Self Control and Food Consumption at Home and in the Wild – Empirical Evidence of the Age Cohorts in Taiwan

Hung-Hao Chang*
(Corresponding Author)
Assistant Professor
Department of Agricultural Economics
National Taiwan University
No 1, Roosevelt Rd, Sec 4, Taipei 10617, Taiwan
E-mail: hunghaochang@ntu.edu.tw
Tel: +886-2-3366-2656
Fax: +886-2-2362-8496

David R. Just
Associate Professor
Applied Economics and Management
Cornell University
254 Warren Hall, Cornell University, 14853
Email: drj3@cornell.edu

Ta-Chuan Chang
Master
Department of Agricultural Economics
National Taiwan University

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Abstract

As the increasing prevalence of obesity in the world, how to prevent increasing body weight has became important policy issue. This paper addresses this issue using the behavioral economic models to empirically test food consumption behaviors and self-control problem. In contrast to replying on experimental evidence of the behavioral economic studies, age cohort data are constructed for households in Taiwan and food away from home and several categories of food consumption at home are recognized. Results show that self-control problem are evident for food away from home, and the effects are more pronounced for younger age cohorts. In contrast, staple and secondary food consumption at home are more stable across life-time periods and no self-control problem is evident.

Keyword: cohort analysis, food expenses, self-control, behavior economics.

Introduction

Self control is a central issue of behavioral economics. This notion that the individual must exert some effort to control their own actions is particularly useful when discussing the increasing problem of obesity. If self control is not part of the problem, then the primary policy levers are better health information and adjustments in prices. However, if self control is contributing to the problem, policies that are designed to appeal to highly conscious thought may be ill-suited to address the growing problem. Food psychologists have long examined the impact of environmental cues and consumption norms on consumption volume (e.g., Wansink 2004). Essentially, individuals tend to overeat when they face an environment that prevents monitoring consumption volume, or when environmental cues (such as plate size) tell them they should eat more than is healthy. These effects are often stronger among the overweight people. Self control is difficult to document generally because we cannot directly observe the costs of controlling ones actions.

The primary emphasis of this paper is to examine the relationship between food consumption and self-control. To understand self-control problem and food consumption is of particular policy interest since it has been argued that the changes of food consumption pattern over the past decades has resulted in the increasing prevalence of obesity (Cutler, Glaeser and Shapiro 2003). Also, studies had pointed out that the lower food price due to technology improving can't fully explain the increasing food away from home consumption. Instead, evidence from the behavioral economics literature indicates that self-control problem may be an important reason to determine food consumption. For instance, people usually over-eat despite they want to lose weight (Cummings 2003).

A growing body of literature has applied behavior economic models to various topics, and the most notable exception is finance. Behavioral finance has became a thriving literature with many innovation and important results (see Shefrin 2000 for a review). Little attention has been paid on the link between behavioral economics and food consumption. One exception is Just *et al.* (2008) who conducted experimental designs in college cafeteria to assess the effects of various payments options and menu selection methods on food choices. Using 191 college students of the Cornell University, their results show that payment options for food choices can significantly affect the types of food chosen.

The objective of this paper is twofold. We first examine food consumption pattern over the life cycle. Food consumption expenditures include total food consumption, food away from home, and food at home. The food at home expenditures are further categorized into staple food, secondary food, dairy products, and fruits. Based on the observed food consumption expenditures, our second objective is to empirically test if each food consumption pattern reflects self-control or time-inconsistency. Several unique features may set our analysis apart from the previous studies. First, in contrast to Just *et al.* (2008) using experimental designs to examine food choices, this study empirically test self-control problem by constructing age cohort data sets drawn from the annual cross-sectional household survey of the Survey of Family Income and Expenditure in Taiwan between 1986 and 2006. To our best understanding, this study is among the first that empirically test the self-control and food consumption using the micro-level data. Additionally, unlike the previous studies that examined the exogenous determinants of the food consumption, this study looks at time-inconsistency over life-cycle consumption of food at home and away from home.

