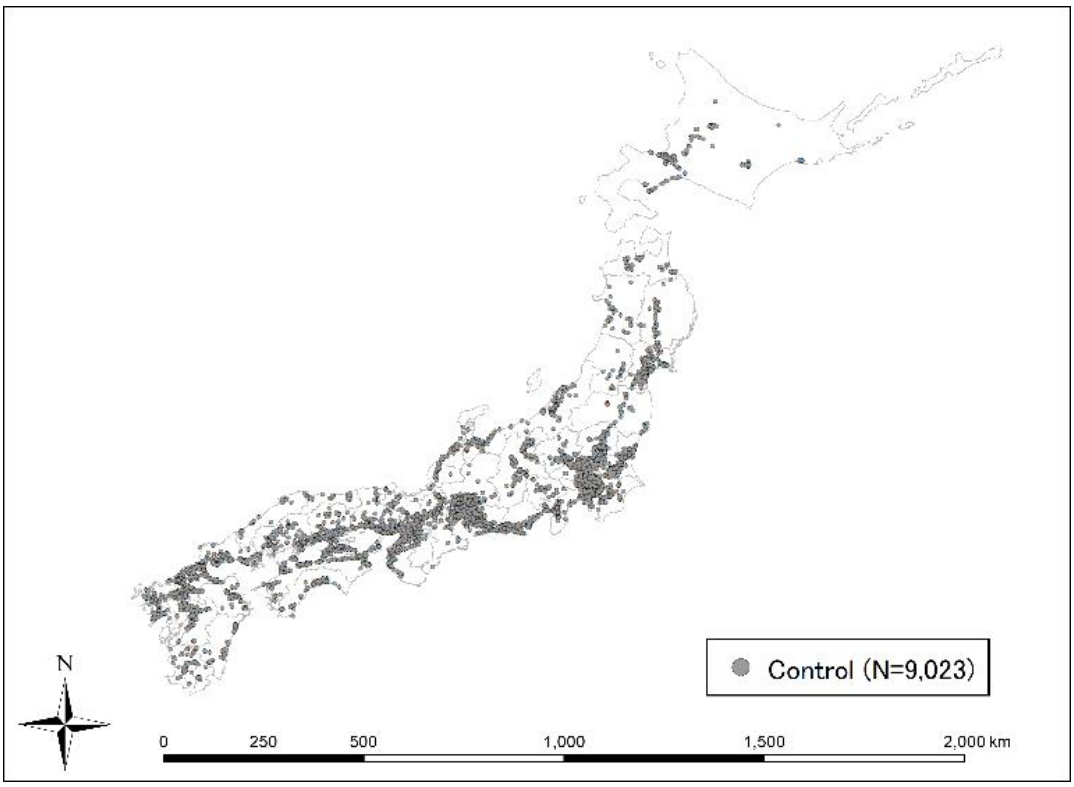
Figure 4: The explanation sticker for vending machines used in the experiment

Note: The text has been translated from Japanese (used in the experiment) to English.

Figure 5: Locations of the vending machines used in the experiment: (A) Treated vending machine locations; (B) Control vending machine locations.

