Brain Food is not Health Food in the Field: Limited Self-Control and Food Choice under Academic Pressure [1]

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(Preliminary)
Version: July 16th, 2013

Abstract

The "strength model" (Baumeister et al, 1998) conceptualizes self-control as a constrained resource whose effectiveness tends to dwindle when a decision-maker attempts to resist multiple sources of temptation. We find field evidence for the strength model in the food decisions of university students who face time-varying requirements on academic self-control. Demand for relatively more unhealthy fast foods at a large public university campus in the US increases in the week of final exams, compared to the demand for such foods in other weeks during the year. To address the limits and external validity of the American field data, we conduct a snack choice survey and field experiment at a large university in China. We find that in the experiment, the main robust and significant predictor of choosing an unhealthy snack over a healthy snack, is the self-estimated time needed to complete one's academic responsibilities during the upcoming week. Self-reported stress levels on the other hand, were not predictive of snack choice, while self-reported efforts on self-control in food choices were negatively predictive of the healthy choice. These findings are consistent with an economic model of limited self-control in which students must choose how to allocate their self-control between academic activities and eating activities. From a policy perspective, the findings imply that even when situations requiring self-control are presented to a decision-maker on a recurring basis, multitasking or multiple sources of pressure can pose significant challenges for healthy food decisions.

Keywords: health economics, self-control, strength model, fast food, consumer choice
JEL codes: I10, D12, D03

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The nutritional and health content of food intake among young people is a policy issue which has drawn increasing attention in recent years. The Centers for Disease Control estimates that over 1/3 of adults and around 17% of youth in the United States were obese in 2010, and the associated medical costs of obesity nationwide were about $147 billion.[2] The policy concern is reflected in recent food bans, for example in New York City, which has banned trans-fat in restaurants, and is considering similar such limits on sweetened drinks and salt. Targeting school-aged children, the Child Nutrition Act of 2010 aimed to set more rigorous standards on food choices available in schools, and to promote healthy eating decisions by students. Some have even gone as far as to label obesity an epidemic, with numerous studies pointing to fast food as a key culprit.

As a large body of psychology literature points out, following common sense intuition, that resisting the temptation of unhealthy but tasty foods often requires self-control. In the economics literature, self-control has been modeled as a dual-self process (Fudenberg and Levine, 2006; Wang and Zheng, 2012), as a consequence of dynamic inconsistency in time preference (Strotz, 1968; Laibson, 1994), and as a distaste for temptation (Gul and Pesendorfer, 2001). Our paper focuses on the "strength model" of self-control proposed by Baumeister and colleagues, which hypothesizes that self-control is a limited and depletable resource. The strength model implies that when a decision-maker must exert self-control in one aspect of life, their self-control in other aspects are likely to falter. We present an economic model of self-control allocation following in the theory of Baumeister et al, and empirically test the theory using field data on university students' food choices.

University students present an interesting subgroup of youth to study in terms of eating habits and self-control allocation. Firstly, they are typically new to living apart from their family members who may have previously made food choices on their behalf, and are thus likely to be fairly new to making fully independent food choices over prolonged time periods. Their behavior may be interpreted as a natural, relatively untrained response to food choices under varying degrees of stress. Furthermore, college students face a predictable and recurring variation in another major demand on their self-control efforts besides health choices – studying demands, which are also being made independently by them in the context of college life. Studying at the university level, whether it involves completing assignments or preparing for an exam, requires self-regulation and concentration (see Crede and Kuneel, 2008 for a survey).

Thus, according to the strength model of self-control, we would expect to see lapses in students' self-control on health-related decisions during studying-intensive time periods during the academic year, such as time periods immediately prior to and during exams. Using a campus debit card system at a large public university in the United States, we test this hypothesis. We categorize dining options on and around campus where the debit card can be used, by their food type, paying particular attention to fast food versus cafeteria options. We find that students are significantly more likely to make purchases at nearly all available categories of fast food restaurants during final exam weeks compared to eating at healthier cafeteria options, and that the most popular purchase venue during this time is the "classic" hamburger fast food establishment.

We note that finding such behavior in the field is intuitive but is far from being an obvious conclusion. Contrary to the strength model, self-control across different domains could in fact be complementary, in the sense that exercising self-control in one realm could enhance one's self-control ability in other realms. That is, students might switch into an across-the-board disciplined lifestyle when

[2] http://www.cdc.gov/obesity/data/adult.html

final exam time arrives, studying hard and eating healthily at the same time. Alternatively, students' eating choices might be primarily dictated by some other unseen factor unrelated to stress levels, such as tastes, location or convenience, amounting to little discernible pattern with respect to food healthiness and stress timing. Thus the fact that we find an inverse relationship between stress levels and healthiness of food choice, lends a degree of surprising support for the idea that self-control in different domains compete with each other in the field.

Our paper is certainly not the first academic study to document a propensity towards unhealthy foods caused by psychological pressure. Several psychology experiments (Shiv and Fedorikhin, 1999; Baumeister et al. 1994, 1998, 2006) have documented such behavior in controlled laboratory settings. We provide a more detailed summary of this literature as it relates to our work in Section 2. Our study is however, one of few to our knowledge to propose an economic framework for the strength model and to provide evidence of such a relationship using data on individuals' actual purchasing behavior in the field. We view our study as a complement and external validation to existing laboratory work.

We also contribute to the health economics literature on determinants of non-healthy food choices. Previous economics literature has focused on availability of unhealthy food options (Currie, DellaVigna, Moretti and Pathania, 2010), prices (Powell, 2009), and health information (Kozup, Creyer, and Burton, 2003). Additional literature review is provided in Section 2. Our work focuses on the less frequently discussed impact of lifestyle on health decisions. For individuals in our data, their lifestyle in terms of stress levels is fairly transient. However for individuals in society already in the workforce, a high stress lifestyle may be perpetual and carry an additional and indirect health hazard according to our findings: the reduced ability to resist tempting but unhealthy foods. Lifestyle stress may even account for some portion of inequality of obesity prevalence across income groups and social classes, as well as increases in obesity rates and other unhealthy indicators over time.

The remainder of the paper proceeds as follows: Section 2 overviews the relevant literature on self-control and food choices; Section 3 presents our model of self-control in food choice and study activity; Section 4 presents our main empirical results; Section 5 provides robustness checks; Section 6 describes our field survey and experiment; Section 7 provides the experimental findings; Section 8 concludes.

2. Relevant Literature

Our study is one of few to estimate the relationship between psychological stress levels and self-control choices using actual transactions data in the field. Psychology studies conducted in laboratories have made substantial advances in revealing the factors which are associated with an individual's success in self-control. The classic "marshmallow test" (Mischel et al, 1972, 1989) measured the ability of children to delay gratification for a reward in the form of increased marshmallow treats. They found that the ability of children to exercise self-control in the lab setting was associated with a variety of positive life outcomes.

Shiv and Fedorikhin (1999) conducted an experiment in which subjects were asked to perform a task of varying cognitive difficulty (memorizing a number of varying digit length), and were asked to choose between a healthy snack (fruit salad), and unhealthy snack (chocolate cake). Subjects were more likely to choose the unhealthy snack when they were asked to memorize a longer digit number. While the discussion in Shiv and Fedorikhin (1999) focuses on affect rather than explicitly on self-control, their results seem consistent with a strength model of temptation resistance.

