The Effect of an Information Intervention on the Healthfulness of College Meal Plan Purchases in a Use-it or Lose-it Meal Plan Currency System

Matthew V. Pham, The Ohio State University, pham.148@osu.edu
Brian E. Roe, The Ohio State University, roe.30@osu.edu

Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2014 AAEA Annual Meeting, Minneapolis, MN, July 27-29, 2014
.

Policy makers seek to reduce the obesity prevalence in the young adult population through legislation such as the recently passed Healthy, Hunger-Free Kids Act of 2010 (HHFKA). This federal legislation dictates the amount of calories that a lunch may contain along with the required servings of grains, fruits, and vegetables for each meal, for schools who participate in the National School Lunch Program. However, the federal regulatory influence over the meal intake of U.S. youth ends with a student's graduation from an NSLP regulated high school. Students who continue to higher education meet a school meal environment free from federal regulatory intervention, and a dining situation that is often bundled with collegiate housing expenditures and considered a profit center for universities and colleges.

Traditionally, many college students consume meals in all-you-care-to-eat formats, though increasingly, college meal services involve variable retail-style formats. While students face less regulation of food purchased from school-related meals, they have also gained greater latitude over all meal decisions as many students no longer live with parents during college. This rapid deregulation of meal governance among newly independent young adults can lead to rapid weight gain and dysfunctional eating habits that may persist into later adulthood. A problem associated with this rapid deregulation of meal governance amongst college students is called the "Freshman 15" (Hoffman et al. 2006, Levitsky, Halbmaier, and Mrdjenovic 2004), which can lead to dietary habit formation with ramifications that linger well beyond a student's freshman year of college.

This leaves higher educational officials in a difficult position, as students choosing less healthful meal options can enhance institutional profit centers, but at a cost of diminished health to students. We explore the tensions that can arise at institutions of higher education by modeling the choices made by students at Ohio State University under an unusual set of incentives created by a popular meal plan offered to students.

University Residential and Dining Services at Ohio State University revamped its meal plans when the university's calendar system transitioned from quarters to semesters in 2012. The original meal plan's currency, called 'swipes,' allowed students to purchase a set amount of food for one meal currency unit. Under the new system, called 'blocks,' customers pay for each item on an a la carte basis. Each block has a $5.00 value. Students who do not utilize the entire $5.00 block value forfeit the balance (i.e., a use-it or lose-it system for each block during each dining occasion). For example, if a student purchases food and beverage items totaling $6.00, he or she expends two $5.00 blocks, and the $4.00 balance (2 x $5 - $6) is forfeited unless he or she finds a way to spend the money at the time of the transaction. Customers who want to maximize their meal plans' values will purchase their food and beverage items in a way to minimize the forfeited meal plan currency.

Another option that block users had was to utilize a second payment form called BuckID cash to pay for their meals. The BuckID cash is a pre-paid account that students may utilize to pay for various campus expenses including meals and printing costs. In the context of this study, a block user may utilize a split payment system to pay for the meal if the total amount does not fall exactly within the $5.00 block value. For example, a block user who faces a $5.30 meal cost may decide to use one block ($5.00 value) and pay the balance ($0.30) with the BuckID cash rather than with two blocks ($10.00 value). Block users may also utilize this split payment system to efficiently utilize their blocks.

The majority of students who have meal plans are first-year students who live in on-campus housing. Over 90% of first-year students at The Ohio State University live on campus.

These students are required to select from meal plans offered by the campus dining service. Parents have a role in the meal plan decision since most students are relying on their parents to pay the tuition and room and board expenses. Although parents can influence students' initial meal plan decision, students were able to change these meal plans up until the second Friday of the beginning of a new semester.

At the time this study was offered, the students only had the option of purchasing their blocks in advance and using them as they desired through a given semester. Residential students could purchase 450 or 650 blocks and commuter students could purchase 80 or 160 blocks for the semester. The 450 and 650 block meal plans also included a $150 BuckID cash deposit. There was also the option to purchase a meal plan with unlimited meal privileges at three "all-you-care-to-eat" locations and 10 blocks per week to utilize at other campus locations with a $150 BuckID cash deposit and another "traditional" option where students receives 19 meal allocations per week at the same "all-you-care-to-eat" locations with 2 blocks available per week to utilize at other campus dining locations and no BuckID cash deposit. For the semester in which this study took place, the dining services department introduced a 350 block meal plan with the $150 BuckID cash deposit in response to parent and student feedback. The costs for the unlimited, 600 blocks, 450 blocks, 350 blocks, and "traditional" meal plans were $2,650, $2,550, $2,175, $1,850, and $1,737.50, respectively.

Students who purchased a set number of blocks to use the entire semester faced some challenges. The set number of blocks resulted in some students conserving blocks early in the semester in order to have enough at the end of the semester. The University dining services department suggests that students use 1 block for a quick snack and 2 blocks for a full meal. However, these students often had many unused blocks at the end of the semester. As a result, these students would make extra purchases in order to avoid losing the value of blocks at the end of the semester. In response to this behavior, the University dining service introduced another system that would allow for a certain number of blocks each week, though this was introduced after the period considered in the present study.