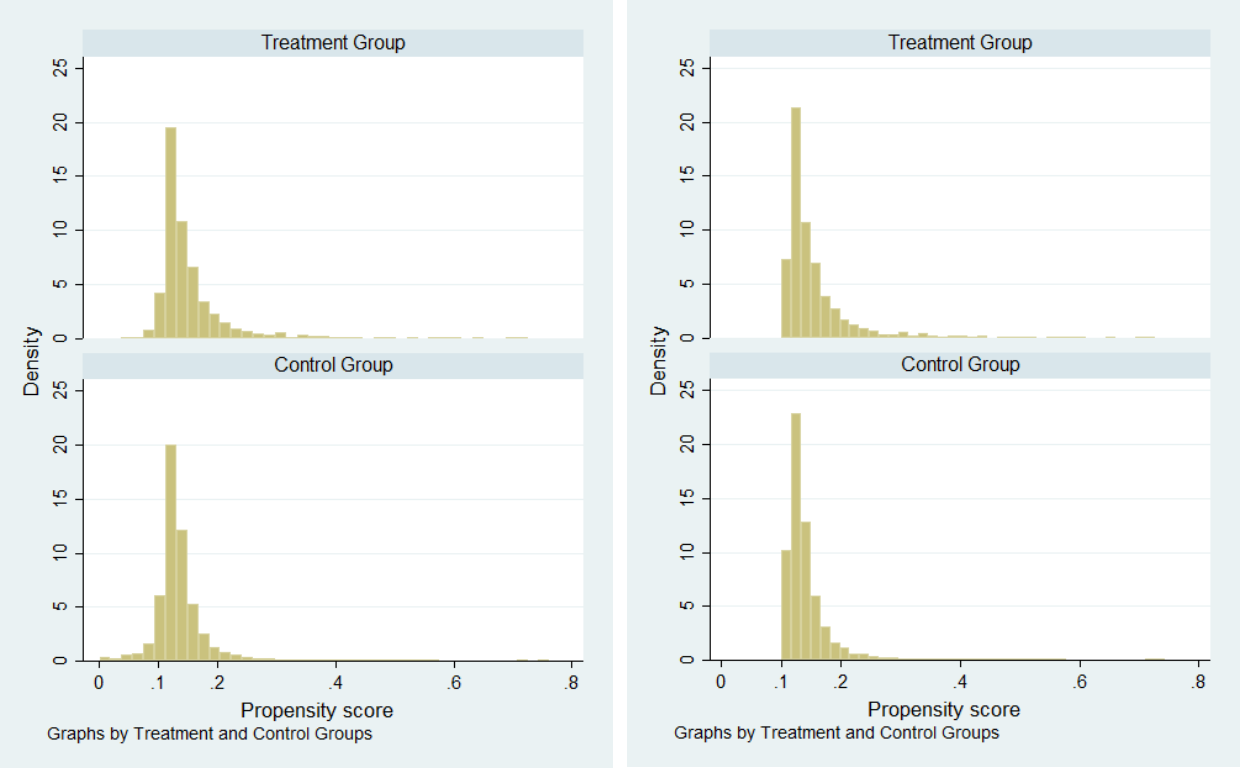


(A)



(B)

Figure 6: Distribution of the propensity scores between the treatment and control groups before (A) and after (B) the prescreening procedure

