Effects of Impulsivity and Self-control on Calorie Intake

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Abstract:
Neoclassical economic theory models individuals as making consistent choices over time and it assumes these choices are the outcome of rational utility maximization. Recent theoretical developments in the theory of consumer decision-making have drawn evidence from other disciplines such as, neuroscience (McClure et al, 2004) and psychology, and proposed more generalized models in a dual-self framework explicitly accounting for self-control or impulsivity (Gul and Pesendorfer, 2004; Fudenberg and Levine, 2006; and Brocas and Carillo, 2008). This study attempts to understand the dietary choices in a dual-self framework while explicitly identifying calorie intake owing to impulsivity and self-control. We construct standard psychological measures using the responses to the Dutch Eating Behavioral Questionnaire (DEBQ) filled by the respondents of the UK Diet and Nutrition Survey. These measures have been tested for their validity and apply to a broad range of population: of different weights, across gender, ethnicity (Bardone-Cone, and Boyd, 2007) and are used in experiments (Ouwens, 2005).Using panel data methods, we find that impulsivity increases calorie intake and self-control decreases calorie intake. Further, caloric intake is larger than one can restrain and therefore the result of the intrapersonal conflict is positive calories intake on average.

Keywords: Self-control, Nutrition, diet, health, impulsivity, BMI

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Introduction

Neoclassical economic theory models individuals as making consistent choices over time and it assumes these choices are the outcome of rational utility maximization. By contrast, experimental studies have shown that quite often dietary decisions are not dynamically consistent, i.e., even individuals who plan to eat healthy often eat unhealthy foods. Recent theoretical developments in this line of research have drawn evidence from neuroscience (McClure *et al*, 2004) and psychology and proposed more generalized models in a dual-self framework explicitly accounting for self-control and impulsivity (Gul and Pesendorfer, 2004; Fudenberg and Levine, 2006; and Brocas and Carillo, 2008[1]). In this framework, each individual has two selves, i.e., long-run self and the short-run self, who play distinct roles in making dietary choices. The long-run self is hyperopic and therefore takes into account the long-run implications of decisions. In contrast, the short-run self is myopic and is therefore more impulsive. In any situation, the outcome is based on the interaction of the two selves. Using the dual-self framework, we explicitly measure the increase or decrease in calorie intake due to impulsivity and self-control. Identifying the underlying behavioral causes would help us better address the issue of excess calorie intake, which has resulted in increased body mass index (BMI).

Studies have found economic incentives that cause excess intake of calories such as, decrease in price of calorie-dense foods or per unit calorie, increased opportunity costs of meal preparation whether in market or at home, and decreased cost of food away from home. On the other hand, long-term health benefits of healthy diet also provide economic incentive to exercise restraint so as to consume only optimal, in the long-run, amounts of food. Exercising restraint

[1] Thaler and Shefrin (1981) proposed a general framework.

needs high willpower[2] or self-control (Thaler and Shefrin, 1981; and Bénabou and Tirole, 2004) which is especially true because of the ubiquity of food and the economic incentives that lead to excess calorie intake[3]. Most of the studies have ignored the systematic increase in caloric intake (Stutzer, 2007) due to problems of restraining oneself or that of yielding to impulsive tendencies, or from the distinct interaction of self-control problems in a food environment characterized by convenience and ubiquity.

This study attempts to understand the dietary choices in a dual-self framework while explicitly identifying calorie intake owing to impulsivity and self-control. We construct standard psychological measures using the responses to the Dutch Behavioral Questionnaire filled by the respondents of the National Diet and Nutrition Survey (NDNS). These measures have been tested for their validity and apply to a broad range of population: of different weights, across gender, ethnicity, and countries (Bardone-Cone, and Boyd, 2007; van Strien, 2002) and are also used in experiments (Ouwens, 2005). The rest of the paper is organized as follows. The following section discusses the obesity literature relevant to this study. Section III outlines the economic framework including theory. Survey data and the psychological measures are described in section IV. Results are discussed in Section V and conclusions drawn in Section VI.

Theory

Neoclassical economic theory models the individual as a single entity who is rational and makes optimal choices. Simon (1957) introduced the concept of bounded rationality which essentially implies dynamic consistency because individuals make nearly optimal choices given information

[2] Willpower used in their study and here implies control of one's impulses and actions or self-control.
[3] While discussing excess calorie intake due to impulsivity or reduced intake by exercising restraint, it is important to note that gain in a pound of body weight in a year for a person weighing 150 pounds requires only about 10 extra calories a day.

and cognitive capacity. However, it fails to explain dynamic inconsistency[4] in the choices such as, choosing unhealthy foods despite increase in diet-health knowledge (Blaylock *et al*, 2003) or overweight and obese individuals continuing to eat more than what they know to be about optimal.

