Are Work Intensity and Healthy Eating Substitutes? Field Evidence on Food Choices under Varying Workloads

Jaimie W. Lien[†] Jie Zheng[‡]

Current Draft: October 21st, 2017
Initial Draft: March 16th, 2013

Abstract[1]

The strength model proposes that self-control is a constrained resource whose effectiveness tends to dwindle when an individual attempts to resist multiple sources of temptation at a time. We develop an economic framework for the strength model, and test its consequences in the field by analyzing the appeal of various food types by university students who face time-varying academic self-control demands. Our study utilizes both empirical analysis of actual university-wide transactions data, and a field survey approach with a real snack choice task. Compared to cafeteria purchases, purchase of less healthy fast foods increases during the week of final exams when students' workloads are most cognitively demanding, compared to the purchase ratio of food sources during other times of the year. Helping to rule out alternative explanations, in the field survey the main robust and significant predictor of choosing an unhealthy snack over a healthy snack is subjects' self-reported time needed to complete their academic responsibilities during the upcoming week. As combined evidence, these findings are consistent with an economic model of limited self-control in which students choose how to allocate their self-control between academic activities and eating activities. Under such a framework, the overall effectiveness of policies designed to help individuals make beneficial choices in a specific domain could be in practice, adversely affected by limited self-control capacities.

Keywords: limited self-control, strength model, food choice, work intensity
JEL codes: D12, D03, I10

[1†]Lien: Department of Decision Sciences and Managerial Economics, The Chinese University of Hong Kong, Hong Kong, China; jaimie.academic@gmail.com; [‡]Zheng: Department of Economics, School of Economics and Management, Tsinghua University, Beijing, China; jie.academic@gmail.com ; We thank our editor, Daniel Houser, and two anonymous referees for helpful comments which improved the paper. We gratefully acknowledge the U.S. university which provided access to the field data for research purposes only. For excellent research assistance in implementing the field study, we thank HUANG Wanqi, NI Xuanming, PENG Qingqing, Emma Wang, and WU Yanshuang. We especially thank Vincent Crawford, Julie Cullen, and Daniel Houser for their detailed comments on the manuscript. We are also grateful for helpful comments from Pak Hung Au, Te Bao, Claire Baudouin, Youngho Chang, Xiaoping Chen, David Eil, Hanming Fang, Liang Guo, Fuhai Hong, Brad Humphreys, Nan Jiang, Hans van Kippersluis, Ilyana Kuziemko, Sanxi Li, Shirlee Lichtman-Sadot, Juanjuan Meng, Joshua Price, Jane Ruseski, Eko Riyanto, Adam Sanjurjo, Jason Shachat, Daniel Silverman, Walter Thesiera, Chun-lei Yang, Songfa Zhong, as well as participants in the China Meeting of the Econometric Society, Asia Meeting of the Econometric Society, the ICES brown bag seminar at George Mason University, the 1st Meeting in Theoretical and Behavioral Economics at Shanghai Jiaotong University, the Western Economic Association Meeting, Denver, and the economics seminar at Nanyang Technological University for helpful comments and suggestions. The authors gratefully acknowledge research funding support from Tsinghua University (#20151080397), The Chinese University of Hong Kong, the National Natural Science Foundation of China (#71203112, #71303127 and #61661136002), and the Hong Kong Research Grants Council (#14500516). All errors are our own.

1. Introduction

The nutritional and health content of food intake among young people is a policy issue which has drawn increasing attention in recent years. These concerns are reflected in policies at the local and national levels, including New York City, which has banned trans-fat in restaurants, and has considered similar regulations 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, as well as to promote healthy eating decisions by students. Yet there is no complete list of influential factors, let alone consensus regarding how to promote and encourage healthy eating habits.

In this paper we re-examine a theory of limited self-control from the psychology literature (Baumeister et al., 1994 -2007) which implies that individuals are most prone to unhealthy food choices at times when there are other demands on their self-control. Several psychology experiments (Shiv and Fedorikhin, 1999; Baumeister et al., 1994, 1998, 2006) have documented a propensity towards unhealthy foods caused by psychological pressure in controlled settings. We develop a model of limited self-control and test its implications using field data from a large university in the US, where students have access to healthy and unhealthy food options available to them during times of varying demands on their academic self-control. To pinpoint our hypothesis more precisely, as well as to explore the external validity across cultural settings, we run a controlled field survey and experiment at a large university in China.

In the field data, we find that the likelihood of making a fast food purchase (less healthy) versus cafeteria (healthier) is highest during final exam weeks than during other times requiring less discipline. In order to rule out convenience and time constraints as alternative explanations for this behavior, and in order to check the influence of academic factors which are unobservable in the field data, we also conduct a survey combined with a snack choice field experiment. We find that in spite of equal access and convenience of the different snack choices, students who reported higher time commitments needed to complete their upcoming academic responsibilities, were more likely to choose the unhealthy snack options. The experimental findings are consistent with what we find in the transactions data.

A substantial body of psychology literature points out, following 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; Fang and Silverman, 2009), and as a distaste for temptation (Gul and Pesendorfer, 2001), but has rarely discussed the issue of competing self-control demands. Our analysis focuses on the "strength model" of self-control proposed by Baumeister and collaborators, which hypothesizes that self-control is a limited and exhaustible resource. The strength model implies that when a decision-maker must exert self-control in one aspect of life, his or her self-control in other aspects are more likely to falter. To our knowledge, the only prior study which offers a formal economic theory of self-control limits is Ozdenoren, Salant and Silverman (2012). In their model, decision-makers solve a dynamic cake-eating problem under a willpower constraint, where other activities of the decision-maker draw from the same stock of willpower. We propose a model of limited self-control in a purely contemporaneous allocation decision, focusing on the tradeoff between self-control in different activities a decision-maker faces 'at once'.

Studying at the university level, whether completing assignments or preparing for an exam, requires self-regulation and concentration (see Crede and Kuneel, 2008 for a survey). For university students, workloads tend to vary substantially based on the timing of the academic quarter or semester,

with many courses having synchronized deadlines for important assignments at the end of an academic term. The academic schedule thus serves as a natural experiment for inferring behavioral responses to increased cognitive workloads, where the end of an academic term is a 'high workload' event.

According to the strength model, we should expect to see lapses in students' self-control on health-related decisions during studying-intensive time periods during the academic year, particularly those time periods immediately prior to and during exams. This is consistent with the ego depletion effect (see Baumeister and Vohs, 2016, section 2.1) which is the signature implication of the strength model in the short-term. 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 restaurants versus cafeteria options. Public health and marketing research consistently finds that making healthy food choices is difficult in fast food restaurant settings (Stender, Dyerberg and Astrup, 2007; Chandon and Wansink, 2007; see also Story, Kaphingst, Robinson-O'Brien and Glanz, 2008), even in the presence of "healthy" menu 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 the healthier cafeteria options. To rule out convenience-based explanations, we implement a food choice field experiment, which draws on variation in students' self-reported workloads and a real food choice task. Evidence from our field experiment indeed reinforces the evidence that individuals find less healthy foods more appealing when they are under higher workloads.

We note that finding such behavior in the field is intuitive but is far from being an obvious conclusion. 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 (see for example, Muraven, Baumeister and Tice, 1999; Oaten and Cheng, 2006a,b; Wang, Rao and Houser, 2017 which find evidence for the strengthening of self-control across domains over longer time periods). That is, individuals might switch into an across-the-board disciplined lifestyle when final exam time arrives, studying hard and eating healthy at the same time. Alternatively, eating choices might be primarily dictated by some other unseen factor unrelated to self-control demands, such as tastes, location or convenience, amounting to little discernible pattern with respect to healthy food and workload timing. Thus the fact that we find an inverse relationship between workloads and healthy food choice, lends a degree of surprising support for the idea that self-control in different domains compete with each other in the field. While clean identification of the limited self-control motive may be challenging to establish using field data alone, we refer to the existing experimental psychology literature on this point, and instead focus on documenting the real-world consequences in the field across similar domains as in the experimental literature.

In addition to providing field evidence on the strength model, our study contributes to the literature which seeks to explain differences in health-related behaviors among individuals of different economic circumstances. The influence of health status on a wide range of economic behaviors has been established (Finkelstein, Luttmer and Notowidigdo, 2013). At the same time, economists are interested in understanding how economic circumstances can in turn affect health behaviors. Koc and van Kipperslius (2015) find evidence that the educational disparity in healthy food consumption may be due to the marginal value of health rising with education. In a line of research which bears similarity to the argument of the limited self-control theory, Mani, Mullainathan, Shafir and Zhao (2013) find that poverty serves to reduce the cognitive capacity of farmers, arguing that having to deal with poverty drains individuals' capacity for addressing other cognitive tasks. Shah, Mullainathan and Shafir (2012) argue that living under scarce resources causes shifts in attention which tend to lead to over-borrowing.

We provide supporting evidence for the theory that demands on individuals in one cognitive domain (ex. various self-control demands), can potentially explain different outcomes in a completely different domain (ex. health factors).

The remainder of the paper is organized as follows: Section 2 presents an overview of the relevant literature on self-control and food choices; Section 3 presents our model of self-control in food choice and studying activity; Section 4 presents the empirical study in the US; Section 5 describes our field survey and experiment in China; Section 6 concludes and discusses policy implications.

2. Related Literature

2.1 Evidence on Limited Self-control

Our study is one of few to our knowledge that estimates the relationship between different self-control choices across domains using actual transactions data from 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 are consistent with a strength model of temptation resistance.

A series of studies by Baumeister et al. (1994, 1998, 2006 plus see 2007 and 2016 for surveys) 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…. 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." Baumeister and Vohs (2016) provides a detailed survey of the literature and up-to-date conceptual framework for the strength model.

Laboratory experiments testing for limited self-control typically vary the self-control requirement or difficulty on a first task and measure subjects' self-control ability in another unrelated task. The frequent finding is that performance in the second task decreases as the demands on one's self-control in the first task increase. Baumeister and co-authors explore this hypothesis even more directly using a biological approach: Gailliot et al. (2007) showed using experimental glucose injections, that glucose levels, needed for most brain activities, were directly predictive of subjects' self-control abilities. Low glucose levels in the bloodstream reduced subjects' self-control. Indeed, if the evidence from the psychology and physiology literatures are valid outside the laboratory, individuals' choices in the marketplace should reflect the underlying tendency to lapse in self-control when the environment is cognitively taxing.

In spite of its intuitive appeal and physi ological 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. In fact, 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 students about their behaviors. They find that students who reported a limited resource belief about self-control earlier in the semester were more likely to self-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 more general view of the strength model concept, 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.'s marshmallow test, their hypothesis studies a source of heterogeneity in self-control capacity. In the current study, we are most interested in whether taken as a whole, students tend to increase their consumption of certain types of foods during intense workload times. We do not attempt to address the issue of whether individuals with especially high self-control and/or belief in unlimited self-control eventually hit some form of willpower constraint. Some recent work along these lines includes Tsukayama, Duckworth and Kim (2012).

Enhancing the understanding of the origins of the self-control budget, several studies show that individual self-control abilities across domains can be enhanced in the long-term through practice and training. Muraven, Baumeister and Tice (1999), and Oaten and Cheng (2006a,b) test whether training and practice in self-control implementation improve self-control outcomes in a variety of daily life domains, and find positive evidence. Wang, Rao and Houser (2017) utilize a natural experiment in alcohol tolerance and social pressure for alcohol drinking, to show that the impulse control skills obtained through experience in the alcohol domain extend to impulse control in the domain of selfish temptations.

In the short-term frame, where limited self-control tends to predict a tradeoff in success across domains, experiments by Bucciol, Houser and Piovesan (2011, 2013) show that being exposed to temptation without being allowed to indulge in it has an adverse effect on labor productivity. In their studies, subjects in the treatment groups are exposed to a temptation (attractive snacks and drinks, or a funny video) and are specifically told *not* to indulge in the temptation. They find that subjects in the treatment group are significantly less productive in a subsequent work task, compared to subjects who were never exposed to the temptation originally. Their findings are consistent with self-control limits, since subjects in the treatment groups were instructed not to indulge in the tempting activity, shifting self-control away from the work task. Our study can be seen as complementary to theirs in that we exploit variation in student workloads as a natural experiment and examine the effect on tempting fast foods and junk foods. Thus, regardless of whether the manipulation is in the tempting (ex. food) or non-tempting (work or study) domain, the self-control constraint seems to be robust.[2] In Bucciol, Houser and Piovesan (2011), which specifically exposed children to attractive snack temptations, the lower

[2] The results of Bucciol, Houser, and Piovesan (2011, 2013) suggest that if students were restricted from consuming tempting but unhealthy food during high academic workload periods, their academic performance would be worse.

productivity was primarily found among the younger children. Our study implies that the temptation of food is similarly influential even into adulthood. Vohs and Heatherton (2000) experimentally test the effect of temptations both related and unrelated to the food domain on self-control success in dieters, also finding evidence for the substitutability of self-control across domains.

Other related studies include Burger, Charness and Lynham (2011), which tests the effect of deadline spacing and cognitive load on procrastination and task completion. The experiment yields mixed support for the limited self-control hypothesis, with high cognitive load inducing both procrastination and higher success rates among subjects in an academic task. Kuhn, Kuhn and Villeval (2017) also find mixed evidence for the strength model using glucose intervention experiments. Their results which find significant placebo effects, are supportive of a hypothesis that the interventions operated through the framing of participants' decisions rather than resource-depletion.

2.2. Evidence on Food Choices

Our study also contributes to the health economics literature, where recent studies have been especially concerned about the behavioral determinants of obesity and other health risks. Currie, DellaVigna, Moretti and Pathania (2010) estimate the effect of fast food restaurant proximity on weight gain. They find that for 9th grade students, having a fast food restaurant within 0.1 miles 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. Courtemanche, Heutel and McAlvannah (2011) use time preference to explain patterns in obesity rates in the US, and use a quasi-hyperbolic discounting model to predict Body Mass Index. 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. 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 the current study, 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 when under no stress. In a study which provides complementary evidence to ours, Wansink, Cao, Saini, Shimizu and Just (2012) use food purchase data from university cafeterias to show that in the aggregate, purchase of unhealthy foods increases significantly towards the end of the semester. While providing compelling evidence, their analysis does not distinguish whether these effects are due to within-person or across-person behavior. Our analysis shows that the effects are indeed robust within-person, and thus increases in unhealthy food consumption towards the end of the semester cannot be explained away by students with less healthy eating habits visiting the cafeteria more frequently during high workload times. At the same time, since their analysis is conducted fully within the domain of cafeterias, the evidence in Wansink et al. (2012) provides support for our assertion that such effects are not driven by convenience motivations, an assertion also supported in our snack choice test in Section 5.

Finally, in a paper which investigates how schools strategically respond to the positive effect of high caloric intake on cognitive functioning, Figlio and Winicki (2005) show that Virginia schools facing testing-based accountability criteria, increase the calories on the cafeteria menus on testing days. They additionally find suggestive evidence that this strategy is successful in terms of increased passing rates. Our study complements theirs in showing that the demand for relatively high calorie foods naturally occurs in response to especially high cognitive demands, especially among university students who may be fairly sophisticated about how to maximize their short-run performance on cognitive tasks.

