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Holiday and Weight Gain: Evidence from the National Day Holiday in China

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Holiday and Weight Gain: Evidence from the National Day Holiday in China

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Holiday and Weight Gain: Evidence from the National Day Holiday in China

Abstract:

We use the regression discontinuity model and CHNS (China Health and Nutrition Survey) data, to study the body weight gain effect of the National Day holiday in China. We find that Chinese adults tend to gain 1.561 kg during the National Day holiday. The weight gain effect shrinks to 0.967 kg or even 0.491 kg, when we extend the time window from one-week level to two-week level and the one-month level. It implies that holiday weight gain could lead to the long-term body weight accumulation. Besides, the middle-age group is the most fragile group to the holiday weight gain. Young and middle aged males and old females suffer more to the weight gain compared to their counterpart.

Key Words: Holiday weight Gain, National Day holiday, Regression discontinuity, obesity

JEL: I12, I18

1. Introduction

Obesity is now regarded as an "epidemiology" globally: the prevalence rate of adult overweight globally reached 39% in 2015(IFPRI, 2016). The Global Nutrition Report by IFPRI (2016) shows that the prevalence rates of both adult overweight and obesity are continuously increasing in recent years. As an emerging economy, China is no exception. In compliance with rapid economic growth, China has experienced a nutrition transition from deficiency to affluence. The food structure has been rapidly changing, changing from a dietary dominated by cereals to one with more animal products (Yu and Abler, 2009; Tian and Yu, 2013 and 2015). Consequently, China transfers from malnutrition to overweight and obesity rapidly, with the percentage of overweight adults almost tripled from 1991 to 2011(Gordon-Larsen et al. 2014). The prevalence rate of adult overweight has reached 34.4% in 2015, slightly below the global average level. However, the overweight prevalence rate for children under 5 is 6.6% in 2015, which has overtaken the global average level of 6.1%. It mirrors an increasing trend of overweight/obesity prevalence in the future.

In addition to food structure and dietary change, lifestyles and holiday arrangements are believed to be related to increasing overweight and obesity. Notwithstanding, the latter has not been well examined in the literature. Particularly, it has been observed that the average working hours annually are globally shrinking while leisure time and holidays become longer. For instance, people can arrange more parties, family unions, and tourism activities, and consume more food and drinks. One can speculate that such behavior can lead to body weight increment (Wagner et al., 2012).

The time of the National Day holiday is fixed from October 1 to October 7 since 2000 (except in 2009, 2012 and 2017), it provides us a good opportunity to examine the weight change before and after the holiday. Specifically, we implement a regression discontinuity design and use the CHNS data (China Health and Nutrition Survey). We find that Chinese adults on average tend to gain 1.561 kg during the 7 days of the National Day holiday in China. The holiday weight effect could shrink to 0.967 kg for about two weeks and to 0.491 kg in one month. It implies that even if such weight gain could remain and contribute to the long-run weight accumulation, the effect is trivial.

2. Literature and Background

There was a popular point of view on the holiday weight gain that adults tend to gain 2-5 kg weight in the US during the winter holiday which started from Thanksgiving Day and ended on New Year's Day in the US. Newspapers and fashion magazines enforced a deep impression, so that folks accepted the assertion, although it was not true (Wagner et al. 2012). However, situations are different in other countries. Specifically, it is widely convinced that Chinese adults tend to gain 1.5 kg during the week-long National Day holiday and the Spring Festival holiday individually in the social media in China (Mei Feng Jia Jie Pang San Jin). Though quite a few scientific studies on holiday weight gain have been conducted, the study on China is only conducted in a limited way.

Few studies have been conducted based on all year round. Yanovski et al. (2000) conducted an early study on holiday weight gain with use of the data of 195 adult subjects recruited from the employees of the National Institute of Health in the US and found that people tend to have an average net weight gain of 0.48 kg in the three months. Roberts (2000) proposed a review for the NIH study in the same year, arguing that the representative samples and clear channels for the disproportionate seasonal distribution of weight gain are needed for further study.

Hull et al. (2006) later used the data of 94 college student subjects who reported their height and weight at the laboratory in the University of Oklahoma and find that people who are classified as overweight or obese tended to gain more weight (1.0 kg) than those who are classified as normal (0.2 kg) during the two-week-long holiday. Furthermore, Wagner et al. (2012) used both the BMI (body mass index) and body composition of 34 non-university student subjects from North Utah as indicators and found no significant holiday weight gain although the participants held the belief that they gain weight a lot during the winter holiday. All these studies focused on the winter holiday from Thanksgiving Day to New Year's Day in the US. After that, a review by

Schoeller (2014) concluded that winter holiday tends to accompany a body weight gain of 0.4 to 0.7 kg in the United States.

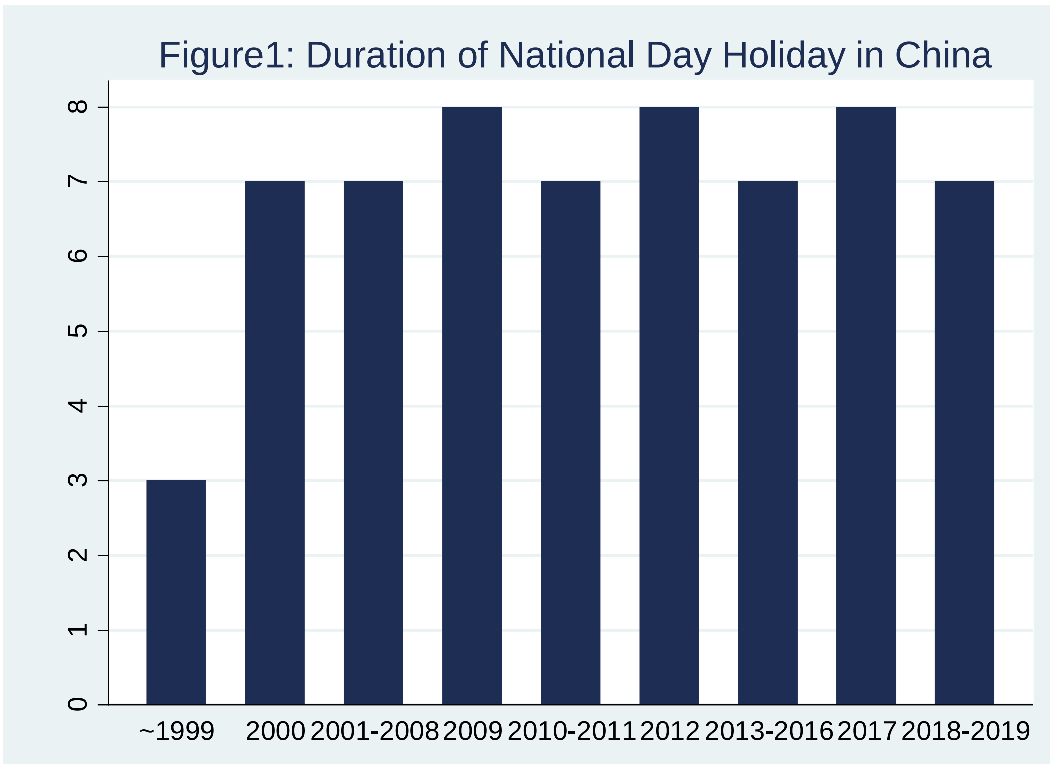
Limited studies show interest in the holiday weight of citizens from Europe or Asia. Recently, through daily body weight data of 2924 wireless users from the US, German, and Japan, Helander et al. (2016) revealed that people tend to gain weight during holidays despite the cultural and environmental differences between these three countries. Although the volume of weight gain varies, the weight gain that happened on the holiday of Christmas and New Year was significant in all three countries. In summary, they observed weight gain during the Easter in the US and German, as well as during the "Golden Week" in Japan. However, the holiday weight gain in an emerging country, such as in China, is still worth further investigation.