The hyperbolic discounting model allows for dynamic inconsistency in choices and incorporate commitment rules such as mental accounting. Self-control or impulsivity is implicit in the discount rates and based on hyperbolic discounting model, one can attribute individuals to have varying degrees of patience. Fudenberg and Levine, 2006 (FL), argue that self-control is an exhaustible resource and that it is part of the entire mental capacity and therefore needs to be explicitly modeled. Their model is an improvement of the "planner-doer" model proposed by Thaler and Shefrin (1981) (TS), while also a simpler representation, in their words, of the Gul and Pesendorfer (2004) (GP) model. In this study we refer to the myopic agent (Brocas and Carillo, 2008 model, BC in short), doer (in TS model), or the short-run self as the impulsive self, while the principal (in BC model) or planner (in TS model) as the long-run self having a long-run perspective. It is the long-run self who exercises restraint to maximize long-run utility. One of the ways to exercise restraint is by making commitments or setting rules that allow for the short-run self to choose goods that yield long-term benefits.

The *first hypothesis* is that internal tendencies or a predisposition to impulsive eating leads to increased calorie intake. Individuals who identify their impulsiveness could make plans, deliberate attempts or commitments to choose healthier foods over unhealthier ones (BC; Fudernberg and Levine, 2006; and Gul and Pesendorfer, 2004). Given information on specific strategy, or rules, set by individuals to regulate or decrease calorie intake in an otherwise

[4] Dynamic inconsistency refers to the inconsistency in what one planned to chose and the final choice.

impulsive environment, we could test if these lead to a decrease in calorie intake which would be the *second hypothesis*[5].

Since self-control is an exhaustible resource (in FL model), exercising willpower is painful (ST model), or that increased reliance on willpower makes one more compulsive (Ainslie, Precis Breakdown of Will, pp. 151–53), the individual may relapse now and then. This would be true especially in situations where the individual has lesser control of self or lower ability to control impulsivity. Muraven and Baumeister, 2000 (MB), show that exercising self-control reduces the strength available for subsequent self-control action which is likely to show in excessive calorie intake, in the case of food consumption[6]. This relates to the first hypothesis discussed above which are internal to the individual. There are also unanticipated shocks that are external to the individual which might cause impulsive consumption. For example, an irresistible smell when passing by a bakery or seeing others eat could cause one to eat[7]. According to the hyperbolic discounting model and the dual-self (FL) model, such unanticipated shocks could cause greater discounting of future consumption which might cause increased calorie intake. Therefore the *third hypothesis* is that such external stimuli lead to more calorie intake.

We test the above three hypotheses using econometric tools developed for large samples (large-N) with limited time observations (small-T). It should be noted that the purpose of this paper is to examine behavior for the sample as a whole and therefore help us understand self-

[5] The variable would be the restraint eating psychological measure.
[6] From another perspective (or dimension), this would show as high variability in the calorie intake of the individual. We do not study it in this paper.
[7] The options to each of the questions were: never, seldom, sometimes, often and very often.

control issues at the sample level. Below we describe the data and the psychological measures used to estimate calorie differences owing to the dual-self.

Data

a. National Diet and Nutrition Survey (NDNS), 2000-01

Diet and Nutrition Survey is a national survey conducted by the British Food Standard Agency (FSA) and the Department of Health (DH) for collecting information on the dietary habits and the nutritional status on seven consecutive days of the population in Great Britain. This study uses the latest survey of the adults aged 19 to 64 years in year 2000. The Social Survey Division of the Office for National Statistics (ONS) and the Medical Research Council Human Nutrition Research Cambridge (HNR) were commissioned to carry out this survey.

A nationally representative sample was selected from among those living in private households with only one respondent per household. This reduced the problem of "clustering associated with similar dietary behavior within the same household" (NDNS report, pg 4). The fieldwork for data collection was divided into four waves[8] which spanned over the 12-month period to cover any seasonality in dietary choices or behavior.

The sampling frame was stratified by the 1991 Census variables and included all the postal sectors within the mainland Great Britain. The sample selection was based on multi-stage random probability design. A total of 152 postal sectors were selected as first stage units with probability proportional to the number of postal delivery points. Of the 152 postal sectors, each of the four fieldwork waves covered 38 sectors and within each postal sector 40 addresses were randomly selected.

An achieved sample of 2,000 respondents was needed for analysis and for comparison with previous survey (1986/87 Adult Survey). Costs towards analysis including blood analysis,

[8] Wave 1: July to September 2000; Wave 2: October to December 2000; Wave 3: January to March 2001; Wave 4: April to June 2001

anthropometric measures, and others, and the cost of the individual to maintain the seven-day dietary record were important considerations in selecting the sample size. The eligibility of the participating individual was simply the age criteria and not being pregnant or breastfeeding. Large number (35%) of addresses randomly selected was ineligible due to age out of range or pregnant. Of the eligible sample, 61% (n=2251) completed dietary interview while only 77% of these completed the seven-day dietary record. Thus the response rate for the seven-day dietary record was 47% (n=1724). The proportion of the sample completing the diary record was lowest in the youngest age group 19 to 24 years for both men (71%) and women (72%) and highest (78% for both sexes) in the oldest age group of 50 to 64 years.