A limited literature examines the effect of meal pricing strategies on food consumption patterns where trade-offs may exist between improved economic efficiency and nutrition. This literature presents differing conclusions. One study by Just and Wansink (2011) examined whether overall food consumption at an all-you-can-eat pizza buffet was positively correlated with the meal price. The researchers approached people in groups as they walked into the restaurant and offered them 50% off the meal price along with free drinks for those in the treatment group or free drinks for those in the control group. They found that consumers in the all-you-can-eat buffet maximized the perceived value of the meal price. In other words, meal price was found to be positively correlated with food consumption.

Another study conducted by Siniver and Yaniv (2013) examined the impact of the amount of food consumed as a function of whether some pays for the meal before or after eating. This study drew participants from a college campus and utilized two experiments with an all-you-can-eat sushi buffet. The first study included only students. Half of the students were told to pay before eating, and the other half was told to pay after eating. The second study included everyone else from the college community. This study found that customers who paid after consuming the sushi ate 4.5 fewer units of sushi (about 14%) compared to those who paid beforehand.

This study differs from the Just and Wansink (2011) and Siniver and Yaniv (2012) in several ways. First, in the present study, consumers maximize perceived meal value not by eating as much as desired when faced with a fixed price, but rather purchasing as much as desired for an endogenously chosen number of meal currency units. In other words, a consumer pays an amount proportionate the food purchased. However, a consumer purchasing food using blocks must use the entire block at once as previously described to maximize purchasing power. Second, the current study focuses on a retail setting that repeatedly services students, whereas all-you-can-eat pizza or sushi buffets are unlikely to be a daily dining venue for many individuals. Finally, the current research setting features individuals with access to the same meal options at the same currency prices, but without the $5.00 currency block entanglement. Therefore, this study is distinct from the extant literature because it measures whether people forgo food and beverage healthiness in order to reduce the money wasted on food and beverage purchases and whether a modified version of a currency purchasing system influences the food purchasing decision of consumers. Also, given this same system governs multiple meal settings a day during the semester for students during a sensitive time of life in terms of habit formation, the potential long-run consequences of the structure is of interest for school administrators.

This study explores the healthfulness of meals purchased by participants using this meal plan currency system versus those purchasing with cash and assesses how an educational intervention may have altered meal plan currency users' tradeoffs between economic efficiency and nutritional uptake. Specifically, this study assesses how the display of signs accentuating healthy menu combinations that efficiently utilize the meal plan currency influence consumer food choices by measuring the health index of the food and beverages purchased and the amount of meal plan currency forfeited in a pre- and post-intervention setting.

Study Methodology and Design

An education intervention was utilized to prompt healthier and more economical meal selections. The literature has documented many forms of utilizing educational interventions to encourage people to make certain food choices in food service settings. These nudges include posting flyers (McGuckin et al. 2004, Kennedy et al 2011) or promoting educational programs to change the targeted groups' attitudes about nutrition (Abood et al. 2004) or motivational attitude about physical exercise (Wallhead et al. 2004). The nudge utilized in this study is a sign designed to influence dining patrons' decision making processes in a way that encourages healthier, more economically efficient food choices.

In this study, signs were posted in one dining location that listed four healthy combinations that one could purchase to maximize overall meal healthiness while minimizing the money wasted on the transaction for those who purchased their meals with blocks. The menu items were designed to maximize the number of healthy "nudges" described by Johnson et al. (2012). Healthy nudges are viewed as expanding the number of healthy choices available to patrons by creating more categories for the healthy items, such as fruits and vegetables, while grouping the unhealthy items into one category. This design is meant to give guidance towards those with undecided tastes while those with decided tastes will likely ignore the posted signs. Signs were posted after the midway point of the Spring 2013 semester. Table 1 lists the menu items that were part of each combination. Due to a clerical error, one of the promoted combinations actually cost $5.05 rather than the $5.00 price advertised on the sign, meaning its purchase would have induced nearly the maximum possible block use inefficiency. However, only 1 patron of the 1,351 patron checks analyzed revealed that this exact combination was purchased at the location featuring the sign.

Combination	Items Served	Price	Number of Combinations Sold Post-Intervention
1	Half Triple Cheese & Tomato Herb Panini with Small Garden Vegetable Rotini Soup	$5.05	1
2	Full General Tso's with Pistachios	$5.00	1
3	Full Chicken & Broccoli Alfredo with Hummus and Vegetables, Whole Fruit, and Soy Milk	$9.50	0
4	Quesadillas de Pollo with Vegetable of the Day and Soy Milk	$9.50	0

Table 1. Menu Items in Each Combination

Meal data collections methods used in the literature include self-reported purchases, random observations of actual customer food purchases by researchers, and food waste collection. I chose to collect data from itemized sales receipts since this allows greatest amount of data collection with little interruption as possible in the study locations. Itemized sales transaction data was collected from two dining locations at Ohio State University.