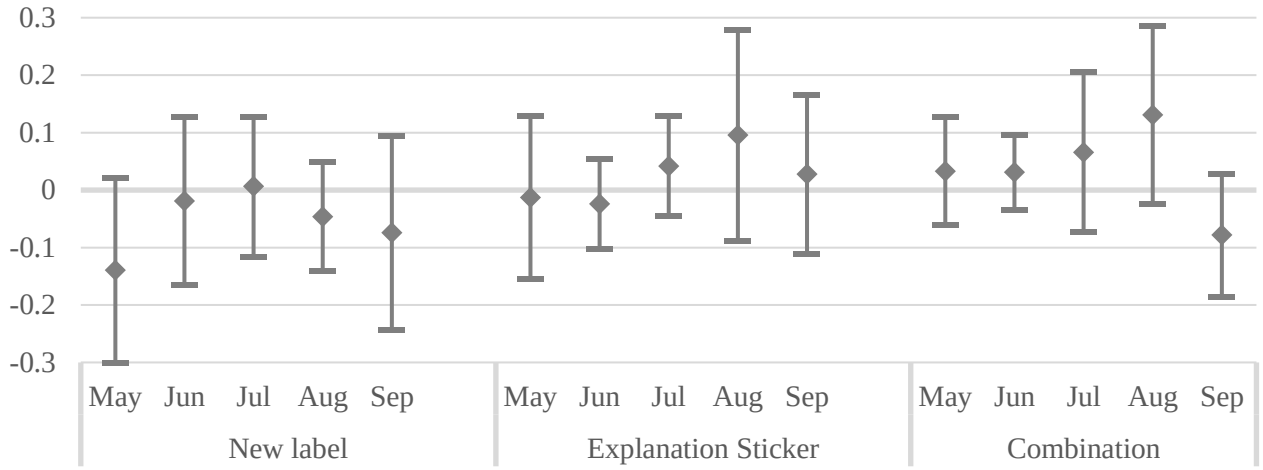


(A) Before prescreening

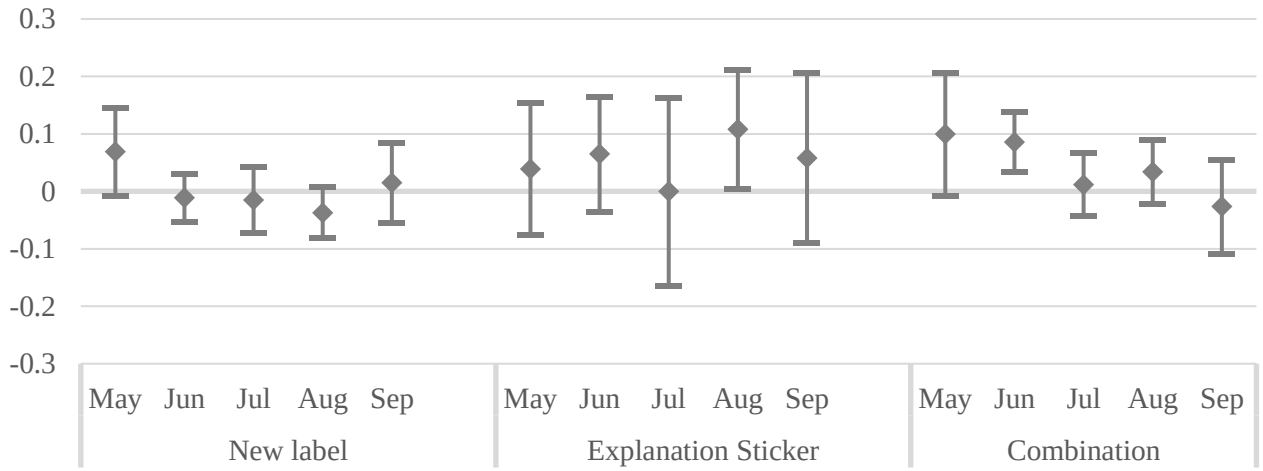
(B) After prescreening

Figure 7: Estimated impact of the information provision for non-social and social spaces by month