A weighed food inventory type of the prospective method was used for recording all food and drink consumed both in and out of home for seven consecutive days. The advantages are that the information collected is more accurate; better measurement of the day-to-day variation; and it relies very less on memory (Anderson, 1995). The disadvantages are that recording each meal time might change eating habits particularly for those watching their diet; it requires subjects to be literate; requires their high degree of co-operation; and it is time consuming for the subject (Anderson, 1995).

There was a feasibility work[9] carried out before the main survey testing the validity of the dietary recording methodology by comparing energy expenditure against energy intake. Extensive training was provided for the interviewers which among others included five-day residential briefing and also required successful completion of own three-day weighed intake

[9] It was undertaken to understand if recording food intake for seven consecutive days and other aspects of the study were feasible. Further details of the feasibility work are presented in Appendix C of the NDNS report.

record. Nelson *et al* (1989) analyzed data from six studies using a criterion[10] developed by Black *et al* (1983) and estimated that ensuring sufficiently accurate results of energy and macronutrients (carbohydrate, protein and fat) intake in adults would require between four and seven days of dietary record except that for protein in females required eight days.

An important component of the survey also does cross checking for any under-reporting with the self-completion Psychological Restraint Questionnaire (Eating Habit Questionnaire) and for circumstances or illness that would have affected the usual eating behavior. Respondents who completed seven days of dietary record were awarded £10. Other than diet and nutrition and physical activity components, this large survey collects information including anthropometric measurements, blood and urine analysis, oral health, and others.

In NDNS, respondents had to write time spent at work and time spent on hard, moderate or light activity. The amount of time spent on work is also included in the time spent on hard, moderate or light activity so we do not include work time as another variable in our analysis.

Due to its long and detailed survey, it suffered from non-response and low response rate. Skinner and Holmes (2002) have studied the potential impacts of the non-response on the usability of this survey data. They found evidence for differential non-response[11] effects but no evidence for bias on the estimates based on nutritional variables which rarely exceed one percent. The main reason as they cite is that variables associated with differential non-response are not strongly associated with the nutritional variables. Distinguishing the differential non-response bias into non-contact and non-cooperation helps in developing or modifying method for

[10] $D = (r^2 / (1-r^2)) * (s_w^2 / s_b^2)$, where r is the unobservable correlation coefficient between the observed and true mean nutrient intakes of individuals, and s is variances within and between subject as subscripted in the formula.

[11] This refers to difference in response rates across specific characteristics such as, low response of a particular ethnic group.

analysis. Although non-contact showed to be more differential in the health variables, its only four percent in this survey and therefore its bias should be relatively minor. While the non-cooperation is lower and fortunately its only slightly related to health and nutritional variables. However, the authors caution on the weight placed on the results as the overall response rate is only about 50 percent. The authors conclude that weighting should be used for obtaining population estimates but not essential to adjust for non-response.

b. Descriptive Statistics

The daily calorie intake varied between zero (=20 observations) and 7,000 calories. Among the 20 observations with zero calories, only two individuals reported 3 such days and one reported two such days. With about one percent with zero calories, we expect negligible if no effect on the regression estimates. All of them except four were females and none of them except one were on diet. They fall into different categories of income, education and of different age implying it is not nonrandom and therefore of little concern. None of them except one reported doing zero minutes of hard activity and all but two reported zero or less than hour of moderate activity. Most of their time was spent on light and very light activities and sleep.

The psychological measures are discussed in the subsection below. Light activities had the largest share among all the activities followed by sleep. On average 14 hours were spent on light activities and 15 minutes more than an hour on moderate activities and only about 17 minutes on hard activities. It should be noted that this is on average and the time spent varied across individuals. Coefficient of variation showed most dispersion on hard activities and least on light activities. This could be because of few occupations that are classified as hard activities while majority of activities are light or moderate in nature.

Research has shown that calorie intake differs by day of the week (Haines *et al*, 2003). This is true for weekend relative to the other days of the week. In their study, the calorie intake during Monday through Thursday was more similar and intake on Friday was more similar to Saturday and Sunday. We find the same trend in this dataset and therefore define weekend as Friday, Saturday and Sunday.

This dataset distinguished between the place of eating and the place of preparation or purchase. Majority of the meals (=70 percent) were consumed at home while a much smaller share of meals (=30 percent) was either prepared or brought from home. This shows that lot of meals were bought or brought for consumption at home.