3. Formalizing the Strength 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 such as those faced by the students in our sample.

In a dynamic version of the strength model, Ozdenoren, Salant and Silverman (2012) model a cake-eating problem under limited willpower constraints. In their model, the decision-maker must trade off the willpower forgone from resisting over-consumption of a fixed supply of a particular good (the 'cake' or durable consumption item), against the implied utility from applying that willpower to other activities, simultaneously with the intertemporal decision regarding how much willpower to apply to each period.[3] In their model, the stock of cake and stock of willpower serve as dynamic constraints, while in our model we assume a per period budget constraint of self-control, and no durable goods. The per period self-control budget accords with the idea that individuals' self-control may be replenished after a certain period of time, and the lack of durable consumption in our model mirrors our particular field setting.

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. For simplicity, our model has self-control as the sole choice variable, but the implications for actual actions in each domain directly follow. First consider the case of self-control in a single domain. We specify $U: R \to \mathbb{R}$ where R is the domain of self-control choice r, and $U(r) \equiv W(a^*(r), r)$. Here, W is the original utility function, and a^* is the optimal action given self-control choice r. That is, in addition to the direct disutility of implementing self-control, the individual's utility is increasing in their optimal action choice a^*, which is in turn an increasing function of their self-control choice r. An individual's utility can thus be written in simplified format U as purely a function of self-control choice r. For example, exerting self-control on food choice, may directly give an individual disutility, since self-control requires effort. At the same time, exerting self-control in food choice, increases the fraction of healthy foods consumed, and provides a 'long run' health benefit from this choice of observable action in the food domain. We can easily extend this basic

[3] Their model can replicate some commonly observed phenomenon in the intertemporal choice literature, such as activity specific discount factors. While their model generates a rich set of implications in the dynamic setting, our model focuses on a behaviorally plausible static setting which can explain our field data without dynamic considerations.

reasoning to the case of self-control across multiple activities. Further, we note that the framework is general and is not limited to the analysis of food and studying decisions.

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

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

where c_f is the cost of exerting self-control on food, and 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 initial 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:* $\forall a \in \{f, s\}$, $\frac{\partial U_a}{\partial r_a} > 0$.

Monotonicity implies that the marginal payoff from implementing greater self-control in either activity is positive.[4] For both studying and eating healthy this is reasonable, with the exception that exerting excessive self-control in any activity may potentially lead to decreasing total payoffs, due to the disutility of implementing self-control outweighing the benefit realized through the action choice. Without loss of generality, we assume that utility-maximizing individuals are on the part of the payoff function that is increasing in self-control implementation.

2. *Concavity:* $\forall a \in \{f, s\}$, $\frac{\partial^2 U_a}{\partial r_a^2} < 0$.

Concavity implies diminishing marginal utility U_a to greater self-control choice r_a. 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 $U_a = U_a^+ - U_a^-$.[5] We first consider the concavity of the gross utility function with respect to self-control. In the case of studying, our assumption is

[4] This implies $\frac{\partial W_a}{\partial a}\frac{\partial a^*}{\partial r_a} + \frac{\partial W_a}{\partial r_a} > 0$.

[5] The result holds in a more general sense under the following assumptions: $\frac{\partial^2 a^*}{\partial r_a^2} < 0$, $\frac{\partial^2 W_a}{\partial a^2} < 0$, $\frac{\partial^2 W_a}{\partial a \partial r_a} < 0$, $\frac{\partial^2 W_a}{\partial r_a^2} < 0$.

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 healthy for one more meal is less beneficial when one eats healthy frequently, as compared to when one seldom eats healthy. 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. Individuals are operating in this portion of the payoff function.

Under the above two assumptions the optimal choice of the student is determined by the following first order condition: $\frac{\alpha \cdot U_f^{'}(r_f^*)}{c_f} = \frac{(1-\alpha) \cdot U_s^{'}(r_s^*)}{c_s}$.

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

3. *Substitutability:* $\frac{\partial r_f^*}{\partial c_s} > 0$ *and* $\frac{\partial r_s^*}{\partial c_f} > 0$.

We note that this substitutability assumption can be more fundamentally expressed as a criterion on the utility functional form of U_a. Specifically, the coefficient of relative risk aversion, $r_a \cdot \frac{\partial^2 U_a}{\partial r_a^2} \Big/ \frac{\partial U_a}{\partial r_a}$ should be greater than -1.[6] Since the equivalence between the substitutability and relative risk aversion conditions is standard, we skip the proof. A large class of commonly used utility functions in the literature can satisfy this criterion, such as constant relative risk aversion utility, $U_a = \gamma \cdot (r_a)^{\rho} + \kappa$, where $\gamma, \kappa > 0$ and $\rho \in (0,1)$.

An intuitive interpretation of the substitutability assumption is that during different time periods, depending on the 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 during 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 and less self-control towards the food choice. In a world of finite self-control, the substitutability assumption perfectly captures the phenomenon that less self-control is allocated to the food realm when the "relative price" of self-control on studying drops during intensive academic periods. The same intuition holds for the relative price of self-control on studying falling due to the price of self-control on food increasing, all else equal. An interpretation is that during final exam times, the cost of failing in self-control in academics is high, thus the opportunity cost of implementing one's efforts in the food domain is also high.

[6] Note that since $\frac{\partial^2 U_a}{\partial r_a^2} < 0$, this means that $abs\left(r_a \cdot \frac{\partial^2 U_a}{\partial r_a^2} \Big/ \frac{\partial U_a}{\partial r_a} \right) < 1$.

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 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 interpretation since it reflects an "external" change rather than an internal one, which more accurately reflects our field settings.

Our framework implies that higher self control implemented in a particular domain leads to utility increasing outcomes in that domain. That is, higher (lower) self-control on food implies lower (higher) likelihood of purchasing the "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.

In summary, substitutability in our framework implies that as the price of academic self-control decreases, the optimal degree of self-control in the food domain declines. Given the monotonic relationship between self-control and the related action, reduced self-control in the food domain has a negative impact on healthy choices. Thus 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. Empirical Study in the United States

We analyze the data from a campus-wide debit card system used 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 on-campus. All major fast food restaurant and cafeteria establishments on-campus accept the campus debit card as a payment method.[7]

The university campus is structured so that each student dormitory has a corresponding cafeteria directly adjacent to it, where anyone can purchase meals. The university is in fact arranged into individual colleges, where each college has a set of dormitories, academic buildings/classrooms and cafeteria, corresponding to a geographic area of the campus. Students are assigned into a college upon entry into the university.[8] The fast food restaurants are primarily located in the student center on-campus. Thus, students have opportunities to purchase meals at either cafeteria or fast food options, both of which offer "to-go" as well as "sit-down" eating options. In general, the campus cafeterias tend to hold earlier and later service hours than the fast food restaurants.[9]

[7] Selected eating establishments off-campus also accept the campus debit card as payment through an arrangement with the university. The great majority (about 91.5%) of the debit card purchases occur on-campus.
[8] The assignment of students into the colleges is not fully random, but is also not perfectly correlated with major choice.
[9] In Section 4.2.4 we examine the frequency of purchase by time of day which confirms this.

Use of the campus debit card is prevalent among students and staff at the university. In terms of transaction convenience, compared to other payment options such as cash or credit card, it is the simplest payment method for both customers and retailers. Our data include all transactions made using a campus debit card in the year 2005 - 2006. Since the eating choices of non-student users should be considerably less affected by the timing of exam periods, we exclude university staff from the analysis.[10] Indeed, among the relatively low number of observations we have from the accounts of university staff members, we observe that fast food restaurants were generally quite unpopular among staff, accounting for just 8 percent of observed transactions. The corresponding analysis on the staff data does not yield the same patterns that we observe for students Since the workload for staff members do not differ substantially between final weeks and regular weeks in the same way as for the students, the lack of similar effects among staff members serves as a type of counterfactual robustness check on the effects found among the students.[11]

The data are rich in that we observe all purchases made using the campus debit card at the transaction level, including the date, time, restaurant name, and dollar amount of the purchase. These are the main useful variables that we observe in the data set. However, the data are limited 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, specifically the likelihood that a purchase was made by an individual at a specific type of restaurant in a particular week. 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 insignificance.

4.1 Likelihood of Different Fast Food Purchases

To estimate the relative likelihoods of making a purchase of each food type at different time points in the year, we estimate 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. For each fast food restaurant group, the likelihood of purchasing a given food type is estimated relative to the comparison restaurant group: campus cafeterias. According with the general intuition of American consumers, studies in the health and nutrition field consistently confirm the unhealthiness of fast food cuisine (see for example, Stender, Dyerberg and Astrup, 2007). 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). Table 1 shows our K categories of food types and the restaurants contained in each type.

[10] The data allow us to classify users as either staff or students, or sometimes do not allow us to classify the type of user. Although the estimates we report in the paper assume that unclassified users are students instead of staff (consistent with the food purchase patterns observed), all of the results reported are robust to the stricter classification of student users.

[11] In particular, among the 3,673 transactions we observe from staff members 70% of them were made at university cafeterias. Coffee stand purchases account for another 22% of the staff transactions. Running our empirical specifications on the data of staff members does not yield a pattern similar to that which we obtain for students.

Table 1: Data Summary

Food Type	*Included Restaurants (* denotes on-campus location)*	*Transactions*	*Avg. Spent($)*
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 multinomial logit specification, X_i includes indicator variables for weeks of final exams as well as the weeks immediately before and after final exams, 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 we do not observe any demographic variables in the data, the aforementioned variables serve as proxies for consumer types. In Section 4.2.2 we consider a binomial conditional logit model with individual consumer fixed effects to more completely control for individual heterogeneity, with essentially the same results.

Our use of time indicator variables resembles an event-study analysis. We expect the week of finals and the week leading up to finals to impose the greatest demands on students' self-control in the studying domain. These two weeks are the 'treatment weeks'. In other words, letting t_f denote a final exam week, we also look for possible effects in week t_{f-1}, where much of the studying may have taken place. In addition to these two main candidate weeks, we include indicator variables for t_{f-2} and t_{f-3}, as well as t_{f+1} and t_{f+2}, as control weeks. The remaining weeks that are not included in the regression serve as an average reference group, allowing us to see whether the likelihood of purchase in the aforementioned weeks is higher or lower than the average omitted week.

Due to the institutional rules of the same university's on-campus cafeteria program, we restrict our main analysis to the first two final exam periods of the year. Students enrolled in the cafeteria program are implicitly discouraged from depositing additional money into their cafeteria plan due to the policy that unused cafeteria money is non-refundable. Thus, in the third quarter of the academic year, as some students begin running low on cafeteria money, they begin to use their debit card to pay for cafeteria meals, which artificially drives the ratio of fast food to cafeteria purchases in our data downward throughout the third quarter. In order to avoid biasing our coefficient estimates of interest upwards due to this policy, our main results omit all weeks from the third quarter, except the first two weeks of the third quarter which serve as post-finals control weeks for the second quarter. The results which include the third quarter are provided in Appendix A, and indeed produce a stronger effect due to

this shift in payment patterns.[12] We also estimated a specification which excludes all weeks after the second finals period, thus cutting the third quarter out of the data completely, with similar results. Both of these alternative specifications tend to inflate the estimated likelihood of fast food purchases during finals week.[13]

Figure 1 shows the relative likelihood ratio and 95% confidence intervals of hamburger restaurant purchases compared to a cafeteria purchase, for our weeks of interest. Final exam weeks t_f are highlighted with orange vertical bars. The figure shows that making a purchase at the hamburger fast food restaurant is significantly more likely than making a cafeteria purchase during final exam week. 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. Students did not eat fast food hamburgers very often, but they were most likely to do so during final exam time.

Figure 1: Relative Likelihood of Hamburger Restaurant Purchase (comparison group: Cafeterias)

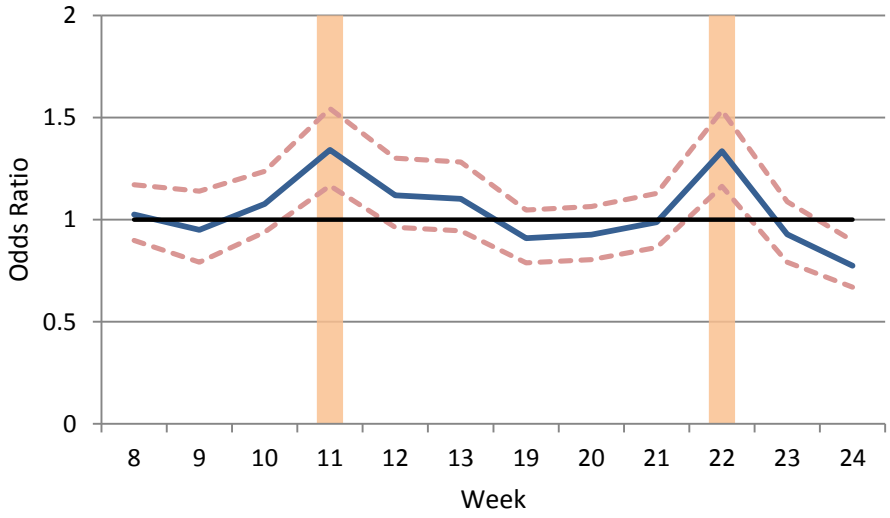


Figure 2 shows the relative likelihood charts for all other restaurant categories, again with cafeterias as the comparison group.

We find similar patterns for Mexican restaurants, Asian restaurants, sandwich establishments and the "Other" category of chain restaurants which consists primarily of off-campus restaurants. The charts for the complete set of restaurant types are shown in Figure 2. The variety of restaurant types displaying this final exam week purchase pattern 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. We concretely rule out the convenience alternative hypothesis using a field experiment in Section 5.