A series of studies by Baumeister et al. (1994, 1998, 2006 and see 2007 for a survey) proposed the strength model of self-control, which formalized folk wisdom that willpower was a type of limited energy or resource. As Baumeister, Vohs, and Tice (2007) explain, "We observed that self-control appeared vulnerable to deterioration over time from repeated exertions, resembling a muscle that gets tired. The implication was that effortful self-regulation depends on a limited resource that becomes depleted by any acts of self-control, causing subsequent performance even on other self-control tasks to become worse." Laboratory experiments to test this hypothesis typically vary the self-control requirement on a first task and measure subjects' self control ability in another unrelated task, and find that performance in the second task is decreasing in the demands on one's self-control in the first task. Baumeister and co-authors explore this hypothesis even more directly by taking a biological approach: Gailliot et al. (2007) showed experimentally that glucose levels, needed for most brain activities, were directly predictive of subjects' self control abilities, in that low glucose levels in the bloodstream reduced subjects' self-control. Indeed, the evidence from the psychology and physiology literatures strongly suggest that individuals' choices in the marketplace should reflect the underlying tendency to lapse in self-control when the environment is cognitively taxing or stressful.

In spite of its intuitive appeal and physiological support, the strength model is not undisputed. In a recent study, Job, Dweck and Walton (2010) question whether the willpower as a limited resource model is absolute. Using a combination of survey questions regarding self-control beliefs, inducing different self-control beliefs and surveying subjects on their subsequent behaviors, they find that subjects' depletion of self-control ability depends on whether they themselves believe that self-control is a limited resource. Indeed, similar to our study's use of final exam periods as a time of increased stress, Job et al. use a final exam period as one of the time periods in which to survey student subjects about their behaviors. They find that students who reported a limited resource belief about self-control earlier in the semester were more likely to report procrastination, unhealthy eating and poor self-control during finals period.

One interpretation is that Job et al's hypothesis might be seen as a generalization of the strength model where individuals' self-control budget depends on their own beliefs about self-control. That is, high self-control individuals may have a larger budget for self-control making it more difficult to observe a tradeoff between self-control in different activities, whereas the tradeoff for low self-control individuals is easily detectible. As Job et al suggest, the budget may even be endogenous to individual beliefs. Like Mischel et al. their hypothesis studies a source of heterogeneity in self-control capacity. In the current study, we have neither the data nor study design to explore the relationship between self-control capacity and beliefs. However, what we are most interested is in whether taken as a whole, students tend to increase their consumption of certain types of foods during stressful academic times. Regarding whether individuals with especially high self-control and/or belief in unlimited self-control, eventually hit a willpower constraint, further work needs to be done in this area.

Our study also contributes to the health economics literature, where recent studies have been especially concerned about the determinants of obesity and other health factors. Currie, DellaVigna, Moretti and Pathania (2010) estimate the effect of fast food restaurant proximity on weight gain. They find that for 9^{th} grade students, having a fast food restaurant within $1/10^{th}$ of a mile from their school corresponds to a 5.2% increase in obesity rates. The authors also find a similar but slightly weaker effect on pregnant women. Ruhm (2012) proposes a dual-self framework to explain why individuals, also influenced by the strategic behavior of food producers, eat more and gain more weight than they would like to. The author's model is supported by survey evidence from the National Health and Nutrition Examination Survey, and the Behavioral Risk Factor Surveillance System. Dragone and Savorelli (2012)

propose a theoretical model of socially desirable weight when individuals are heterogeneous in their body weights and weight ideals. Powell (2009) examines the relationship between the price of fast food and body mass index of adolescents, finding evidence that prices of fast food may be more influential on demand among teens than availability of fast food.

Other work on healthy eating choices has also focused on the influence of nutritional labeling and claims. Kozup, Creyer, and Burton (2003) find that consumers' attitudes towards foods and purchase intentions, are indeed influenced by health information placed on food labels and menus. In a study quite related to ours, Kandiah, Yake, Jones and Meyer (2006) survey female college students about their eating habits under stress. They find that the great majority of respondents reported a change in appetite due to stress, with an increase in appetite being more prevalent than a decrease. Respondents reported an increase in consumption of sweet and "mixed" foods under stress, where mixed dishes included burgers, pizza, casserole, tacos, fast food and ethnic foods. Interestingly, they find that the variety of foods eaten under stress is lower than that under no stress.

3. Model

The strength concept of self-control lends itself readily to an economic model of optimization under resource constraints. We model the students' problem as a self-control allocation decision subject to a self-control budget constraint. We assume that students' decisions are independent in each week, and we interpret the utility function they maximize as reflecting their long run payoffs. Self-control models often have interesting dynamics (Laibson 1994, O'Donoghue and Rabin, 2002), but we abstract from exploring them here in order to focus on the static trade-off between self-control allocation in different activities. We propose that this is a reasonable assumption for many day to day choices that individuals may not think too carefully about, such as those faced by the students in our sample.

Assume a typical student receives a total payoff V from his or her self-control in the domain of two activities: consuming food f which yields payoff $U_f(\cdot)$, and studying s which yields payoff $U_s(\cdot)$, where both U_f and U_s are differentiable. Note that our model has self-control as the sole choice variable, but the implications for actual actions in each domain directly follow. In the single activity self control case, one can think of an individual deriving utility from their action choice a, which is a function of their self-control choice r. In other words, an individual's utility can be written as purely a function of self-control choice $U : R \to \mathbb{R}$ where R is the domain of self control choice r, and $U(r) = W(a^*(r), r)$, where a^* is the optimal action given self-control choice r. This can be extended to the case of self-control across multiple activities.

Let payoff function V be linearly separable in U_f and U_s, with relative weight α on U_f, and (1- α) on U_s. A student chooses self-control levels r_f towards food and r_s towards studying, to maximize objective function V:

$$\underset{r_f, r_s}{Max} V\left(r_f, r_s\right) = \left[\alpha \cdot U_f(r_f) + (1-\alpha) \cdot U_s(r_s)\right]$$

$$subject \quad to \quad c_{f,t} r_f + c_{s,t} r_s \leq 1$$

where c_f is the cost of exerting self-control on food, c_s is the cost of exerting self-control on studying. These costs may vary over time t, and any individual's total self-control resource is normalized to 1, representing the budget constraint.

We make two assumptions on the functional form of U_a for $a \in \{f, s\}$: monotonicity and concavity. While these are often standard assumptions made in economic problems, we would like to briefly discuss them in the context of self-control inputs.

1. Monotonicity: $\frac{\partial U_a}{\partial r_a} > 0$

Monotonicity implies that the payoff from implementing greater self-control in either activity is positive. For both studying and eating healthily this is reasonable, with the exception that exerting excessive self-control in any activity may potentially lead to decreasing payoffs, driven by decreasing enjoyment of the activity. We assume that individuals are operating on the part of the payoff function that is increasing in self-control implementation since they are optimizing.

2. Concavity: $\frac{\partial^2 U_a}{\partial r_a^2} < 0$

Concavity implies diminishing marginal net utility U_a to greater self-control choice. In both the context of studying and healthy eating, this assumption is justifiable in terms of hypothetical gross utility function U_a^+ and gross disutility function U_a^-, where $U_a = U_a^+ - U_a^-$. We first consider the concavity of the gross utility function with respect to self-control. In the case of studying, our assumption is consistent with the intuition that an extra hour of studying yields a lower marginal gross utility conditional on having studied a given amount already. In the case of eating, such concavity might be conceptualized in terms of propensity to make healthy choices. Eating healthily for one more meal is less beneficial when one eats healthily very frequently, as compared to when one eats healthily very seldom. In terms of the gross disutility of self-control, we are assuming it is either linear or convex. In either case, the concavity of the benefit curve will yield a section of the net utility function which is not only concave, but also monotonic in accordance with our first assumption. It is in this portion of the payoff function that individuals are operating.

Under the above two assumptions the optimal choice of the student is determined by the following first order condition: $\frac{\alpha \cdot U_f^{'}(r_f^*)}{c_{f,t}} = \frac{(1-\alpha) \cdot U_s^{'}(r_s^*)}{c_{s,t}}$.