Below we provide a conceptual framework establishing the linkage between food consumption and self-control to guide the empirical analysis. Data used in the analysis are described. An econometric procedure is then developed. We then present the empirical results and summarize the findings.

Conceptual Framework

Our empirical analysis is built on the simple version of the theoretical framework by Gul and Pesendorfer (2001) and Huang, Liu, and Zhu (2007) of the temptation and self-control behavior. For simplicity, assuming there are only two-period of time (period 0 and 1) and the representative consumer makes optimal decision of current consumption and saving for asset of the next period. Let C_0 and B_1 be the consumption of period 0 and wealth/asset in period 1 for maximizing utility at time period 0. The utility function of the representative consumer in period 0 can be specified as:

(1) $$G_0(S(B_0)) = \max_{C_0, B_1} \{U(C_0) + V(C_0) + \rho E[G_1(s(B_1))] - V(A_0 + X_0)\}$$

where ρ is the time discount factor and $E[G_1(s(B_1))]$ is the expected utility for holding wealth B_1. A_0 is the initial wealth in period 0 and X_0 is the earned income in time period 0. As a result, A_0+X_0 measures the disposal income which can be possibly used for consumption. The term $V(C_0) - V(A_0 + X_0)$ can be seen as the mental cost of self-control which measures the cost to keep wealth instead of consuming all of them in time 0. In other words, if he spends all wealth in time 0 (i.e. $V(C_0) - V(A_0 + X_0) = 0$), he has no mental cost of holding asset to the next period.

The overall utility of equation (1) contains three part. The first part $U(C_0)$

measures the utility gain of consumption C_0, the second term $\rho E[G_1(s(B_1))]$ is the discount expected utility of consumption C_1, and the third term $V(C_0)-V(A_0+X_0)$ is the mental cost of self-control by holding the wealth into the second period and not consumed at the current period.

The budget constraint in period *0* can be shows as:

(2) $A_1 = A_0 + X_0 - C_0$

where A_1 is the initial wealth in period 1. For simplicity, let $w_0 = A_0 + X_0$ and r_1 is the gross return on assets between period 0 and 1. Solving equation (1) and (2) for the maximization problem, the first order intertemporal Euler equation can be derived as:

(3) $U'(C_0)+V'(C_0)=\rho E[U'(C_1)+V'(C_1)-V'(w_1)](1+r_1)$

Equation (3) can be re-organized and simplified as:

(4) $1 = EH_{0,1}(1+r_1)$

where $H_{0,1}=\dfrac{\rho[U'(C_1)+V'(C_1)-V'(w_1)]}{U'(C_0)+V'(C_0)}$ which measures the intertemporal marginal rate of substitution between period 0 and 1.

Assume the utility to follow the Constant Relative Risk Aversion form (CRRA) with the risk averse parameter γ, and let $V(C)=\theta U(C)$ where the parameter θ measures the self-control problem. θ >0 then indicates the lack of self-control or suffers from temptation of consumption. The larger the value θ is, the stronger of the temptation is. In contrast, $\theta \leq 0$ indicates no self-control problem. In this case, a smooth consumption pattern is expected. Substituting the CRRA utility function and $V(C) = \theta U(C)$ into equation (4) will yield:

$$(5)\quad \ln(H_{0,1}) = \ln(\rho) - \ln(1+\sigma) - \gamma \ln\left(\frac{C_1}{C_0}\right) + \gamma\sigma\left[\ln\left(\frac{w_1}{C_1}\right) - \ln\left(\frac{w}{c}\right)\right] + K_1$$

where $\sigma = \dfrac{\theta}{(1+\theta)(\frac{w}{c})^{\gamma} - \theta}$. The term $\frac{w}{c}$ measures the steady state condition of income-consumption ratio. For simplicity, let $\frac{w}{c} > 1$ and K_1 includes the second or higher moments in consumption growth and the wealth-consumption ratio. Therefore,

$$(6)\quad \frac{d\sigma}{d\theta} = (\frac{w}{c})^{\gamma} / \left[(1+\theta)(\frac{w}{c})^{\gamma} - \theta\right]^2 > 0$$