For the other restaurant categories, the relationship is less clear. We generally find an increase in the likelihood of pizza purchase in the week prior to exams versus exam week itself. One possibility is

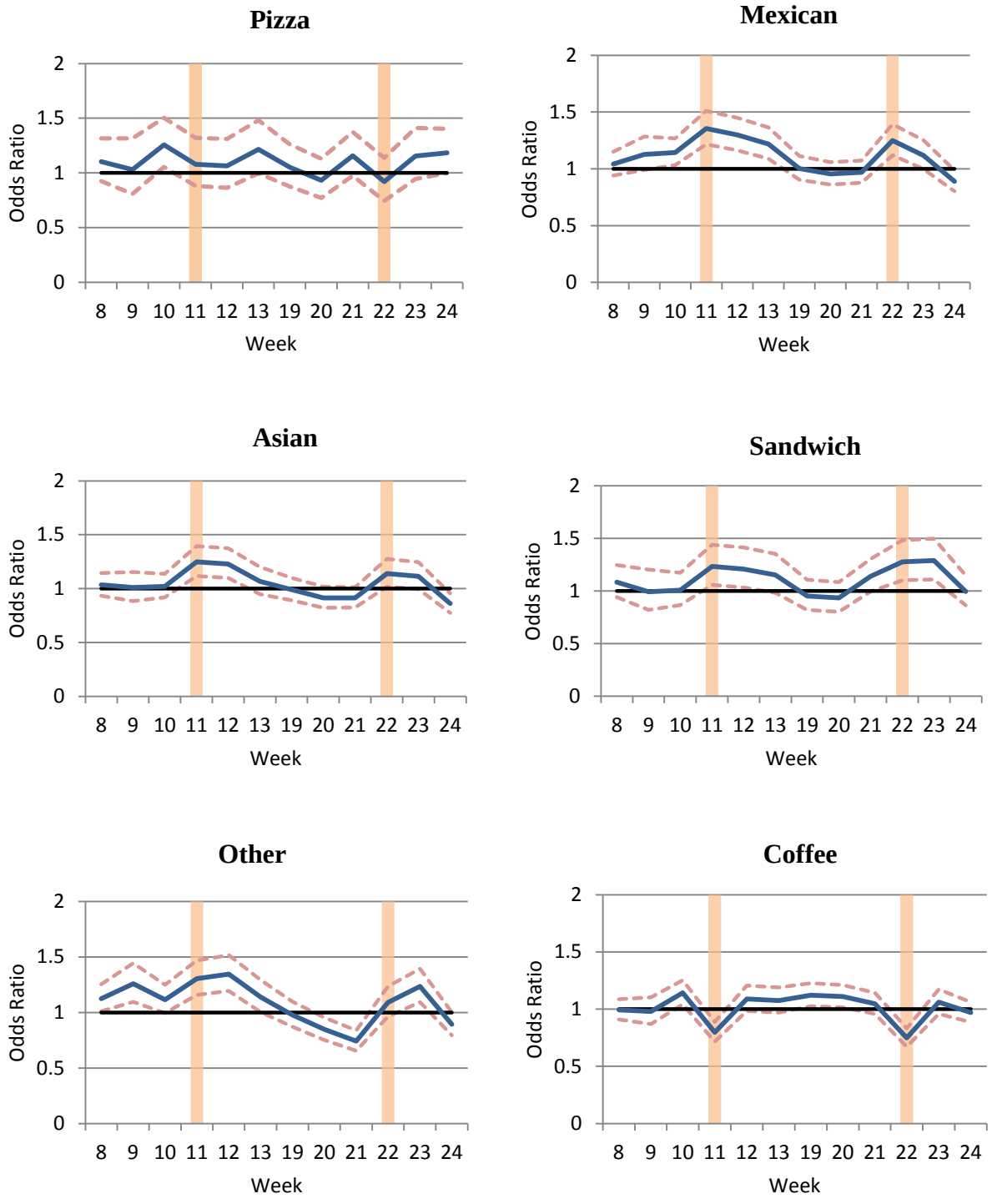
[12] The downward trend in fast food purchases during the third quarter can be seen clearly from the charts in Appendix A.
[13] In the case of excluding the third quarter completely, the estimates of finals week fast food purchases are inflated compared to the baseline model because fast food purchase during the first week of the quarter tends to be higher than in the average week. These estimates are available on request, although to avoid repetition we omit them here.

that pizza may be thought of as more of a study time food, as the coefficient is slightly positive in the weeks directly before final exams. As Table 1 shows, pizza was one of the less popular food categories overall. This may be in part due to the fact that pizza was relatively more expensive per transaction, also shown in Table 1.

More surprisingly, we find slight evidence of an opposite effect in the case of coffee stand purchases where coffee was less likely to be purchased during exam weeks. We speculate that the pattern could possibly be due to school sponsored study breaks which provide free coffee, or perhaps a strong appeal of off-campus brands of coffee during final exam periods. Other possible reasons include social factors, such as fewer student gatherings at coffee retailers on campus during final periods.

In the Other category, we also do not find as pronounced effect, which seems reasonable given the diverse set of stores included in this category, the majority of which are in fact located off-campus.

Figure 2: Relative Likelihood of Fast Food Restaurant Purchase (comparison group: Cafeterias)



4.2 Robustness Checks

Several robustness checks are conducted in order to support and understand the mechanisms behind our main results. In this section we discuss each of the robustness checks we implement. The Tables and Figures containing these results are shown in the Appendix.

In Section 4.2.1 we allow for individual student fixed effects in a binomial logit. The result is essentially similar to the multinomial specification with spending habit controls in the previous section.

In Section 4.2.2 we investigate to what extent the original pattern varies based on the amount of purchase, rather than only the frequency of purchase. First, we re-estimate the main multinomial logit results, but imposing a minimum purchase amount cutoff. This is intended to check the possibility that students are merely buying beverages at the fast food restaurants during final exam time out of convenience. We find that restricting the sample to a minimum purchase amount cutoff actually strengthens the results found in the previous section. That is, the final exam week effects are not able to be explained using beverage or other possible purchases of "small cost" items.

Then, we investigate whether the gravitation towards fast food in high workload 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 the frequency of fast food purchase, but conditional on purchasing something they did not systematically increase their spending per transaction.

Section 4.2.3 addresses potential time constraints in students' purchasing abilities. First, we use the time stamp data on each transaction to confirm that our main results are not driven by differences in operating hours of cafeterias and fast food restaurants. In fact, making a late night purchase was relatively more common at cafeterias than at the fast food restaurants. We then address the possible explanation that students might have found the fast food restaurants more conveniently accessible during the exam period due to the scheduling and locations of the final exams. We utilize the time stamp data on each transaction to verify that our main results are not driven by the scheduling of the final exams.

In Section 4.2.4 we conduct a robustness check on the effects of weather, specifically temperature and precipitation, on food choices. The original results are robust to the inclusion of weather variables, while the weather variables do have some significant effects on the attractiveness of various food options.

4.2.1 Individual Fixed-Effects

The previous analysis showed the aggregate likelihood trends of purchase for each food category in the aggregate. However, one question is whether the result holds within-person.

To test this we run a conditional logit specification with individual customer fixed effects so that the comparison is made for each fast food type relative to students' own purchases from all other establishments during other weeks of the year. Within each regression, the coefficients represent the average effect across individuals. Note that one key source of potentially different results in the fixed-effects case is that within each food-type regression, individuals who never made a purchase in that particular category will be dropped from the sample.

The results for the fixed-effect regressions are very similar to the multinomial logit specification with customer purchasing characteristics from the previous section. Table B1 in Appendix B displays these results for all fast food categories.

The results for Hamburger restaurant purchases, Mexican fast food, and Sandwiches remain similar. The effect for Asian fast food weakens in the second quarter such that it is no longer significant at the 10% level, but the effect in the first quarter remains strong and significant. As in the multinomial logit specification, the relationships for coffee and pizza remain relatively unsupportive of the hypothesis. However, in the conditional logit case, the coefficients in the pizza regression for the week before finals week are significant (first quarter) or else on the margin of significance (second quarter). This supports the idea that pizza may be a preferred food during studying periods but not during exam periods. The Other category of fast food restaurants does not show a clear pattern for either finals week or the week before finals.

Table B2 in Appendix B shows the analogous results including all three quarters of data, and the finals week increases in purchase likelihood for the aforementioned fast food groups in Quarters 1 and 2 remain. The fact that fast food purchases increase sharply during final exam week compared to other weeks appears to be quite robust.

4.2.2 Quantity or Value Effects

Minimum Purchase Amounts

A potential drawback of the field data is that we do not actually observe the items being purchased in each restaurant. We have assumed that the purchases being made at different times of the year are uniformly representative of the items that restaurant specializes in. In other words, as long as students do not proportionally increase their purchase frequency of 'healthy' foods from fast food establishments during finals week, the results in the previous section should remain valid.

However one possibility is that during final exam weeks, students go to fast food restaurants to purchase beverages and other small items which are not representative of the main type of food that particular fast food restaurant serves. To check this hypothesis, we rerun the multinomial logit specification of the previous section, restricting the sample to transactions made which exceed $2.50 (the number of transactions in the data was reduced by 23,516 or about 20% of the original sample). We note that censoring the sample based on minimum amounts in this manner could also inadvertently exclude other unhealthy yet inexpensive purchases made such as French fries, cookies, and other small side dishes. The results are shown in Appendix C.

We find the results are generally *stronger* than in the baseline estimation results. Thus small purchases are not driving the desire to purchase from fast food restaurants during high workload periods. Varying the minimum purchase amount within reasonable ranges yields similar results.

The Intensive Margin (Expenditures)

We also test whether students tended to spend more on each transaction during finals periods. We do not find consistent evidence that students spend more on fast food during final exams, on a per visit basis. Tables C1 through 3 in Appendix C 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 tended to show strong finals week effects in terms of likelihood of making a transaction.

Each regression includes only the data for the restaurant type in question. We restrict the data in this way since otherwise the purchase decision itself dominates, making the intensive margin appear significant.[14] 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 the result is tangential to our main question of interest. For simplicity, in these regressions, we consider just one week before and after the main candidate weeks of pre-final exam week and final exam week. However, the lack of consistent result is similar regardless of the time window considered.

Table D1 shows that visitors to the Hamburger restaurant did not significantly increase their spending amount in response to high workload, at least not in the first and last quarters. There is some degree intensive margin effect in the second quarter, but the magnitude is not large, at less than a 10% increase. A similar effect exists for Mexican restaurants (Table D2), but the effect size is even smaller. While Asian fast food restaurants (Table D3) show a significant effect in terms of the likelihood of purchase, there is no significant effect for transaction amount. The only significant coefficient is negative in quarter two for the week after finals. The other restaurant types show similarly insignificant and/or irregular patterns of spending variation by week. We omit them due to space considerations. Overall, the evidence seems to indicate that students did not tend to lapse in self-control on spending amounts, but rather in the choice of *what type* of food to eat.

4.2.3 Time Factors

Restaurant Opening Hours

One question is whether the increased likelihood of purchasing fast food during final exam weeks could be due to extended serving hours of the fast food restaurants during that period of time, or late night snacking on fast foods by students during exam week. The former factor would refute our limited self-control hypothesis, while the latter factor would provide additional detail on our hypothesis. The data indicate that neither of these explanations were the source of the final exam week effect.

Appendix D, Figures D1 through D4 show histograms of the distributions of purchase times by hour of the day, for each restaurant type, during different weeks of the year. The horizontal axis plots the hour of day, demarking approximate hours of typical mealtimes, where purchases made after 21:00 may reflect late night snacking. The prevalent pattern in the data is that late night purchases were in fact more likely to occur at *cafeterias* rather than fast food restaurants, whether during finals or non-finals weeks of the year. This is consistent with the fact that the cafeterias are located near students' residence halls.

The tabulation of purchase frequencies based on hours of the day indicates two important facts in the data: 1. The increase in fast food purchase during finals week was not due to fast food restaurants opening longer hours compared to cafeterias as both categories of restaurants proved to be open late at night; 2. Students tended to do their late night snacking at the cafeterias rather than at fast food establishments, perhaps due to the proximity of the cafeterias to their dormitories.

[14] In other words, the impact of spending nothing at a given restaurant type compared to spending a small amount dominates, when this is actually a decision about whether to spend at that restaurant rather than how much to spend.

Final Exam Schedules

One potential confounding factor in our results is the possibility that the structure of the final exam schedule arrangement makes fast food dining significantly more convenient than cafeteria dining. In order to check this possibility, we obtain the exact final exam schedule and arrangements in the year of our data.

The final exam arrangements at the university are scheduled in a pre-determined university-wide mapping between weekly scheduled lecture time and final exam time during final exam weeks. Furthermore, the classroom location of the final exam is the same as the classroom of the weekly lecture.[15] This means that students will visit the same locations during final exam weeks that they visit during the regular weeks of the quarter.

It remains for us to check whether the timing of the final exams during the course of the day might account for the attractiveness of fast food from the convenience perspective. In other words, while the final exams are indeed spread around the campus in the classrooms according to the college system, some students with exams near the fast food restaurants may choose to eat there mainly for convenience purposes during the break-time in between the final exams.

In each quarter, the first scheduled final exam block of the day is 8:00am to 11:00am. A half-hour break is followed by the next final exam period, 11:30am to 2:30pm. Another half-hour break is followed by the next exam period, 3:00pm to 6:00pm. Finally, there is a one hour break, followed by the last final exam period, 7:00pm to 10:00pm.

We conduct a multinomial logit model for final exam weeks only, with food type choice as the dependent variable, and break-times and adjacent time periods as the explanatory variables. The results are shown in Appendix D, and show that the morning break period was typically significantly less likely than other times to generate a fast food purchase, while the effect of the afternoon break period was statistically insignificant. The dinner break period generated higher purchase of Mexican and Asian fast foods, but also did so in the adjacent hours beforehand and afterward, suggesting that it was not the presence of the exam break alone which made purchase more likely during this time. The analogous regressions for the conditional logit model confirm that break times in the exam schedule were not responsible for the transactions increases.

4.2.4 Weather-related Effects

Outside temperature is an external factor which may also affect food choices. Since our empirical strategy in the main specification relies on the calendar timing of final exam periods, we implement robustness checks to ensure that eating patterns driven by temperature or other weather shifts are not responsible for the results reported earlier.

To test the potential impact of weather, we collect temperature and precipitation data for the city where the university is located and include them as variables in the regression.[16] Firstly, we note that the university is located in a moderate climate, where the average daily temperature during the academic

[15] Changes to the schedule and location are allowed by instructor request, however the registrar's office informs us that such requests are not common.

[16] The weather data are obtained from the site Weather Underground (www.wunderground.com), a subsidiary of the Weather Company which provides weather data originating from official government sources to various media outlets.

year studied reached a minimum of 48.2 and a maximum of 80.6 degrees Fahrenheit. In other words, compared to other climates, the temperature in our study location was relatively stable.

We implement the robustness check on our main multinomial logit model, although similar results hold for the other specifications we implemented earlier in the paper (conditional or fixed effect logit). Appendix E displays the regression results. With the weather variables included, the odds ratios for final exams weeks remain significantly greater than one for the same fast food categories as in the original specification. The magnitudes of the odds ratios are also similar to those found in the original regression.

Interestingly, there are significant weather effects in some of the food categories. When significant, precipitation is negatively associated with fast food transactions, perhaps reflecting a reluctance of students to venture out for the fast foods. Among the food categories, the likelihood of transactions at the Hamburger, Sandwich and Other restaurants are significantly increasing with temperature, while the likelihood of Mexican restaurant transactions were slightly significantly decreasing with temperature.

This concludes our robustness checks on the field data. We now turn to our field survey and snack choice experiment, designed to test our hypothesis about workload and food choice in a more controlled field setting.

5. Survey and Choice Task in China

In order to further investigate into the determinants of food choice as a function of workload, including the external validity of the strength hypothesis outside of the U.S. context, we conducted a small scale field experiment at a large university in China.

Our field data in the US setting relies on time-based factors to identify the impact of workload on food choices, but a shortcoming of the field data is that we do not have any information about the academic requirements of individual students in the sample. We have been assuming that self-control demands in the academic realm are largest during and directly before the final exam week. Having direct information on student workloads would be useful, since it would help us in ruling out alternative explanations such as convenience, or perhaps fast food discounts which could plausibly drive food purchase patterns, but which are not well-observed in our field data.

