Take all You Want, but Eat all You Take: Effectiveness of a Financial Incentive on Individual Food Waste

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Abstract

We investigate the effect of a fixed financial incentive on students' food consumption and associated food waste, through a randomized control trial at an all-you-can-eat university dining hall. Results indicate the financial incentive was instrumental in increasing the likelihood of students cleaning their plates (reduction in waste). However, there was no reduction in the amount of food consumed by the students. The incentive had an unintended consequence of students possibly consuming more food, which may encourage adverse eating habits. A failure to consider the relative responses of food taken, plate waste, and consumption behavior from the point of waste-reduction can lead to ineffective policies and programs.

1. Introduction

Dining halls, food courts, and fast-food restaurants are major sources of food waste. Annually university dining halls account for nearly 540,000 million tons of food waste (Whitehair et al. 2013). Such waste generates external costs in the form of groundwater contamination, overuse of natural resources, greenhouse gas emissions, and food insecurity (Coleman-Jensen et al. 2014; Grizzetti et al. 2013).

Availability of extensive food choice and large portion size are possible explanations of dining hall plate waste (Gunders 2012). Previous literature suggests that interventions such as food-waste awareness messaging, reduced plate size, and introducing social cues in all-you-can-eat dining-halls/buffets has shown to reduce individual food waste (Whitehair et al. 2013; Kallbekken and Sælen 2013; Wansink and Van Ittersum 2013). However, there is little if any research dedicated to studying the effect of economic incentives on food waste reduction at the individual level.

The food-waste literature in economics indicates that when consumers are faced with high transaction costs for matching food consumption with purchases, they will tend to absorb the cost of some food waste as a premium for food safety and convenience (De Gorter 2014). This results in some positive levels of food waste. Katare et al. (2017) theoretically investigate this positive level by deriving social-optimal food waste taxes and subsidies. Their results indicate the optimal levels depend on the responsiveness of individual food waste to the mechanisms. However, there are limited if any efforts on quantifying the impact of financial incentives on food-waste behavior.

We attempt to fill the literature gap by investigating the effect of a fixed economic incentive on reducing the amount of individual level food waste, generated by students in an all-you-can-eat university-dining hall. Our hypothesis is students are responsive to an economic incentive with respect to the food taken and the associated plate waste. We test this hypothesis through a randomized controlled experiment, where the intervention offers students a fixed financial incentive to eat all they have taken on their lunch plate – clean their plate. This fixed financial incentive has a positive and statistically significant effect on zero plate waste. In contrast, we find no evidence of reduction in food taken.

2. Experimental Design

In Spring 2017, we conducted the experiment at a fixed price all-you-can-eat dining hall at a large Midwest university. To avoid any self-selection bias, food waste was not mentioned while recruiting the participants. Our sample consists of 90 students, with 39 randomly assigned to the treatment and 51 to the control group. Table 1 reports the descriptive statistics of students' characteristics. The sample is well-balanced between treatment and control groups with no statistical difference in the pre-treatment baseline characteristics. A balance test results in Appendix Table A.1 indicate no significant difference between student's baseline characteristics in the treatment and control groups.

Table 1. Descriptive Statistics of Students' Demographic Variables

Variable Name	Financial Incentive Group	Control Group
Age (years)	20.358	19.568
	(3.452)	(1.431)
Female	0.435	0.490
	(0.502)	(0.504)
Local Student	0.769	0.803
	(0.426)	(0.400)
Foreign Student	0.230	0.196
	(0.426)	(0.400)
Race = Other	0.282	0.215
	(0.455)	(0.415)

Race = White	0.384	0.490
	(0.492)	(0.504)
Race = Asian	0.333	0.294
	(0.477)	(0.460)
Freshman	0.435	0.490
	(0.502)	(0.504)
Urban	0.487	0.411
	(0.506)	(0.497)
Rural	0.512	0.588
	(0.506)	(0.497)
Number of Students	39	51

Standard deviations are in parentheses.

The experiment spanned for two weeks with the first week for baseline and the second for intervention data collection. Students ate alone, which prevented them from food sharing or collecting food waste on one plate to increase collective receipts of zero plate waste.