We impose an additional assumption on the allocation of self control in the two activities, (r_f^*, r_s^*)

3. Substitutability: $\frac{\partial r_f^*}{\partial c_{s,t}} > 0 \quad and \quad \frac{\partial r_s^*}{\partial c_{f,t}} > 0$

During different time periods, depending on the present environment the student faces, the relative costs of exercising self-control on food and on studying can vary. For example, during studying intensive periods such as nearing final exam time, the cost of self-control in studying may decrease as friends also engage in studying, professors hold review sessions, and other social activities accommodate the academic schedule. All else equal, the student responds to this decrease in cost c_s by allocating more self-control towards studying, such that the marginal payoff from studying is lowered in

the optimal allocation. In a world of finite self-control, and the substitutability assumption, this immediately implies less self-control allocated to the food realm.

We note that a similar conclusion can be drawn by allowing the weighting parameter α to vary over time depending on the environment. In this case, a lower α during finals periods makes the marginal payoff of self-control in the food domain lower, and students would optimize by allocating more self-control to studying. While we do not have the ability to distinguish between these two different mechanisms in our data, we favor the cost-based explanation for the reason that it reflects an "external" change rather than an internal one, which more accurately reflects our field setting.

We impose a final assumption that lower self-control on food implies higher likelihood of purchasing those "tempting" but unhealthy foods. Thus a direct consequence of this framework is that increases in the cost of allocating self-control in the food domain relative to such cost in the studying domain, implies a tendency to purchase relatively unhealthy foods.

Given our model, individuals maximize their utility derived from self-control subject to their self control budget, obtaining their optimal allocation of self control within each task, food choice and studying, (r_f^*, r_s^*). Although our theoretical framework, in accordance with the strength model, formulates self control allocation as the choice variables, these are unobservable in our data. We thus extend the model's implications via the empirical framework to reflect what we observe in the data: actual purchase decisions made.

Comparative statics show that as the price of academic self-control decreases, the optimal degree of self-control in the food domain declines. Assuming that reduced self-control has a negative impact on healthful choices, the relative likelihood of making an unhealthy food purchase during demanding academic time periods, should *increase* compared to the likelihood of making a purchase of a healthier alternative.

4. Data and Main Empirical Results

Our data are from a campus-wide debit card system at a large public university in the United States. The debit card is an electronic account stored on students' and employees' university ID cards, and serves as a convenient way for individuals associated with the university to pay for items sold in and nearby campus.

Use of the campus debit card is prevalent, and in terms of transaction time, compared to other payment options such as cash or credit card, it requires the least hassle by both customer and retailer. Since our observation of purchases is partial in the sense that we only observe purchases actually made with the debit card and not other payment forms, our data are noisy, tending to bias estimates towards zero.

All major restaurant establishments on-campus accept the campus debit card. Certain eating establishments off-campus also accept the campus debit card through an arrangement with the university. Understandably, the majority of debit card purchases occur within campus. Our data include all transactions made using a campus debit card in the year 2005 - 2006. Since within our limited self-control framework the eating choices of non-students should be considerably less affected by the timing of exam periods, we include only students in the analysis and exclude staff members.

The data are rich in that we observe all purchases made using the campus debit card at the transactions-level, including the date, time, restaurant name, and dollar amount of the purchase. These are the only variables that we usefully observe in the data set. The data have limitations in that we do not observe any demographic characteristics of the campus debit card users, nor do we observe the exact items being purchased. For this reason we focus on blunt measures, such as the likelihood that a purchase was made by an individual at a specific type of restaurant in a particular week.

4.1 Likelihood of Different Fast Food Purchases

To get an initial idea of the relative likelihoods of making a purchase of each food type at different time points in the year, we consider a multinomial logit model as follows:

$$\Pr(f = j) = \frac{\exp(X_i \cdot \beta_j)}{1 + \sum_{k=1}^{K-1} \exp(X_i \cdot \beta_k)}$$

where k indexes food type and includes food type j of interest. Each likelihood of purchasing a given food type is estimated relative to the comparison restaurant group: campus cafeterias. Our data is panel data on repeated choices by individuals, so in order to use the multinomial logit approach, we need to assume that unobserved factors affecting food choices are independent over time (Train 2009). The table below shows our K categories of food types and the restaurants which are contained in each type:

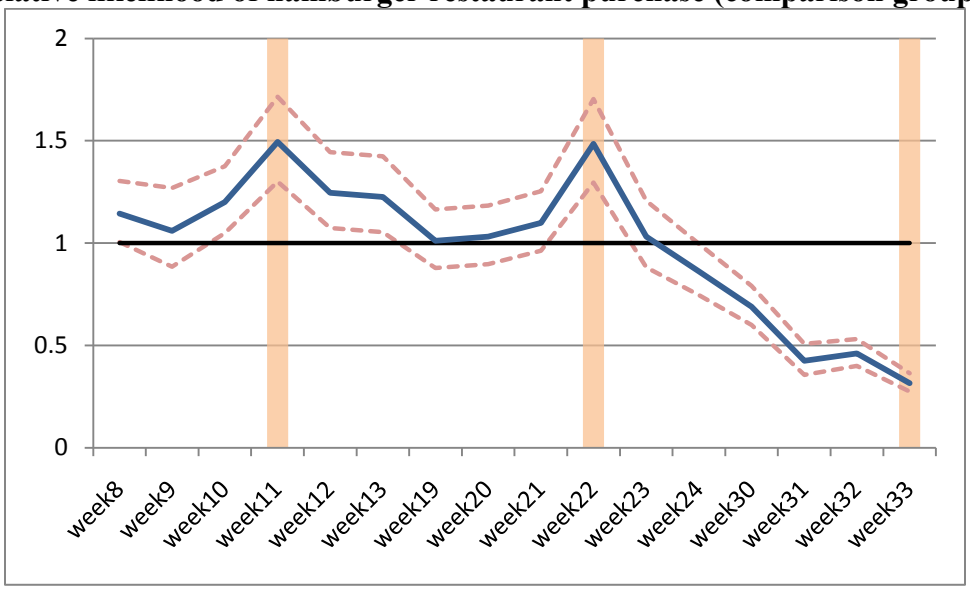
Table 1: Data Summary

Food Type	*Included Restaurants*	*Transactions*	*Average Amount ($)*
Hamburgers	Wendy's	8826	4.43
Pizza	Domino's, Round Table Pizza, Z Pizza	4420	7.31
Mexican	Chipotle, Rubio's, Tacone	21500	6.67
Asian	Panda Express, Shogun	19601	6.11
Sandwiches	Subway	7731	6.48
Other	Baskin Robbins, Crouton's, Daphne's Greek Café, Islands, Jamba Juice, etc.	15320	6.31
Coffee	10+ campus coffee carts/shops	35584	2.94
Cafeteria	10+ campus cafeterias	48978	4.39

In our logit specification, X_i includes week dummy variables, and also the following three individual-specific variables to help in controlling for debit card use: Total annual expenditures, Total number of transactions made, Total number of cafeteria transactions made. As mentioned earlier, we do not observe any demographic variables in the data, so the aforementioned variables serve as proxies for consumer types. In Section 5 we consider a binomial conditional logit model with individual fixed effects to more completely control for individual heterogeneity, finding essentially the same results.

Figure 1 below shows the estimated relative likelihood ratio and 95% confidence intervals of hamburger restaurant purchase compared to a cafeteria purchase, for several weeks in the academic year. Specifically, for each academic quarter, we include dummy variables for final exam weeks (week 11, 22 and 33 highlighted in orange), the week directly prior to finals weeks, and 2 additional adjacent weeks on either side. The comparison weeks are all other weeks (out of 33 total weeks) not shown in the x-axis.