The parameter θ and σ have the same sign. After substituting equation (5) into equation (4) will yield:

$$(7)\quad \ln\left(\frac{C_1}{C_0}\right) = a_0 + \frac{1}{\rho}\ln(1+r_1) + \sigma \ln\left(\frac{w_1}{C_1}\right)$$

Equation (7) provides the guideline of the empirical analysis. The interest parameter to be estimated is σ which is called the "temptation parameter". If $\sigma > 0$ then temptation problem exist, otherwise there is no temptation problem of consumption (see Huang, Liu, and Zhu 2007).

Data Source

Our data are drawn from the Surveys of Family Income and Expenditure (SFIEs) in Taiwan, conducted by Taiwan's Directorate General of Budget, Accounting and Statistics in 1986-2006. The SFIE survey was conducted every two years prior to 1976 and annually thereafter. In each year, data collected included household income from salaries, entrepreneurial, property, and government transfers, as well as expenditures on both durable and nondurable goods in different categories.

Age cohort are defined as all households whose head was born during a certain period. We first exclude households whose head's age is below 28 because we would like to focus on the employed households with the household head of full-time work to afford the household expenditures. In the present paper, birth cohorts are separated into 5-year intervals. In total, six groups of age cohorts are defined. Cohort 1 is the youngest, with the household head aged 28-48 during the study period, whereas cohort 6, the oldest cohort, had the household head aged 53-73 during the study period. Table 1 presents the cohort definitions, the average ages during 1986–2006, and average cell size of each cohort.

With respect to the food consumption, five different types of food expenditures are recognized. These include total food consumed away from home and several categories of food consumed at home including staple food, secondary food, dairy products, and fruit products consumed. Staple food includes raw food items such as rice, noodles and other grain products; secondary food includes meat, fish, vegetables and oils; dairy products include milk, yogurt and other food made from milk; fruit products consist of all kinds of fruits. Table 2 presents each food consumption of different age cohorts. As exhibited in Table 2, the food consumption differs among different age cohorts. In general, the old cohorts consumed less in food away from home and at home. For instance, the average food expenditure away from home and at home are 59% and 26% of the average food expenditure of the youngest cohort respectively.

Econometric Model

As discussed in the theoretical section, equation (7) is of particular interest. Equation (7) can be econometrically specified by adding an error term and other exogenous variables:

(8) $$\ln\left(\frac{C_t}{C_{t-1}}\right) = \alpha + \frac{1}{\rho}\ln(1+r_t) + \sigma\ln\left(\frac{w_t}{C_t}\right) + \pi_j D_j + \tau_j [D_j * \ln\left(\frac{w_t}{C_t}\right)] + \upsilon H_t + \varepsilon_t \quad \text{(j=2..J)}$$

where the variable D_j is the dummy variable for the j^{th} age cohort. In addition to the income-consumption ratio ($\frac{w_t}{C_t}$) and the rate of return on asset ($1+r_t$), other exogenous determinants are included to controlled for the household characteristics among different cohorts (H_t). These include the number of family members aged <6 (children) and number of family members aged >= 65 (elderly), the annual average employment rates and Consumer Price Index. It is of note that the equation (8) allows for testing the different temptation behavior among age cohorts by including several dummy variables to capture cohort fixed effect. Moreover, several interaction terms between cohort dummies and income-consumption ratio are also specified. Therefore, the temptation of each age cohort is the combined parameters: $\sigma + \tau_j D_j$.

Two econometric methods are used to estimate equation (8). The first method is the commonly used ordinary least square method (OLS). However, the necessary assumptions that need to be satisfied to implement classical OLS method are usually violated. The reason why the assumptions of classical regressions are regularly violated relates to the way data used to undertake analysis are generated. The evolutionary processes observed in the econometric literature are due to the need to develop new techniques to cope with these data problems. Two data problems have been recognized which can lead to inconsistent estimators of the classical regression model. In a case of relatively small sample, it is usually non-stationary and the results are very sensitive due to outliers. Another problem is related to collinearity of the data when one or more exact, or near exact, linear dependencies among the set of explanatory variables exist. In this case, the design matrix does not have full rank or a numerically stable inverse matrix. Although exact collinearity is rare, severe collinearity will lead to high variances for least squares estimators, which in turn results in large variation in parameter estimates.