Although most of the respondents indicated they had some qualifications, about 20 percent said that had no qualifications beyond high school. Only 17 percent had a college degree or equivalent qualification. The majority (46 %) had a high school degree. Among other demographics, the sample comprised of 55 percent females, the average age was 42 years, and the average household size was 2.6 with children, and the mean annual income was about £18,000.

c. Psychological Construct of Impulsivity and self-control

The respondents were asked to fill out the Dutch Eating Behavior Questionnaire (DEBQ) as part of the survey. Respondents were each provided with a set of Soehnle Quanta digital scales (pg 530). This DEBQ contained three scales that measured the respondents' emotional eating, external eating and restrained eating predisposition. The measures are mutually exclusive; applies to a range of individuals by BMI and gender; it has good predictive validity, internal consistency, convergent validity, and discriminate validity (van Strien, 2002).

Emotional eating, based on the psychosomatic theory, measures the degree of the desire or natural tendency to eat in different emotional states such as, fear, anxiety, hunger, depression, etc, that are internal cues[12]. External eating, based on the externality theory, measures the degree of individual's response to food-related stimuli, regardless of the internal state of satiety or fear. Studies have found differences in response to the emotional states. For example, Abramson and Wunderlick (1972) found that obese males were more responsive to the anxiety provoking stimuli compared to normal males.

Other than response to emotional states or external cues, individuals could deliberately eat less for losing weight or maintaining healthy weight. The restraint eating measure assesses deliberate ways to regulate eating because of concerns related to body weight. Some ways individuals control food intake are by eating fewer meals, or eating less snacks. The first two measures, i.e., emotional and external eating, also indicate impulsiveness while the latter indicates self-control. Higher emotional or external eating scores imply higher impulsiveness and vice versa. Similarly, higher restraint eating scores imply higher self-control and *vice versa*.

The construction of the psychological measures assumes that if a person is given to an impulsive factor he or she would be susceptible to those impulsive factors in all meal occasions. For instance, if a respondent is more likely to eat foods when in a depressed mood, he or she would more likely eat comfort foods whenever in a depressed mood during the time period of the data collection. This assumption makes it time invariant in the sense that the person exhibits consistency in the impulsivity. We can also state it in two different ways: 1) the model specified here assumes a person to be consistent in the degree of impulsivity; or 2) the coefficient indicates average impulsivity and self-control throughout the 7-day period. The variable has options of

[12] Complete list of questions is in Appendix A

more likely to less likely in a five point Likert scale and hence captures the degree of impulsivity.

The questions on impulsive factors were administered after the dietary record was completed as mentioned in the pick-up interview file, i.e., after the food diary was turned in. So we assume that it did not have any impact on the dietary records.

Analytical Framework

In the survey, the households were required to keep dietary record for seven consecutive days which allows us to employ panel data methods to obtain estimates for both time varying and time invariant individual characteristics. Previous studies have suggested that current consumption is influenced by past consumption (Beaton *et al*, and Sukhatme *et al*). Thus a more appropriate model would be an autoregressive process with error components (Bhargava *et al*, 1994). Random effects model has a restrictive assumption of strict exogeneity and therefore we use dynamic random effects model which relaxes the strict exogeneity assumption. Following Roodman (2005), we analyze systematically from OLS to the final dynamic panel data model in a GMM framework and thereby addressing the dynamic panel bias. The econometric model is:

$$(1) \qquad y_i = \beta_o + \beta_1 y_{i,t-1} + \sum_{j=1}^{3} \beta_{2j} M_j + \beta_3 X_i + \beta_4 Q_{it} + \beta_5 D + v_{it}.$$

where, $|\beta_1| < 1$; y_{it} is the calorie intake in t period and y_{it-1} is the lagged calorie intake; M_j is the j^{th} psychological measure; X_i is the vector of time invariant individual characteristics; Q_{it} is the vector of time variant individual level variable; D is the indicator or dummy variable; and $v_{it} = c_i + u_{it}$, where, c_i is the individual specific effects and u_{it} is the idiosyncratic error term. The psychological measures, *M* vector, include emotional impulsive eating, restrained eating, and external impulsive eating. Vector *D* includes variables such as weekdays or weekends. The OLS model assumes that all observations are independently drawn across households and time which understates the standard error thus making it inefficient. It further assumes that all regressors are exogenous implying that they are uncorrelated with the error term. In other words, the strict exogeneity assumption implies that the error component, v_{it}, is uncorrelated with all the

explanatory variables with the past, current and future time periods. However, in a dynamic framework, it also yields inconsistent estimate of the lagged calorie intake[13].