These two locations were selected by the food services director at the University to ensure matching dining formats because these were the only two on-campus locations that featured a food court style layout. Shortly after the University switched meal plans, staff at one location posted signs to inform block users what items to purchase in order to minimize the residual block balances. However, these signs did not take into account the nutrient density of these items. Further, the staff at this location created and posted the signs without permission or knowledge of central dining services administration. Therefore, the other food court location was utilized since there were no signs previously posted by the campus dining service. Hence, the choice of treatment and control locations was driven by the idiosyncratic decisions made by one local staff member who arguably had no knowledge of the comparative efficacy of signage across the two locations. Hence, I treat the assignment of treatment location as exogenous to any potential efficacy of the sign treatment.

These locations attracted students who purchased their meals with blocks and other visitors who purchased their meals with other payment methods. One location had the signs while the control location did not have the signs posted. The data for the pre-intervention consisted of five Wednesdays before the signs were posted. The signs were posted over the spring break period on Monday and then data for the post-intervention period consisted of first five Wednesdays after the signs were posted.

For all intervention phases, itemized sales receipt data was collected from 11 am to 1 pm as the lunch hour provides a time when many non-block buyers also frequent these locations. All receipts contained the items purchased, the masses of items purchased if the price was charged by mass, the prices of the items purchased, the transaction dates and times, payment tender, and number of blocks remaining if the meal was paid for with blocks. No special software or dining service personnel training was needed to carry out the study as all point-of-sale systems stored the sales data on the web-based point-of-sale interface, and one can search for a specific item across the sales transactions of interest.

Some receipts from the targeted times and dates are not included in the present analysis. For example, at the control location, calculation of the nutritional index attached to each receipt is continuing. Only receipts featuring the chicken wrap entrée and the grilled cheese panini entrées are currently included in the data set. Further, at the treatment location, a subset of receipts failed to correctly code data needed for either nutritional or block efficiency calculations, though there appears to be no systematic correlation between receipt content and coding failure.

The intervention and the control locations are separated by about a 10 minute walk. Two of the main entrees, numbers 1 and 4 in Table 1, were served at both locations. Due to the similarities in main entrees served in both locations, itemized sales receipt data was partitioned by location to avoid possible confusion of treatment groups.

Empirical Model

Nutrient-Rich Food Index

To measure the healthfulness of any purchase, I use a health index that is based on a modified version of the nutrient-rich food index (Drewnowski and Fulgoni 2008). This index is designed to rank foods based on their nutrient content where healthy components (such as Vitamin A) contribute towards a food item's positive score while unhealthy components (such as saturated fat) subtract points from the score. The nutrient score was calculated following the equations given by Drewnowski and Fulgoni (2008) with one exception. A modification to the calorie standardization was performed by assigning foods with a calorie level of zero to have calorie levels of one. This modification allowed food and beverage items with zero calories to be counted towards the overall nutrient density score. Without this modification, these food would not have been included since the standardized calorie calculation would not have produced a valid calorie level.

Several assumptions were made to the food items listed on the sales receipts to obtain a nutrient score. Fountain beverages were randomly assigned to one of the twelve options available excluding water. Indices for weighted salad bar purchases were computed by determining the average composition of a salad purchased. The average components in a salad were determined by measuring the masses of all salad components, including leafy greens, side fixings, and dressings, taken during a randomly selected weekday lunch period from 11 am to 1 pm and determining an average mass of food item taken per salad purchased. Some items were excluded due to lack of available nutrient information, such as open food convenience store purchases, defined as purchases of items that were not listed on the point-of-sale database. For example, a cashier might have to use the open food key on the point-of-sale system to manually key in the price information for someone who purchased a 12 bottle case of orange juice that is not sold on a typical basis. These purchases typically contain items for later consumption outside of the immediate meal period and thus would invalidate the assumption about satiation from purchases.

Econometric Model

I estimate difference-in-difference regressions with the health index, measured as the meal's nutrient density score, and a efficiency of block use measure, described below, as the dependent variables. The first difference is that between pre- and post-treatment times (sign postings) and the second difference is between treatment and control locations. Explanatory variables include the amount of money spent on the purchase, whether the purchase was paid for with the meal plan currency (for the health index only), the number of items purchased, an indicator variable for purchases made after the sign was posted, and an interaction term, or treatment effect, between the post-intervention indicator variable and the used blocks indicator.

The difference-in-difference modeling approach used in this experiment is described by Wooldridge (2009). This study provides the case of a field experiment because the educational signs may cause some students to shift their purchases from unhealthy items to healthy items.