An alternative estimation methodology, Generalized Maximum Entropy method (GME), has been shown not subject to the problems of outlier and collinearity (Golan and Judge, 1995 ; Golan, Judge, and Miller, 1996).[1] To introduce the GME method, let all of the parameters and the endogenous (exogenous) variables of equation (8) be β and N (y) with the error term ε . The reformation of equation (8) for GME estimation can be shown as:

(9) $y = N\beta + \varepsilon = NZp + Vm$

where β=Zp and ε=Vm. Z is the a matrix of known support values for β, and p is a vector of unknown probabilities such that p_k>=0 and $p_k s_m$=1. *M* is the number of support points. Using the reparameterization, the GME estimation is to solve the

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[1] Golan *et al.* (1996) have tested the performance of GME estimation in ill-conditioned data. They found that a higher degree of precision can be achieved in terms of the estimation when using GME compared to alternative estimation methodologies. Mean squared error loss for GME is significantly lower than for the more traditional estimation methodologies. They suggest that GME is a feasible alternative method of estimation when faced by ill-conditioned linear inverse problems.

following constrained maximization problem (see Golan, Judge, and Miller, 1996):

(10) $$\underset{p,m}{Max}\, H(p,m) = -\sum\sum p_{km} \ln p_{km} - \sum\sum w_{tj} \ln w_{tj}$$

s.t $$y = N\beta + \varepsilon = NZp + Vm$$

$$\sum p_{km} = 1$$

$$\sum w_{tj} = 1$$

In our empirical analysis, we first estimate equation (8) using the OLS method, and then test for the collinearity (see appendix for detailed results of the test). In what follows, equation (10) is estimated using the GME method. The results of OLS and GME methods for each food expenditure equation are presented in Table 4. To highlight the differential effects of self-control on food consumption among different age cohorts, we test the temptation behavior of each age cohort ($H_0 : \sigma + \tau_j D_j > 1$) and the results are presented in Table 5.

Empirical Results

As exhibited in Table 4, the GME estimations have small MSE and RMSE compared to the OLS results. In addition, the standard errors of parameters are smaller in GME results. These results are pronounced by the statistical tests for the collinearity and the outlier. Results in the appendix show that all of the food expenditure equations suffer from the collinearity problems.

Perhaps, the most interesting case is on the examination of the temptation parameter of each age cohort and the results are presented in Table 5 based on the GME estimations. Results show that temptation are found in total food consumption, food at home and food away from home. The effects are more pronounced for the food away from home, and the temptation is significant for all age cohorts. Among all age cohorts, the largest effect of temptation is found for cohort 2 (the effect is 0.049), and the smallest effect of temptation is found for cohort 5 and 6 (the effect is 0.023). This result may not be surprising in that cohort 2 is aged 33-53. This group of people are of good employment experience and may have more extensive social activities. Therefore, they are more likely to have irregular food consumption away from home. This finding is also in accordance with the evidence of the cross-sectional studies of a negative association between age and the expenditures on food away from home (e.g., Nayga and Capps 1994; Fan *et al.* 2007). These studies suggest that people's food away from home change as a result of their lifecycle stages. In contrast, cohort 5 and 6 are those at the retirement age from the labor market. The smaller variation of their food consumption away from home can be expected.

With respect to the food consumption at home, temptation is found for dairy products and fruits and it is significant for all age cohorts. A slightly stronger strength of temptation of fruit is evident for cohort 1 who are aged between 28-58. This finding may reinforced the fact that these groups of people are more active in social activities and therefore, they have relatively irregular food consumption for fruit at home. In addition, the most significant effects of temptation are found for older age cohorts which may reflect the fact that some of the diary consumption at home are more variant among older adults. In contrast, no evidence of temptation is found for staple and secondary food products at home.