To understand the dynamic panel bias, let us consider the case of an unobserved individual characteristic or omitted variable namely, label use, which has been found to decrease calorie intake implying a negative coefficient. The coefficient for the lagged calorie intake will be lower for label users. This positive correlation between the y_{it-1} and the label use inflates the coefficient for the lagged calorie intake. One (naïve) way to eliminate this bias is to use the fixed effects model (or the within groups estimator), which transforms each variable into mean-deviations. However, y_{it-1} in the transformed lagged calorie intake is negatively correlated with $\left(1/(T-1)\right)\boldsymbol{v}_{i,t-1}$ in the new error component, and the $\left(1/(T-1)\right)\boldsymbol{y}_{i,t}$ is negatively correlated with v_{it}. This results in a downward bias of the lagged dependent variable. Although not a solution, the naïve OLS and the fixed effects model provide a bound within which the parameter estimate must lie. We specifically use GMM as it addresses potential endogeneity of other regressors also. Other than OLS[14], we show the result of the one-step GMM and two-step efficient GMM. The two-step estimator is efficient and robust to patterns of heteroskedasticity and cross-correlation that the sandwich covariance estimator models. *In this draft we have used excluded exogenous variables as instruments. In the future we plan to estimate system GMM estimates.*

[13] We note here that this is not the primary variable of interest. However, obtaining correct estimate of the lagged calorie intake and testing for unit root would be imperative for the model to be valid. In essence, β_1 needs to be different from unity for the model to be valid.

[14] The fixed effects model estimates are no reported in the table but are available upon request.

Results and Discussion

The GMM framework allows correcting and testing for endogeneity of the lagged dependent variable, here calorie intake, and other regressors. As discussed earlier, OLS and fixed effects models (FE) yield biased estimates. The GMM estimates fall within the bounds of OLS and FE model. However, GMM estimates in column 2 and the OLS estimates are similar in magnitude because the suspect endogenous variables fail the test for endogeneity in spite of using valid instruments (table 3). Based on the tests, we prefer the two-step GMM method and its results are discussed below.

The important result that makes the results valid is that the lagged calorie intake is less than unity. The emotional eating variable measures internal tendencies or predisposition to eat more in response to emotional states of the individual. This coefficient is not significant indicating no calorie intake that can be attributed to the emotional psychological measure. Thus our first hypothesis is not valid in this sample. The restrained eating variable measures the degree of restraint on calorie intake which appears to be negative indicating those who are exercising restraint do consume relatively less than those who do not exercise restraint. This estimate supports our second hypothesis. This estimate accounted for calories reduction that was due to specific strategies adopted by individuals. It is different from the reduction in calorie intake because of being on diet.

Individuals who were on any diet to lose weight consumed 75 fewer calories on average compared to those were not on diet. External impulsivity measure estimate is positive indicating that impulsivity increased food intake. This variable also measures impulsivity due to external factors beyond their control such as, a bakery on the way. Given the range of external impulsivity and restrained eating score (1 through 50), the mean estimate of 6 and 3 calories

imply larger effects. Thus our third hypothesis is supported by the coefficient of the external impulsivity measure.

To balance calorie intake, individuals engage in activities that "burn off" calories. All the activities have been classified under three broad categories which do not distinguish between time at work, at home and leisure time. All the activities whether at work, home or leisure are classified under light, moderate and hard activities plus sleep time. Individual time spent on hard activity and moderate activity suggest increased intake to compensate for the extra calorie expenditure. The estimated calorie expenditure per minute of hard activity and moderate activity relative to very light or light activities are modest. An estimate of additional 0.33 calorie for every minute spent on hard activity and moderate activity translates to about 20 and 10 more calories an hour relative to an hour spent on very light or light activity. The coefficient of the sleeping time variable is negative indicating an additional minute of sleep reduces calorie intake by 0.37 calories. This estimate translates to 22 calories for every hour after controlling for differences in calories due to other factors included in the model. Consistent with Haines *et al* (2003), our estimates show an average of 60 more calorie consumed during weekends.

Place of food preparation and place of eating showed large differences in calorie intake. Those who ate outside the home consumed about 200 more calories regardless of the place of purchase or preparation. The source of food whether eaten at home or brought from home, resulted in mean intakes that were 170 calories lower when compared to those who bought food from outside or ate outside. One concern here is that these two variables could be measuring aspect that are overlapping and hence, perhaps, to some extent double counting.

Education level attained which showed differences but only in two levels relative to the least educated in the sample and they are degree or equivalent and GCE A level or equivalent.

Income influences diet decision in two ways: one is that higher income implies more affordability indicating higher consumption; and secondly, higher income levels are also associated with higher valuation of health and therefore more prudent consumption or moderate intake. In this study we cannot separate out these effects but perhaps these effects cancel out yielding an insignificant estimate of the income variable.

Age variable indicates higher consumption with age but the quadratic component indicates that this increase lowers with age. The largest effect was seen in the case of women, who reported to consume about 310 calories less than men. Biologically women do have lower caloric requirement, which is about 100-150 calories lower than men. Thus a magnitude of about 365 calories shows that gender accounted for the biggest calorie difference.