There are several assumptions that need to hold in order for difference-in-difference estimator to identify a casual effect. The first assumption is that only one outcome is observable for each person in the study population. This assumption is known as the Stable Unit Treatment Value assumption (SUTVA) and is described by Rubin (1977). The second assumption is that the treatment does not influence the conditioning, or covariate, variables. The third assumption is that the treatment had no effect on the pre-treatment study population and that those participants that were subjected to the treatment do not change their behavior in anticipation of a future study. The common trend assumption is that differences in the expected potential non-treatment outcomes over time are unrelated to belonging to the treated or control group in the post-treatment period.

Most of the SUVTA assumption holds since one's improved health index does not directly impact a non-treated person from being able to consume foods at his or her pleasure. The control variables in this study are not influenced by the posted signs since, for example, block users are not going to stop using blocks to make purchases as students prepay for these meal plans at the beginning of the semester prior to the intervention. It may be possible for the posted signs to affect one of the control variables in the experiment. Most notably, this could be the case for the number of items purchased since the customers might purchase additional items in response to the signs listing these additional items as healthy. Customers at the treatment location were not able to anticipate being exposed to the educational intervention since this location has never conducted this kind of study. Finally, all customers at the location are subjected to the treatment and therefore there is no overrepresentation of block users over non-block users in the treatment and control groups.

The study population features both meal plan (block) users and non-meal plan users. The first regression accounts for the combined users. The functional form is:

$$y_i = \beta_0 + \beta_1 block_i + \beta_2 item_i + \beta_3 amtpsent_i + \beta_4 loc_i + \beta_5 treat_i + \beta_5 interact_i + u_i \quad (12)$$

where for each observation, *i*, *y* denotes the health index, *treat* denotes the second-period dummy variable equal to unity to denote the post-intervention period, *loc* denotes the dining location transactions where the treatment took place, *item* denotes the number of items purchased, *block* denotes a meal plan was used to purchase the meal, *amtspent* denotes the amount of money one spent on a meal, *interact* denotes the interaction term between *treat* and *loc*, and *u* denotes the idiosyncratic error. In addition separate regressions are estimated for block users and non-block users to allow for differential response by group.

A second model was regressed to obtain information about the efficiency aspects of users. In this second model, the dependent variable is block efficiency, defined as

$$Block\ Efficiency(\%) = \frac{Total\ Value\ of\ Blocks - Residual\ Balance\ Not\ Spent}{Total\ Value\ of\ Blocks} x\ 100 \quad (13)$$

The *Total Value of Blocks* is the total cash value of the blocks used. It is denoted in multiple of $5.00.

Results

Figure 1 shows the distribution of meal cost for block users. The dark color is denoted by the non-block users and the light color is denoted for the block users. As seen in Figure 1, the majority of total meal cost on receipts is in the $5.00 increments at $5.00, $10.00, $15.00, and $20.00 for the block users, and is more spread out for the non-block users with two concentrations at $3.75 and $6.50. These two concentrations for non-block purchasers are not at the $5.00 increment marks.

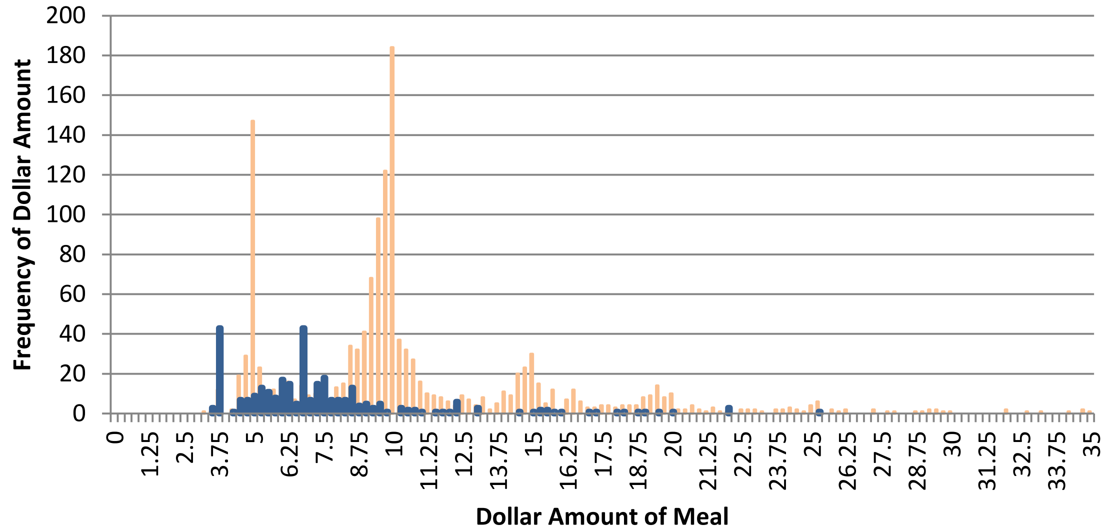

Figure 1. Distribution of Money Spent on Meals by Block Users

Note: Block users are denoted by the lighter shaded bars while the darker shaded bars denote non-block purchases

Figure 2 shows the pre- and post-intervention nutrient density scores for the treatment and control groups while Figure 3 shows the pre- and post-intervention block efficiencies for the treatment and control groups. For the control location, the nutrient density scores did not change by much between the pre- and post-intervention periods. However, the nutrient density score decreased a little from the pre- to post-intervention period for the treatment group.