We collected data by taking photographs of students' plates at the beginning and the end of their lunch. This allowed us to record food consumption and waste data without interfering with students' lunch. The digital photography method is extensively employed for collecting and analyzing plate waste (Taylor et al. 2014; Williamson et al. 2003). All students had zero marginal monetary cost for eating lunch, and were compensated with a $10 gift card for participation.

At the beginning of the intervention week, students in the treatment group were emailed information about the financial incentive and clean plate. They were offered a fixed financial incentive of $2 per day for cleaning their plate equating to 15% discount on their fixed priced lunch. The incentive encourages taking only the amount of food they can consume. A reminder email about the continuation of the experiment was sent to the control group.

3. Data Extraction and Estimation

Pre- and post-lunch photos were collected daily, for the entire experiment. We obtained the standard serving size for each food item and its weight from the dining services. We validated these weights by physically weighing each food item per serving. Three experienced data assessors were employed for portion size estimation of each food item. Portion size of a food item was determined by comparing the portion size of each food item present in the pre-lunch photo with corresponding standard serving size, using a 10% estimation scale (e.g., 0, 0.1, 0.2, etc.). If the portion in the photo was greater than the standard serving size, the estimation would be greater than one, and vice versa. We calculated the percent of average portion size for each food item by taking the average of the three estimations by the assessors. The amount of each food item taken was calculated by multiplying weight of standard serving and average portion size percent. We added the weights of all the food items taken by a student on a day to create the outcome variable of total *Food Taken*. The outcome variable *Clean Plate* was generated by observing post-lunch photos. If a student had zero plate waste, variable *Clean Plate* was coded 1 and 0 otherwise. Table 2 lists the descriptive statistics for the outcome variables.

Table 2. Descriptive Statistics for Outcome Variables

Variable Name	Week 1		Week 2	
	Control Group	Financial Incentive Group	Control Group	Financial Incentive Group
Average Number	0.456	0.577	0.472	0.858
of *Clean Plates*	(0.499)	(0.496)	(0.500)	(0.350)
Average Total	1.052	0.995	1.053	1.036
Food Taken (lb)	(0.407)	(0.382)	(0.461)	(0.449)
Observations	160	116	161	134

Standard deviations are in parentheses.

4. Empirical Framework

We begin by comparing the average treatment effect with the linear model

$$(Clean\ Plate)_{i,t} = \beta_0 + \beta_1 Treatment_{i,t} + \beta_2 Post_{i,t} + \beta_3\left(Treatment_{i,t} * Post_{i,t}\right) + \boldsymbol{\beta_4 Z_i} + \boldsymbol{\beta_5 Day_t} + u_i \qquad (1)$$

where $(Clean\ Plate)_{i,t}$ is equal to 1 if student i has a clean plate on day *t* and 0 otherwise. $Treatment_i$ is 1 if the student i is exposed to the treatment and 0 otherwise. $Post_{it}$ equals 1 for treatment week and 0 otherwise. Vector $\boldsymbol{Z_i}$ represents demographic control variables (age, gender, race, nationality, freshman, and rural/urban). $\boldsymbol{Day_t}$ is the vector of day fixed effects to control for the common shocks all students faced (eg: a bad tasting item). Standard errors are corrected for heteroscedasticity and are clustered at individual level.

For exploring possible heterogeneity in response to the financial incentive through the intervention week, we interact, $Treatment_{i,t}$, and exposure $Post_{it}$. This interaction captures the effect of being in the treatment group relative to being in the control group during the intervention week. This specification is shown in (2), and it also includes the demographic variables and day fixed effect as in (1). $\boldsymbol{Post\_Day_{i,t}}$ represents a set of dummies for the treatment days during the intervention week

$$(Clean\ Plate)_{i,t} = \beta_0 + \beta_1 Treatment_{i,t} + \beta_2\left(Treatment_{i,t} * \boldsymbol{Post\_Day_{i,t}}\right) + \boldsymbol{\beta_3 Z}_i + \boldsymbol{\beta_4 Day_t} + u_i \qquad (2)$$

Lastly, we also estimate the outcome variable total *Food Taken* using equation 1 and 2 as described above.