Figure 1: Relative likelihood of hamburger restaurant purchase (comparison group: cafeterias)



We use this particular time dummy variable approach for a few reasons. First, we are primarily interested in the relationship between finals week and fast food purchase, rather than the entire time path of relative fast food likelihoods. We include the week before finals week because there is some psychology evidence that *anticipation* of stressful times can lower self-control. We include an extra two weeks on either side of these two stress-associated weeks as "control" weeks, similar to a regression discontinuity approach. We omit all other weeks from the set of dummy variables to allow their average to serve as the comparison group. We could alternatively choose a single week out of the 33 weeks as the comparison group – however, the interpretation would be less clear since we have no logical reason to pick one particular non-finals week over another. There are other potentially stressful non-finals weeks during each quarter, however these are not easily identifiable due to the fact that some courses offer one midterm exam per quarter while others offer two midterm exams. Thus many possible weeks in each quarter might be deemed stressful, but finals week should indeed be the *most* stressful time. Thus, the current empirical strategy estimates the role of finals week (and proximity) on relative likelihood of particular food purchases, compared to the average relative likelihoods in other weeks. The general pattern of relative frequencies is robust to changes in the window of weeks around finals week included as dummy variables.

The finals week effect is most prominent for the traditional hamburger fast food restaurant. As Figure 1 shows, the first two final exam weeks highlighted in orange, correspond to the highest likelihood of purchase at a hamburger fast food restaurant as compared to making a purchase in the school cafeteria. Making a purchase at the hamburger fast food restaurant is about 1.5 times as likely as making a cafeteria purchase. This is especially notable when we consider the relative unpopularity of the hamburger restaurant as shown in the total number of transactions in Table 1. As the results for the other

food categories will confirm, students did not eat fast food hamburgers very often on the whole over the year, but they were significantly most likely to do so during final exam time.

Note that the likelihood of hamburger restaurant purchase is in fact lower for the very last week of the school year, and declines in the weeks directly preceding it. This is a pattern common across all the fast food categories we consider, and is due to a "deadline effect" via the expiration of students' cafeteria points at the end of the academic year in Spring quarter inducing higher cafeteria use.[3] Students' cafeteria points are on a separate account, and can only be used in cafeterias. Debit card money can be used at both fast food and cafeteria establishments. We take the first two final exam periods as representative of students' fast food purchase behavior in the absence of the cafeteria point deadline, and our results are robust to eliminating the entire Spring quarter from the analysis.

We find similar patterns for Mexican restaurants, Asian restaurants, sandwich establishments and the "other" category of chain restaurants which consists primarily of off-campus establishments. The variety of restaurant types with the final exam week effect, helps refute the alternative hypotheses that students preferred the hamburger restaurants for either convenience or speed of service. The Asian fast food restaurants serve pre-prepared foods as the hamburger establishment does, and the off-campus restaurants are no more convenient in terms of travel time than the cafeterias. The relative likelihood plots of the other restaurant types with finals week effects are shown in Figures 2 through 5.

Surprisingly, we do not find any significant effects for pizza establishments, and perhaps even more surprisingly, we find slight evidence of an *opposite effect* in the case of coffee stand purchases. In the case of pizza, the lack of effect could be due to lower popularity of pizza establishments compared to other fast foods restaurants. In the case of coffee shop or stand purchases, we have no current concrete explanation, but speculate that the pattern might be due to school sponsored study breaks which provide free coffee, or a strong appeal of off-campus brands of coffee during finals periods.

5. Robustness checks

In this section we provide some alternative estimations to explore the robustness of the result in Section 4. In Section 5.1 we allow for individual student fixed effects in a binomial logit.[4] The result is very similar to the multinomial specification with spending habit controls.

In Section 5.2 we investigate whether the gravitation towards fast food in stressful weeks also induces spending greater amounts of money on fast food purchases per order (intensive margin). We find no strong pattern in the spending amount domain – individuals tended to increase their fast food purchase incidents, but conditional on purchase they did not increase their spending per transaction significantly.

5.1 Individual fixed-effects

We run a conditional logit specification with individual fixed effects so that the comparison is made within-person relative to a student's own purchases from other establishments in other weeks of the year. Coefficients are assumed to be constant across individuals. Coefficients are displayed for the

[3] Lien (2013) analyzes this deadline effect within the cafeteria points system, finding that the change in spending patterns nearby the deadline is due to students' increased attention to dynamic planning problems.

[4] Note that in a future version, further robustness checks may be incorporated via a more general mixed logit.

specification with a one week window before and after the 2 week "stressful" period, but the results are similar for a two week window.

The results are very similar to the multinomial logit specification with customer purchasing characteristics in the regression whose displayed in the graphs in the previous section. Again, the hamburger, Mexican, and Asian restaurants display the greatest magnitude and clearest patterns of increase in likelihood of purchase.

Table 2:

conditional logit (individual fixed-effects): hamburger restaurant purchase, coefficients

	Quarter 1	Quarter 2	Quarter 3
week before week before finals	-0.055	0.097	-0.474***
	(0.092)	(0.071)	(0.093)
week before finals	0.068	0.062	-0.313***
	(0.069)	(0.067)	(0.087)
finals week	0.284***	0.304***	-0.269***
	(0.066)	(0.077)	(0.104)
week after finals	0.037	-0.104	-
	(0.074)	(0.079)	-

comparison group: all other academic weeks

Robust standard errors in parentheses

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

conditional logit (individual fixed-effects): Mexican restaurant purchase, coefficients

	Quarter 1	Quarter 2	Quarter 3
week before week before finals	0.085	0.015	-0.024
	(0.058)	(0.047)	(0.062)
week before finals	0.036	0.002	-0.212***
	(0.046)	(0.046)	(0.062)
finals week	0.195***	0.210***	-0.352***
	(0.047)	(0.047)	(0.070)
week after finals	0.126***	0.086*	-
	(0.048)	(0.048)	-

comparison group: all other academic weeks

Robust standard errors in parentheses

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

conditional logit (individual fixed-effects): Asian restaurant purchase, coefficients

	Quarter 1	Quarter 2	Quarter 3
week before week before finals	-0.018	-0.005	-0.332***
	(0 .064)	(0 .049)	(0 .069)
week before finals	0 .040	0 .001	-0.272***
	(0 .048)	(0 .049)	(0.062)
finals week	0 .172***	0 .124**	-0.417***

	(0 .053)	(0 .053)	(0.078)
week after finals	0 .132**	0 .046	-
	(0 .052)	(0 .054)	-
comparison group: all other academic weeks			

Robust standard errors in parentheses
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Sandwich and other fast food establishments showed results similar to the multinomial specification, with less decisive effects, and are shown in the Appendix. Coffee shop and pizza purchases again showed no particular finals effect pattern, and we omit them here since the basic lack of significant result can be seen from the graphs in Section 4.

We also estimated a random effects approach, obtaining similar results.

5.2 The intensive margin (Expenditures)

We do not find any consistent evidence that students change their food choice behavior during final exams on the intensive margin, on a per visit basis. Tables 7 through 9 show a linear regression with log restaurant purchase amount by transaction as the dependent variable, for the categories hamburger, Mexican and Asian restaurants. These were the food types which showed the strongest finals week effect in terms of likelihood of making a transaction. Each regression contains only transactions at the restaurant type in question, since when including all of the observations the purchase likelihood effect dominates.

All regressions include a constant term, and a coefficient for an individual's average per visit expenditure (to control for individual spending magnitudes). The coefficient on average expenditure is always positive and significant, and we omit it from the tables since there is no particularly interesting result there.