The survey/experimental approach helps rule out some other possible explanations as well. For example, a possible explanation which is difficult to directly rule out in the field data, is that the fast food during finals week was primarily purchased by students who were celebrating the completion of their final exams. Although the fact that we found little increase in spending per transaction conditioning on restaurant choice (intensive margin) suggests against this hypothesis, it may be helpful to rule this out more definitively. In the survey, we ask students very specifically about their current and upcoming workloads, so we can be sure that the appeal of unhealthy meals is not attributed to a post-workload celebration.

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 when final exams were held. Students completing the survey by the date specified in their invitation e-mail, received a free gift, their choice of an imported Korean brand snack worth about 15 yuan.

In choosing the snacks for the free gift task, we first conducted some preliminary interviews of our target subject population in order to determine which of their favorite snack foods are generally considered healthy and unhealthy.[17] We conducted this initial field research because Chinese students might have quite different ideas about the health content of various foods compared to Americans. Furthermore, health education resources in China may be less developed than in the United States, where substantial information about nutrition is available in school curricula (for example, the USDA food pyramid) and in the media (for example, the popular films "Super Size Me" and "Fast Food Nation"). The interviews served as a cross-check on the degree to which perceptions of healthiness are consistent in the two countries.[18] Based upon our interviews on subjects' favorite foods and their believed health content of these foods, combined with the feasibility of delivering the items to students without spoilage, our healthy and unhealthy snack choices for the experiment were made.

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 to sample from for our survey. 4th year students were excluded from the sampling due to the fact that they do not take courses or exams in the spring semester before their graduation, and therefore, are likely to have very different time and effort objectives during the survey period. The survey was implemented using the online survey software Sojump.

Every other day from June 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 invited to participate in an online survey 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. The two day deadline was implemented in order to maintain control over the 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 Appendix F. Out of the 200 invitations sent, 82 individuals replied, for a total response rate of 41%. After correcting for minor procedural errors, 78 individuals are used in the final sample.[19]

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). We ordered the questions in the survey in a way which could facilitate 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 important answers. The survey asked a series of straightforward questions, requiring each participant probably no more than 10 minutes to complete. A translated version of the survey is shown in Appendix F.

[17] We also conducted background research on our subject population regarding their academic workloads and their behavioral responses to stress, as these may also differ significantly than the US cultural standard.

[18] Favorite healthy foods mentioned in the interviews: fresh beef/pork/chicken (subjects said: as long as not too salty or oily), fruits, vegetables, fish or frog in chili oil, sushi, corn, cereals, bread, soy milk, biscuits, nuts (subjects said: if not too salty), flower tea, yogurt, egg, fish.
Favorite unhealthy foods mentioned in the interviews: cakes and other sweet foods, barbeque, fatty meat, cheese (subjects said: not sure), Chinese pickles, ice cream, soda, instant noodles, chocolate, spicy hot pot, hot and sour rice noodles.

[19] Out of the total respondents four individuals were 4th year students who received the survey due to a sampling error, so we omit them from the analysis, leaving a total of 78 respondents in the data.

The layout ordering of the types questions in the survey was approximately as follows (anticipated degree of relevance to the strength model in parentheses):

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

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 generally less universally 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 Diget wheatmeal crackers (neither salty nor sweet) or 2 packs of Haoliyou (Korean) brand original flavor potato chips (salty). If the respondent had replied that they prefer sweet snacks, they had a choice between 2 packs of the same Diget wheatmeal crackers (healthy) or 1 pack of Haoliyou (Korean) brand brownie squares (sweet). The quantities of each product offered were determined by their approximate relative prices in the market. We note that high salt content foods and sweet foods such as cakes and chocolate were identified in our preliminary interviews as unhealthy food choices (see footnote 14 for details). Biscuits or crackers were identified as a type of perceived healthy food.[20]

We chose Korean imported products rather than local Chinese products, so that students would be less likely to choose based on their prior familiarity with the product. Haoliyou (好丽友) 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 the gift's value. There remained small actual differences in the value of the different gifts however, with the Diget wholemeal crackers being worth 15 yuan, the chips worth 13.3 yuan, and the brownies worth 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. Indeed the choice patterns in the data do not support the suggestion of students choosing their thank you gift based on value.

At the end of the survey, subjects were informed that their 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 within one week based on the individual choice and location data.

[20] In testing the limited self-control model in a food choice task, subjects' beliefs about the healthiness of the food matter more than the actual nutritional content (ie. they believe they are giving up self-control in making their choice). On a calorie per mass basis, based on the package label, these items also fit the stereotypical ordering: wheatmeal crackers (4.79 kcal/g), brownies (5 kcal/g), chips (4.83 kcal/g). The relevant figures for fat content per mass are: wheatmeal crackers (0.212 g fat/ g), brownies (0.3 g fat/ g), chips (0.233 g fat/ g). We do not expect subjects to have exact knowledge of these figures since the information was not provided to them at the time of the choice task.

Three deliveries were unable to be completed due to the respondents being out of town. Almost all subjects wrote some insights about their quality of life at school in the optional comments section, which suggests that they were interested in completing the survey in a conscientious manner.

5.1 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 wheatmeal crackers. 36 out of 78 respondents reported preferring sweet snacks over salty snacks. 28 of them chose the brownies and 8 of them chose the wheatmeal crackers.

Contrasting with the field data in the first part of the paper, the data obtained from this survey experiment is cross-sectional. Our main objective in the analysis is to check the relation between food choice and academic workload variables, where these workload variables are observable in the data. We run a standard probit specification to estimate the relationship between likelihood of choosing the unhealthy snack (chips or brownies) 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, as we are most interested in whether certain variables have significant positive or negative effects. Many of our explanatory variables are categorical and ordinal in order to make responding more convenient, and many of the replies of interest involve the respondent making an "estimate". We treat the responses to the survey as ordinal data in the regression, and emphasize a qualitative interpretation of the regression results. Table 6 shows the results of our three specifications, which include basic information (1), academic obligations (2), and interaction effects (3), respectively.

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 overall. Aside from gender, none of the other explanatory variables in specification (1) were significant predictors of snack choice, 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). Previous literature would suggest some correlation between stress level and snack choice, but we do not find this in our data.

Table 6: Probit: Dependent Variable: Unhealthy Snack (Chips or Brownies) Chosen

	(1)	(2)	(3)
Stress level	0.0334	0.0286	0.0162
	(0.0834)	(0.1038)	(0.1081)
Self control on food	0.1221	0.1716	2.4159*
	(0.3248)	(0.3300)	(1.4159)
Care for healthy food	-0.0901	-0.2427	-1.5547
	(0.3402)	(0.3584)	(1.5166)
Snacking for relaxation	-0.3100	-0.7015*	-0.5649
	(0.3453)	(0.3695)	(0.3725)
Snack flavor	0.5135	0.6330*	0.6489*
	(0.3365)	(0.3549)	(0.3683)
Time of last snack	0.1633	0.1743	0.1834
	(0.1657)	(0.1854)	(0.1884)
Gender	-0.6351*	-0.8962**	-0.8630**
	(0.3480)	(0.3791)	(0.3861)

Units enrolled		-0.5282** (0.2106)	-0.5003** (0.2069)
Estimated study time this week		0.4615** (0.1368)	0.5894** (0.2388)
Exams this week		-0.1584 (0.1368)	-0.1554 (0.1396)
Other commitments this week		-0.0610 (0.1199)	-0.0779 (0.1207)
Study time this week*Self control on food choice			-0.5524 (0.3473)
Study time this week*care for healthy food choice			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 (2) adds academic workload variables into the regression. The result shows 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. The number of exams in the coming week, other time commitments, and units enrolled did not have positive impact on the choice of the unhealthy snacks. The number of course units a student was enrolled in was actually significantly negatively associated with choice of the unhealthy snack. This suggests possible selection effects into the self-control problem, such as individuals with better overall self-control taking a higher course load, and also 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 was also perceived as being more convenient, since all snack gifts were delivered using the same promise to participants. Thus it appears that being busy with challenging tasks leads people to make less healthy food choices, and this is consistent with the previous laboratory psychology evidence on limited self-control.

Specification (2) also indicates that controlling for academic variables, preferring sweet over salty snacks was also positively associated with the unhealthy choice. This could be consistent with Galliot et al.'s aforementioned glucose self-control experiment. Surprisingly, individuals who reported snacking as one of their frequent relaxation activities were *less* likely to choose the unhealthy snack. Self-reported care for healthy 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 "Estimated study time this week".

"Exams this week" itself, did not have a significant effect on the snack choice, which on first glance may appear at odds with our results from the field data. As a robustness check, we also estimated a specification in which "Estimated study time this week" was not included in the regression, to check whether the coefficient on "Exams this week" might become significantly positive. The coefficient remained insignificant (and negative). A specification with "Homework this week" instead of "Exams this week" in the regression gave similarly insignificant results, while the specification with only the "studying time" variable consistently gave a positive and significant relationship to junk food choice. A cross-tabulation of studying time and exams by snack choice shows that among students who chose the unhealthy snack, there was a higher concentration of reported high studying times needed compared to

the distribution of the students who selected the healthy snack.[21] To better understand the relationship between "exams this week" and "estimated study time this week", we implemented a specification replacing "exams this week" with a threshold binary variable for "many exams this week". We note that all students in our sample had at least one final exam that week, which makes the survey analogous to the situation in the transactions data. The regressions show that having more than 2 exams that week serves as a significant predictor of unhealthy food choice when the studying time variable is omitted. The regression results for the binary exam variable are included in Appendix F for reference. Thus, the robustness checks on the survey data allow us to understand in more detail, the more precise workload specifications which lead to unhealthy food choice.

Specification (3) adds interaction terms and 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 healthy food. 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.[22]

Although the sample size is limited, we also implement the regressions above separately by snack choice flavor. The results, reported in Appendix F, indicate that the coefficient on studying time remained positive for both snack flavors, but not reaching the 10% threshold of significance. The results are slightly more favorable significance-wise, for the salty snack category. Overall, based upon the current sample, we can only assert that overall unhealthy snack choice is positively related to anticipating studying time, but a larger sample size would be needed to assess the significance of effects by individual snack choice flavors.

The lack of significant effect of reported stress levels on snack choice is notable and may be due to noise in respondents' perception and self-reporting. For example, students may be heterogeneous in terms of how much they either perceive or are willing to admit high stress levels. "Self-reporting on time to be spent studying", where we do find an effect on the other hand, is more framed more neutrally or with less potential stigma. Finding no significant effect of stress levels on snack choice may also be interpreted as being supportive of the limited-self control story, since it would imply that stress, which may be correlated with both workload and unhealthy food choice, may not be the *primary* driving factor behind subjects' snack choices. Future research may work more carefully on disentangling the effects of stress and workload on eating decisions.

Finally, we note that the strength model is primarily a theory about concurrent self-control and concurrent choices. However, due to the logistics of being able to deliver the snack to participants, our experiment actually addresses future anticipated self-control demands and current choices about future consumption. We use the survey as a priming device to encourage the subjects to think carefully about their future workloads in the present. The fact that we do find a significant relation between these two

[21] We omit the cross-tabulation due to space considerations, but it is available on request.

[22] 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 may be 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.

variables suggests that the priming was effective, and that our subjects may have had rational expectations about their future desires.

6. Conclusions

The strength model of self control is a natural candidate for an individual maximization framework. The idea behind the strength model is that self-control is a limited resource, and competing demands on individuals' self-control in different domains reduce the efficacy of self-control. Unlike some of the other psychological theories, which focus more on differences across individuals in self-control ability (Job, Dweck and Walton, 2010; Tsukayama, Duckworth and Kim, 2012), the strength model focuses on the depletion of a self-control budget within-person. We formalize this notion in terms of utility maximization, prices (costs) and a budget constraint in a two-dimensional self-control allocation problem. The key assumption needed in economic terms to deliver the strength model's prediction, is substitutability – that is the self-control allocated towards one domain is increasing in the price of self-control in the other domain. This type of framework can be straightforwardly extended to the case of self-control across several domains.

In our restaurant transactions data from a large US university throughout the academic year, we find that during high workload times, when individuals have high cognitive self-control demands, eating at fast food restaurants is substantially more likely to occur. The transactions data provide naturally occurring field evidence on a phenomenon which has usually focused on experimental evidence. Our field experiment pinpoints a more direct relationship between workload and food choice in the same context as the transactions data. In our survey/experiment, we find that our hypothesized connection between academic workload and unhealthy eating choices is robust. In particular, students' self reported study time requirements over the coming week were significantly positively related to the selection of the unhealthy snack to be delivered during that same time interval. This finding is robust to inclusion of several control variables such as overall course load, subjects' degree of concern about healthy eating, their degree of self-control exerted on food choice, their preferred snack flavor, and even self-reported stress levels. When people perceive that they have a more demanding workload ahead of them, the less healthy snack becomes more attractive.

Through our experiment, we are able to refute the alternative possible hypothesis from the transactions data that convenience consideration could have driven the increased fast food purchases during exam weeks, since in our experiment, the waiting and preparation time were identical for each snack choice. We can also rule out potential sales promotions, coupons or other possible interferences which might have occurred in the US field data. Since we can observe students' actual workloads from the survey, it rules out the notion that students find less healthy foods appealing as a celebration for finishing their workloads. Some potential alternative explanations however, are more difficult to rule out completely, particularly those which are biologically based, as we do not collect biological data in this study. For example, one argument is that sleep deprivation is associated both with higher academic workloads, and the desire for unhealthy foods. This can in fact be viewed as a biological basis for the strength model, as Baumeister and colleagues (Galliot et al., 2007) actually use a glucose injection treatment to test the strength model theory. The psychological and biological barriers to self-control are very likely to be intertwined.

From a policy perspective, the strength model carries some potentially important general implications: individuals cannot be expected to have perfect self-control across all domains in their life at once. If a particular policy induces high self-control among individuals in a particular domain, we

may expect their self-control in other domains to concurrently lapse. Thus policies which encourage high self-control implementation should carefully consider the possibility of this self-control externality. A direct implication of these findings for food choice decisions is that high self-control demands in other realms, such as in the workplace or personal life, may adversely affect healthy food decisions, a factor which may have been previously overlooked or underestimated. It implies that not only students, but workers who face sizable fluctuations in demands on their concentration and self-control, may be especially susceptible to unhealthy food choices during those highly demanding times. More work is needed to determine whether less healthy eating is a hidden occupational hazard for certain types of jobs with high self-control demands.

There are also industrial consequences to the limited self-control theory. For example, if the empirical pattern between work intensity and unhealthy food choice is robust among workers, insurance companies might find it profitable to charge different premium amounts for health insurance policies depending on the profession of the insured. Similarly since employers often provide health insurance programs to their employees as part of the benefits package, they may have a direct interest in the wellness of their employees. Knowing that workers have tendencies to lapse in self-control during the most demanding times in the workplace, companies can try to implement activities such as sponsored healthy snack breaks during high workload periods to combat the temptation to snack unhealthily. Another possibility is to sponsor employee exercise-oriented activities during or after high workload intervals to partially counteract the consequences of gravitation towards junk foods. In a more direct approach, perhaps addressing the root of the issue, firms can make increased attempts to design evenly distributed and reasonable workloads which would not require employees to substitute their self-control in other domains to complete their duties in the work-related domain. Similar ideas are increasingly being considered and promoted among wellness advocates in the workplace.[23]

Finally, our study provides preliminary evidence for the idea that competing self-control needs influence individuals similarly across different cultures. With high savings rates, and an education system more heavily focused on discipline, one might have expected that our Chinese subjects would not make unhealthy food choices under high workload situations as their US counterparts, yet they in fact exhibited similar choice behavior. Although the specific attitudes towards self-control may indeed differ by culture, it appears that the tendency for individuals to indulge during demanding times could hold a universal appeal.