The effect of holiday weight gain is not conclusive. Some literature found that there indeed exist the phenomena of holiday weight gain, although the amount was lower than the media claimed (Yanovski et al. 2000 and Helander et al. 2016). While some other researchers believed that there was no significant evidence of the holiday weight gain (Hull et al. 2006 and Wagner et al. 2012). One possible argument that leads to the mixed results is that cultural convention and environment, such as the temperature, in those destinations are different.

Many explanations of holiday weight gain already exist in the literature. One explanation is that people will react to the seasonal cycles and temperature change during the winter holiday. However, it cannot fully explain those increases in BMI in South Africa and Japan during summertime holiday (Sturm et al. 2016, Helander et al. 2016). Thus, the traditional culture of having big meals in those long-term holidays serves as the main factor which contributes to weight gain. That is, the changes in lifestyle in the longtime holiday are linked to weight gain. Besides, even if people do not gain a big amount of weight gain during the holiday, such the holiday weight gain has the potential to incur a substantial effect on the yearly weight gain. Thus, when people eat more, participate in less physical activities, temporarily change lifestyles, and thus gain weight during their holiday, there is little chance for them to fully recover to the normal weight during the working days (Whitney and Rolfes 2015).

Compared to the previous studies, whose samples are either recruited from an institute on health research or those rich, highly educated and health conscientious users with a passion for losing weight and tracking their body weight records, we use a large-scale survey data, which is more representative. Another problem that could occur in the previous studies is that the samples, whether college students or non-college students, are needed to take health exams both before and after the holiday. Once the subjects were taken the health exam before the holiday, they fully realized that they had to give another report about their body weight and health conditions after the holiday. Thus, the participants have a chance to form the consciousness on their health condition and have incentives to keep their body weight during the whole holiday intendedly or unintendedly. While our study only requires subjects to report their health exam results once in the survey year. With the consideration of the average holiday weight gain, our sample avoids those potential endogeneity issues on the reaction of subjects to the other upcoming health exams. Besides, compared with past studies using small samples, our research using a relatively large sample with 38,180 observations can better reveal the nutritional dynamics in China.

Since 2000, the Chinese government has implemented a policy to shift the working calendar, and then the National Day holiday which starts from the first day of October has been enlarged from legally three days to seven days to create a “Golden Week” for “Tourism Promotion”. Usually, two-weekend breaks around October 1 are shifted to form the holiday. The National Day Holiday arrangements are shown in Figure 2.1.



Note: From 2000 to 2019, the National Day Holidays all start on November 1 and end on November 7, except for 4 exceptions: in 2008, the National Day Holiday starts on September 29 and ends on November 5; in 2009, the National Day Holiday starts on November 1 and ends on November 8; in 2012, the National Day Holiday starts on September 30 and ends on November 7; in 2017, the National Day Holiday starts on November 1 and ends on November 8.

It is noticeable that there are exceptions in 2009, 2012 and 2017. In those years the National Day holiday lasted for 8 days because the government had combined the National Day holiday with the Mid-Autumn Festival holiday. In the rest years, the National day holiday only lasted for 7 days.

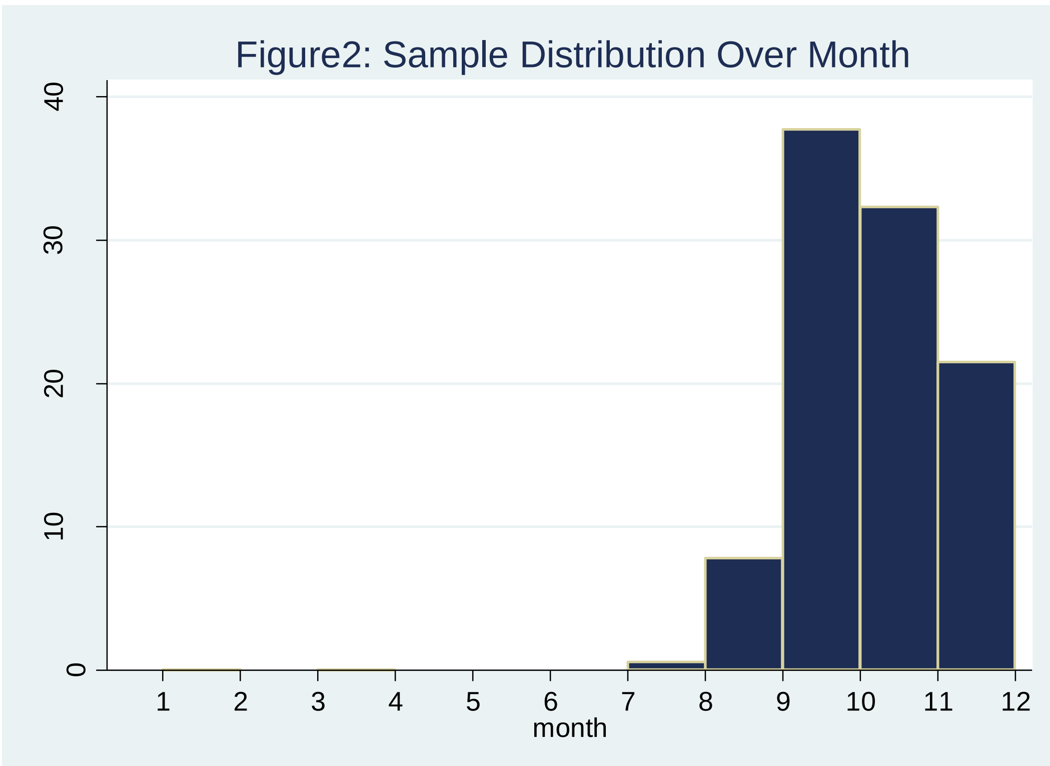
The rearrangement of the National Day holiday could change biological clocks, people's lifestyle and consumption patterns. Particularly, there are more parties for family or friend's reunion during the holiday where more food and drinking are consumed. Eventually, it could lead to the body weight change. The paper aims to analyze the dynamics of nutritional status before and after the National Day holiday in China, and after some side health effects for the holiday. This may help the policymakers to rethink the holiday arrangement from the perspective of health.