Table 3:

Linear regression: log hamburger restaurant purchase amount, coefficients

	Quarter 1	**Quarter 2**	**Quarter 3**
week before week before finals	0.038	-0.014	0.034
	(0 .042)	(0 .034)	(0 .050)
week before finals	0.016	0.070**	-0.032
	(0 .033)	(0 .029)	(0 .039)
finals week	0.002	0.069**	-0.003
	(0 .034)	(0 .028)	(0 .039)
week after finals	-0.050	-0.046	-
	(0 .034)	(0 .040)	-
comparison group: all other academic weeks			

Robust standard errors in parentheses
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 3 shows that visitors to the hamburger restaurant did not significantly increase their spending amount in response to stressful times, at least in the first and last quarters. There is some

intensive margin effect in the second quarter, but the magnitude is not large at less than 10% increase. A similar small effect exists for Mexican restaurants, but the effect is even smaller.

Table 4:

Linear regression: log Mexican restaurant purchase amount, coefficients

	Quarter 1	Quarter 2	Quarter 3
week before week before finals	0 .002	0.011	0.057***
	(0 .019)	(0 .016)	(0 .017)
week before finals	0.006	0.046***	0.033*
	(0 .014)	(0 .014)	(0 .018)
finals week	0.028*	0.042***	0.025
	(0 .016)	(0 .016)	(0 .020)
week after finals	0.012	0.027	-
	(0 .016)	(0 .017)	-
comparison group: all other academic weeks			

Robust standard errors in parentheses
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

While Asian fast food restaurants show a significant effect in terms of likelihood of purchase, there is no significant effect for transaction amount, the only significant coefficient being negative for the week after finals.

Table 5:

Linear regression: log Asian restaurant purchase amount, coefficients

	Quarter 1	Quarter 2	Quarter 3
week before week before finals	0 .003	-0.001	-0.018
	(0 .019)	(0 .017)	(0 .021)
week before finals	0.003	-0.002	0.008
	(0 .015)	(0 .016)	(0 .016)
finals week	-0.025	0.015	0.006
	(0 .016)	(0 .016)	(0 .019)
week after finals	-0.020	-0.044***	-
	(0 .017)	(0 .016)	-
comparison group: all other academic weeks			

Robust standard errors in parentheses
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

The other restaurant types show similarly insignificant and irregular patterns of spending variation by week. We omit them here for space considerations. Overall, the evidence seems to indicate that students did not lapse in self-control on spending amounts, but in choosing *what type* of food to eat.

6. Field Survey and Experiment

Our field data in the previous section relies on time-based factors to identify the impact of final exam stress and pressure on food choices, but we do not have any information about the academic requirements or behavior of individual students in the sample. Having such information would be useful, since it would help us in more directly ruling out factors such as convenience, or discounts which could plausibly drive food purchase patterns, but which are not well-observed in the field data.

In order to investigate further into the determinants of food choice during stressful times, including the external validity of the strength hypothesis outside of the US context, we conduct a small scale field experiment at a large university in China. The field experiment took the form of an online survey sent to select students throughout the month of June in 2013, which included the weeks in which final exams were held. Students completing the survey by the specified date received a free gift, which was a choice of imported snack from Korea worth about 15 yuan each.

The sample of potential participants consisted of all 1st through 3rd year undergraduate students holding either a primary or secondary major within the business school at the university. In total there were over 1000 students from which to draw the sample. 4th year students were excluded from the sampling due to the fact that 4th year students in the Chinese university system do not take courses or exams in the semester before their graduation, and are likely to have very different time and effort objectives during the survey period.

Every other day from Jun 5th through June 23rd, 20 randomly selected students were sent an email invitation to complete an online survey regarding student life at the university. In the invitation email they were informed that the survey was being conducted by researchers in the business school, and that they would receive a small gift as a token of appreciation for their participation, to be delivered to their dormitory if they completed the survey within two days of the invitation. We set the two day reply deadline in order to maintain control over the timing inflow of survey responses, and to ensure variety in student workload which is likely highly correlated with timing. We kept the invitation rate small rather than sending large batches of invites at once, in order to prevent peer effects which could arise if friends or roommates were all invited to the survey. The translated text of the invitation email is provided in the Appendix. Out of the 200 invitations sent, 82 individuals replied, for a total response rate of 41%. Out of the respondents four individuals were 4th year students who received the survey due to a sampling mistake, so we omit them from the analysis, leaving a total of 78 respondents in the data.

A translated copy of the survey is shown in the Appendix. The survey consisted of approximately 30 questions (some questions appeared conditionally on individual answers to previous questions, so the number of questions was not always fixed). Generally speaking, we ordered the questions in the survey in a way which facilitates priming of the issue of self-control in different domains, and we arranged the page divisions as much as possible in a way which did not allow subjects to go back and revise previous answers. The survey asked simple and straightforward questions, requiring only a few minutes to complete. The approximate layout ordering of the types questions in the survey was as follows (Note: The sections most relevant to limited self-control hypothesis are underlined, the moderately relevant sections are in italics, and the remainder of the question types were either logistical information for the snack delivery or included to enhance the stated premise of the survey):

- ✓ general personal information and contact information
- ✓ hobbies

- ✓ *general course load information and study habits*
- ✓ social and psychological support
- ✓ personal regard for healthiness of food, self-control tendencies over food, preferred snack flavor
- ✓ academic and non-academic workload in the coming week
- ✓ length of time since having preferred snack type
- ✓ *self-reported stress level*; comment (optional)
- ✓ snack choice task (with photos)

The snack choice set, framed as a thank you gift, depended upon the respondent's answer to an earlier question in the survey asking whether they generally prefer salty snacks or sweet snacks. Eliciting the snack flavor preference is important in the Chinese context since very sweet snacks are typically less popular than in the US. If the respondent had replied that they prefer salty snacks, they had a choice between 2 packs of Haoliyou (Korean) brand whole wheat crackers, or 2 packs of Haoliyou (Korean) brand original flavor potato chips. If the respondent had replied that they prefer sweet snacks, they had a choice between 2 packs of Haoliyou (Korean) brand whole wheat crackers, or 1 pack of Haoliyou (Korean) brand brownie squares.

We chose Korean imported products rather than local products, so that students would be less likely to choose based on prior familiarity with the product. Haoliyou is a popular brand within China and produces similar products for the Chinese market. We also adjusted the quantity of items in each gift, keeping the market price of the different choices as uniform as possible, so that participants' choices were not influenced by their perception of value. There remained small actual differences in the value of the different gifts however, with the whole wheat crackers being worth 15 yuan, the chips being worth 13.3 yuan, and the brownies being 16.9 yuan. Participants were only informed that each gift had an approximately 15 yuan value, and we believe the value of the gift was too small to induce value considerations in the subjects outside of subjects' intrinsic utility. The choice patterns do not support the suggestion of students choosing based on value.

Subjects were informed that the thank you gift would be delivered to their dormitory by one of the project research assistants within 7 days. A team of research assistants subsequently made the deliveries based on the individual choice and location data. Three deliveries were unable to be completed due to respondents being out of town. Almost all subjects wrote some insights about their quality of life at school in the optional comments section, suggesting that they were interested in completing the survey sincerely.

7. Survey results

In the sample 42 out of 78 respondents reported preferring salty snacks over sweet snacks. 25 of them chose the potato chips and 17 of them chose the whole wheat crackers. 35 out of 78 respondents reported preferring sweet snacks over salty snacks. 28 of them chose the brownies and 8 of them chose the whole wheat crackers.

The data obtained from the survey experiment is cross-sectional. We run a standard probit specification to estimate the relationship between likelihood of choosing the unhealthy snack, and

several self-reported explanatory variables from the survey. We do not expect the magnitudes of the effects we find here to be necessarily externally valid outside of the field experiment, so we are most interested in whether certain variables have significant positive or negative effects. Many of our explanatory variables are categorical (yet ordinal) in order to make responding more convenient, giving another reason for a qualitative interpretation of the regression results. Table 6 shows the results of three specifications.