[23] See for example, the discussions in Section 3 of http://fortune.com/2015/04/13/corporate-wellness/

References:

Baumeister, R.F., Heatherton, T.F., and Tice, D.M., Losing Control: How and why people fail at self-regulation, Academic Press (1994).

Baumeister, R.F. and Vohs, K.D., "Strength Model of Self-Regulation as Limited Resource: Assessment, Controversies, Update", Advances in Experimental Social Psychology, Vol. 54 (2016), p. 67 – 127.

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.

Bucciol, A., Houser, D., and Piovesan, M., "Temptation and productivity: A field experiment with children", Journal of Economic Behavior and Organization, Vol. 78 (2011), p. 126 – 136.

Bucciol, A., Houser, D., and Piovesan, M., "Temptation at Work", PLOS One, Vol. 8 (2013), Issue 1, e53713.

Burger N., Charness, G., and Lynham, J., "Field and online experiments on self-control", Journal of Economic Behavior and Organization, Vol. 77 (2011), p. 393 – 404.

Chandon, P., and Wansink, B., "The Biasing Health Halos of Fast-Food Restaurant Health Claims: Lower Calorie Estimates and Higher Side-Dish Consumption Intentions", Journal of Consumer Research, Vol. 34 (2007), No. 3, p. 301 – 314.

Courtemanche, C.J., Heutel, G, and McAlvanah, P., "Impatience, Incentives, and Obesity", Economic Journal, Vol 125 (2015), No. 582, p. 1 – 31.

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.

Fang, H., and Silverman, D., "Time-Inconsistency and Welfare Program Participation: Evidence from the NLSY", International Economic Review, Vol. 50 (2009), No. 4, p. 1043 – 1077.

Figlio, D.N., and Winicki, J., "Food for Thought: The Effects of School Accountability Plans on School Nutrition", Journal of Public Economics, Vol. 89 (2005), p. 381 – 394.

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.

Koc, H. and van Kippersluis, H., "Thought for Food: Understanding Educational Disparities in Food Consumption", Working Paper, 2015.

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.

Kuhn, M., Kuhn, P., and Villeval, M.C., "Decision-environment effects on intertemporal financial choices: How relevant are resource-depletion models?" Journal of Economic Behavior and Organization, Vol. 137 (2017), p. 72 – 89.

Laibson, D., "Golden Eggs and Hyperbolic Discounting", Quarterly Journal of Economics, Vol. 112 (1997), No. 2, p. 443 – 477.

Mani, A., Mulainathan, S., Shafir, E., and Zhao, J., "Poverty Impedes Cognitive Function", Science, Vol. 341 (2013), p. 976 – 980.

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.

Muraven, M. and Baumeister, R.F., "Self-Regulation and Depletion of Limited Resources: Does Self-Control Resemble a Muscle?" Psychological Bulletin, Vol. 126 (2000), No. 2, p. 247 – 259.

Muraven, M., Baumeister, R.F., and Tice, D.M., "Longitudinal Improvement of Self-Regulation Through Practice: Building Self-Control Strength Through Repeated Exercise", The Journal of Social Psychology, Vol. 139 (1999), No. 4, p. 446 – 457.

Muraven, M., Tice, D.M., and Baumeister, R.F., "Self-Control as a Limited Resource: Regulatory Depletion Patterns", Journal of Personality and Social Psychology, Vol. 74 (1998), No. 3, p. 774 – 789.

Oaten, M. and Cheng, K., "Improved Self-Control: The Benefits of a Regular Program of Academic Study", Basic and Applied Social Psychology, Vol. 28 (2006a), No. 1, p. 1 – 16.

Oaten, M. and Cheng, K., "Longitudinal gains in self-regulation from regular physical exercise", British Journal of Health Psychology, Vol. 11 (2006b), p. 717 – 733.

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

Ozdenoren, E., Salant, S.W., and Silverman, D., "Willpower and the Optimal Control of Visceral Urges", Journal of the European Economic Association, Vol. 10 (2012), Issue 2, p. 342 – 368.

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.

Shah, A.J., Mullainathan, S., and Shafir, E., "Some Consequences of Having Too Little", Science, Vol. 338 (2012), p. 682 – 685.

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.

Stender, S., Dyerberg, J. and Astrup, A., "Fast Food: unfriendly and unhealthy", International Journal of Obesity, Vol. 31 (2007), p. 887 – 890.

Story, M., Kaphingst, K.M., Robinson-O'Brien, R., and Glanz, K., "Creating Healthy Food and Eating Environments: Policy and Environmental Approaches", Annual Review of Public Health, Vol. 29 (2008), p. 253 – 272.

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.

Tsukayama, E., A.L. Duckworth, and B. Kim, "Resisting Everything Except Temptation: Evidence and an Explanation for Domain-specific Impulsivity", European Journal of Personality, Vol. 26 (2012), p. 318 – 334.

Vohs, K.D. and T.F. Heatherton, "Self-Regulatory Failure: A Resource-Depletion Approach", Psychological Science, Vol. 11 (2000), No. 3, p. 249 – 254.

Wang, J, Rao, Y, and Houser, D.E., "An experimental analysis of acquired impulse control among adult humans intolerant to alcohol", Proceedings of the National Academy of Sciences, Vol. 114 (2017), No. 6, p. 1299 – 1304.

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 (2015). "Infinitely Repeated Games with Self-Control: A Dual-Self Interpretation of the Monks Story." Automation and Remote Control, 2015, 76(3): 521-534

Wansink, B, Cao, Y., Saini, P., Shimizu, M., and Just, D.R., "College cafeteria snack food purchases become less healthy with each passing week of the semester", Public Health Nutrition, Vol. 16, No. 7, p. 1291 – 1295.

Appendix A: Multinomial logit estimates, 3rd quarter data included

Figure A1: Relative likelihood of Hamburger restaurant purchase (comparison group: Cafeterias)

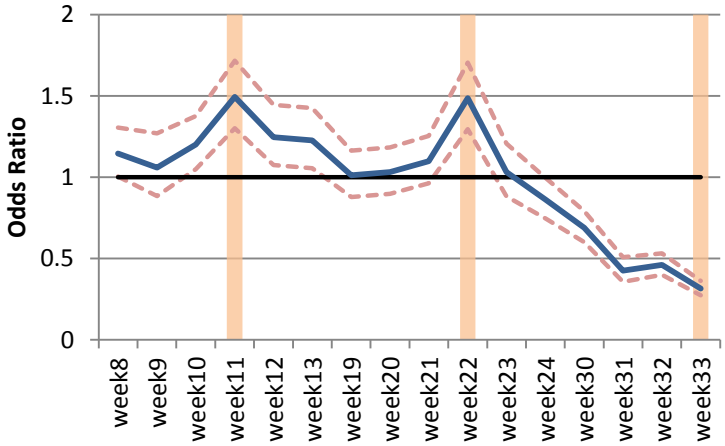


Figure A2: Relative likelihood of Mexican restaurant purchase (comparison group: Cafeterias)

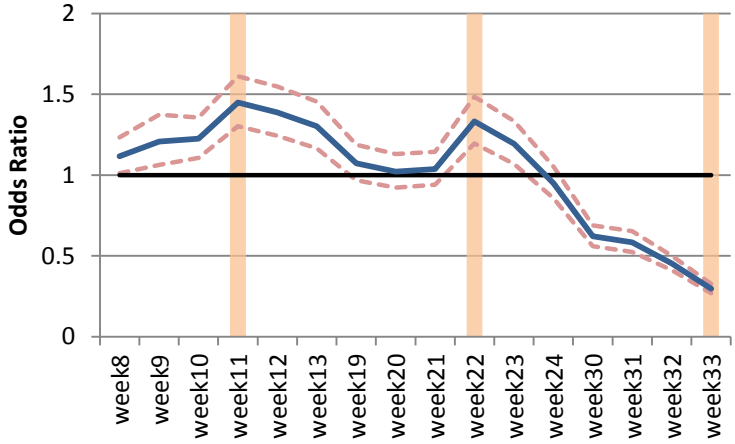


Figure A3: Relative likelihood of Asian restaurant purchase (comparison group: Cafeterias)

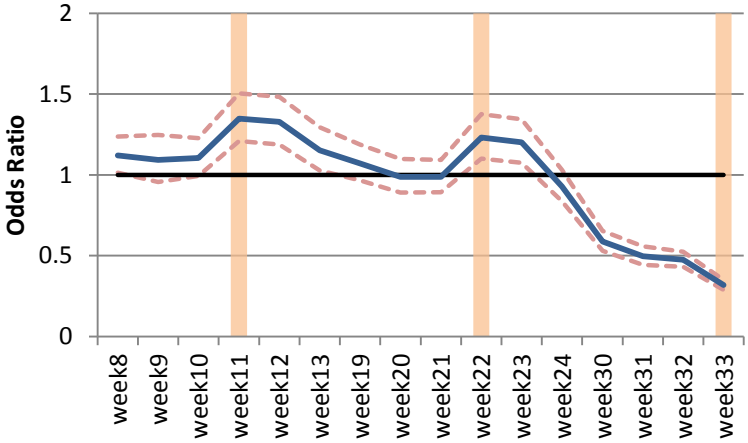


Figure A4: Relative likelihood of Sandwich restaurant purchase (comparison group: Cafeterias)

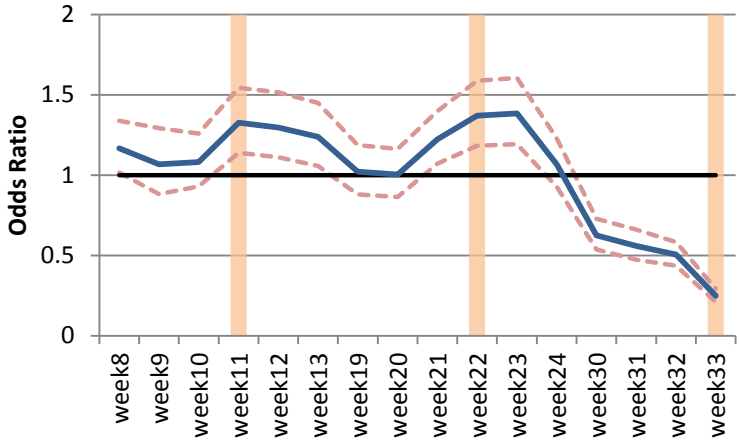


Figure A5: Relative likelihood of "Other" restaurant purchase (comparison group: Cafeterias)

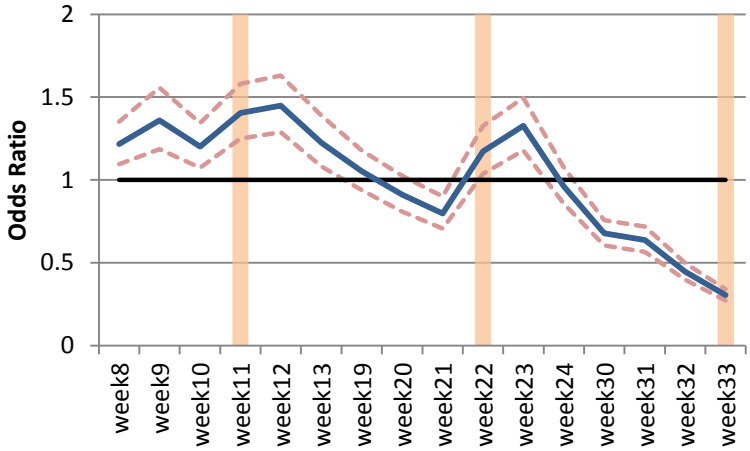


Figure A6: Relative likelihood of Pizza restaurant purchase (comparison group: Cafeterias)

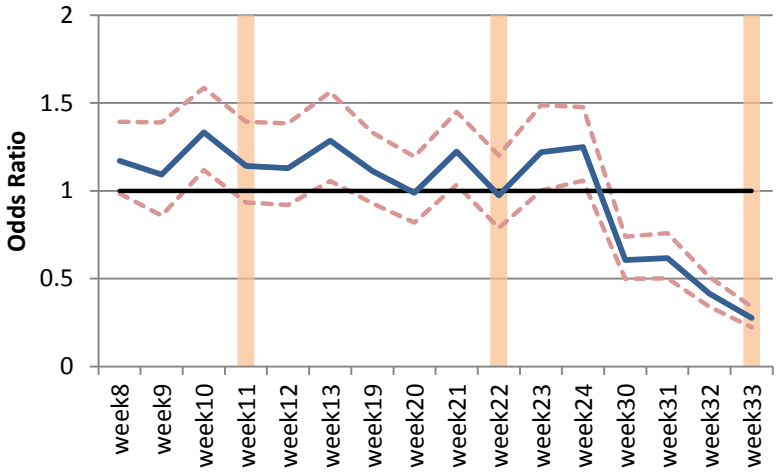
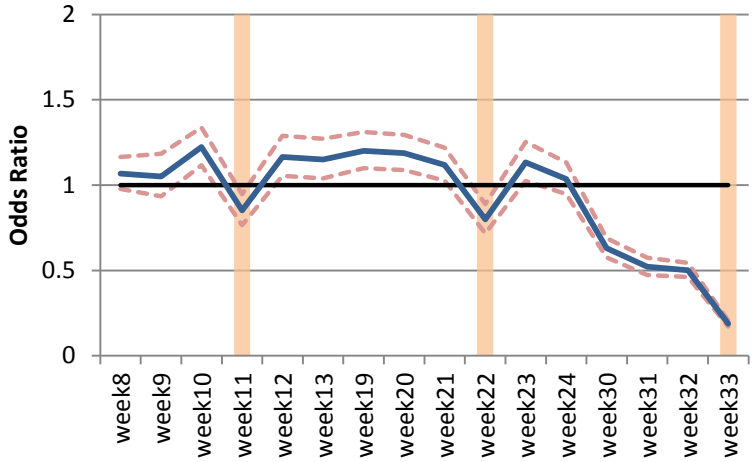


Figure A7: Relative likelihood of Coffee shop/stand purchase (comparison group: Cafeterias)



Appendix B: Conditional Logit Results

Table B1:

Conditional Logit (consumer fixed-effects): Coefficients

	Q1 Burger	Q2 Burger	Q1 Pizza	Q2 Pizza	Q1 Mexican	Q2 Mexican	Q1 Asian	Q2 Asian
finals week - 3	-0.005	-0.205***	0.135	0.005	0.015	-0.010	-0.42	-0.004
	(0.063)	(0.072)	(0.092)	(0.107)	(0.045)	(0.047)	(0.046)	(0.050)
finals week - 2	-0.988	0.345	0.040	-0.088	0.074	0.006	-0.062	-0.045
	(0.094)	(0.075)	(0.136)	(0.104)	(0.059)	(0.050)	(0.064)	(0.052)
finals week - 1	0.033	0.004	0.197**	0.155	0.037	-0.010	0.000	-0.045
	(0.071)	(0.071)	(0.091)	(0.097)	(0.046)	(0.049)	0.047	(0.052)
finals week	0.249***	0.248***	-0.003	-0.184	0.194***	0.199***	0.128**	0.077
	(0.069)	(0.081)	(0.114)	(0.134)	(0.047)	(0.051)	(0.054)	(0.057)
finals week + 1	0.010	-0.194**	-0.102	-0.084	0.117**	0.073	0.106**	0.023
	(0.075)	(0.086)	(0.103)	(0.118)	(0.048)	(0.053)	(0.051)	(0.061)
finals week + 2	0.095	-0.188**	0.111	0.173	0.113**	-0.045	-0.018	-0.120**
	(0.073)	(0.081)	(0.097)	(0.109)	(0.048)	(0.054)	(0.052)	(0.059)

	Q1 Sandwich	Q2 Sandwich	Q1 Other	Q2 Other	Q1 Coffee	Q2 Coffee
finals week - 3	0.050	-0.115	0.123**	0.018	-0.080*	0.148***
	(0.069)	(0.077)	(0.048)	(0.056)	(0.043)	(0.042)
finals week - 2	-0.055	-0.073	0.201***	-0.129**	-0.095*	0.137***
	(0.094)	(0.077)	(0.064)	(0.061)	(0.057)	(0.045)
finals week - 1	-0.057	0.146**	0.024	-0.306***	0.054	0.116**
	(0.076)	(0.074)	(0.056)	(0.066)	(0.043)	(0.466)
finals week	0.165**	0.180**	0.140**	0.066	-0.483***	-0.447***
	(0.080)	(0.079)	(0.061)	(0.065)	(0.056)	(0.060)
finals week + 1	0.149*	0.142*	0.139**	0.126*	-0.125***	-0.037
	(0.078)	(0.077)	(0.057)	(0.066)	(0.047)	(0.052)
finals week + 2	0.116	0.059	0.015	-0.149**	-0.020	0.067
	(0.824)	(0.086)	(0.061)	(0.071)	(0.044)	(0.052)

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 (consumer fixed-effects): Coefficients, 3rd Quarter data included

	Q1 Burger	Q2 Burger	Q3 Burger	Q1 Pizza	Q2 Pizza	Q3 Pizza	Q1 Mexican	Q2 Mexican	Q3 Mexican
finals week - 3	0.029	-0.130*	0.001	0.143	0.042	-0.133	0.023	-0.005	-0.129**
	(0.063)	(0.069)	(0.080)	(0.095)	(0.101)	(0.112)	(0.046)	(0.046)	(0.058)
finals week - 2	-0.058	0.091	-0.480***	0.065	-0.057	-0.054	0.085	0.014	-0.030
	(0.093)	(0.071)	(0.095)	(0.136)	(0.100)	(0.130)	(0.058)	(0.047)	(0.064)
finals week - 1	0.066	0.056	-0.319***	0.195**	0.179*	-0.272**	0.036	0.000	-0.218***
	(0.070)	(0.068)	(0.089)	(0.092)	(0.094)	(0.116)	(0.046)	(0.047)	(0.063)
finals week	0.282***	0.298***	-0.274***	-0.023	-0.179	-0.287**	0.196***	0.208***	-0.357***
	(0.067)	(0.077)	(0.106)	(0.112)	(0.127)	(0.135)	(0.047)	(0.048)	(0.071)
finals week + 1	0.035	-0.111		-0.087	-0.047		0.127***	0.083*	
	(0.074)	(0.080)		(0.104)	(0.110)		(0.048)	(0.048)	
finals week + 2	0.123*	-0.108		0.129	0.189*		0.104**	-0.025	
	(0.072)	(0.074)		(0.098)	(0.097)		(0.048)	(0.048)	

	Q1 Asian	Q2 Asian	Q3 Asian	Q1 Sandwich	Q2 Sandwich	Q3 Sandwich	Q1 Other	Q2 Other	Q3 Other
finals week - 3	-0.010	0.031	-0.240***	0.070	-0.098	-0.129	0.150***	0.038	-0.062
	(0.047)	(0.048)	(0.058)	(0.069)	(0.076)	(0.082)	(0.048)	(0.054)	(0.066)
finals week - 2	-0.028	-0.017	-0.352***	-0.021	-0.052	-0.205**	0.231***	-0.105*	-0.005
	(0.064)	(0.049)	(0.071)	(0.093)	(0.074)	(0.092)	(0.063)	(0.060)	(0.075)
finals week - 1	0.030	-0.012	-0.290***	-0.039	0.160**	-0.170**	0.048	-0.268***	-0.322***
	(0.048)	(0.050)	(0.060)	(0.076)	(0.071)	(0.080)	(0.055)	(0.062)	(0.071)
finals week	0.161***	0.111**	-0.436***	0.182**	0.192***	-0.510***	0.158***	0.092	-0.476***
	(0.054)	(0.054)	(0.078)	(0.080)	(0.075)	(0.100)	(0.060)	(0.060)	(0.100)
finals week + 1	0.122**	0.032		0.156**	0.197***		0.162***	0.178***	
	(0.052)	(0.055)		(0.077)	(0.072)		(0.057)	(0.057)	
finals week + 2	0.006	-0.083		0.136	0.107		0.054	-0.063	
	(0.053)	(0.051)		(0.083)	(0.070)		(0.060)	(0.058)	

(continued on next page)

(Table B2 continued)	Q1 Coffee	Q2 Coffee	Q3 Coffee
finals week - 3	-0.066 (0.044)	0.153*** (0.042)	-0.143*** (0.053)
finals week - 2	-0.086 (0.057)	0.136*** (0.043)	-0.156*** (0.060)
finals week - 1	0.066 (0.045)	0.121*** (0.044)	-0.090 (0.062)
finals week	-0.458*** (0.056)	-0.426*** (0.057)	-0.972*** (0.083)
finals week + 1	-0.110** (0.046)	-0.048 (0.046)	
finals week + 2	-0.019 (0.044)	0.068 (0.044)	

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

Appendix C: Quantity or Value Effects

Multinomial logit estimates, excluding purchases under $2.50

Figure C1: Relative Likelihood of Hamburger restaurant purchase (comparison group: Cafeterias)

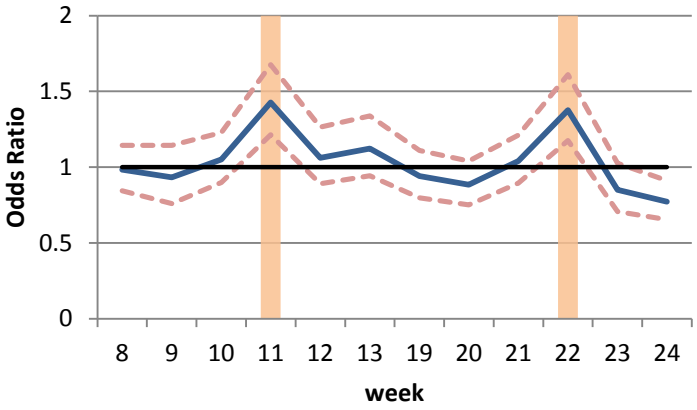


Figure C2: Relative likelihood of Mexican restaurant purchase (comparison group: Cafeterias)

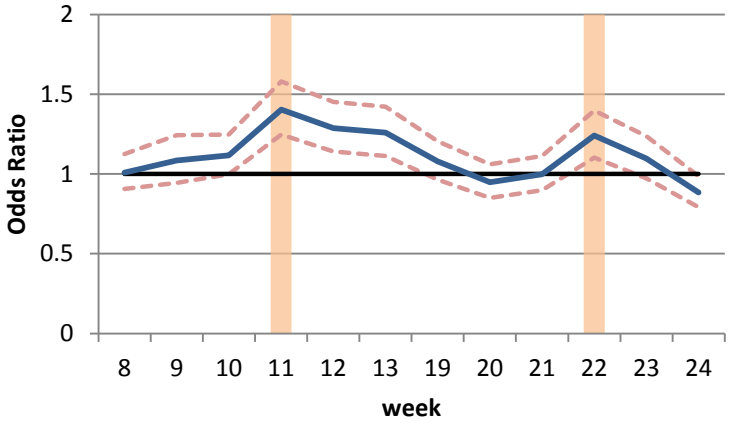


Figure C3: Relative likelihood of Asian restaurant purchase (comparison group: Cafeterias)

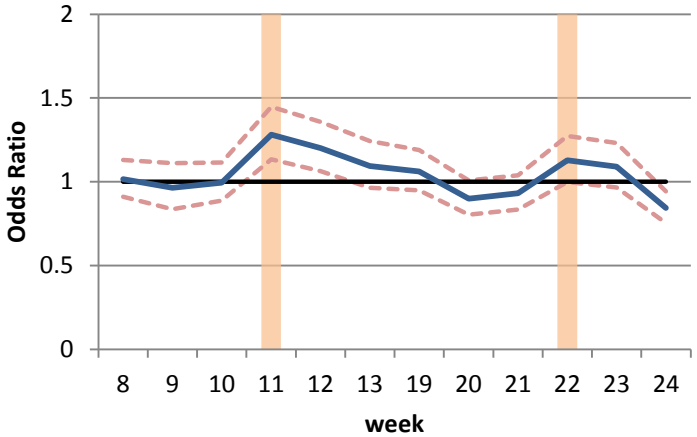


Figure C4: Relative likelihood of Sandwich restaurant purchase (comparison group: Cafeterias)

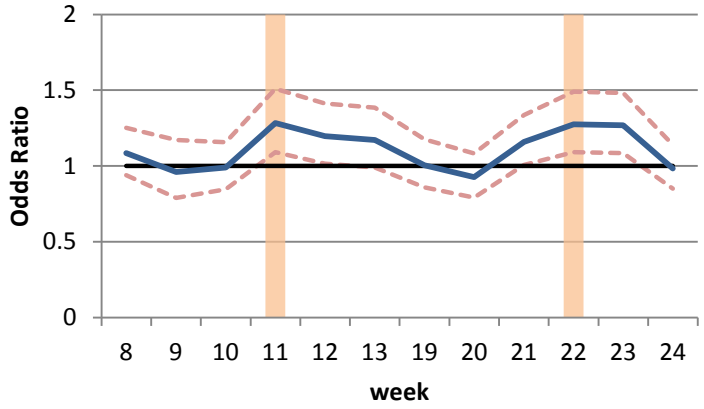


Figure C5: Relative likelihood of "Other" restaurant purchase (comparison group: Cafeterias)

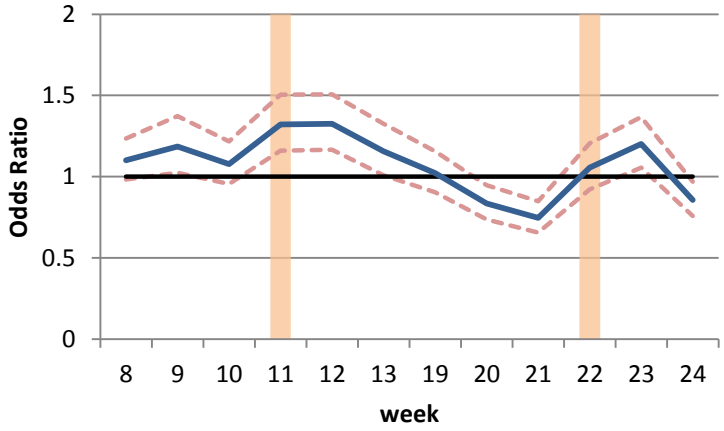


Figure C6: Relative likelihood of Pizza restaurant purchase (comparison group: Cafeterias)

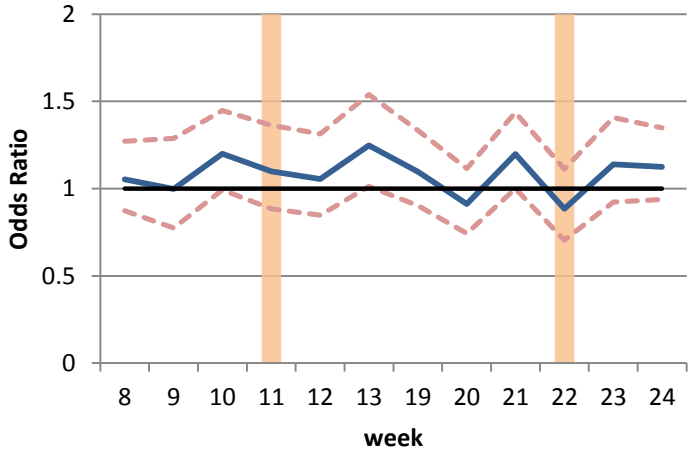
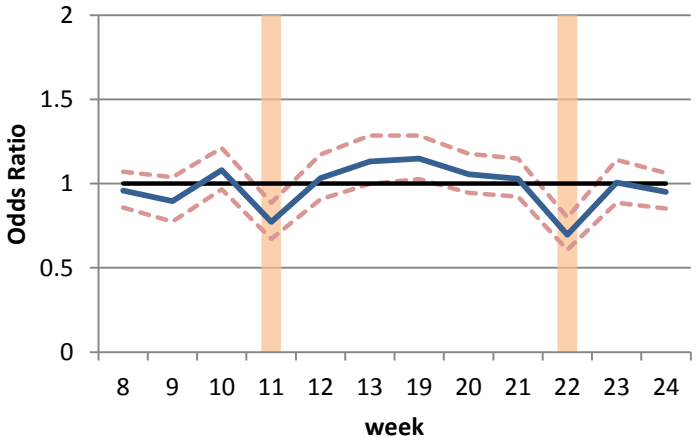


Figure C7: Relative likelihood of Coffee shop/stand purchase (comparison group: Cafeterias)



Intensive Margin (Expenditures) Results

Table C1: Linear regression: log Hamburger restaurant purchase amount, Coefficients

	Quarter 1	Quarter 2	Quarter 3
Finals week - 2	0.038	-0.014	0.034
	(0.042)	(0.034)	(0.050)
Finals week - 1	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)
Finals week + 1	-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 C2: Linear regression: log Mexican restaurant purchase amount, Coefficients

	Quarter 1	Quarter 2	Quarter 3
Finals week - 2	0.002	0.011	0.057***
	(0.019)	(0.016)	(0.017)
Finals week - 1	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)
Finals week + 1	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

Table C3: Linear regression: log Asian restaurant purchase amount, Coefficients

	Quarter 1	Quarter 2	Quarter 3
Finals week - 2	0 .003	-0.001	-0.018
	(0.019)	(0.017)	(0.021)
Finals week - 1	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)
Finals week + 1	-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

Appendix D: Time Factors

Figure D1: Distribution of Purchase Time (by hour) for each Restaurant Category, All weeks
Hours labeled on x-axis based on 24 hour clock