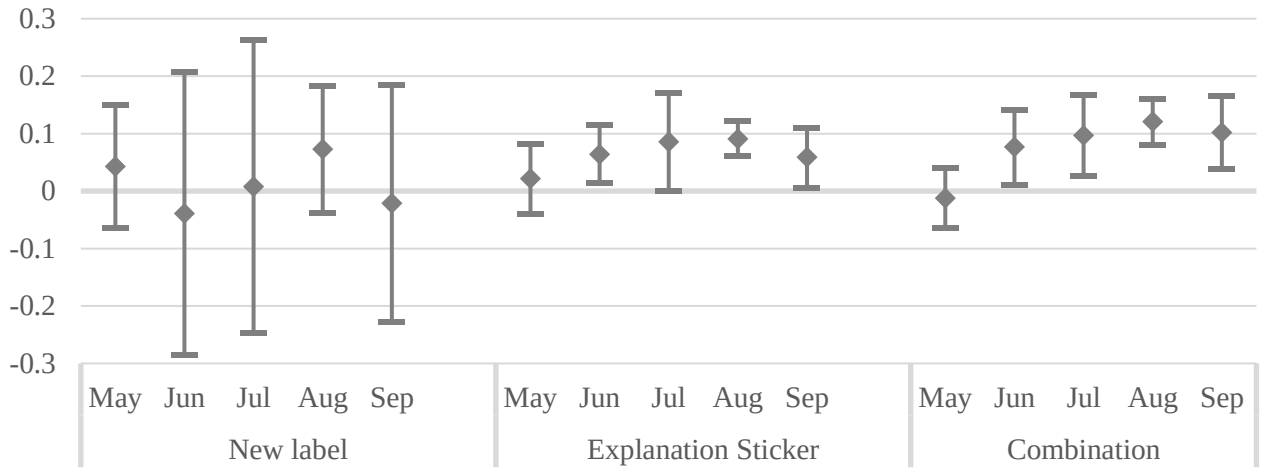
(A) Cup sales in non-social spaces



(B) Total sales in non-social spaces



(C) Cup sales in social spaces



(D) Total sales in social spaces

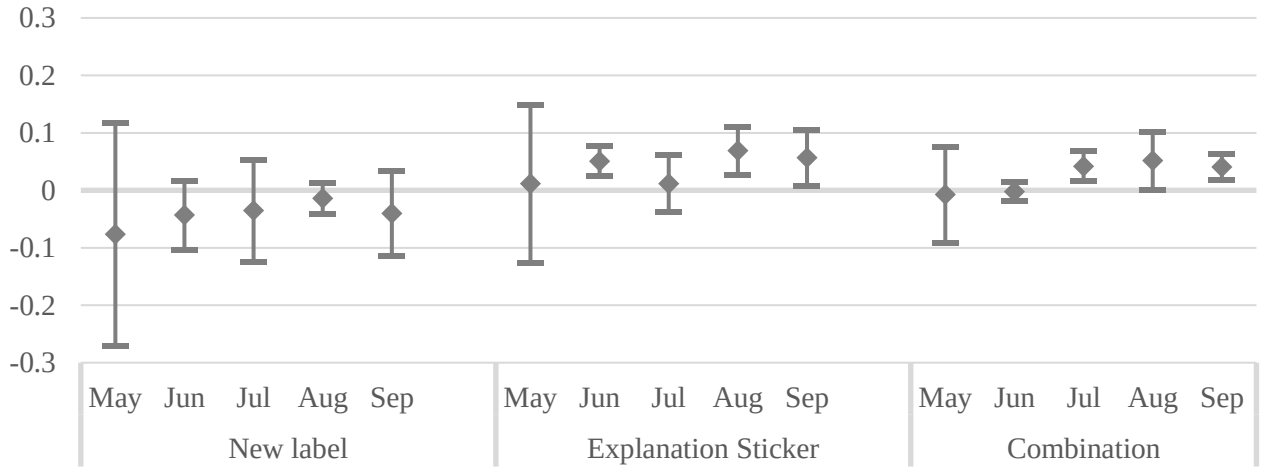


Table 1: Summary statistics

	Non-social spaces		Social spaces		
	Treatment group	Control group	Treatment group	Control group	Total
	(1)	(2)	(3)	(4)	(5)
Number of observations	317	2,466	1,135	6,557	10,475
New label (N)	122	0	274	0	396
Information sticker (N)	106	0	388	0	494
Combination: new label and sticker (N)	89	0	473	0	562
Difference in the log of cup sales of eco-friendly coffee	-0.017 [a]	-0.051 [a]	-0.033 [a]	-0.093 [b]	-0.076
	(0.593)	(0.661)	(0.807)	(0.881)	(0.828)
Difference in the log of total sales of vending machines	-0.031 [a]	-0.058 [a]	-0.047 [a]	-0.121 [b]	-0.098
	(0.525)	(0.742)	(0.742)	(0.818)	(0.789)

Note: Standard deviations are presented in parentheses.

[a],[b]: Indicate statistically significant differences between the two groups based on Scheffe's multiple comparison test at the 5% level.

Table 2: Demographic characteristics of the located regions

	Non-social spaces		Social spaces		
	Treatment group	Control group	Treatment group	Control group	Total
	(1)	(2)	(3)	(4)	(5)
Number of observations	317	2,466	1,135	6,557	10,475
Share of highly educated residents in 2010	33.45 [a]	28.44 [b]	33.56 [a]	29.95 [c]	30.09
	(5.19)	(4.96)	(5.60)	(4.61)	(5.06)
Changes in the share of highly educated residents between 2000 and 2010	2.23 [a]	3.62 [b]	1.80 [c]	3.48 [d]	3.29
	(1.87)	(1.29)	(1.98)	(1.42)	(1.58)
Average annual income in 2016 (million yen)	3.41 [a]	3.11 [b]	3.59 [c]	3.30 [d]	3.29
	(0.46)	(0.51)	(0.61)	(0.55)	(0.56)
Changes in average income between 2013 and 2016 (million yen)	0.10 [a]	0.10 [a]	0.14 [b]	0.12 [c]	0.11
	(0.07)	(0.08)	(0.10)	(0.08)	(0.09)
Unemployment rate in 2015	4.24 [abc]	4.35 [a]	4.23 [b]	4.13 [c]	4.19
	(0.67)	(0.93)	(0.75)	(0.96)	(0.93)
Changes in the unemployment rate between 2010 and 2015	-2.12 [ab]	-2.24 [a]	-2.17 [a]	-2.09 [b]	-2.13
	(0.87)	(0.82)	(0.77)	(0.79)	(0.80)
Recycling rate in 2015	22.66 [a]	20.39 [b]	19.98 [b]	20.38 [b]	20.41
	(10.45)	(9.40)	(9.71)	(9.66)	(9.64)
Changes in the recycling rate between 2013 and 2015	-0.34 [a]	-0.21 [a]	-0.43 [a]	-0.17 [a]	-0.21
	(1.47)	(3.98)	(1.44)	(3.25)	(3.26)