Among the household types, only the households with dependent children without a spouse showed about 80 calories lower than those living alone. The regional variables indicate no regional differences in the time period July 2000 – June 2001.

Conclusion

This study was undertaken to study the effects of impulsive influences on food intake. We use the dual-self framework using the information on impulsivity and restraint related to diet in the National Diet and Nutrition Survey, UK. Given the range of scores in each of the impulsivity factors, the effect seems large. The total calorie intake owing to impulsivity and restraint is higher intake. Impulsive caloric intake is larger than one restrains and therefore the result of the intrapersonal conflict is a positive caloric intake on average. If we are using hyperbolic discounting model, we would sum the calorie intake attributed to the restraint self and the impulsive self. A reasonable conclusion of using that model would be that the average individual in UK is relatively long-run impatient. However, using dual-self framework allowed us to see the contribution of the impulsive and the restraint self. Estimating calorie intake to each of the selves help us develop strategies to counter the excessive intake.

Apart from the calorie intake attributed to the dual-self, we also find considerable calorie difference across other variables. Some of these variables are modifiable such as, place of eating, dieting, day of eating, etc. Place of eating and place of preparation or packing made considerable difference in calorie intake. Individuals eating outside the home consumed considerably higher calories compared to those who ate at home. Individuals who ate food prepared at home or brought from home, consumed about 160 fewer calories. Those who ate outside home consumed about 200 more calories or average per day. Both of these results are consistent with existing research.

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Tables and Graphs

Table 1: Descriptive statistics and description of the variables.

Variable	**Mean**	**Std. Dev.***	**Min**	**Max**
Daily calories	1939	794	0	6942
Slim (Yes=1 and No=0)	19	-	-	-
Psychological Measures				
Emotional Eating	23.1	10.4	0	65
Externality Eating	24.7	8.1	0	50
Restrained Eating	22.8	10.6	0	50
*Activity in minutes** (Light activity omitted)*				
Hard activity (e.g. jogging, rowing)	16.90	79.62	0	945
Moderate activity (e.g. gardening, aerobics)	76.22	158.37	0	1080
Light activity (e.g. clerical work, shopping)	853	183	20	1385
Sleep	492	98	55	1280
Day, place and source of eating				
Weekend (Friday, sat or sun = 1, else 0)	29	-	-	-
Proportion of mealtimes away from home	30	-	-	-
Proportion of meals made or brought from	24	-	-	-
Education (No qualification omitted. Education levels decrease in order)				
No qualifications	19	-	-	-
Degree or equivalent	17	-	-	-
Higher education below degree level	3	-	-	-
GCE 'A' level or equivalent	6	-	-	-
GCSE Grades A-C or equivalent	30	-	-	-
GCSE Grades D-G or equivalent	10	-	-	-
Other qualifications	14	-	-	-

*not reported for binary variables

**Coefficient of variation for hard, moderate and light activities was 4.7, 2.1 and 0.2.

Table contd…

Table 1 contd…

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
Other Demographic				
Gender (Female)	55	-	-	-
Age (years)	42.1	12.2	19	64
Income category	8.9	3.2	1	12
Household size (children + adults)	2.6	1.3	1	10
Household Type				
Living alone	2	-	-	-
With spouse or partner, no dep. children	35	-	-	-
With other adults, no spouse, no dep.ch.	1	-	-	-
With dep.ch, with spouse	27	-	-	-
With dep.ch, no spouse	8	-	-	-
			-	-
Region (North East omitted)			-	-
North East	5	-	-	-
North West	9	-	-	-
Merseyside	3	-	-	-
Yorks & Humberside	9	-	-	-
East Midlands	6	-	-	-
West Midlands	9	-	-	-
Eastern	10	-	-	-
London	10	-	-	-
South East	17	-	-	-
South West	10	-	-	-
Wales	4	-	-	-
Scotland	7	-	-	-
Year of Survey				
Year 2000	40	-	-	-
Year 2001	60	-	-	-

Table 2: Estimates of the different econometric models.

Variables	**OLS**	**GMM**	**GMM-2 step**
Lagged calorie intake	0.45	0.45	0.36
	(0.00)*	(0.00)*	(0.04)**
On diet	-76.51	-76.23	-90.68
	(0.00)*	(0.00)*	(0.00)*
Psychological Measures			
Externality Eating	6.10	6.22	7.35
	(0.00)*	(0.00)*	(0.00)*
Restrained Eating	-3.31	-3.30	-3.93
	(0.00)*	(0.00)*	(0.01)*
Emotional Eating	1.32	1.31	1.65
	(0.15)	(0.16)	(0.15)
Activity in minutes (Light activity omitted)			
Hard activity	0.35	0.35	0.42
	(0.00)*	(0.00)*	(0.01)*
Moderate activity	0.18	0.18	0.19
	(0.00)*	(0.00)*	(0.00)*
Sleep	-0.45	-0.44	-0.44
	(0.00)*	(0.00)*	(0.00)*
Day, place and source of eating			
Weekend	69.67	68.47	86.97
	(0.00)*	(0.00)*	(0.02)**
Proportion eaten away from home	175.51	177.14	202.28
	(0.00)*	(0.00)*	(0.00)*
Proportion made or brought from home	-140.03	-140.96	-161.84
	(0.01)*	(0.01)**	(0.02)**