5. Results

Table 3 presents estimation results for equation (1) for outcome *Clean Plate.* Results show that students in the treatment group responded to the financial incentive by modifying their consumption behavior. For the treatment group, the probability of cleaning their plates during the intervention was roughly 0.26 per day higher than for the control group from a base of 0.4 per day. Specifically, the probability of the treatment group cleaning their plate was 63% higher than the control group. Results also indicate 85% of the students cleaned their plates during the treatment week. For a payout of $2, the incentive was able to increase the probability of a clean plate by 22%.

Table 3. Impact of Financial Incentive on Probability of Clean Plates and Food Taken

Variable Name	Clean Plate = 1	Food Taken (lb)
Treatment	0.112	−0.068
	(0.081)	(0.060)
Post	0.107	−0.010
	(0.085)	(0.060)
Treatment*Post	0.265***	0.027
	(0.083)	(0.063)
Observations	571	571

Standard errors in parentheses are corrected for heteroscedasticity and clustered at individual level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. We control for individual demographic variables, and day fixed effects. Complete estimation results are available in Appendix Table A.2.

Results for equation (2) presented in table 4 column 1, indicate students' responsiveness to the treatment was constant throughout the treatment week. The probability of cleaning the plate each day of the intervention week was not statistically different from each other ($p > 0.1$), implying the treatment effect was consistent through time. There is no decline in the effect, which is common in financial incentive interventions (Royer et al. 2015). We sent the email about the intervention once before the intervention started with no additional reminders. These results are encouraging as they show effect even in the absences of repeated reminders, thus confirming the salience and effectiveness of the treatment.

Table 4. Impact of Financial Incentive on Probability of Clean Plates and Food Taken for each Treatment Day

Variable Name	Clean Plate = 1	Food Taken (lb)
Treatment	0.112	−0.068
	(0.082)	(0.060)
Treatment*Day6	0.318***	−0.051
	(0.117)	(0.118)
Treatment*Day7	0.270**	0.115
	(0.123)	(0.108)
Treatment*Day8	0.221*	0.068
	(0.123)	(0.098)
Treatment*Day9	0.250*	0.113
	(0.135)	(0.115)
Treatment*Day10	0.257**	−0.117
	(0.110)	(0.100)
Observations	571	571

Standard errors in parentheses are corrected for heteroscedasticity and clustered at individual level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. We control for individual demographic variables, and day fixed effects. Complete estimation results are available in Appendix Table A.3.

Results for the outcome variable total *Food Taken* are reported in column 2 of tables 3 and 4 for equation (1) and (2), respectively. The incentive had no effect on the amount of food taken by the students. This indicates the economic incentive has a relatively strong effect on students cleaning their plate with no effect on food taken. The actual consumption of food increases with a relatively larger decline in plate waste, implying that students will likely not tradeoff consumption for the incentive.

6. Discussion and Conclusion

Financial incentives have been extensively used to motivate healthy behavior (Royer et al. 2015; Volpp et al. 2008) with success. However, in our case, the main question is whether financial incentives are appropriate tools for motivating individual food-waste reduction. An unintended consequence of this financial incentive is that students are possibly consuming more food, which might encourage adverse eating habits. For internalizing the negative externalities of food waste and poor diets, policies encouraging cleaning plates with healthy foods may be warranted. Determining effective policies for addressing food waste may then interrelate with healthy-eating policies. Considering them in isolation may not yield effective results. Policies such as using nutrition labeling (Driskell et al. 2008) and benefit-based messages indicating healthy food choices (Peterson et al. 2010) can be used in tandem with an incentive to overcome challenges of developing healthy eating habits (Just and Price 2013). The incentive is then an impetus to eat healthy, and can be considered as a reverse soda tax.