3. Data

The data used in this project is the secondary data from the CHNS (China Health and Nutrition Survey). CHNS is a long-term investigation project conducted by three institutes: Carolina Population Center of the University of North Carolina at Chapel Hill, the National Institute of Nutrition and Food Safety, and the Chinese Center for Disease Control and Prevention. This project focuses on the transformation of the socioeconomic and nutritional status of the Chinese Society. More than 4300 households are randomly chosen from more than 200 communities covering nine provinces.

The survey was initially conducted in 1989, and sequentially carried out in 1991, 1993, 1997, 2000, 2004, 2006, 2009, 2011 and 2015. However, the physical examination data for 2015, classified in the Biospecimen questionnaire, has not been disclosed to the public. Since we aim to investigate the effect of the week-long National Day holidays on weight gain, the data used in this research cover 2000, 2004, 2006, 2009 and 2011. In each survey round, each individual provides physical exam results only once, which means the daily or monthly tracking data of body weight are not available for any subject.

The majority of health examinations in CHNS occurred in the second half of the year and analyzing the weight-gain effect of the National Day holiday is shown as in Figure 2.2. In the setting of regression discontinuity design, the treatment variable is a dummy variable that describes whether the health exam was conducted before or after the holiday[1].



Note: this figure is based on the dataset after eliminating the observations with missing values. In the first half of all the survey years, there are only two subjects who take physical examinations. Thus, we eliminate this observation for our analysis since we treat them as outliners.

We take the *BMI* (body mass index) as the dependent variable, which is constructed by dividing body weight (in kg) by the square of height (in meters). The natural

[1] Only two subjects reported their health condition in the first half year.

logarithms of per capita annual income, gender, age, the quadratic term of age and year dummy of 2009 are treated as control variables. The national holiday in 2009 lasted for 8 days.

Besides, we construct an assignment variable $timelag$. It measures the number of days between the health exam date and the National Day holiday period, which helps to describe (potential) time trend of the *BMI*. Precisely, for those who reported their health condition before the National Day holiday, $time\_lag$ = examination date – October 1 and forms a negative number; for those who reported their health condition after the National Day holiday, we construct $timelag$ = examination date - October 7 (October 8 in 2009), and ends up with a positive figure. Allowing for asymmetric time trend effect before and after the holiday, we also take the interaction term of the $time\_lag$ and treatment variable *treat* is into account in the model. The treatment variable is the dummy named as $treat$ which describes whether the survey occurred before or after the holiday. It is noticeable that the treatment variable $treat$ jumps from zero to one when the assignment variable $time\_lag$ achieves zero.

To remove outliers, all the samples whose BMI is less than 14 or more than 40 are excluded from the sample. Neither extremely underweighted people nor extremely obese people are considered. Besides, we only care about adults who are at working age, those whose age is less than 18 or greater than 65 are excluded as well. Since the very limited number of samples got health exams during the National Day holiday, we exclude all those observations.

Table 2.1: Descriptive Statistics

Variable	Definition	Unit	Mean		
			Full sample	Sample before holiday	Sample after holiday
weight	body weight	kilogram	61.221	61.105	61.321
height	height	centimeter	161.750	161.656	161.830
Dependent variable					
BMI	body weight Index	kg/m^2	23.323	23.311	23.334
Treatment variable					
treat	survey date before or after the National Day holiday	binary	0.538		
Assignment variable					
time_lag	survey date-the nearest Holiday date	day	4.397	-19.356	24.814
Control variables					
age	age	year	44.830	44.829	44.830
agesqr	squred term of age	year^2	2148.677	2146.688	2150.386
eight_days	dummy of year 2009	binary	0.188	0.212	0.167
interaction	interaction term of time_lag and treat	day	13.344	8.305	24.814
lincome	logarithm of income	CNY	8.381	0.484	8.446
sex	gender, male=1, female=0	binary	0.485		0.486
Obs.			38180	20532	17648

Note: The full sample is composed of all observations that neither have missing value nor are extremely overweight/underweight. The age of observations is constrained to the interval from 18 to 65. We use the National Day Holiday as the rule to divide the full sample into the before-holiday sample and the after-holiday sample.

As shown above, the total number of observations in the full sample is 38,180, in which 20,532 had health exams after the holiday and 17,648 before the holiday. Their average heights are 161.83 cm and 161.656 cm respectively, while the average weights are 61.321 kg and 61.105 kg respectively before and after the holiday.

The independent variable *sex* is a dummy for gender (0 for females and 1 for males). In our sample, 48.5% are males, and 51.5% females. The variable *age* denotes the age of the subject when the survey was conducted. In the sample of interest, the average age of subjects is 44.5 years old. Similarly, age_sqr stands for the quadratic term of age. And the variable *interaction* stands for the interaction term between $treat$ and $time\_lag$, which describes the different influence of $timelag$ before and after the holiday weight gain. As mentioned above, *treat* is a variable whether the health exam occurred before or after the National Day holiday. Its average is 0.538, indicating the sample is distributed evenly before and after the National Day holiday.

We choose the maximum lags by facilitating the rule of thumb in Newey-West standard error lag length $T = N^{1/4}$, and $14 \approx 38180^{1/4}$. Alternatively, we also use 30 days length and 7 days length for a comparison of robust check.

Our main analysis focuses on the estimated holiday weight gain under three time window specifications: 7 days window, 14 days window and 30 days window before and after the National Day holiday in China. Specifically, 7 days and 30 days could capture short-run and long-run effects, in addition to the time window of 14 days.