Note: Standard deviations are presented in parentheses.

[a],[b],[c],[d]: Indicate statistically significant differences between the two groups based on Scheffe's multiple comparison test at the 5% level.

Table 3: Demographic characteristics of subsample groups in non-social spaces

	Observations in the treatment prefecture		Observations in cities with similar demographic characteristics	
	Treatment group	Control group	Treatment group	Control group
	(1)	(2)	(3)	(4)
Number of observations	1,123	1,641	666	666
Share of highly educated residents in 2010	33.56	33.11	32.91	33.03
	(5.62)	(4.92)	(5.31)	(4.86)
Changes in the share of highly educated residents between 2000 and 2010	1.79	1.90	1.67	1.78
	(1.98)	(1.90)	(2.06)	(2.17)
Average annual income in 2016 (million yen)	3.60	3.69 [a]	3.75	3.69
	(0.62)	(0.70)	(0.72)	(0.75)
Changes in average income between 2013 and 2016 (million yen)	0.14	0.16 [a]	0.19	0.18
	(0.10)	(0.11)	(0.11)	(0.11)
Unemployment rate in 2015	4.22	4.34 [a]	4.35	4.34
	(0.75)	(0.98)	(0.86)	(0.95)
Changes in the unemployment rate between 2010 and 2015	-2.18	-2.14	-2.32	-2.41
	(0.77)	(0.65)	(0.71)	(0.78)
Recycling rate in 2015	20.03	19.34	16.64	16.75
	(9.73)	(8.69)	(8.12)	(8.05)
Changes in the recycling rate between 2013 and 2015	-0.42	-0.17 [a]	-0.36	-0.19
	(1.44)	(2.45)	(1.45)	(1.96)

[a]: Indicate statistically significant differences between the treatment and control groups at the 1% level.

Table 4: Number of observations before and after matching by locational category

	Before matching			After matching		
Category	Treatment group	Control group	Total	Treatment group	Control group	Total
1. Manufacturing companies	645	4,342	4,987	631	631	1,262
2. Non-manufacturing companies	511	2,397	2,908	483	483	966
3. Service companies	63	447	510	46	46	92
4. Public offices	42	231	273	38	38	76
5. Schools	54	244	298	53	53	106
6. Service stations on freeways	0	397	397	0	0	0
7. Hospitals	97	581	678	92	92	184
8. Amusement areas	40	384	424	33	33	66
Total	1,452	9,023	10,475	1,376	1,376	2,752

Table 5: Balancing test for the PSM estimation

	Difference before matching	Difference after matching
	(1)	(2)
Total sales of vending machines in May	-1,400.5	3,098.3
Total sales of vending machines in June	4,875.8 [a]	3,093.3
Total sales of vending machines in July	1,991.5	2,597.5
Total sales of vending machines in August	-2,345.8	2,412.8
Total sales of vending machines in September	833.9	2,913.3
Cup sales of eco-friendly coffee in May	37.7 [a]	3.2
Cup sales of eco-friendly coffee in June	49.4 [a]	5.6
Cup sales of eco-friendly coffee in July	42.8 [a]	5.9
Cup sales of eco-friendly coffee in August	37.5 [a]	3.2
Cup sales of eco-friendly coffee in September	42.8 [a]	5.4

[a]: Indicate statistically significant differences between the treatment and control groups at the 1% level.