The experiment was conducted in real-time during regular dining hours at a well-functioning dining hall. The students had no constraints on the amount or type of food they could order, eat, or waste. Results are consistent over time, without any repeated reminders. Our results provide a foundation for policymakers implementing and evaluating policies to reduce food waste. The results demonstrate the effectiveness of a well-established policy in behavior modification toward waste reduction. However, they also manifest that failure to consider the relative responses of food taken, plate waste, and consumption with the aim of waste-reduction can lead to ineffective policies and programs.

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Appendix

Table A.1. Difference between the Base Characteristics of Students in the Treatment and Control Group (N = 90)

Variable Name	Difference between Financial Incentive and Control Group[a]
Age (years)	0.790
	(0.587)
Female	−0.054
	(0.107)
Local Student	−0.034
	(0.088)
Foreign Student	0.034
	(0.088)
Race = Other	0.066
	(0.093)
Race = White	−0.105
	(0.105)
Race = Asian	0.039
	(0.099)
Freshman	−0.054
	(0.107)

Continued

Table A.1. continued

Variable Name	Difference between Financial Incentive and Control Group[a]
Rural	−0.075
	(0.106)
Urban	0.075
	(0.106)
Clean Plate	0.121
	(0.080)
Food Taken (lb)	−0.056
	(0.060)

Standard errors in parentheses are corrected for heteroscedasticity and clustered at individual level. * p < 0:10, ** p < 0:05, *** p < 0:01.

Table A.2. Impact of Financial Incentive on Probability of Clean Plates and Food Taken

Variable Name	Clean Plate = 1	Food Taken (lb)
Treatment	0.112	−0.068
	(0.081)	(0.060)
Post	0.107	−0.010
	(0.085)	(0.060)
Treatment*Post	0.265***	0.027
	(0.083)	(0.063)
Age (years)	0.005	0.021**
	(0.010)	(0.010)
Female	−0.075	−0.106*
	(0.068)	(0.060)
Local Student	Base	Base
Foreign Student	−0.055	0.012
	(0.111)	(0.099)
Race = Other	Base	Base
Race = White	−0.020	−0.016
	(0.078)	(0.082)
Race = Asian	−0.050	−0.062
	(0.088)	(0.091)

Continued

Table A.2. continued

Variable Name	Clean Plate = 1	Food Taken (lb)
Freshman	−0.050	−0.010
	(0.068)	(0.068)
Urban	−0.038	0.008
	(0.073)	(0.058)
Rural	Base	Base
Constant	0.417**	0.659***
	(0.195)	(0.228)
Observations	571	571

Standard errors in parentheses are corrected for heteroscedasticity and clustered at individual level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. We control for individual demographic variables, and day fixed effects.

Table A.3. Impact of Financial Incentive on Probability of Clean Plates and Food Taken for each Treatment Day

Variable Name	Clean Plate = 1	Food Taken (lb)
Treatment	0.112	−0.068
	(0.082)	(0.060)
Treatment*Day6	0.318***	−0.051
	(0.117)	(0.118)
Treatment*Day7	0.270**	0.115
	(0.123)	(0.108)
Treatment*Day8	0.221*	0.068
	(0.123)	(0.098)
Treatment*Day9	0.250*	0.113
	(0.135)	(0.115)
Treatment*Day10	0.257**	−0.117
	(0.110)	(0.100)
Age (years)	0.005	0.021**
	(0.010)	(0.010)
Female	−0.075	−0.107*
	(0.068)	(0.060)
Local Student	Base	Base
Foreign Student	−0.055	0.011
	(0.111)	(0.099)

Continued

Table A.3. continued

Variable Name	Clean Plate = 1	Food Taken (lb)
Race = Other	Base	Base
Race = White	−0.019	−0.016
	(0.078)	(0.082)
Race = Asian	−0.050	−0.063
	(0.088)	(0.092)
Freshman	−0.052	−0.011
	(0.068)	(0.068)
Urban	−0.038	0.009
	(0.073)	(0.058)
Rural	Base	Base
Constant	0.421**	0.656***
	(0.198)	(0.228)
Observations	571	571

Standard errors in parentheses are corrected for heteroscedasticity and clustered at individual level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. We control for individual demographic variables, and day fixed effects.