4. Econometric Model

The regression discontinuity method is adopted to judge if there is any jump in weight before and after the National Day holiday. We find have two advantages of regression discontinuity design: first, the regression discontinuity design is equivalent to a local random trail around the breakpoint (7-days-holiday); second, a recent study shows (Imbens and Lemieux, 2008), a well-behaved regression discontinuity does not need any control variables, so this design could eliminate the omitted-variable bias. Using the pooled setting, we ignore the potential structural change of BMI from 2000 to 2011. BMI (body mass index) is the dependent variable, and the demographics are included as the control variables. Because of the limitation of the data source, we evaluate only the average holiday weight gain over the whole sample, but not able to trace and identify the weight gain individually. However, we use the demographic variables to control for the individual heterogeneities. The model is specified as follows:

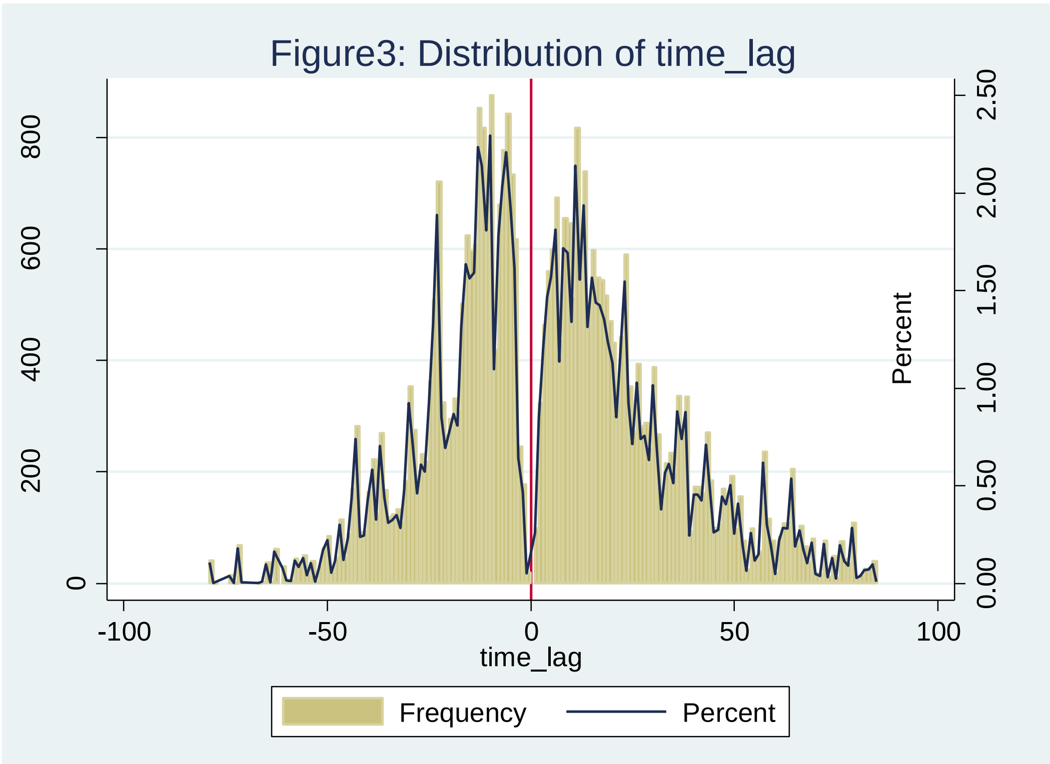
$$BMI_i = x_i'\beta_1 + \beta_2 treat_i + \beta_3 time\_lag_i + \beta_4 treat_i * time\_lag_i + e_i, \qquad (1)$$

where e_i is an error term with a zero mean normal distribution. x_i is the vector of all control variables: age_i, age_sqr_i, $eight\_days_i$ and $lincome_i$, β_1 is the vector of the corresponding coefficients. As mentioned in the data section, $treat_i$ is the treatment variable. The coefficient of the variable $treat_i$, β_2, is the coefficient of interest because it describes the holiday weight gain before and after the holiday. Both the variable $time\_lag_i$ and the interaction $treat * time\_lag_i$ are important for controlling the time trend. β_3 denotes the symmetric time trend effect on BMI of an additional day while β_4 represents the asymmetric time trend.

5. Empirical Results

- Model specification

Before we start our analysis on the results, it is important to take the distribution of $time\_lag$ into consideration. The results of the histogram graph and the line chart are depicted in Figure 2.3. It is worth mentioning that both the distribution of $time\_lag$ of males and females are very close to the whole sample case, thus we do not report their results separately.



Note: The histogram shows the frequency of *time_lag*. While the line graph shows the corresponding percentage of *time_lag*.

The low frequency around the point *time_lag*=0 happens because we exclude a few samples whose health exams were taken during the National Day holiday. In terms of *time_lag* distribution, our sample does not violate the random sampling assumption. Some dates are given a larger weight than the average, while other parts are given a smaller weight when we run the regression. Meanwhile, the sample shows no big jump of the assignment variable at the cutoff. We can hardly imagine the subjects intentionally manipulated the date of the health exams. Thus, there is no support for the existence of assignment variable manipulation both theoretically and practically.

In order to reduce the measurement errors caused by seasonality, we take a strategy of asymmetric time windows before and after the holiday. For the samples before the holiday, we only use a time window of 7 days, because a longer time window may entail more measurement errors. After the holiday, we take three different time windows, specifically, 7 days, 14 days, and 30 days, which respectively could capture short-run, medium-run and long-run effects, though 14 days might be the best one by the Newey-West ‘s Rule of Thumb.

- Result discussion

All the regression results under these three different window lengths are reported in Table 2.2.

Table 2.2: Empirical results

	Time windows			
Dependent Variable	(1)	(2)	(3)	(4)
BMI	Whole sample	7-7 window	7-14 window	7-30 window
treat	0.0353	0.593**	0.369	0.187
	(0.0566)	(0.266)	(0.225)	(0.211)
sex	0.0395	0.190**	0.131**	0.111**
	(0.0332)	(0.0803)	(0.0619)	(0.0485)
age	0.291***	0.260***	0.281***	0.296***
	(0.00989)	(0.0237)	(0.0184)	(0.0146)
agesqr	-0.00283***	-0.00236***	-0.00266***	-0.00287***
	(0.000113)	(0.000270)	(0.000210)	(0.000165)
lincome	0.183***	0.196***	0.171***	0.167***
	(0.0133)	(0.0334)	(0.0253)	(0.0194)
time_lag	0.00645***	0.00757	0.00633	0.00538
	(0.00179)	(0.0380)	(0.0379)	(0.0376)
interaction	-0.0126***	-0.0916*	-0.0336	-0.0125
	(0.00217)	(0.0514)	(0.0392)	(0.0378)
eight_days	0.0317	0.0596	0.0172	0.0264
	(0.0430)	(0.0970)	(0.0767)	(0.0592)
_cons	14.92***	15.02***	14.95***	14.75***
	(0.242)	(0.620)	(0.493)	(0.407)
Obs.	38180	6582	11047	17731
adj.R-square	0.047	0.054	0.049	0.047

Note: For each explanatory variable, the upper part is the coefficient estimation value, the lower part is the standard error, ***, **, * means significant at 1%, 5%, and 10% respectively. *lincome* is the natural logarithm of total individual income (inflated to the 2009 price level).

As we can see, the estimated coefficient of the treatment variable $treat$ is statistically significant under all the symmetric time windows: 7-7 window, 7-14 window, and 7-30 window. Their coefficients are 0.593, 0.369 and 0.187 respectively.