Table 6: Probit: Dependent variable: Unhealthy snack (chips or brownies) chosen

	(1)	(2)	(3)
Stress level	0.0334 (0.0834)	0.0286 (0.1038)	0.0162 (0.1081)
Self control on food	0.1221 (0.3248)	0.1716 (0.3300)	2.4159* (1.4159)
Care for healthy food	-0.0901 (0.3402)	-0.2427 (0.3584)	-1.5547 (1.5166)
Snacking for relaxation	-0.3100 (0.3453)	-0.7015* (0.3695)	-0.5649 (0.3725)
Snack flavor	0.5135 (0.3365)	0.6330* (0.3549)	0.6489* (0.3683)
Time of last snack	0.1633 (0.1657)	0.1743 (0.1854)	0.1834 (0.1884)
Gender	-0.6351* (0.3480)	-0.8962** (0.3791)	-0.8630** (0.3861)
Units enrolled		-0.5282** (0.2106)	-0.5003** (0.2069)
This week estimated study time		0.4615** (0.1368)	0.5894** (0.2388)
Exams this week		-0.1584 (0.1368)	-0.1554 (0.1396)
This week other commitments		-0.0610 (0.1199)	-0.0779 (0.1207)
This week study time*Self control on food			-0.5524 (0.3473)
This week study time*care for healthy food			0.2953 (0.3751)
Constant	yes	yes	yes
Obs	78	78	78
R-sq	0.1014	0.2120	0.2296

*Robust standard errors in parentheses; *significant at 10% level; **significant at 5% level*

Specification (1) checks the correlation of basic personal characteristics on choice of the unhealthy snack. Females were significantly less likely to choose the unhealthy snack. Aside from

gender, none of the other explanatory variables in specification (1) were significant predictors, including subjects' self reported stress levels (on a scale from 1 to 9), reported self-control efforts in the food domain (binary coded), or reported care about health content of food eaten (binary coded).

Specification (2) includes academic explanatory variables into the regression, and shows our main result that subjects' estimated time needed to complete the homework and exams in the coming week to their satisfaction was positively associated with choice of the unhealthy snack. This is consistent with limited self-control in that those students who reported higher time requirements in terms of their academic activity in the coming week, were more likely to choose the unhealthy snack. The number of exams in the coming week, other time commitments, and units enrolled all did not have positive impact on the choice of unhealthy snack. The number of course units a student was enrolled in was actually significantly negatively associated with choice of the unhealthy snack. It suggests a possibility of selection effects, such as individuals with better self-control taking a higher course load, and being more likely to make the healthy choice. In our experiment, unlike in the field data, there was no possibility that the unhealthy food choice were also perceived as being more convenient, since all snack gifts were delivered under the same promise to participants. Thus it appears that being kept busy with challenging tasks leads people to make less healthy food choices, and this is consistent with the previous laboratory experimental evidence from psychology.

Specification (2) also indicates that controlling for academic variables, preferring sweet over salty snacks was also positively associated with the unhealthy choice. Surprisingly, individuals who reported snacking as one of their frequent relaxation activities were *less* likely to choose the unhealthy snack. Females remained less likely to choose the unhealthy snack compared to males. Self-reported care regarding the healthiness of food and self-reported self-control efforts in the food domain remain insignificant predictors of snack choice. Inclusion of the academic factors doubles the explanatory power of the regression, primarily through units enrolled and upcoming week's study time.

In specification (3) which adds interaction terms, estimated study time in the current week remains a robust significant predictor of unhealthy snack choice. We add two additional explanatory variables: an interaction variable of coming week's study time and reported self-control efforts in the food domain; and an interaction variable of the coming week's study time and reported care about health content of food eaten. While neither of these variables themselves appear to be significant predictors in the regression, controlling for interaction effects leads the reported self-control efforts on food variable to have a large positive effect on food choice, although only significant at the 10% level. That is, once self control on food conditioning on study time is accounted for, subjects reporting higher self-control efforts in food choice are actually more likely to choose the unhealthy snack. This implies that self-reporting more effort exerted in self-control is actually fundamentally associated with less actual self-control success. This is an intuitive finding since individuals with self-control difficulties may be more likely to report exerting effort in self-control.

8. Conclusions

In this paper we have presented an economic framework for the strength model of self-control, and provided preliminary evidence for limited self-control in a natural field setting, and in a field experiment. Using data from campus meal purchase decisions throughout the year, we find evidence that during stressful academic times, students are substantially more likely to eat at certain fast food restaurants instead of the school cafeterias. The relative magnitudes of the likelihood effects are also consistent with a limited self-control story, in the sense that students were most likely to gravitate to the

"classic" (and perhaps least healthy) fast food choice: hamburgers. Using the field experiment, we find that the connection between academic workload and unhealthy eating choices is robust.

We see several possible directions for further development of this work. In particular, one potentially interesting next step is to more closely examine individual eating profiles and the role of habits. For example, are students with less regular dining habits in terms of time of day and spending amounts, more prone to making food choices consistent with diminished self-control during stressful times? We have not yet had a chance to explore these issues.

References:

Baumeister, R.F., Vohs, K.D., and Tice, D.M., "The Strength Model of Self-Control", Current Directions in Psychological Science, Volume 16, No. 6, 2007.

Crede, M., and Kuneel, N.R., "Study Habits, Skills, and Attitudes: The Third Pillar Supporting Collegiate Academic Performance", Perspectives on Psychological Science, Vol. 3, No. 6, 2008, p. 425 – 453.

Currie, J., DellaVigna, S., Moretti, E., and Pathania, V., "The Effect of Fast Food Restaurants on Obesity and Weight Gain", American Economic Journal: Economic Policy, August 2010, p. 32 – 63.

Dragone, D., and Savorelli, L., "Thinness and obesity: A model of food consumption, health concerns, and social pressure," Journal of Health Economics, vol. 31, 2012, p. 243 – 256.

Francis, L.A., Granger, D.A., and Susman, E.J., "Adrenocortical regulation, eating in the absence of hunger and BMI in young children", Appetite, Vol. 64, May 2013, p. 32 – 38.

Fudenberg, D. and Levine, D.K., "A Dual-Self Model of Impulse Control", American Economic Review, Vol. 96, No. 5 (2006) pp. 1449-1476.

Galliot, M.T., Baumeister, R.F., DeWall, C.N., Maner, J.K., Plant, E.A., Tice, D.M., Brewer, L.E., Schmeichel, B.J., "Self-Control Relies on Glucose as a Limited Energy Source: Willpower is More Than a Metaphor", Journal of Personality and Social Psychology, Vol. 92, No. 2, 2007, p. 325 – 336.

Gul, F. and Pesendorfer, W., "Temptation and Self-Control", Econometrica, Vol. 69, No. 6 (Nov 2001), pp. 1403 – 1435.

Job, V., Dweck, C.S., and Walton, G.M., "Ego Depletion – Is It All in Your Head? Implicit Theories About Willpower Affect Self-Regulation", Psychological Science, 21(11), 2010, p. 1686-1693.

Kandiah, J., Yake, M., Jones, J., and Meyer, M., "Stress influences appetite and comfort food preferences in college women," Nutrition Research, 26, 2006, p. 118 – 123.

Kozup, J.C., Creyer, E.H., and Burton, S., "Making Healthful Food Choices: The Influence of Healtlh Claims and Nutrition Information on Consumers' Evaluations of Packaged Food Products and Restaurant Menu Items," Journal of Marketing, Vol. 67, No. 2, 2003, p. 19 – 34.