Conclusions

As the increasing trends of obesity, great attentions have been paid to the prevention of obesity. Among all of the other factors, self-control on food consumption has been shown as one of the possible reasons which result in the overeating. This paper aims to address this issue by empirically test if the temptation behavior of the food consumption at home and away from home using a age cohort data in Taiwan.

Several interesting findings can be highlighted. First, sample statistics show that life-cycle food consumption differs by food products. Particularly, food away from home, dairy products and fruit consumption are not stable across the life-cycle compared to staple and secondary food consumption. With respect to time-consistency, food consumption away from home and dairy and fruit consumption at home are evident for self-consumption problem. Furthermore, the effects are more pronounced for the age cohorts between 33-53 years old. Interestingly, food consumption at home is also evident for the age cohort between 28-48 years old. Last, our results are supportive for using the maximum entropy method for estimation. The estimation results of the maximum entropy method perform much better than the OLS results.

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Table 1: Cohort statistics

Cohort	Age in 1986	Age in 2006	Average cell size
1	28	48	2,390
2	33	53	2,488
3	38	58	1,722
4	43	63	1,207
5	48	68	1,022
6	53	73	832

Table 2: Average consumption of different cohorts

Cohort	1	2	3	4	5	6
Food Expenditure (NT 1,000)						
Total food	149	149	147	136	118	98
	--	*0%*	*-1%*	*-9%*	*####*	*-35%*
Food at home	109	110	109	105	94	81
	--	*1%*	*0%*	*-4%*	*####*	*-26%*
Staple food	13	13	13	13	11	10
	--	*3%*	*3%*	*-2%*	*####*	*-24%*
Secondary food	62	63	63	61	55	47
	--	*2%*	*1%*	*-3%*	*####*	*-24%*
Dairy products	7	6	5	5	4	4
	--	*###*	*###*	*###*	*####*	*-46%*
Fruits	18	18	18	17	15	13
	--	*1%*	*0%*	*-7%*	*####*	*-31%*
Food away from home	40	39	37	31	24	16
	--	*-2%*	*-6%*	*###*	*####*	*-59%*
Explantory Variables**						
Disposal household income (NT$ 1,0(	790	805	836	785	692	558
Number of kids (age<6)	0.8	0.6	0.4	0.4	0.4	0.4
Number of elderly (age>= 65)	0.2	0.2	0.2	0.2	0.4	0.7

percentage are compared to the youngest cohort (i.e cohort 1).