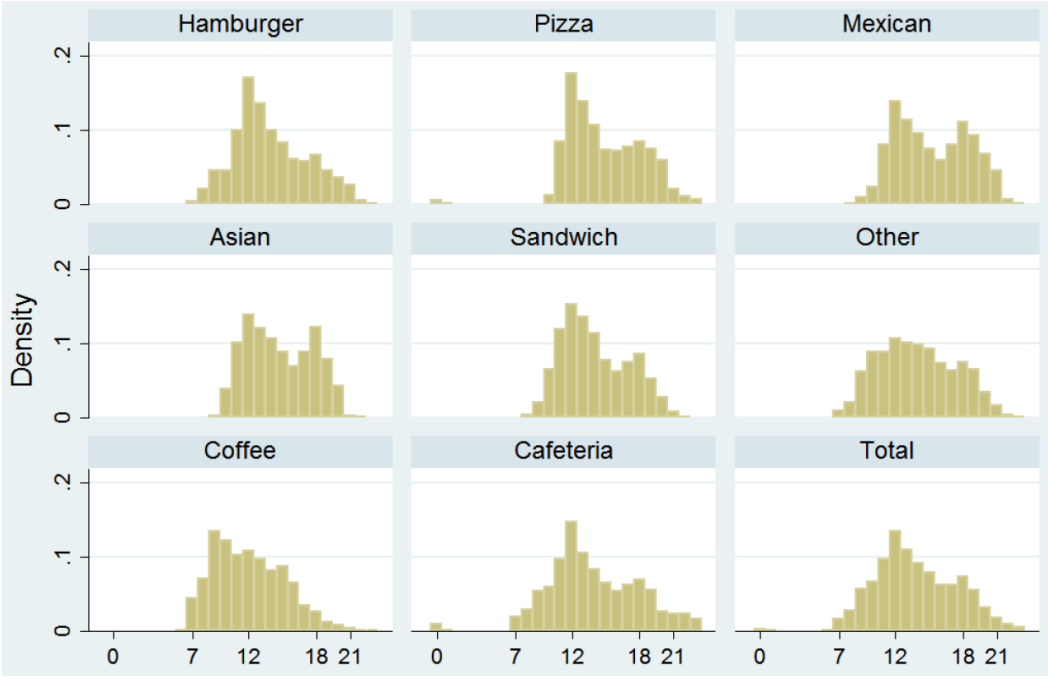


Figure D2: Distribution of Purchase Time (by hour) for each Restaurant Category, non-finals weeks, 1st and 2nd quarter
Hours labeled on x-axis based on 24 hour clock

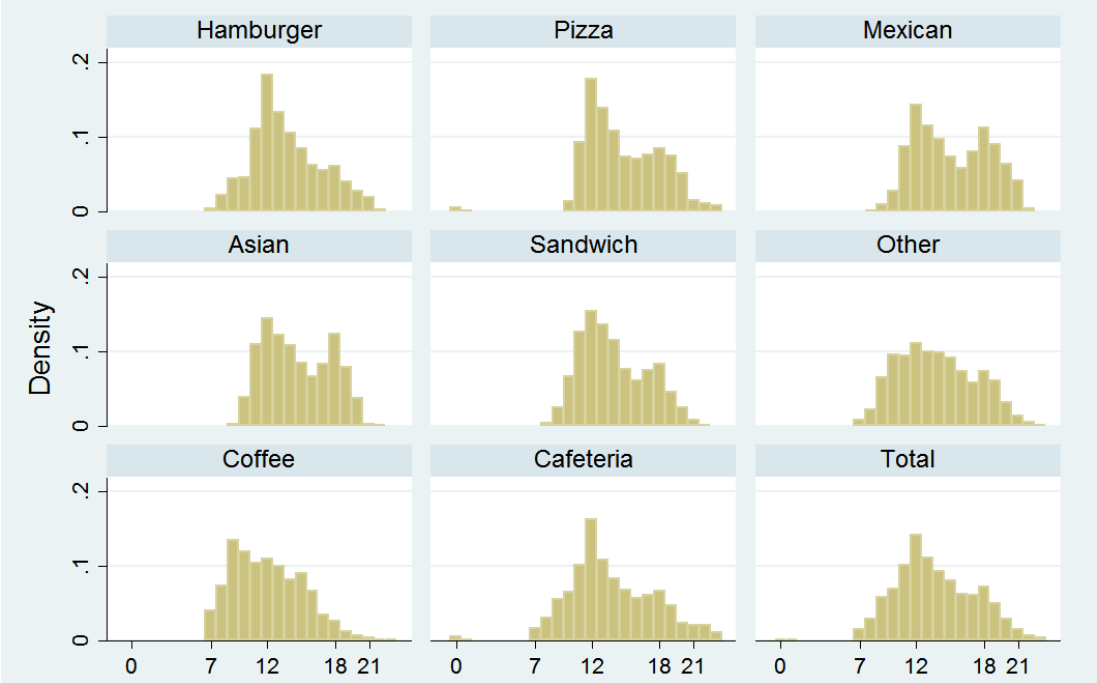


Figure D3: Distribution of Purchase Time (by hour) for each Restaurant Category, Finals week of 1st quarter

Hours labeled on x-axis based on 24 hour clock

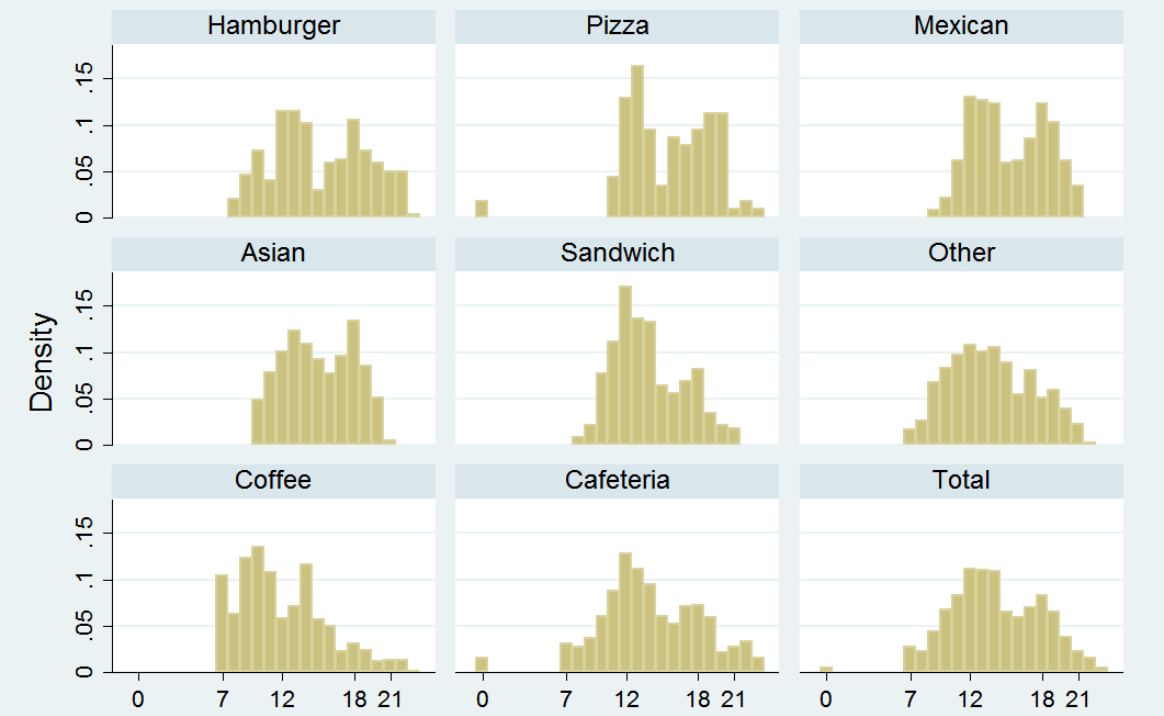
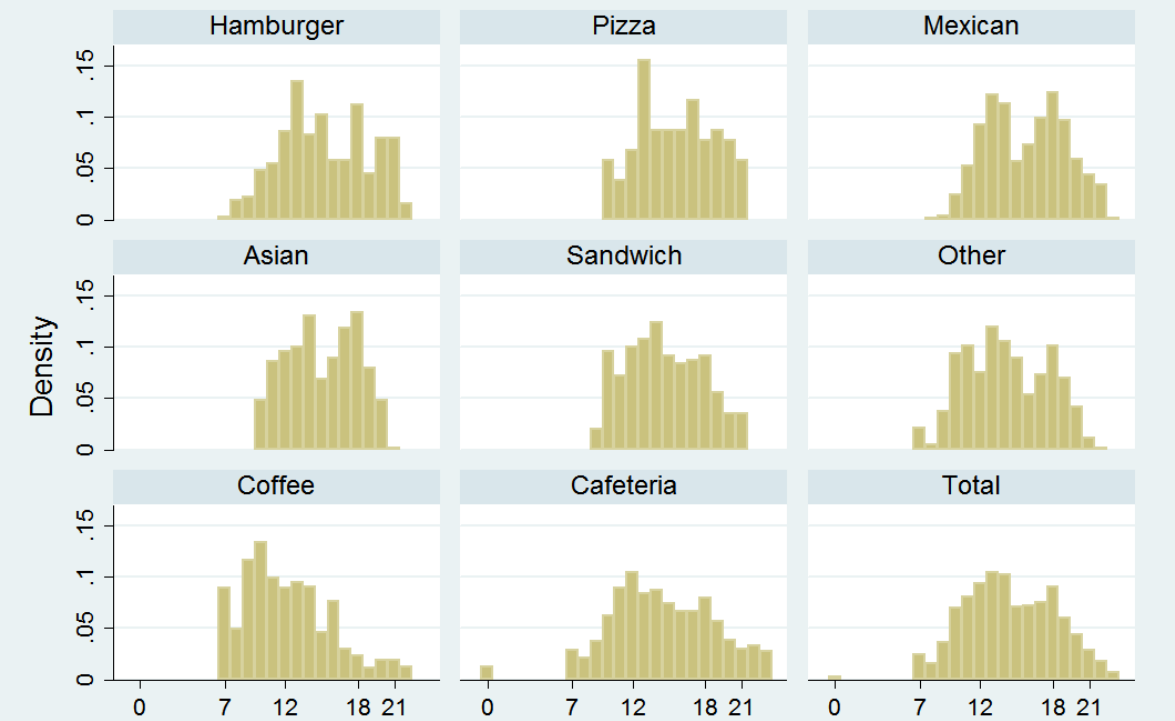


Figure D4: Distribution of Purchase Time (by hour) for each Restaurant Category, Finals week of 2nd quarter

Hours labeled on x-axis based on 24 hour clock



Robustness Check on Final Exam Scheduling

A concern with the transactions data results might be that students are more limited in their scheduling and locations during final exam weeks, and therefore may gravitate to fast food restaurants primarily for convenience reasons rather than for the hypothesized reduced self-control reasons. To test the effect of the final exam scheduling on students dining choices, we obtain information about students' final exam schedules from the university registrar's office.

In each academic quarter, the final exam schedule during finals week is directly determined by the time and location of the regularly scheduled lecture time in order to avoid time and location conflicts. In other words, there is a direct mapping between the lecture time/day of the week and the final exam time/day of the week. The locations of the final exams are by default in the same location as the lecture location, which are scattered around the campus in accordance with the college-system.[24]

Since the locations of the exams are identical to the weekly lecture locations, we focus on the potential time constraints that students may face if they have back-to-back final exams, and check whether this is a factor significantly driving attraction to the fast food restaurants. The daily final exam periods and the scheduled break times are as follows: Exams: 8:00am to 11:00am, 11:30am to 2:30pm, 3:00pm to 6:00pm, 7:00pm to 10:00pm; (Breaks: 11:00am to 11:30am; 2:30pm to 3:00pm, 6:00pm to 7:00pm).

To check whether fast food restaurants enjoyed increased transactions due to the exam break times, compared to other times of day, we utilize a regression specification similar to that in our main empirical approach in the paper. First, we limit our sample to final exam weeks of the first two quarters of the academic year (the corresponding sample of our main results in the body of the paper), and the overall interval of the day in which final exams take place (8:00am to 10:00pm). For each break time we include corresponding dummy variables for the time interval directly before and directly after the break time, where the interval length is identical to the length of the break itself for comparison purposes. Thus, PreBreak1 corresponds to 10:30am to 11:00am, Break1 corresponds to 11:00am to 11:30am, and PostBreak1 corresponds to 11:30am to noon, and etc.

Table D1 below shows the results of this specification for the multinomial logit regression, and similar results hold for the conditional logit regression (omitted for space concerns). For both Break1 and Break2, there is essentially no evidence of significantly higher (if there is any, significantly lower) transactions likelihood across any of the fast food categories, and in the case of Break1, the odds are significantly lower than other time periods for the major fast food categories. The sole exception is during Break2, for which students were significantly more likely (at 5% level) to purchase at Subway. During Break3 which most closely corresponds to the dinner hour, the Mexican and Asian fast food restaurants were significantly more likely to experience purchases, but the odds ratio is of similar magnitude and significance as the hours immediately before (PreBreak3) and after (PostBreak3) the official break time.

Thus, we conclude that the scheduling of the final exams and potentially associated convenience were not the main driving force behind students' preference for fast food purchases during final exam weeks.

[24] The registrar's office informs us that while it is possible for instructors to request changes from the university-determined time and location schedule, it is not a common practice.