Table 6: Effect of the information provision strategies on cup sales of eco-friendly coffee and total sales of vending machines in non-social spaces

	Amount of eco-friendly coffee sold				Total sales			
	Prescreening		PSM		Prescreening		PSM	
	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
New label dummy	0.005	-0.017	0.005	0.003	-0.002	-0.029	-0.021	-0.027
	(0.048)	(0.043)	(0.048)	(0.033)	(0.037)	(0.034)	(0.021)	(0.029)
Sticker dummy	0.070	-0.047	0.058	0.031	0.039	-0.025	0.010	0.020
	(0.042)	(0.056)	(0.067)	(0.060)	(0.032)	(0.028)	(0.032)	(0.024)
Combination dummy	0.044	0.006	0.009	-0.048	0.020	-0.007	0.009	0.008
	(0.056)	(0.067)	(0.049)	(0.104)	(0.031)	(0.040)	(0.014)	(0.019)
Constant	0.090***	0.090***	0.111***	0.111***	0.095**	0.095**	0.130***	0.130***
	(0.021)	(0.018)	(0.026)	(0.018)	(0.040)	(0.037)	(0.029)	(0.026)
Monthly fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Prefecture fixed effect	-	YES	-	YES	-	YES	-	YES
Observations	10,520	10,520	3,015	3,015	10,520	10,520	3,015	3,015
R-squared	0.016	0.031	0.022	0.068	0.015	0.026	0.023	0.027

Note: Standard errors in parentheses; *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 7: Effect of the information provision strategies on cup sales of eco-friendly coffee and total sales of vending machines in social spaces

	Amount of eco-friendly coffee sold				Total sales			
	Prescreening		PSM		Prescreening		PSM	
	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
New label dummy	0.023	0.053	0.039	0.059	0.018	0.013	0.029	0.008
	(0.040)	(0.047)	(0.070)	(0.090)	(0.028)	(0.027)	(0.026)	(0.020)
Sticker dummy	0.071**	0.063*	0.085***	0.040**	0.078**	0.064*	0.080***	0.040*
	(0.036)	(0.032)	(0.025)	(0.015)	(0.037)	(0.034)	(0.029)	(0.022)
Combination dummy	0.070**	0.091***	0.071**	0.076***	0.049*	0.041**	0.047*	0.042**
	(0.029)	(0.030)	(0.035)	(0.026)	(0.025)	(0.019)	(0.028)	(0.016)
Constant	0.023*	0.023*	0.051**	0.051***	0.015	0.015	0.090***	0.090***
	(0.014)	(0.013)	(0.022)	(0.018)	(0.024)	(0.021)	(0.027)	(0.024)
Monthly fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Prefecture fixed effect	-	YES	-	YES	-	YES	-	YES
Observations	37,746	37,746	10,745	10,745	37,746	37,746	10,745	10,745
R-squared	0.008	0.019	0.010	0.023	0.010	0.046	0.018	0.022

Note: Standard errors in parentheses; *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 8: Robustness to unobservable factors (Proportional selection γ)

	Amount of eco-friendly coffee sold				Total sales			
	Prescreening		PSM		Prescreening		PSM	
	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
New label dummy	-0.004	-0.012	-0.002	0.057	-0.004	-0.012	0.008	0.009
Sticker dummy	-0.014	-0.051	-0.028	-0.315	-0.019	-0.167	-0.005	-0.009
Combination dummy	-0.014	-0.032	-0.003	-0.001	-0.012	-0.061	-0.005	-0.004

Note: Given that R_{max} is equal to 1.