Lien, J.W., "Limited Attention and the Deadline Effect: Simple Dynamic Spending Rules in the Field", Tsinghua University, working paper, 2013.

Mischel, W., Ayduk, O., Berman, M.G., Casey, B.J., Gotlib, I.H., Jonides, J., Kross, E., Teslovich, T., Wilson, N.L., Zayas, V., and Shoda, Y., " 'Willpower' over the life span: decomposing self-regulation", Social Cognitive and Affective Neuroscience, 6(2), 2011, p. 252-256.

O'Donoghue, T., and Rabin, M., "Doing It Now or Later", American Economic Review, Vol. 89, No. 1 (1999), pp. 103 – 124.

Powell, L.M., "Fast food costs and adolescent body mass index: Evidence from panel data," Journal of Health Economics, Vol. 28, 2009, p. 963 – 970.

Ruhm, C.J., “Understanding overeating and obesity,” Journal of Health Economics, vol. 31, 2012, p. 781 – 796.

Shiv, B. and Fedorikhin, A., “Heart and Mind in Conflict: The Interplay of Affect and Cognition in Consumer Decision Making”, Journal of Consumer Research, Vol. 26, 1999, p. 278 – 292.

Strotz, R.H., “Myopia and Inconsistency in Dynamic Utility Maximization”, The Review of Economic Studies, Vol. 23, No. 3 (1995-1956), pp.165-180.

Thaler, R.H., and Shefrin, H.M., “An Economic Theory of Self-Control”, The Journal of Political Economy, Vol.89, No. 2 (Apr. 1981), pp. 392-406.

Train, K., Discrete Choice Methods with Simulation, Cambridge University Press, 2003. Second edition, 2009.

Wang, W. and J. Zheng (2012). "Multi-Period Complete-Information Games with Self-Control: a Dual-Self Approach." Operations Research Transactions 16(4): 95-104.

Wang, W. and J. Zheng (2013). "Cooperative Equilibrium in Non-Cooperative Games with Self-Control: A Dual-Self Analysis of the Driver-Pedestrian Game." Working Paper.

Appendix A:

Figure A1: Relative likelihood of Mexican restaurant purchase (comparison group: cafeterias)

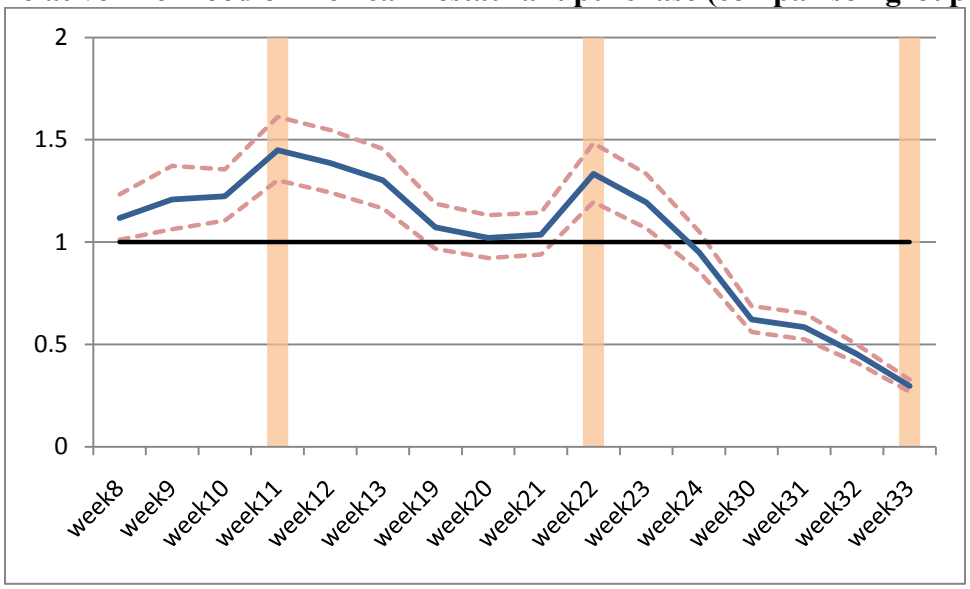


Figure A2: Relative likelihood of Asian restaurant purchase (comparison group: cafeterias)

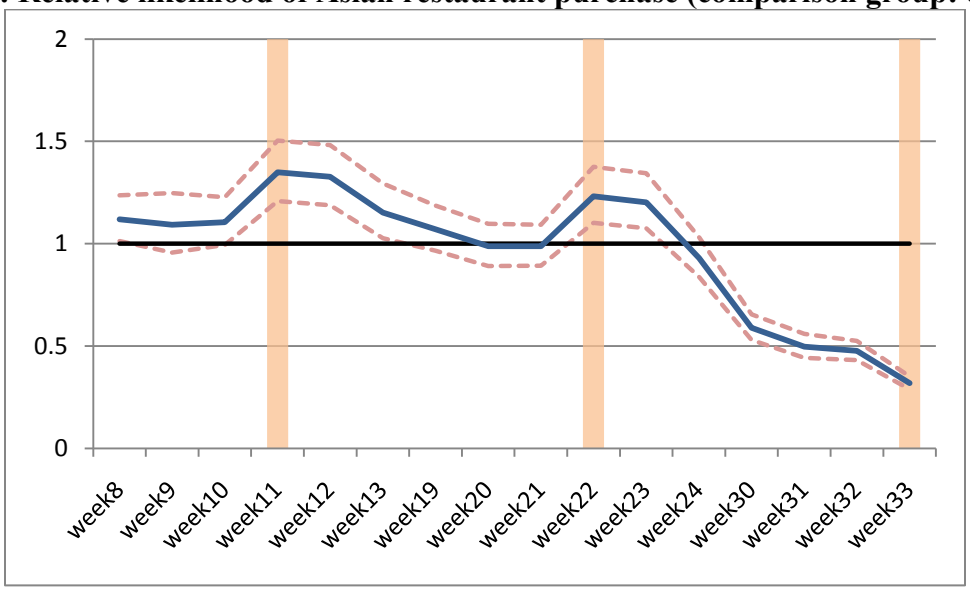


Figure A3: Relative likelihood of Sandwich restaurant purchase (comparison group: cafeterias)

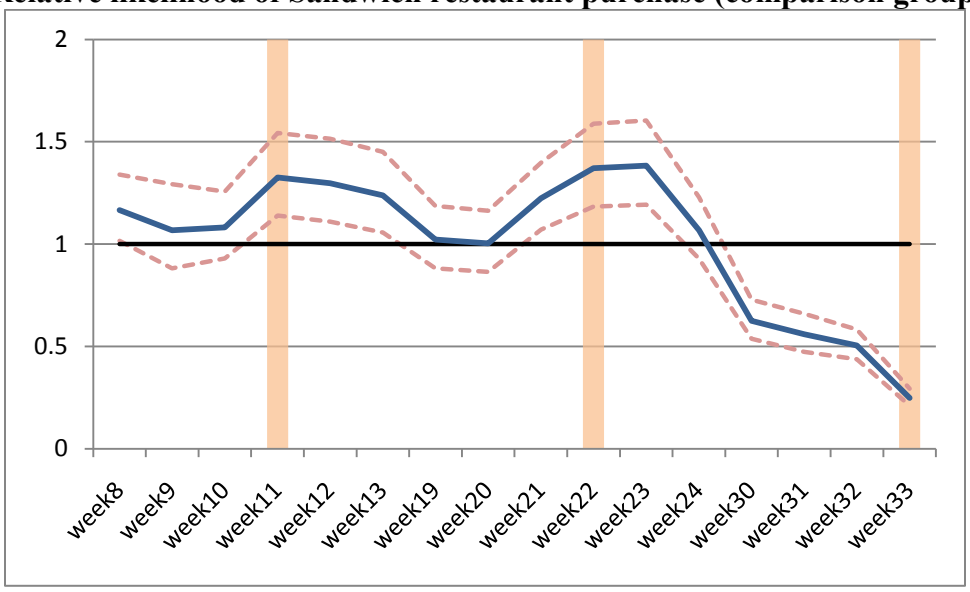


Figure A4: Relative likelihood of "other" restaurant purchase (comparison group: cafeterias)