According to Figure 3, the block efficiency improved for the control group in the post-intervention phase compared to the pre-intervention phase. However, the block efficiency dropped from the pre- to the post-intervention stage for the treatment group.

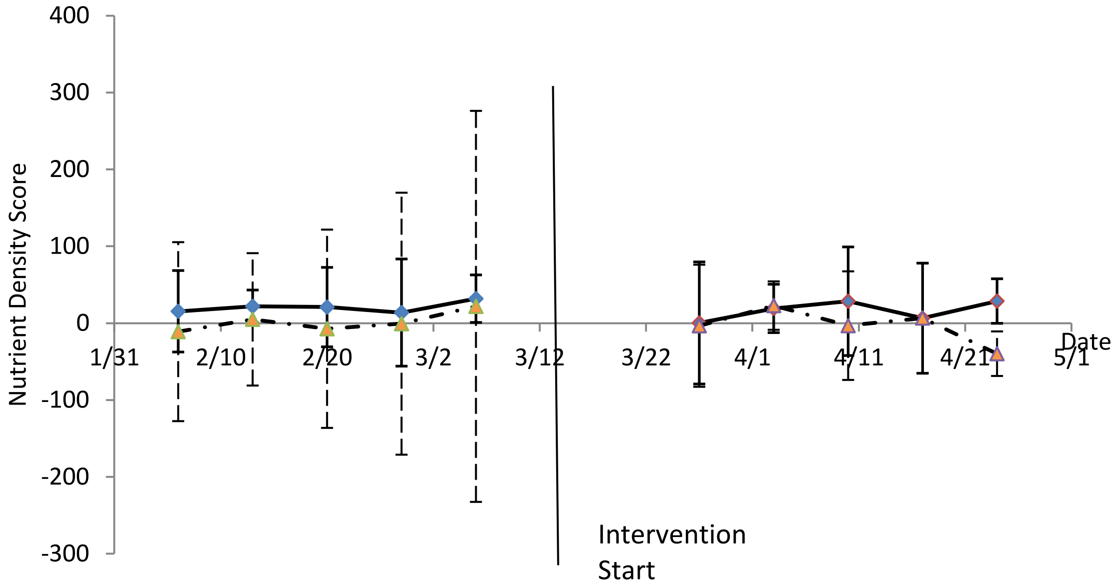

Figure 2. Pre- and Post- Treat Average Nutrient Density Scores for the Treatment and Control Locations

Note: Blue diamonds, solid trend lines, and the solid error bars represent the control location and green triangles, dashed tread lines, and the dashed error bars represent the treatment location.

Table 2 lists the summary statistics for the explanatory variables used in this regression. All non-interaction variables other than nutrient density score, number of items purchased, amount spent, and days remaining in the semester are given as fractions of the total population. The majority of the observations took place in the treatment location and utilized blocks to pay for the meals.

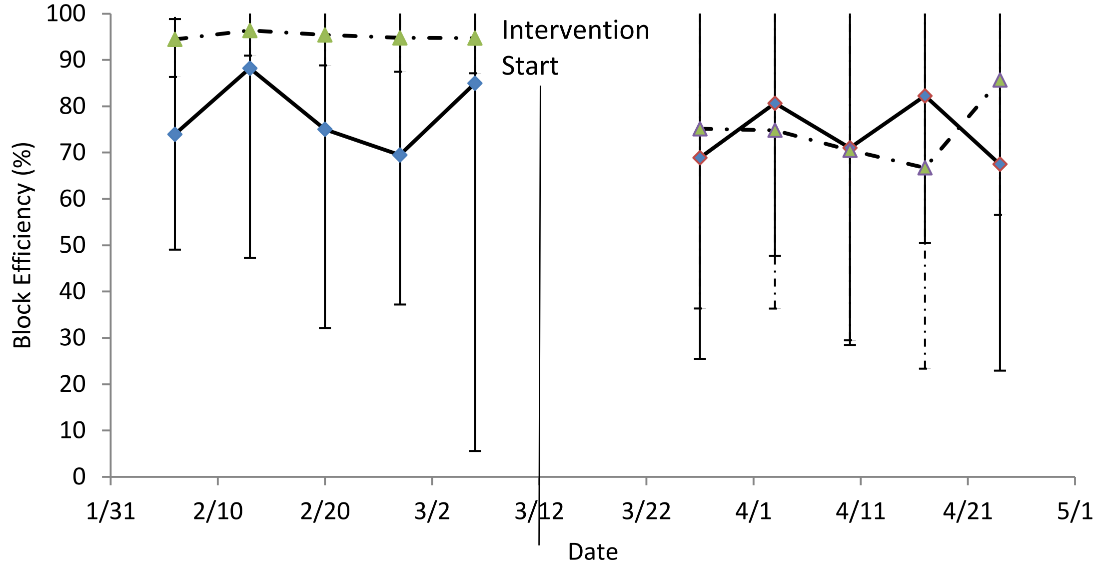

Figure 3. Pre- and Post- Treat Block Efficiency for the Treatment and Control Locations

Note: Blue diamonds, solid trend lines, and the solid error bars represent the control location and green triangles, dashed trend lines, and the dashed error bars represent the treatment location.