Table 3: Estimation of the Food Expenses of the Households

	Total food				Food at home				Staple food				Secondary food			
	GME		OLS		GME		OLS		GME		OLS		GME		OLS	
Variables	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Log (inc-consum ratio)	0.058***	0.007	0.230***	0.034	0.007***	0.002	0.069*	0.039	-0.002*	0.001	-0.006	0.050	0.000	0.001	0.007	0.048
Log (number of kids)	0.003***	0.000	-0.004	0.007	0.005***	0.001	0.013	0.010	0.001	0.001	-0.019	0.024	0.002**	0.001	0.009	0.016
Log (number of elderly)	-0.004***	0.001	0.021***	0.006	-0.003***	0.001	0.014	0.009	0.001	0.000	-0.013	0.021	-0.001	0.000	0.013	0.014
Price index	-0.077***	0.011	-0.331***	0.063	-0.009***	0.002	-0.098	0.086	-0.009**	0.004	-0.039	0.244	-0.005*	0.003	0.033	0.148
Unemployment rate	-0.128***	0.017	-0.659*	0.334	-0.047***	0.010	-0.199	0.495	-0.007	0.015	0.999	1.111	-0.030**	0.014	-0.419	0.771
D2	0.012***	0.004	0.271***	0.090	0.009**	0.004	0.143	0.095	0.002	0.010	0.515*	0.275	0.007	0.006	0.194	0.166
D3	0.003	0.004	0.2560***	0.070	0.003	0.004	0.119	0.083	-0.001	0.009	0.344	0.234	0.001	0.005	0.080	0.142
D4	-0.008**	0.004	0.303***	0.062	-0.002	0.004	0.186**	0.083	-0.006	0.008	0.321	0.227	-0.003	0.006	0.182	0.140
D5	-0.018***	0.004	0.297***	0.057	-0.006	0.004	0.135	0.084	-0.007	0.007	0.101	0.239	-0.004	0.005	0.079	0.144
D6	-0.029***	0.004	0.271***	0.053	-0.009***	0.003	0.08	0.078	-0.008	0.007	0.088	0.242	-0.006	0.004	-0.002	0.135
D2*Log (inc-consum ratio)	-0.007**	0.003	-0.174***	0.058	-0.001	0.002	-0.072	0.051	0.001	0.003	-0.128*	0.068	0.001	0.003	-0.074	0.066
D3*Log (inc-consum ratio)	-0.011***	0.003	-0.174***	0.045	-0.002	0.002	-0.06	0.045	0.000	0.002	-0.090	0.059	0.000	0.002	-0.033	0.057
D4*Log (inc-consum ratio)	-0.013***	0.003	-0.208***	0.039	-0.00311	0.002	-0.100**	0.044	-0.002	0.002	-0.087	0.056	-0.002	0.003	-0.076	0.056
D5*Log (inc-consum ratio)	-0.012***	0.003	-0.215***	0.037	-0.00322	0.002	-0.080*	0.046	-0.002	0.002	-0.035	0.059	-0.002	0.002	-0.040	0.058
D6*Log (inc-consum ratio)	-0.009***	0.003	-0.207***	0.036	-0.004**	0.002	-0.053	0.044	-0.002	0.002	-0.033	0.061	-0.003	0.002	-0.010	0.056
R-squared	0.30		0.67		0.13		0.29		0.02		0.15		0.04		0.13	
RMSE	10		107		5		11		11		1051		7		104	
MAE	3.10		30.70		2.18		4.88		1.73		129.61		1.79		25.20	

*** significance at 1% level; ** significance at 5% level; * significance at 10% level.

D2-D6 are dummy variables for cohort 2-6 respectively.

GME is generalized maximum entropy, OLS is ordinary least squared regression.

Table 3: Estimation of the Food Expenses of the Households (cont.)

	Dairy products				**Fruits**				**Food away from home**			
	GME		OLS		GME		OLS		GME		OLS	
Variables	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Log (inc-consum ratio)	0.016***	0.003	0.103***	####	0.016***	0.002	0.099***	0.022	0.037***	0.004	0.200***	0.037
Log (number of kids)	0.003***	0.000	-0.001	####	0.007***	0.001	0.019	0.012	0.009***	0.001	0.029	0.030
Log (number of elderly)	-0.002***	0.000	0.023	####	-0.004***	0.001	0.027***	0.010	-0.003***	0.000	0.033	0.022
Price index	-0.049***	0.011	-0.471**	####	-0.038***	0.006	-0.330**	0.096	-0.035***	0.009	-0.567**	0.157
Unemployment rate	-0.171***	0.027	-1.708	####	-0.061***	0.007	-0.344	0.566	-0.093***	0.012	0.354	1.470
D2	0.000	0.012	-0.008	####	32924	0.006	-0.022	0.258	0.007032	0.013	0.615**	0.274
D3	0.000	0.012	0.773	####	-0.003	0.006	0.034	0.217	0.000	0.012	0.337	0.352
D4	-0.010	0.013	1.095	####	-0.007	0.007	0.344	0.254	-0.023*	0.014	0.579	0.561
D5	0.004	0.011	0.345	####	-0.013**	0.007	0.537***	0.168	-0.041***	0.013	0.958**	0.396
D6	-0.007	0.011	0.419	####	-0.015**	0.006	0.238*	0.133	-0.045***	0.012	0.834**	0.325
D2*Log (inc-consum ratio)	-0.003	0.002	-0.004	####	-0.001	0.002	0.007	0.069	0.012***	0.004	-0.179**	0.080
D3*Log (inc-consum ratio)	0.000	0.002	-0.147	####	-0.002	0.002	-0.008	0.057	0.004242	0.004	-0.102	0.101
D4*Log (inc-consum ratio)	0.004*	0.002	-0.200	####	-0.004**	0.002	-0.091	0.066	-0.006	0.004	-0.189	0.156
D5*Log (inc-consum ratio)	0.004	0.002	-0.067	####	-0.003	0.002	-0.146**	0.045	-0.014***	0.004	-0.300**	0.104
D6*Log (inc-consum ratio)	0.004*	0.002	-0.083	####	-0.003*	0.002	-0.070*	0.036	-0.014***	0.004	-0.263**	0.081
R-squared	0.15		0.49		0.23		0.57		0.26		0.64	
Root of mean square error	24		367		1		3		23		701	
Mean absolute error	4.33		69.51		0.54		1.26		2.73		80.27	