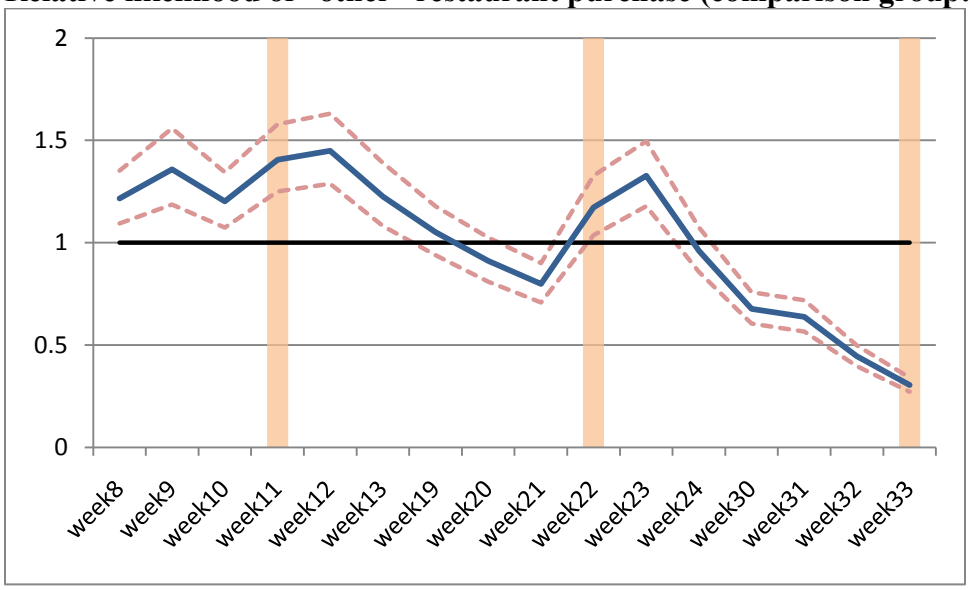


Figure A5: Relative likelihood of Pizza restaurant purchase (comparison group: cafeterias)

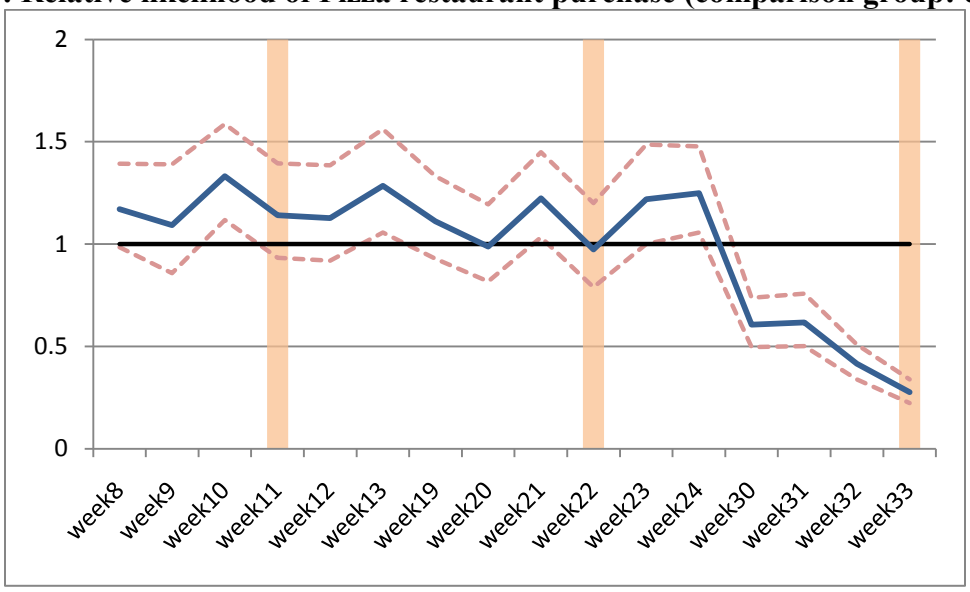
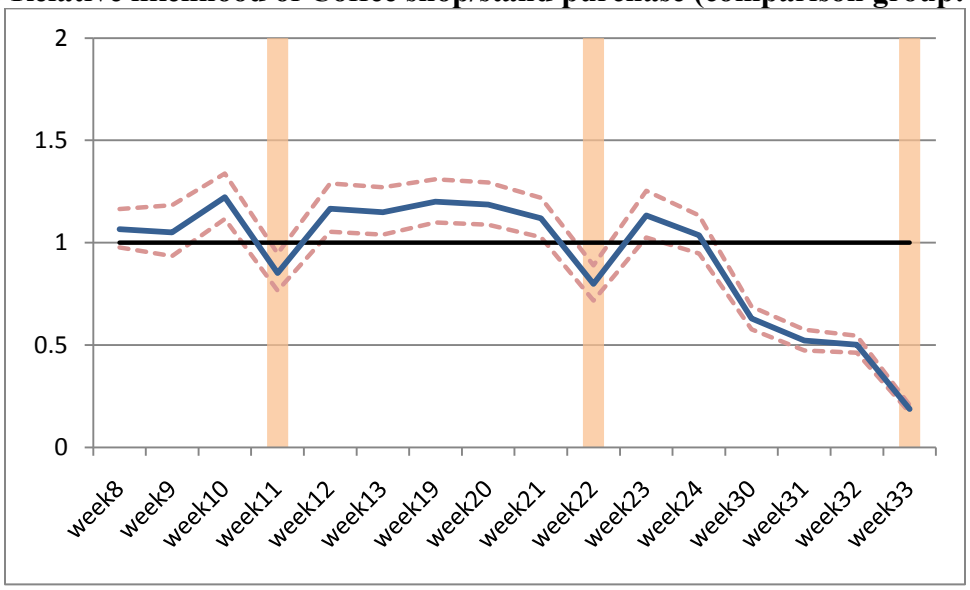


Figure A6: Relative likelihood of Coffee shop/stand purchase (comparison group: cafeterias)



Appendix B:

Table B1:

conditional logit (individual fixed-effects): Sandwich restaurant purchase, coefficients

	Quarter 1	Quarter 2	Quarter 3
week before week before finals	-0.026	-0.054	-0.205**
	(0.092)	(0.073)	(0.091)
week before finals	-0.044	0.157**	-0.170**
	(0.075)	(0.070)	(0.078)
finals week	0.177**	0.189***	-0.510***
	(0.079)	(0.074)	(0.099)
week after finals	0.151**	0.193***	-
	(0.076)	(0.071)	-
comparison group: all other academic weeks			

Robust standard errors in parentheses
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table B2:

conditional logit (individual fixed-effects): Other restaurant purchase, coefficients

	Quarter 1	Quarter 2	Quarter 3
week before week before finals	0.222**	-0.111*	-0.007
	(0 .063)	(0 .059)	(0 .073)
week before finals	0.040	-0.273*	-0.324***
	(0 .055)	(0 .061)	(0 .069)
finals week	0.151**	0 .087	-0.479***
	(0 .059)	(0 .059)	(0.099)
week after finals	0 .155***	0 .174**	-
	(0 .056)	(0 .056)	-
comparison group: all other academic weeks			

Robust standard errors in parentheses
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level