In Table 3, a total of 1,751 block and non-block purchase occasions are included in the nutrient density score regression. The standard errors are clustered by week of intervention. There is a weak fit to the data since the goodness of fit measure is less than 0.05. The only significant variables are the used blocks indicator, number of items purchased, amount spent, and the treatment location indicator. This result indicates that the intervention had a positive effect on the nutrient density score, though the effect is measured with imprecision and is not statistically significant. However, it does indicate that block users purchased meals with a higher nutrition index. This may reflect that block users eat at this location on a regular basis for multiple meals, while non-block users may treat these occasions as a special dining experience and, hence, eat meals that are less nutritious. Further, the nutrition index declines significantly with the number of items purchases, suggesting that additional items added to meals beyond the entrée tend to drag down nutrition as measured by this index. Also, holding constant the number of items, greater total expenditure has a positive and marginally significant effect on nutrient density, suggesting that more nutrient items also tend to be more expensive.

Variable	Mean	Standard Deviation
Nutrient Density Score	4.70	169.33
(1) Post-Intervention Period	0.51	0.50
(2) Treatment Location	0.76	0.43
(3) Used Blocks to Purchase Food	0.81	0.39
(4) Number of Items Purchased	3.28	1.91
(5) Amount Spent ($)	10.21	5.64
(6) Days Remaining in Semester	44.39	26.47
Interaction Between (3) and (4)	2.89	2.22
Interaction Between (3) and (5)	8.85	6.60
Interaction Between (3) and (1)	0.41	0.49
Interaction Between (3) and (2)	0.62	0.49
Interaction Between (1) and (2)	0.39	0.49

Table 2. Summary Statistics for Explanatory Variables

Note: All non-interaction variables other than nutrient density score, number of items purchased, amount spent, and days remaining in the semester are given as fractions of the total population.

Variable	Coefficient	Clustered Standard Error by Week
Used Blocks to Purchase Food	21.11**	7.27
Number of Items Purchased	-12.01***	3.59
Amount Spent ($)	1.89*	0.99
Post-Intervention Period (a)	-9.97	14.63
Treatment Location (b)	-31.26*	14.83
Interaction (Between (a) and (b))	6.12	19.54
Constant	34.16**	14.33
N	1751	
R^2	0.0131	
F	3.11	

Table 3. Nutrient Score Regression Results for Block and Non-Block Users

Note: ***, **, *: Parameter estimate significant at 1%, 5%, and 10% significance levels, respectively

For the block users, the number of items purchased and the amount spent were statistically significant. These results are shown in Table 4. For the non block users, the number of items purchased and the treatment location fixed effect are the biggest drivers of non-block meal purchases. These results are shown in Table 5. While both treatment effects were insignificant, both treatment effects were positive with the larger effect among non-block users. Also, among non-block users, the amount spent was not statistically significant, while it was for block users.

Variable	Coefficient	Clustered Standard Error by Week
Number of Items Purchased	-12.29**	4.01
Amount Spent ($)	2.36*	1.23
Post-Intervention Period (a)	-10.76	18.39
Treatment Location (b)	-27.18	18.14
Interaction (Between (a) and (b))	2.60	22.15
Constant Term	49.90***	17.62
N	1435	
R^2	0.0111	
F	2.67	

Table 4. Nutrient Score Regression Results for Block Users

Note: ***, **, *: Parameter estimate significant at 1%, 5%, and 10% significance levels, respectively

Variable	Coefficient	Clustered Standard Error by Week
Number of Items Purchased	-12.81*	6.75
Amount Spent ($)	-0.41	1.32
Post-Intervention Period (a)	-10.34	9.82
Treatment Location (b)	-53.53***	14.13
Interaction (Between (a) and (b))	27.51	18.16
Constant Term	61.28***	14.08
N	316	
R^2	0.0974	
F	5.13	

Table 5. Nutrient Score Regression Results for Non-Block Users

Note: ***, **, *: Parameter estimate significant at 1%, 5%, and 10% significance levels, respectively

Variable	Coefficient	Clustered Standard Error by Week
Number of Items Purchased	-0.020*	0.011
Amount Spent ($)	-0.007**	0.003
Post-Intervention Period (a)	-0.088**	0.034
Treatment Location (b)	0.005	0.028
Interaction (Between (a) and (b))	0.045	0.033
Constant	0.562***	0.029
N	1435	
R^2	0.0302	
F	11.69	

Table 6. Block Efficiency Results

Note: ***, **, *: Parameter estimate significant at 1%, 5%, and 10% significance levels, respectively

Table 6 shows the results of a linear probability model of block efficiency, where the dependent variable equals one for those who utilize their blocks 100 percent efficiently and zero otherwise. In this table, the number of items purchased, amount of money spent on the meal, and the post-intervention period are all negative and statistically significant. Hence, as block users add more items to their tray, spend more on the total meal and return after spring break, they are less likely to fully utilize their block expenditures at a given lunch meal.