To calculate the average weight gain, we use the quadratic of the root mean square (RMS) times the estimated coefficient of variable $treat$ to obtain the estimated average body weight gain for the National Day Holiday. The details of all time windows are shown below in Table 2.3.

Table 2.3: Body Weight Gain Estimation

Samples	Total		Male		Female	
Indicator / Time Windows	RMS of Height	Average WG	RMS of Height	Average WG	RMS of Height	Average WG
7-7 Window	162.271	1.561	167.683	1.667	157.030	1.462
7-14 Window	161.961	0.967	167.446	1.035	156.631	0.905
7-30 Window	162.036	0.491	167.495	0.525	156.661	0.459

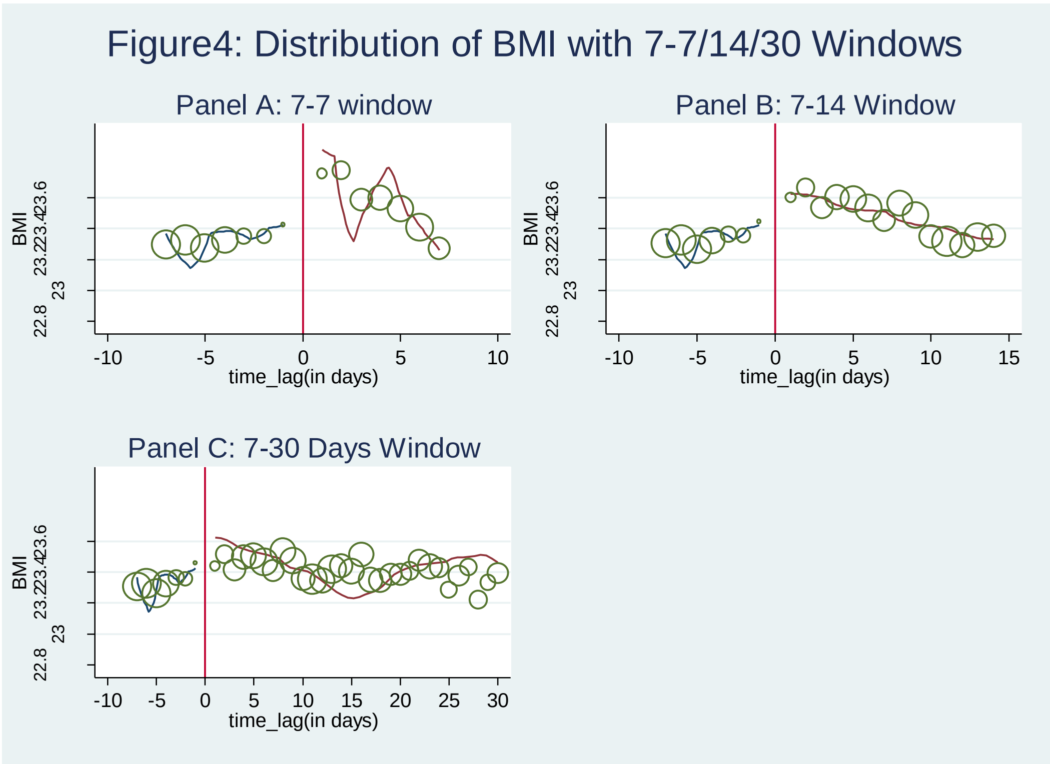
Note: RMS means root mean square. The values of height are calculated in centimeter, while the values of weight are calculated in kilogram. WG means weight gain.

We take advantage of the root mean square of height, under the 7-7 time window, the expected weight gain is 1.561 kg.[2] Based on the coefficients in Table 2.2 and Table 2.3, males on average gain more weight compared with females, from the perspectives of both BMI and body weight, during the National Day Holiday. In summary, it shows that the result is consistent with the Chinese saying: Each holiday people gain 1.5 kg body weight, only in the short run.

As for the time trend, in most cases, either symmetric or asymmetric time trend is not significant. The control variables age and age_sqr both are statistically significant at 1% level under various window lengths, showing older people have higher chances to gain weight during the National Day Holiday, perhaps due to low metabolism. Another control variable, sex, seems a little bit controversial. Although not always significant, the male tends to gain more weight compared with female. One possible rationale is the male indeed gains more holiday weight in a short period. Meanwhile, they recover to ordinary

[2] For the 7-7 time window, the average weight gain of the whole subsample is: 0.593*(MRS^2)=1.561 kg ,where MRS is the root mean square of height in corresponding subsample, and 0.593 is the estimated coefficient of treatment variable $treat$ reported in Table 2.2; similarly , for the other time windows, we can estimate the weight gain by multiplying estimated coefficient with the corresponding MRS. We can also calculate body weight gain per capita the for males and females based on the same rationale.

weight at a faster pace than the female. Richer people are more prone to high body weight as well.



Note: The polyline represents the local polynomial smooth plots before and after the National Day holiday. The hollow circle represents the fitted mean from the regression. The size of hollow circles represents the density of the sample distribution over $time\_lag$.

Another point of view to investigate the treatment effect of the National Day holiday is to draw graphs to visualize the jump of BMI at the cutoff, which is shown in Figure 2.4. Both the local polynomial smooth plot and the fitted values from the regression discontinuity method are reported. We find the graphs are conformed to the results discussed above: the holiday weight gain exists in the 7 days window and no gap window, but it undergoes a reduction in the 14 days window and the 30 days window. It implies that holiday weight gain could contribute to the long-run body weight gain.

6. Robustness Check

So far, our analysis is restricted to holiday weight gain effect using a pooled regression, without considering the potential time trend and geographic effects. Thus, with controlling for the time trend and province effect, we additionally include more samples by imposing no restrictions on weight and age of subjects for robustness check.

Table 2.4: Time Trend and by-Year Analysis

	Time windows					
	Time trend			2000		
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
BMI	7-7 window	7-14 window	7-30 window	7-7 window	7-14 window	7-30 window
treat	0.500*	0.199	0.046	-0.500	-1.034**	-1.378***
	(0.266)	(0.225)	(0.211)	(0.488)	(0.426)	(0.396)
sex	0.199**	0.142**	0.119**	0.035	-0.031	-0.067
	(0.080)	(0.062)	(0.048)	(0.167)	(0.129)	(0.104)
age	0.250***	0.271***	0.288***	0.189***	0.201***	0.244***
	(0.024)	(0.018)	(0.015)	(0.047)	(0.036)	(0.029)
agesqr	-0.002***	-0.003***	-0.003***	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
lincome	0.150***	0.127***	0.128***	0.046	0.011	0.018
	(0.034)	(0.026)	(0.020)	(0.078)	(0.058)	(0.045)
time_lag	0.041	0.040	0.035	0.321***	0.326***	0.321***
	(0.038)	(0.038)	(0.038)	(0.077)	(0.075)	(0.074)
interaction	-0.139***	-0.065*	-0.042	-0.519***	-0.366***	-0.320***
	(0.052)	(0.039)	(0.038)	(0.100)	(0.078)	(0.074)
eight_days	-0.244**	-0.292***	-0.238***			
	(0.106)	(0.084)	(0.065)			
year	0.081***	0.082***	0.071***			
	(0.011)	(0.009)	(0.007)			
_cons	-147.193***	-147.917***	-127.235***	19.290***	19.442***	18.615***
	(22.739)	(17.802)	(14.220)	(1.280)	(0.981)	(0.814)
Obs.	6582	11047	17731	1482	2388	3564
adj.R-square	0.061	0.056	0.052	0.051	0.045	0.042