Table 2 contd…

Table 2 contd…

Variables	**OLS**	**GMM**	**GMM-2 step**
Education (No qualification omitted. The listing is in the increasing order)			
Other qualifications	-53.15	-52.40	-65.78
	(0.17)	(0.15)	(0.14)
GCSE Grades D-G or equivalent	37.85	41.08	41.14
	(0.23)	(0.17)	(0.17)
GCSE Grades A-C or equivalent	9.99	10.35	8.65
	(0.64)	(0.62)	(0.68)
GCE 'A' level or equivalent	55.92	56.96	60.92
	(0.04)**	(0.03)**	(0.03)**
Higher education below degree level	35.44	36.82	39.39
	(0.15)	(0.14)	(0.12)
Degree or equivalent	71.48	72.01	77.88
	(0.00)*	(0.00)*	(0.00)*
Other Demographic			
Age	14.10	14.04	15.27
	(0.00)*	(0.00)*	(0.00)*
Age Sq.	-0.15	-0.14	-0.16
	(0.00)*	(0.00)*	(0.00)*
Gender	-308.62	-307.88	-364.02
	(0.00)*	(0.00)*	(0.00)*
Income category	19.27	18.21	24.22
	(0.12)	(0.16)	(0.16)
Income sq.	-0.82	-0.76	-1.01
	(0.29)	(0.35)	(0.28)
Household size	-7.48	-7.98	-9.77
	(0.38)	(0.35)	(0.29)

Table 2 contd.

Table 2 contd…

Variables	**OLS**	**GMM**	**GMM-2 step**
Household Type (living alone omitted): living with...			
Spouse or partner, no dep. children	16.77	17.55	20.66
	(0.46)	(0.45)	(0.39)
Other adults, no spouse, no dep.ch.	-32.32	-31.58	-34.79
	(0.30)	(0.34)	(0.30)
Dep. Ch., with spouse	-8.16	-6.77	-7.12
	(0.80)	(0.84)	(0.83)
Dep. Ch., no spouse	-79.19	-77.68	-84.02
	(0.01)**	(0.01)**	(0.01)**
Region (North East omitted)			
North West	-21.82	-20.55	-23.05
	(0.54)	(0.57)	(0.53)
Merseyside	62.24	63.16	72.95
	(0.20)	(0.21)	(0.17)
Yorks & Humberside	21.40	20.51	24.42
	(0.55)	(0.58)	(0.51)
East Midlands	-24.80	-24.83	-23.28
	(0.53)	(0.53)	(0.55)
West Midlands	-12.88	-14.76	-11.51
	(0.72)	(0.68)	(0.75)
Eastern	-27.77	-26.75	-26.86
	(0.43)	(0.45)	(0.44)
London	-32.46	-32.14	-36.56
	(0.37)	(0.37)	(0.32)
South East	10.78	11.43	16.04
	(0.74)	(0.73)	(0.64)
South West	19.00	20.86	27.70
	(0.59)	(0.55)	(0.46)
Wales	68.95	70.21	89.62
	(0.10)	(0.11)	(0.12)

Table 2 contd.

Table 2 contd…

Variables	**OLS**	**GMM**	**GMM-2 step**
Scotland	1.14	0.71	4.68
	(0.98)	(0.99)	(0.90)
Year 2001 (2002 omitted)	-26.83	-26.32	-31.06
	(0.04)**	(0.05)**	(0.05)***
Constant	904.04	901.92	1,029.53
	(0.00)*	(0.00)*	(0.00)*
Observations	9600	9600	9600

p values in parentheses

*** significant at 10%; ** significant at 5%; * significant at 1%
Number of caseid
R-squared
Robust p values in parentheses

Summary of the tests shown below:

Anderson canonical test rejects the null which indicates that the instruments (the excluded from the second stage) are valid and that the model is identified.

Hansen J statistic does not reject the null which shows that the instruments in model 3 are jointly valid.