The interaction term is positive, suggesting that the signs increased the likelihood of fully utilizing block amounts. However, the effect is measured with such imprecision that it is not statistically significant. In other words, students are more likely to efficiently use their blocks after seeing the signs posted, but the effect is sufficiently heterogeneous to allow for measuring the effect size precisely.

Discussion

From Figure 1, the distribution of the amount spent per dining occasion is spread out across the various meal costs for the non-block purchases compared to the high concentration of purchases at the $5.00 increments for the block purchases. This is due to the fact that non-block users will purchase enough food to satisfy their satiation levels. There is another problem that non-block users do not have to solve. Block users are thinking about two problems: (1) minimizing the residual value of the blocks wasted in addition to (2) the problem of purchasing enough food to satisfy their own satiation levels. The additional constraint of (1) leads to the peaks in Figure 1 that is not seen for the non-block purchasers.

The results show that the educational intervention increased the nutrient density scores during the post-intervention period in the treatment location for block, non-block users, and the combined block and non-block users. However, the size of the effect was measured with imprecision, rendering the results as statistically insignificant at traditional significance levels. Any effects in eating healthier due to seasonality are ruled out by collecting data at a control dining location with a similar layout.

In addition to evaluating the treatment, the analysis provides several other insights into patron's dining habits. Block users tend to purchase lunch meals with greater nutrient density than non-block users. This may stem from the fact that the meals purchased are the regular meals for block users while those not using blocks may be more likely to treat the meal as a special lunch occasion and focus more on meeting taste demands than balancing taste against nutrition. The number of items purchased has a negative and statistically significant effect on the nutrient density score for the block users, non-block users, and the combined block and non-block users. However, the significance is higher for the block users compared to the non-block users, likely due to a larger sample of block users. However, block users also have an incentive to purchase more items to ensure that the residual balance not spent is minimized. During this process, students may grab lower priced items to use most of this residual balance if these students did not spend enough money on their previously desired items. There were several small items, such as bars, that students could purchase at the checkout register. Several transactions noted the repeated purchases of these small items for the block users but not for the non-block users.

Block users exhibit a positive reaction to the posted signs in terms of block efficiency. Again, however, the effect was measured with imprecision and the results did not reach standard levels of statistical significance. The largest driver of block efficiency was the variable indicating the post intervention period. That is, during the latter portion of the semester, block users were much less likely to use blocks in a fully efficient manner, suggesting that they may have held excess blocks and did not need to worry about maximizing the efficiency of each block.

Taken together, the positive though insignificant effect of the intervention on nutrition density scores imply that educational interventions that highlight certain food combinations may have the potential to be an effective nudge to encourage more nutritious and economical food choice decision making. If there was a spillover effect from the treatment to the control locations, then the effect of the interaction term between the treatment location and post-intervention dates fixed effects would statistically indifferent from zero. The spillover effect could happen if one purchaser sees the signs about healthy meals to purchase and purchases similar items at the control location. Hence, the interaction effect we estimate should be taken as an upper bound to the true effect.

A limitation of this study is with the lack of ability to determine who consumed the purchased food and when. This study assumes that people consume their food items as soon as they purchase them from the dining locations. However, this is not necessarily the case as some people consume some or none of the food items within the defined lunch period. In addition, a prevalent theme amongst block users is to pay for food items for other consumers to use the blocks before they expire or to celebrate a special event. The tendency of these purchases is to spend 3-5 blocks ($15 to $25) on food purchases. These purchases can easily distort the nutrient density scores, and these purchases were omitted since it is unknown how many people would eat the food and what portion sizes these people consume.

Another issue with the study occurred while reconciling nutrient information with point-of-sale transaction records. Some items that were manufactured by local businesses had no nutrition information available on the package. Other purchases could have multiple nutrient values, and therefore were not included in the nutrient density score. An example of the multiple values are purchases with soup. There were four different soups offered each serving day, and the point-of-sale system failed to account for the type of soup. Although the signs did influence healthier meal choices, many customers had their own ideas on how to purchase healthier foods. There were few purchases of the exact menu items as listed on the signs by block and non-block users. However, consumers made alternative purchases of other food and beverage items that resulted in higher nutrient density scores post-intervention. A motivation for this substitution is that the posted signs emphasized healthier food selections, such as soy milk and vegetable of the day, over foods with lower nutrient density scores. This result indicates that the posted signs guided block and non-block consumers who were undecided about how to purchase healthier foods. This observation is substantiated by Johnson et al. (2012) since undecided consumers are more receptive to guidance compared to those consumers with pre-determine food attitudes. Also, the food was not bundled together at the point of sale. Instead, the customer needed to collect each item individually. Had items been bundled by the dining establishment, sales of the featured bundles and the resulting nutrition indices may have responded even more favorably.