2004 2006

Dependent variable	(7)	(8)	(9)	(10)	(11)	(12)
BMI	7-7 window	7-14 window	7-30 window	7-7 window	7-14 window	7-30 window
treat	0.355	0.728	0.915	2.735***	1.209***	0.565
	(0.940)	(0.902)	(0.901)	(0.672)	(0.439)	(0.408)
sex	0.411**	0.253*	0.101	0.298	0.172	0.147
	(0.189)	(0.134)	(0.105)	(0.184)	(0.141)	(0.111)
age	0.171***	0.223***	0.277***	0.204***	0.260***	0.255***
	(0.055)	(0.039)	(0.031)	(0.060)	(0.046)	(0.036)
agesqr	-0.001**	-0.002***	-0.003***	-0.002***	-0.002***	-0.002***
	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)
lincome	0.288***	0.148**	0.180***	0.185**	0.186***	0.185***
	(0.080)	(0.058)	(0.045)	(0.084)	(0.063)	(0.048)
time_lag	-0.166	-0.195	-0.192	-0.071	-0.064	-0.066
	(0.148)	(0.149)	(0.151)	(0.079)	(0.079)	(0.080)
interaction	0.254	0.235	0.203	-0.315**	-0.027	0.053
	(0.163)	(0.151)	(0.151)	(0.137)	(0.082)	(0.080)
eight_days						
year						
_cons	14.942***	15.172***	14.050***	16.007***	15.008***	15.082***
	(1.547)	(1.278)	(1.154)	(1.554)	(1.222)	(0.977)
Obs.	1083	2210	3683	1170	1997	3261
adj.R-square	0.065	0.047	0.045	0.043	0.037	0.033

		2009			2011	
Dependent variable	(13)	(14)	(15)	(16)	(17)	(18)
BMI	7-7 window	7-14 window	7-30 window	7-7 window	7-14 window	7-30 window
treat	-1.042	-0.641	-0.633	2.205***	1.602***	1.534***
	(0.645)	(0.544)	(0.506)	(0.634)	(0.549)	(0.508)

sex	0.234	0.271**	0.255**	0.148	0.106	0.185
	(0.170)	(0.137)	(0.105)	(0.184)	(0.148)	(0.115)
age	0.362***	0.395***	0.381***	0.291***	0.323***	0.334***
	(0.049)	(0.041)	(0.032)	(0.061)	(0.049)	(0.038)
agesqr	-0.003***	-0.004***	-0.004***	-0.003***	-0.003***	-0.003***
	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)
lincome	0.162**	0.175***	0.171***	0.019	0.057	0.070
	(0.067)	(0.054)	(0.041)	(0.078)	(0.060)	(0.045)
time_lag	0.147	0.148	0.144	-0.125	-0.128	-0.128
	(0.092)	(0.092)	(0.092)	(0.084)	(0.085)	(0.083)
interaction	-0.031	-0.150	-0.148	-0.074	0.085	0.093
	(0.126)	(0.096)	(0.092)	(0.116)	(0.089)	(0.084)
eight_days						
year						
_cons	13.866***	13.151***	13.603***	15.597***	14.650***	14.270***
	(1.301)	(1.110)	(0.921)	(1.647)	(1.345)	(1.079)
Obs.	1485	2291	3827	1362	2161	3396
adj.R-square	0.066	0.064	0.054	0.042	0.037	0.042

	Time Windows					
	Time trend			2000		
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
BMI	7-7 window	7-14 window	7-30 window	7-7 window	7-14 window	7-30 window
treat	0.500*	0.199	0.046	-0.500	-1.034**	-1.378***
	(0.266)	(0.225)	(0.211)	(0.488)	(0.426)	(0.396)
sex	0.199**	0.142**	0.119**	0.035	-0.031	-0.067
	(0.080)	(0.062)	(0.048)	(0.167)	(0.129)	(0.104)
age	0.250***	0.271***	0.288***	0.189***	0.201***	0.244***
	(0.024)	(0.018)	(0.015)	(0.047)	(0.036)	(0.029)

agesqr	-0.002***	-0.003***	-0.003***	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
lincome	0.150***	0.127***	0.128***	0.046	0.011	0.018
	(0.034)	(0.026)	(0.020)	(0.078)	(0.058)	(0.045)
time_lag	0.041	0.040	0.035	0.321***	0.326***	0.321***
	(0.038)	(0.038)	(0.038)	(0.077)	(0.075)	(0.074)
interaction	-0.139***	-0.065*	-0.042	-0.519***	-0.366***	-0.320***
	(0.052)	(0.039)	(0.038)	(0.100)	(0.078)	(0.074)
eight_days	-0.244**	-0.292***	-0.238***			
	(0.106)	(0.084)	(0.065)			
year	0.081***	0.082***	0.071***			
	(0.011)	(0.009)	(0.007)			
_cons	- 147.193***	- 147.917***	- 127.235***	19.290***	19.442***	18.615***
	(22.739)	(17.802)	(14.220)	(1.280)	(0.981)	(0.814)
Obs.	6582	11047	17731	1482	2388	3564
adj.R-square	0.061	0.056	0.052	0.051	0.045	0.042
		2004			2006	
Dependent Variable	(7)	(8)	(9)	(10)	(11)	(12)
BMI	7-7 window	7-14 window	7-30 window	7-7 window	7-14 window	7-30 window
treat	0.355	0.728	0.915	2.735***	1.209***	0.565
	(0.940)	(0.902)	(0.901)	(0.672)	(0.439)	(0.408)
sex	0.411**	0.253*	0.101	0.298	0.172	0.147
	(0.189)	(0.134)	(0.105)	(0.184)	(0.141)	(0.111)
age	0.171***	0.223***	0.277***	0.204***	0.260***	0.255***
	(0.055)	(0.039)	(0.031)	(0.060)	(0.046)	(0.036)
agesqr	-0.001**	-0.002***	-0.003***	-0.002***	-0.002***	-0.002***
	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)
lincome	0.288***	0.148**	0.180***	0.185**	0.186***	0.185***
	(0.080)	(0.058)	(0.045)	(0.084)	(0.063)	(0.048)

time_lag	-0.166	-0.195	-0.192	-0.071	-0.064	-0.066
	(0.148)	(0.149)	(0.151)	(0.079)	(0.079)	(0.080)
interaction	0.254	0.235	0.203	-0.315**	-0.027	0.053
	(0.163)	(0.151)	(0.151)	(0.137)	(0.082)	(0.080)
eight_days						
year						
_cons	14.942***	15.172***	14.050***	16.007***	15.008***	15.082***
	(1.547)	(1.278)	(1.154)	(1.554)	(1.222)	(0.977)
Obs.	1083	2210	3683	1170	1997	3261
adj.R-square	0.065	0.047	0.045	0.043	0.037	0.033