C-statistic in model 3 does not reject the null which shows that the test of the exogeneity of the variables in parenthesis is valid. Implying suspect endogenous variables are exogenous

Models used in estimation. *(The number refers to the column in Table 2.)*

Model 4 (IV) ***Lagged calorie intake***

Model: ivreg2 tdnuts05d slim eatext eatrest eatemot tmhardhrs tmmodhrs timslp wknd eatpl1 foodsrce2 incomecd incsq dedn2-dedn7 hs dyear2 dgor2-dgor12 dhh2-dhh5 gender respage agesq (l.tdnuts05d = l.tmhardhrs l.tmmodhrs l.timslp), gmm robust

Anderson canon. corr. LR statistic (identification/IV relevance test): 37.737
Chi-sq(3) P-val = 0.0000
Hansen J statistic (overidentification test of all instruments): 4.290
Chi-sq(2) P-val = 0.1171

Model 3: Endogeneity of lagged calorie intake

Model: ivreg2 tdnuts05d l.tdnuts05d slim eatext eatrest eatemot tmhardhrs tmmodhrs timslp wknd eatpl1 foodsrce2 incomecd incsq dedn2-dedn7 hs dyear2 dgor2-dgor12 dhh2-dhh5 gender respage agesq (= l.tmhardhrs l.tmmodhrs l.timslp), orthog(l.tdnuts05d) gmm robust

Hansen J statistic (Lagrange multiplier test of excluded instruments): 4.597
Chi-sq(3) P-val = 0.2038

-orthog- option:

Hansen J statistic (eqn. excluding suspect orthog. conditions): 4.315
Chi-sq(2) P-val = 0.1156

C statistic (exogeneity/orthogonality of suspect instruments): 0.282
Chi-sq(1) P-val = 0.5954

Model 3: Endogeneity of Psychological measures

Model: ivreg2 tdnuts05d l.tdnuts05d slim eatext eatrest eatemot tmhardhrs tmmodhrs timslp wknd eatpl1 foodsrce2 incomecd incsq dedn2-dedn7 hs dyear2 dgor2-dgor12 dhh2-dhh5 gender respage agesq (= l.tmhardhrs l.tmmodhrs l.timslp), orthog(eatext eatrest eatemot) gmm

Hansen J statistic (Lagrange multiplier test of excluded instruments): 4.597
Chi-sq(3) P-val = 0.2038

-orthog- option:

Hansen J statistic (eqn. excluding suspect orthog. conditions): -
Chi-sq(0) P-val = .

C statistic (exogeneity/orthogonality of suspect instruments): 4.597
Chi-sq(3) P-val = 0.2038

Appendix

Sample questions from the NDNS survey is given below to describe how the self-control measures were created.

Worried: Do you get the desire to eat when you are anxious, worried or tense?

1. Never
2. Seldom
3. Sometimes
4. Often
5. Very Often

Lonely: Do you have a desire to eat when you are feeling lonely?

1. Never
2. Seldom
3. Sometimes
4. Often
5. Very Often

The above two questions fall under emotional self-control category where lower ordinal scores related to stronger self-control and higher ordinal scores indicate lower self-control. Thus an individual who chose option 1 for first question and 2 for the second one will have an emotional self-control score of 3. This individual with 3 score will be considered high in self-control relative to another who has scores above 3.

List of questions

Restrained Eating

1. If you have put on weight, do you eat less than you usually do?
2. Do you try to eat less at mealtimes than you would like to eat?
3. How often do you refuse food or drink offered because you are concerned about your weight?
4. Do you watch exactly what you eat?
5. Do you deliberately eat foods that are slimming?
6. When you have eaten too much, do you eat less than usual the following days?'
7. Do you deliberately eat less in order not to become heavier?
8. How often do you try not to eat between meals because you are watching your weight?
9. How often in the evening do you try not to eat because you are watching your weight?
10. Do you take into account your weight with what you eat?

Emotional Eating

11. Do you have the desire to eat when you are irritated?
12. Do you have a desire to eat when you have nothing to do?
13. Do you have a desire to eat when you are depressed or discouraged?
14. Do you have a desire to eat when you are feeling lonely?
15. Do you have a desire to eat when somebody lets you down?
16. Do you have a desire to eat when you are cross?
17. Do you have a desire to eat when you are approaching something unpleasant to happen?

18. Do you get the desire to eat when you are anxious, worried or tense?
19. Do you have a desire to eat when things are going against you or when things have gone wrong?
20. Do you have a desire to eat when you are frightened?
21. Do you have a desire to eat when you are disappointed?
22. Do you have a desire to eat when you are emotionally upset?
23. Do you have a desire to eat when you are bored or restless?

External Eating
24. If food tastes good to you, do you eat more than usual?
25. If food smells and looks good, do you eat more than usual?
26. If you see or smell something delicious, do you have a desire to eat it?
If you have something delicious to eat, do you eat it straight away?
28. If you walk past the baker do you have the desire to buy something delicious?
29. If you walk past a snackbar or a cafe, do you have the desire to buy something delicious?
30. If you see others eating, do you also have the desire to eat?
31. Can you resist eating delicious foods?
32. Do you eat more than usual, when you see others eating?
33. When preparing a meal are you inclined to eat something?