Table 9: Results of the robustness check for unbalanced characteristics in social spaces

	Observations in treatment prefectures				Observations in cities with similar demographic characteristics			
	Amount of eco-friendly coffee sold		Total sales		Amount of eco-friendly coffee sold		Total sales	
	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
New label dummy	0.053	0.073	0.021	0.030	0.019	0.029	-0.004	0.002
	(0.042)	(0.050)	(0.023)	(0.031)	(0.040)	(0.033)	(0.021)	(0.026)
Sticker dummy	0.103***	0.081**	0.085**	0.084**	0.067*	0.073**	0.057*	0.067*
	(0.037)	(0.035)	(0.033)	(0.035)	(0.039)	(0.032)	(0.033)	(0.036)
Combination dummy	0.098***	0.106***	0.051**	0.054***	0.066**	0.088***	0.028*	0.036
	(0.032)	(0.031)	(0.020)	(0.021)	(0.030)	(0.033)	(0.016)	(0.022)
Constant	0.027	0.028	0.044**	0.044**	0.050***	0.050***	0.052***	0.052***
	(0.021)	(0.020)	(0.022)	(0.022)	(0.015)	(0.014)	(0.017)	(0.017)
Monthly fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Prefecture fixed effect	-	YES	-	YES	-	YES	-	YES
Observations	13,627	13,627	13,627	13,627	6,575	6,575	6,575	6,575
R-squared	0.010	0.014	0.019	0.020	0.010	0.014	0.017	0.019

Note: Standard errors in parentheses; *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 10: Results of the robustness check for demographic factors in social spaces

	Cup sales		Total sales		Cup sales		Total sales	
	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
New label dummy	-0.036	-0.024	-0.038	-0.034	-0.036	-0.025	-0.039	-0.037
	(0.036)	(0.035)	(0.026)	(0.026)	(0.035)	(0.035)	(0.026)	(0.026)
Sticker dummy	0.043	0.093***	0.010	0.043**	0.072**	0.092***	0.039**	0.043**
	(0.032)	(0.030)	(0.022)	(0.018)	(0.030)	(0.030)	(0.016)	(0.019)
Combination dummy	0.019	0.015	0.023	0.017	0.018	0.015	0.022	0.018
	(0.030)	(0.030)	(0.040)	(0.040)	(0.030)	(0.030)	(0.039)	(0.040)
Constant	-0.053	0.150	-0.244	-0.242	0.021	-0.051	0.102	0.071
	(0.120)	(0.285)	(0.237)	(0.349)	(0.055)	(0.076)	(0.113)	(0.094)
Monthly fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Prefecture fixed effect	-	YES	-	YES	-	YES	-	YES
Demographic level	YES	YES	YES	YES	-	-	-	-
Demographic trend	-	-	-	-	YES	YES	YES	YES
Demographic characteristics X Information	YES	YES	YES	YES	YES	YES	YES	YES
Observations	37,746	37,746	37,746	37,746	37,746	37,746	37,746	37,746
R-squared	0.009	0.019	0.014	0.047	0.009	0.020	0.013	0.048

Note: Standard errors in parentheses; *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 11: Results of the robustness check for the demographic factors using pooled data

	Cup sales		Total sales		Cup sales		Total sales	
	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
New label dummy	-0.033	-0.026	-0.036	-0.035	-0.034	-0.026	-0.039	-0.037
	(0.026)	(0.026)	(0.025)	(0.025)	(0.026)	(0.026)	(0.025)	(0.025)
Sticker dummy	0.013	0.006	-0.038	-0.033	0.019	0.006	-0.024	-0.032
	(0.025)	(0.033)	(0.028)	(0.035)	(0.026)	(0.033)	(0.029)	(0.035)
Combination dummy	0.020	0.023	-0.045	-0.046	0.019	0.024	-0.047	-0.047
	(0.040)	(0.040)	(0.045)	(0.045)	(0.041)	(0.040)	(0.045)	(0.045)
New label dummy X Social space	0.051	0.048	0.049	0.052	0.041	0.042	0.031	0.044
dummy	(0.053)	(0.057)	(0.051)	(0.047)	(0.053)	(0.056)	(0.044)	(0.044)
Sticker dummy X Social space	0.074*	0.058	0.127**	0.126***	0.080*	0.056	0.143***	0.128***
dummy	(0.042)	(0.035)	(0.052)	(0.041)	(0.042)	(0.035)	(0.054)	(0.043)
Combination dummy X Social	0.012	0.016	0.034	0.033	0.010	0.016	0.029	0.032
space dummy	(0.070)	(0.067)	(0.052)	(0.050)	(0.070)	(0.067)	(0.051)	(0.050)
Constant	-0.027	0.148	-0.103	-0.181	0.070	0.048	0.126	0.128
	(0.097)	(0.244)	(0.162)	(0.315)	(0.046)	(0.073)	(0.087)	(0.088)
Monthly fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Prefecture fixed effect	-	YES	-	YES	-	YES	-	YES
Demographic level	YES	YES	YES	YES	-	-	-	-
Demographic trend	-	-	-	-	YES	YES	YES	YES
Social space dummy	YES	YES	YES	YES	YES	YES	YES	YES
Demographic characteristics	YES	YES	YES	YES	YES	YES	YES	YES