	2009			2011		
Dependent Variable	(13)	(14)	(15)	(16)	(17)	(18)
BMI	7-7 window	7-14 window	7-30 window	7-7 window	7-14 window	7-30 window
treat	-1.042	-0.641	-0.633	2.205***	1.602***	1.534***
	(0.645)	(0.544)	(0.506)	(0.634)	(0.549)	(0.508)
sex	0.234	0.271**	0.255**	0.148	0.106	0.185
	(0.170)	(0.137)	(0.105)	(0.184)	(0.148)	(0.115)
age	0.362***	0.395***	0.381***	0.291***	0.323***	0.334***
	(0.049)	(0.041)	(0.032)	(0.061)	(0.049)	(0.038)
agesqr	-0.003***	-0.004***	-0.004***	-0.003***	-0.003***	-0.003***
	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)
lincome	0.162**	0.175***	0.171***	0.019	0.057	0.070
	(0.067)	(0.054)	(0.041)	(0.078)	(0.060)	(0.045)
time_lag	0.147	0.148	0.144	-0.125	-0.128	-0.128
	(0.092)	(0.092)	(0.092)	(0.084)	(0.085)	(0.083)
interaction	-0.031	-0.150	-0.148	-0.074	0.085	0.093
	(0.126)	(0.096)	(0.092)	(0.116)	(0.089)	(0.084)
eight_days						

year						
_cons	13.866***	13.151***	13.603***	15.597***	14.650***	14.270***
	(1.301)	(1.110)	(0.921)	(1.647)	(1.345)	(1.079)
Obs.	1485	2291	3827	1362	2161	3396
adj.R-square	0.066	0.064	0.054	0.042	0.037	0.042

Note: For each explanatory variable, the upper part is the coefficient estimation value, the lower part is the standard error, ***, **, * means significant at 1%, 5%, and 10% respectively. *lincome* is the natural logarithm of total individual income (inflated to the 2009 price level).

First, we add an extra time trend indicator $year_i$ to equation (1), which leads to equation (2) for estimation:

$$BMI_i = x_i'\beta_1 + \beta_2 treat_i + \beta_3 time\_lag_i + \beta_4 treat_i * time\_lag_i + \beta_5 year_i + e_i, \qquad (2)$$

In year specific regression, we simply run the same regression based on equation (1) but limit the subjects to a specific year. Which is equivalent to equation (3) as below:

$$BMI_{it} = x_{it}'\beta_{1t} + \beta_{2t} treat_{it} + \beta_{3t} time\_lag_{it} + \beta_{4t} treat_{it} * time\_lag_{it} + e_{it}, \quad (3)$$

As shown in Table 2.4, the time trend can partly explain the holiday weight gain effect. Except for the first year of holiday length expansion that happened in 2000, we observe a positive holiday weight gain effect.

Table 2.5: Province Effect and Sample Choice

Dependent variable	Time windows		
	Province effect		
	(1)	(2)	(3)
BMI	7-7 window	7-14 window	7-30 window
treat	0.038	-0.083	-0.056
	(0.265)	(0.224)	(0.208)
sex	0.203***	0.144**	0.121**
	(0.078)	(0.060)	(0.047)
age	0.264***	0.274***	0.288***
	(0.023)	(0.018)	(0.014)
agesqr	-0.002***	-0.003***	-0.003***
	(0.000)	(0.000)	(0.000)
lincome	0.149***	0.107***	0.106***
	(0.034)	(0.026)	(0.020)
time_lag	0.031	0.028	0.031
	(0.038)	(0.037)	(0.037)
inter1	-0.054	-0.017	-0.029
	(0.051)	(0.039)	(0.037)
eight_days	0.198**	0.209***	0.226***
	(0.099)	(0.077)	(0.059)
pv_ln	0.149	-0.408	-0.554***
	(0.349)	(0.249)	(0.187)
pv_hlj	0.189	-0.464*	-0.741***
	(0.349)	(0.248)	(0.191)
pv_sh	0.000	0.000	0.000
	(.)	(.)	(.)
pv_js	-0.503	-1.001***	-1.207***
	(0.345)	(0.240)	(0.178)
pv_sd	0.960***	0.306	0.072

	(0.345)	(0.241)	(0.179)
pv_hen	0.343	-0.267	-0.547***
	(0.358)	(0.247)	(0.181)
pv_hb	-0.522	-1.076***	-1.225***
	(0.352)	(0.243)	(0.184)
pv_hun	-1.474***	-1.957***	-1.897***
	(0.360)	(0.251)	(0.182)
pv_gx	-1.990***	-2.398***	-2.502***
	(0.373)	(0.255)	(0.185)
pv_gz	-1.556***	-2.093***	-2.105***
	(0.355)	(0.250)	(0.188)
pv_cq	0.203	-0.641**	-0.814***
	(0.425)	(0.300)	(0.222)
_cons	15.823***	16.654***	16.659***
	(0.717)	(0.556)	(0.448)
N	6582	11047	17731
adj. R-sq	0.120	0.110	0.103

Dependent variable	Including extreme weight samples		
	(4)	(5)	(6)
BMI	7-7 window	7-14 window	7-30 window
treat	0.745**	0.488**	0.293
	(0.295)	(0.243)	(0.234)
sex	0.264***	0.156**	0.127**
	(0.089)	(0.067)	(0.054)
age	0.265***	0.284***	0.306***
	(0.028)	(0.021)	(0.017)
agesqr	-0.002***	-0.003***	-0.003***
	(0.000)	(0.000)	(0.000)
lincome	0.218***	0.180***	0.165***
	(0.037)	(0.028)	(0.022)
time_lag	-0.008	-0.008	-0.009

	(0.042)	(0.041)	(0.042)
inter1	-0.087	-0.023	0.001
	(0.057)	(0.042)	(0.042)
eight_days	0.025	-0.015	-0.014
	(0.108)	(0.083)	(0.066)
_cons	14.634***	14.731***	14.477***
	(0.721)	(0.558)	(0.470)
N	6430	10796	17344
adj. R-sq	0.045	0.043	0.039