*** significance at 1% level; ** significance at 5% level; * significance at 10% level.

D2-D6 are dummy variables for cohort 2-6 respectively.

GME is generalized maximum entropy, OLS is ordinary least squared regression.

Table 4: Statistical tests of the self-control among cohort groups

	Total food			Food at home			Staple food			Secondary food		
Cohort	Temptation Parameters	Wald test	p-value	Temptation Parameters	Wald test	p-value	Temptation Parameters	Wald test	p-value	Temptation Parameters	Wald test	p-value
1	0.058***	69.73	<.0001	0.007***	14.14	0.000	-0.002*	3.44	0.064	0.000	0.02	0.878
2	0.051***	75.31	<.0001	0.006**	5.48	0.019	-0.001	0.16	0.685	0.001	0.1	0.749
3	0.047***	64.59	<.0001	0.005**	3.97	0.046	-0.002	0.66	0.417	0.000	0.01	0.917
4	0.045***	52.41	<.0001	0.004	1.94	0.164	-0.004	2.13	0.145	-0.002	0.36	0.546
5	0.046***	49.41	<.0001	0.004	1.69	0.194	-0.004*	2.77	0.096	-0.002	0.35	0.556
6	0.049***	46.8	<.0001	0.003	0.83	0.363	-0.004*	2.98	0.084	-0.003	1.09	0.296

	Diary products			Fruits			Food away from home		
Cohort	Temptation Parameters	Wald test	p-value	Temptation Parameters	Wald test	p-value	Temptation Parameters	Wald test	p-value
1	0.016***	42.29	<.0001	0.016***	70.66	<.0001	0.037***	108.92	<.0001
2	0.013***	28.26	<.0001	0.015***	50.28	<.0001	0.049***	87.04	<.0001
3	0.016***	37.74	<.0001	0.014***	45.76	<.0001	0.041***	69.72	<.0001
4	0.020***	50.16	<.0001	0.012***	35.75	<.0001	0.031***	38.91	<.0001
5	0.020***	52.35	<.0001	0.013***	37.34	<.0001	0.023***	23.38	<.0001
6	0.020***	47.97	<.0001	0.013***	34.19	<.0001	0.023***	23.65	<.0001

Wald test: test the cohort effect on each consumption.

*** significance at 1% level; ** significance at 5% level; * significance at 10% level.

Appendix: Statistical test of the collinearility problem

As indicated earlier, collinearity and outlier are commonly seen in the cohort analysis and results in ill-posed sample. In this appendix, we report the statistical test of the collinearity problem.

<u>Collinearity Test</u>

The collinearlity test is conducted by calculating the conditional number index (CI) for each food expenditure equation. If the CI is greater critical value 30, the empirical specification suffers from collinearlity problem. As exhibited in Table A1, the CI values of all of the food consumption equations are greater than 30, which indicate that collinearity is severe for each food consumption equation.

Table A1: Tests results for multicolinearity

Variables	Condition number*
Total food	91
Food at home	82
Staple food	96
Secondary food	87
Dairy products	263
Fruits	99
Food away from home	88

* If CI>30 then multicolinearity