X Information								
Observations	48,266	48,266	48,266	48,266	48,266	48,266	48,266	48,266
R-squared	0.011	0.019	0.014	0.039	0.010	0.019	0.014	0.039

Note: Standard errors in parentheses; *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 12: Effect of the information provision strategies on cup sales of eco-friendly coffee in social spaces: comparing high and low recycling rate regions

	Amount of eco-friendly coffee sold							
	High recycling rate regions				Low recycling rate regions			
	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
New label dummy	0.018	-0.048	0.015	-0.043	-0.066	-0.045	-0.084	-0.051
	(0.066)	(0.108)	(0.061)	(0.106)	(0.087)	(0.101)	(0.089)	(0.099)
Sticker dummy	0.116*	0.073*	0.139**	0.087**	0.018	-0.002	-0.022	-0.015
	(0.061)	(0.040)	(0.063)	(0.042)	(0.055)	(0.080)	(0.064)	(0.080)
Combination dummy	0.012	0.067	0.087	0.060	-0.052	0.074	-0.051	0.073
	(0.077)	(0.077)	(0.066)	(0.073)	(0.082)	(0.094)	(0.082)	(0.096)
Constant	-0.080	-0.773	0.066	0.197	-0.336	0.801	0.133	-0.097
	(0.219)	(1.107)	(0.077)	(0.161)	(0.328)	(0.639)	(0.192)	(0.263)
Monthly fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Prefecture fixed effect	-	YES	-	YES	-	YES	-	YES
Demographic level	YES	YES	-	-	YES	YES	-	-
Demographic trend	-	-	YES	YES	-	-	YES	YES
Demographic characteristics X Information	YES	YES	YES	YES	YES	YES	YES	YES
Observations	9,459	9,459	9,459	9,459	9,685	9,685	9,640	9,640
R-squared	0.010	0.035	0.011	0.036	0.010	0.028	0.009	0.028

Note: Standard errors in parentheses; *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 13: Effect of the information provision strategies on the total sales from vending machines in social spaces: comparing high and low recycling rate regions

	Total sales from vending machines							
	High recycling rate regions				Low recycling rate regions			
	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect	DID	Fixed effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
New label dummy	0.030	0.067	0.021	0.065	0.102	-0.056	0.039	-0.061
	(0.039)	(0.053)	(0.039)	(0.051)	(0.107)	(0.109)	(0.063)	(0.113)
Sticker dummy	0.061	0.059	0.065	0.049	0.153	0.070	0.209	0.074
	(0.062)	(0.066)	(0.059)	(0.065)	(0.106)	(0.043)	(0.138)	(0.050)
Combination dummy	0.041	0.042	0.062	0.044	0.004	0.041	0.023	0.039
	(0.048)	(0.047)	(0.042)	(0.048)	(0.044)	(0.074)	(0.067)	(0.085)
Constant	0.047	-2.374	0.046	0.149	-1.035	0.620	0.437	0.085
	(0.114)	(1.994)	(0.039)	(0.118)	(0.874)	(0.653)	(0.430)	(0.342)
Monthly fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Prefecture fixed effect	-	YES	-	YES	-	YES	-	YES
Demographic level	YES	YES	-	-	YES	YES	-	-
Demographic trend	-	-	YES	YES	-	-	YES	YES
Demographic characteristics X Information	YES	YES	YES	YES	YES	YES	YES	YES
Observations	9,459	9,459	9,459	9,459	9,685	9,685	9,640	9,640
R-squared	0.016	0.028	0.016	0.024	0.015	0.108	0.013	0.112

Note: Standard errors in parentheses; *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.