Another limitation is that there were only two control entrees studied at the control location while there were four main entrees at the intervention location. As a result, the treatment location composed 76 percent of the total observations as noted in Table 2. These control entrees was intended to originally provide a way to rule out seasonality effects, but it turned out that more entrees were purchased at the treatment location compared to the intervention location. This lack of observations at the control location may have resulted in imprecise standard error estimates for the interaction effect between the treatment location and the post-intervention period fixed effects. Ideally, a pre- and post- intervention study would have a nearly equal number of observations from the control and intervention sites. More data collection is needed at the control site by coding additional patron receipts with a broad array of entrees that could return the ratio of observations at the treatment site to the control site to 50 percent.

Conclusion

The food choices people make have garnered a lot of attention in recent years. In particular, the food choices of young adults over the age of 18 enrolled in post-secondary education is interesting since this is first time for many young adults that they have had to make their own food choice decisions without parental or guardian influence. One specific challenge for the Ohio State University students considered in this study was navigating a meal plan option that could increase tension between eating a nutritional meal and using the meal plan currency in an efficient manner.

This study explored the tensions between the desire to choose healthier foods and to spend the meal plan blocks efficiently for block users. These student block users along with other non-block users were subjected to visual prompts via posted signs in the dining location for 5 weeks.

Compared to the pre-intervention period, meal nutrient density scores for the block users were influenced by the number of items purchased and the amount of money spent during the transaction. Non-block users were motivated by the number of items purchased and the presence of being in the treatment location. Both block and non-block users chose meals with higher nutrient index scores following the intervention, although the effect was measured imprecisely and was not statistically significant. This study suggests that placing informational signs may be able to help patrons spend their meal plan blocks more efficiently and may stimulate thinking about how universities can best promote both health and economical food decisions by students.

References

Abood, Doris A., David R. Black, and Rachel D. Birnbaum. "Nutrition Education Intervention for College Female Athletes." *Journal of Nutrition Education and Behavior* 36, no. 3 (2004): 135-9.

Drewnowski, Adam and Victor Fulgoni. "Nutrient Profiling of Foods: Creating a nutrient-rich Food Index." *Nutrition Reviews* 66, no. 1 (2008): 23-39.

Hoffman, Daniel J., Peggy Policastro, Virginia Quick, and Soo-Kyung Lee. "Changes in Body Weight and Fat Mass of Men and Women in the First Year of College: A Study of the" Freshman 15"." *Journal of American College Health* 55, no. 1 (2006): 41-6.

Johnson, Eric J., Suzanne B. Shu, Benedict GC Dellaert, Craig Fox, Daniel G. Goldstein, Gerald Häubl, Richard P. Larrick, John W. Payne, Ellen Peters, and David Schkade. "Beyond Nudges: Tools of a Choice Architecture." *Marketing Letters* 23, no. 2 (2012): 487-504.

Just, David R. and Brian Wansink. "The Flat-Rate Pricing Paradox: Conflicting Effects of “all-You-can-Eat” Buffet Pricing." *The Review of Economics and Statistics* 93, no. 1 (2011): 193-200.

Kennedy, Allison, Karena F. Sapsis, Shannon Stokley, C. Robinette Curtis, and Deborah Gust. "Parental Attitudes Toward Human Papillomavirus Vaccination: Evaluation of an Educational Intervention, 2008." *Journal of Health Communication* 16, no. 3 (2011): 300-13.

McGuckin, Maryanne, Alexis Taylor, Veronica Martin, Lois Porten, and Richard Salcido. "Evaluation of a Patient Education Model for Increasing Hand Hygiene Compliance in an Inpatient Rehabilitation Unit." *American Journal of Infection Control* 32, no. 4 (2004): 235-8.

Rubin, Donald B. "Assignment to Treatment Group on the Basis of a Covariate." *Journal of Educational and Behavioral Statistics* 2, no. 1 (1977): 1-26.

Siniver, Erez, Yosef Mealem, and Gideon Yaniv. "Overeating in all-You-can-Eat Buffet: Paying before Versus Paying After." *Applied Economics* 45, no. 35 (2013): 4940-8.

Wallhead, Tristan L. and Nikos Ntoumanis. "Effects of a Sport Education Intervention on Students' Motivational Responses in Physical Education." *Journal of Teaching in Physical Education* 23, no. 1 (2004).

Wooldridge, Jeffrey M.,. *Introductory Econometrics : A Modern Approach*. Mason, Ohio: South-Western Cengage Learning, 2009.