Table D1: Multinomial Logit: Dependent Variable: Food Choice

Final exam weeks only, 1st and 2nd quarters;

Relative Odds Ratio displayed, robust standard errors in parentheses

Comparison group: Cafeterias

	Burger	**Pizza**	**Mexican**	**Asian**	**Subway**	**Other**
PreBreak1	0.664	0.695	0.402***	1.057	0.981	1.4010*
	(0.178)	(0.695)	(.102)	(0.212)	(0.265)	(0.270)
Break1	0.341***	0.307**	0.399***	0.611**	1.009	1.031
	(0.099)	(0.159)	(0.084)	(0.122)	(0.223)	(0.180)
PostBreak1	0.648	0.679	1.177	1.950***	1.022	1.370
	(0.189)	(0.322)	(0.2258)	(0.355)	(0.293)	(0.285)
PreBreak2	1.017	1.037	1.424**	1.753***	1.219	1.207
	(0.203)	(0.332)	(0.212)	(0.268)	(0.266)	(0.212)
Break2	0.679	0.854	1.297	1.314	1.607**	1.188
	(0.173)	(0.327)	(0.217)	(0.238)	(0.351)	(0.231)
PostBreak2	0.924	1.056	1.076	1.264	1.428	1.435*
	(0.232)	(0.407)	(0.209)	(0.255)	(0.357)	(0.290)
PreBreak3	0.746	1.331	1.407***	1.849***	1.132	1.164
	(0.144)	(0.337)	(0.183)	(0.244)	(0.221)	(0.180)
Break3	1.227	1.094	1.718***	2.101***	1.1379	1.013
	(0.193)	(0.287)	(0.206)	(0.260)	(0.213)	(0.157)
PostBreak3	0.864	1.659**	1.819***	1.685***	0.781	1.152
	(0.172)	(0.418)	(0.242)	(0.245)	(0.189)	(0.193)
Const	0.331***	0.105***	0.607***	0.462***	0.224***	0.407***
	(0.020)	(0.010)	(0.030)	(0.025)	(0.016)	(0.023)

Robust standard errors in parentheses;

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

Appendix E: Weather Related Effects

Figure E1: Temperature and Dew Point ranges for US university

credit: www.wunderground.com

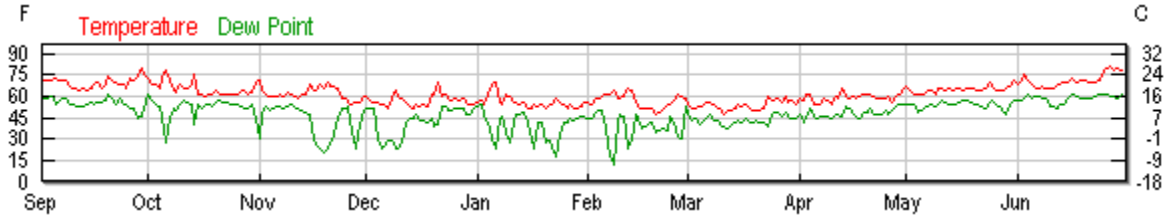


Table E1: Multinomial Logit with Weather Controls: Dependent Variable: Food Choice

	Burger	Pizza	Mexican	Asian	Subway	Other	Coffee
Week 8	0.982	1.060	1.018	1.007	1.028	1.059	1.006
	(0.064)	(0.094)	(0.049)	(0.049)	(0.071)	(0.055)	(0.041)
Week 9	0.886	0.974	1.090	0.970	0.913	1.140*	1.004
	(0.080)	(0.119)	(0.068)	(0.064)	(0.088)	(0.077)	(0.055)
Week 10	1.096	1.223**	1.101*	1.004	1.039	1.163***	1.108**
	(0.075)	(0.109)	(0.055)	(0.053)	(0.079)	(0.065)	(0.047)
Week 11	1.339***	1.016	1.252***	1.182***	1.265***	1.360***	0.734***
	(0.093)	(0.105)	(0.064)	(0.063)	(0.097)	(0.079)	(0.037)
Week 12	1.139*	1.056	1.263***	1.210***	1.258***	1.413***	1.065
	(0.085)	(0.110)	(0.066)	(0.066)	(0.098)	(0.082)	(0.050)
Week 13	1.174**	1.200*	1.171***	1.063	1.274***	1.284***	1.039
	(0.092)	(0.124)	(0.065)	(0.063)	(0.105)	(0.082)	(0.051)
Week 19	0.941	1.066	0.943	0.961	0.979	1.083	1.074*
	(0.070)	(0.104)	(0.049)	(0.051)	(0.078)	(0.064)	(0.046)
Week 20	0.950	0.900	0.881**	0.875**	0.980	0.923	1.029
	(0.069)	(0.090)	(0.046)	(0.047)	(0.076)	(0.056)	(0.043)
Week 21	1.042	1.137	0.903**	0.888**	1.232***	0.842***	0.967
	(0.074)	(0.105)	(0.046)	(0.047)	(0.089)	(0.053)	(0.042)
Week 22	1.441***	0.944	1.193***	1.131**	1.395***	1.270***	0.705***
	(0.103)	(0.106)	(0.064)	(0.064)	(0.108)	(0.080)	(0.037)
Week 23	0.947	1.202*	1.041	1.064	1.271***	1.365***	0.997
	(0.081)	(0.135)	(0.063)	(0.065)	(0.106)	(0.087)	(0.051)
Week 24	0.743***	1.134	0.830***	0.813***	0.969	0.877**	0.906**
	(0.054)	(0.096)	(0.041)	(0.041)	(0.069)	(0.049)	(0.037)
Average Temp	1.017***	1.000	0.994*	1.002	1.022***	1.028***	0.991***
	(0.004)	(0.006)	(0.003)	(0.003)	(0.005)	(0.004)	(0.003)
Precipitation	0.988*	0.978***	0.995	0.995	0.998	0.979***	0.994
	(0.006)	(0.008)	(0.004)	(0.004)	(0.006)	(0.005)	(0.004)
Constant	0.168***	0.105***	0.561***	0.467***	0.128***	0.233***	1.018
	(0.012)	(0.011)	(0.030)	(0.026)	(0.010)	(0.014)	(0.047)

Robust standard errors in parentheses;

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

Appendix F: Online Survey and Experiment (translated from Chinese)

Invitation email:

Dear Student:

You have been randomly selected to participate in our study, thank you for your participation!

This survey is being conducted by researchers at [Department, University] in order to better understand students' studying, schedule and lifestyle. The questionnaire includes a total of about 30 questions, and will take between 15 and 20 minutes to complete. Your careful and serious answers will help our understanding of student needs and improvements in students learning and living environments.

Survey questionnaire linked below: [URL]

This link only permits the survey to be filled out once, so it cannot be forwarded to other people. Participants who fill out the survey two days from the time of this invitation email will receive a small thank you gift as a token of our appreciation. All personal information you provide in the questionnaire will be kept strictly confidential. The survey requires your personal contact information in order to arrange the delivery of the thank you gift by our research assistant, who will contact you within one week's time. Due to the system limitations, once you click "Next" on each page of survey, you will not be able to go back and change your answers, so please answer as accurately as you can.

Survey:

Students' learning, time use and lifestyle survey:

This survey is conducted by researchers in [Department, University] in order to understand college students' learning, time use and habits.

The questionnaire consists of about 30 questions with expected time spent of between 15 and 20 minutes. Your careful and serious answers will help our better understanding of the needs of students, and potential further improvement of students' learning and living environment. (Due to system limitations, once you click "Next" button, you cannot go back to change your answers). All of your personal information will be kept strictly confidential – your dorm room address and contact telephone number will only be used for possible follow up research questionnaires, and not for commercial or other purposes. In order to express our gratitude for your participation, we provide some small gifts for you to choose from upon completion of the questionnaire. A research assistant will contact you within a week to ask about a convenient way to deliver your gift to you. Please fill out the survey within two days of the time when you received the email invitation.

Please answer the following questions:

1. Your student ID number: (required)
2. Your birth date: (required)
3. Your gender: (male; female) (required)
4. Your dormitory address (please specify your dorm building, room number and bed number, which will help us deliver your thank you gift): [fill in blank] (required)
5. Your telephone number (for gift delivery assistance): [fill in blank] (required)
6. You home province: (choose one: Anhui; Beijing; Chongqing; Fujian; Gansu; Guangdong; Guangxi; Guizhou; Hainan; Hebei; Heilongjiang; Henan; Hong Kong; Hubei; Hunan; Jiangsu; Jiangxi; Jilin; Liaoning; Macau; Inner Mongolia; Ningxia; Qinghai; Shandong; Shanghai; Shanxi; Shaanxi; Sichuan; Taiwan; Tianjin; Xinjiang; Tibet; Yunnan; Zhejiang; Overseas) (required)
7. Your year in college: (choose one: year 1; year 2; year 3; year 4) (required)
8. Your primary major: (choose one: humanities; sciences; engineering; business) (required)
9. Your secondary major (if applicable): (choose one: humanities; sciences; engineering; business)
10. Which activities do you do to relax? (choose all that apply: shopping; snacking; eating out; watching TV or movies; playing computer games; listening to music; social media; sports or exercise; DIY crafts; reading books; taking a walk or riding bike to nearby sites; meeting with friends) (required)
11. How many courses are you currently enrolled in this semester: (choose one: 3 or below; 4 or 5; 6 or 7; 8 or 9; 10 or above) (required)
12. How many academic credits is this in total: (choose one: 10 or below, 11 to 15, 16 to 20, 21 to 25, 26 to 30, 31 or above) (required)
13. How many courses have you dropped this semester: (choose one: none, 1,2,3,4 or above) (required)
    [page turn: NEXT]
14. Please think about your most relaxed week so far this semester. That week, how many hours did you spend on studying (not including time spent in class)? (units: hours) [fill in blank] (required)
15. Please think about your most busy week so far this semester. That week, how many hours did you spend on studying (not including time spent in class)? (units: hours) [fill in blank] (required)
16. At school, do you have someone who you can easily talk to about the happy and difficult moments in your life? (choose one: yes; no) (required)
17. How often do you have activities (travel, meals, karaoke singing, etc.) with your roommates? (choose one: basically never; rarely; sometimes; frequently; basically everyday) (required)
18. Are you a Party member? (choose one: yes; no) (required)
19. (appears only if answer to 18 is yes) When did you apply for membership? [fill in blank] (required)
20. (appears only if answer to 18 is yes) When was the last time that you attended a Party sponsored activity? (choose one: within 7 days; 8 to 14 days ago; 15 to 30 days ago; more than 30 days ago) (required)

21. Do you agree with the following statement: “In general people in society can be trusted.” (choose one: strongly disagree; disagree; agree; strongly agree) (required)
22. In your food choices, how much do you care about the healthiness of the food? (choose one: basically I do not care; I do not care very much; I care an average amount; I care about it a quite a bit; I care about this a lot) (required)
23. In your food choices, do you usually need to exert effort to control yourself? (choose one: basically no; rarely; sometimes; frequently; basically all the time) (required)
24. If you have to choose, you prefer (please choose one of the two): (salty snacks; sweet snacks) (required)

[page turn: NEXT]

25. This semester how many final exams do you have in total? (choose one: 0; 1;2;3;4;5;6;7;8 or more) (required)
26. In the coming week, how many assignments do you need to finish (not including exams)? (choose one: 0;1;2;3;4;5;6;7; 8 or more) (required)
27. In the coming week, how many exams do you have? (choose one: 0;1;2;3;4;5;6;7; 8 or more) (required)
28. In order to complete the academic tasks in questions 26 and 27 to your satisfaction, how much time total do you anticipate having to spend on your studies? (choose one: 7 hours or less (on average 1 hour or less daily); 8 to 21 hours (on average 1 to 3 hours daily); 22 to 35 hours (on average 3 to 5 hours daily); 36 to 49 (on average 5 to 7 hours daily); 50 hours or more (on average 7 hours or above daily)) (required)
29. In the coming week, if you plan to participate in any contests, student or other sponsored activities, how many hours do you anticipate spending on these activities total (choose one: I have no such plans; 5 hours or less; 6 to 10 hours; 11 to 15 hours; 16 to 20 hours; 21 hours or more) (required)
30. (appears only if answer to question 24 is salty snacks) When was the last time you had a salty snack? (choose one: today; 2 to 3 days ago; less than 1 week ago; one week ago or longer) (required)
31. (appears only if answer to question 24 is salty snacks) When was the last time you had a salty snack? (choose one: today; 2 to 3 days ago; less than 1 week ago; one week ago or longer) (required)
32. On a scale from 1 to 9, how stressful do you feel this week? (choose one, larger numbers represent higher stress; 1 (no stress); 2;3;4;5(some stress);6;7;8;9 (a lot of stress)) (required)
33. Please use a sentence to describe your satisfaction with life at [University]: [fill in blank] (optional)

[page turn: NEXT]

34. (appears only if answer to question 24 is salty snacks)Thank you for finishing the survey. Please choose one of the thank you gifts below. All gifts options are “Haoliyou” brand Korean import foods, worth about 15 yuan. Within one week of your completion of this survey, our assistants will contact you about the gift delivery (choose one:

Gift A: 2 packs of Diget wheatmeal biscuits

Gift B: 2 packs of original flavor potato chips

) (required)

35. (appears only if answer to question 24 is sweet snacks)Thank you for finishing the survey. Please choose one of the thank you gifts below. All gifts options are “Haoliyou” brand Korean import foods, worth about 15 yuan. Within one week of your completion of this survey, our assistants will contact you about the gift delivery (choose one:

Gift A: 2 packs of Diget wheatmeal biscuits

Gift B: 1 pack of Market O brownies

) (required)

[page turn: SUBMIT (end of survey)]

Snack Choice Experiment Regression with Binary Exam Variable

Table F1: Probit: Dependent Variable: Snack Choice (1 = junk food)

^# exams greater than	**1**	**2**
Stress level	0.059 (0.090)	0.038 (0.098)
Self-control on food	0.070 (0.342)	-0.019 (0.330)
Care for healthy food	-0.251 (0.353)	-0.326 (0.366)
Snack relaxation	-0.607* (0.366)	-0.500 (0.346)
Preferred snack flavor (1 = sweet)	0.476 (0.358)	0.371 (0.362)
Time of last snack	0.198 (0.170)	0.194 (0.174)
Gender	-0.636* (0.348)	-0.643* (0.348)
Units Enrolled	-0.484*** (0.186)	-0.511*** (0.185)
"Many" exams this week^	0.875 (0.582)	0.609* (0.370)
Constant	1.661 (1.140)	2.399* (1.234)
Obs	78	78
R-sq	0.180	0.185

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

Field Experiment Regression Results Separated by Snack Flavor

Table F2: Probit: Dependent Variable: Unhealthy Snack Choice, by Snack Flavor

	(1), sweet	(2), sweet	(3), sweet	(1), salty	(2), salty	(3), salty
Stress level	-0.167 (0.112)	-0.015 (0.206)	-0.956 (1.354)	0.109 (0.130)	0.041 (0.183)	0.004 (0.192)
Self-control on food	-0.373 (0.515)	-1.323 (0.824)	8.876 (7.490)	0.523 (0.483)	0.227 (0.547)	2.148 (2.453)
Care for healthy food	-0.282 (0.544)	0.224 (0.598)	-9.064 (8.547)	-0.207 (0.523)	-0.970* (0.577)	-3.945* (2.429)
Snack relaxation	0.675 (0.575)	0.303 (0.623)	4.402 (5.610)	-0.870* (0.500)	-1.424*** (0.489)	-1.627*** (0.524)
Time of last snack	0.033 (0.269)	0.638 (0.481)	1.878 (2.156)	0.239 (0.246)	0.395 (0.296)	0.366 (0.313)
Gender	-0.748 (0.559)	-0.305 (0.886)	3.492 (4.213)	-0.477 (0.476)	-0.315 (0.492)	-0.427 (0.511)
Units Enrolled		-0.650 (0.483)	-0.335 (1.070)		-0.806*** (0.315)	-0.840*** (0.324)
Est. study time this week		0.298 (0.381) *(p-val: 0.434)*	2.475 (2.060) *(p-val: 0.229)*		0.491 (0.305) *(p-val: 0.108)*	0.502 (0.383) *(p-val: 0.190)*
Exams this week		-0.634*** (0.234)	-1.921 (1.719)		0.241 (0.207)	0.229 (0.211)
Other commitments this week		0.379 (0.428)	2.429 (2.401)		-0.200 (0.199)	-0.203 (0.190)
Study time this week*Self control on food choice			-4.281 (3.967)			-0.399 (0.559)
Study time this week*care for healthy food choice			2.327 (2.371)			0.686 (0.558)
Constant	2.072** (1.011)	4.058* (2.381)	0.560 (2.880)	-0.511 (0.984)	1.748 (1.483)	2.258 (2.248)
Obs	36	36	36	42	42	42
R-sq	0.113	0.413	0.571	0.143	0.295	0.312

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