Dependent variable	Including kids and senior citizens		
	(7)	(8)	(9)
BMI	7-7 window	7-14 window	7-30 window
treat	0.677***	0.445**	0.768***
	(0.246)	(0.208)	(0.182)
sex	0.106	0.043	-0.029
	(0.073)	(0.056)	(0.056)
age	0.310***	0.313***	0.299***
	(0.011)	(0.008)	(0.009)
agesqr	-0.003***	-0.003***	-0.003***
	(0.000)	(0.000)	(0.000)
lincome	0.239***	0.206***	0.256***
	(0.029)	(0.022)	(0.022)
time_lag	-0.013	-0.013	-0.023**
	(0.035)	(0.035)	(0.010)
inter1	-0.067	-0.012	-0.056*
	(0.047)	(0.036)	(0.034)
eight_days	0.025	-0.032	0.041
	(0.088)	(0.069)	(0.066)
_cons	13.377***	13.666***	13.399***
	(0.398)	(0.318)	(0.278)
N	8003	13518	13906

adj. R-sq	0.111	0.117	0.108

Note: For each explanatory variable, the upper part is the coefficient estimation value, the lower part is the standard error, ***, **, * means significant at 1%, 5%, and 10% respectively. *lincome* is the natural logarithm of total individual income (inflated to the 2009 price level). Here, we use the residences in Beijing as a reference. Dummy variables pv_ln, pv_hlj, pv_sh, pv_js, pv_sd, pv_hen, pv_hb, pv_hun, pv_gx, pv_gz, and pv_cq represents the subjects who live in the community which is located in Liaoning Province, Heilongjiang Province, Shanghai, Jiangsu Province, Shandong Province, Henan Province, Hubei Province, Hunan Province, Guangxi Province, Guizhou Province, and Chongqing respectively.

Furthermore, if we want to know the difference of treatment effect evaluation induced by outsiders, we use reports the regression results based on equation (1) but without excluding the hyper overweight or underweight subjects and without excluding the kids and old people. Noticeable that Province Effect is equivalent to the below:

$$BMI_i = x_i'\beta_1 + \beta_2 treat_i + \beta_3 time\_lag_i + \beta_4 treat_i * time\_lag_i + pv_i'\beta_5 + e_i, (4)$$

Where pv_i is the vector of all dummies for each province and municipality (except Beijing, which is treated as the reference). As we argue in Table 2.5, the province of subjects contributes to the holiday weight gain to some extent. While the sample size choice does not change our conclusion. Notice that variable pv_sh_i is excluded from our analysis since all the subjects in Shanghai report their health exam other than the nearest 14 days window.

Table 2.6: Age Group Effect

	Time Windows		
Age Group		18-29	
	(1)	(2)	(3)
BMI	7-7 Window	7-14 Window	7-30 Window
treat	-0.129	0.193	0.215
	(0.729)	(0.614)	(0.596)
sex	1.209***	1.095***	0.912***
	(0.217)	(0.164)	(0.134)
age	1.407***	1.030***	0.868***
	(0.504)	(0.385)	(0.317)
agesqr	-0.027**	-0.018**	-0.015**
	(0.011)	(0.008)	(0.007)
lincome	0.073	0.097*	0.033
	(0.078)	(0.056)	(0.046)
time_lag	0.003	-0.009	-0.020
	(0.105)	(0.104)	(0.107)
interaction	0.060	0.017	0.028
	(0.140)	(0.108)	(0.107)
eight_days	-0.426	-0.483**	-0.230
	(0.279)	(0.223)	(0.180)
_cons	2.364	6.162	8.479**
	(5.942)	(4.589)	(3.798)
N	773	1331	2072
adj. R-sq	0.058	0.064	0.052
Age Group		30-45	
	(4)	(5)	(6)
BMI	7-7 Window	7-14 Window	7-30 Window
treat	0.784*	0.301	0.135
	(0.421)	(0.351)	(0.329)
sex	0.421***	0.454***	0.536***
	(0.130)	(0.099)	(0.078)
age	0.076	0.143	0.157
	(0.270)	(0.204)	(0.162)
agesqr	0.000	-0.001	-0.001
	(0.004)	(0.003)	(0.002)
lincome	0.245***	0.165***	0.139***
	(0.053)	(0.039)	(0.030)
time_lag	0.042	0.042	0.042

	(0.060)	(0.059)	(0.059)
interaction	-0.177**	-0.069	-0.048
	(0.081)	(0.061)	(0.059)
eight_days	0.116	-0.044	-0.030
	(0.162)	(0.124)	(0.098)
_cons	17.911***	17.309***	17.040***
	(5.099)	(3.861)	(3.053)
N	2519	4224	6642
adj. R-sq	0.028	0.025	0.029

Age Group		46-65	
	(7)	(8)	(9)
BMI	7-7 Window	7-14 Window	7-30 Window
treat	0.549	0.408	0.178
	(0.387)	(0.329)	(0.308)
sex	-0.233**	-0.360***	-0.405***
	(0.115)	(0.090)	(0.069)
age	-0.039	-0.004	-0.084
	(0.213)	(0.166)	(0.128)
agesqr	0.000	-0.000	0.001
	(0.002)	(0.002)	(0.001)
lincome	0.205***	0.225***	0.258***
	(0.051)	(0.040)	(0.030)
time_lag	-0.007	-0.008	-0.008
	(0.055)	(0.055)	(0.055)
interaction	-0.072	-0.029	-0.003
	(0.075)	(0.057)	(0.055)
eight_days	0.108	0.142	0.112
	(0.134)	(0.108)	(0.081)
_cons	23.201***	22.525***	24.722***
	(5.846)	(4.573)	(3.535)
N	3290	5492	9017
adj. R-sq	0.005	0.009	0.012

Note: For each explanatory variable, the upper part is the coefficient estimation value, the lower part is the standard error, ***, **, * means significant at 1%, 5%, and 10% respectively.

For the potential age group disparities, we use Table 2.6 to indicate that the most fragile group to the holiday weight gain is the middle-aged group. Not surprisingly, compared with the female at the same age group, young and middle-aged male has a higher BMI. While females tended to have a higher BMI compared to their male counterpart when they getting old.

Until now, we cannot reject the possibility that any other period that is near to but other than the National Day holiday may lead to a hypothetical "holiday weight gain" in China. We further check the placebo effect of holiday weight gain to show that it is not the case. Under such circumstance, we assume hypothetical holidays which happens at other dates other than National Day Holiday. If the holiday weight gain effect still holds for those hypothetical holidays, the National Day holiday weight gain would be skeptical.

Table 2.7: Placebo Holiday Effect

	Time Windows			
treat	(1)	(2)	(3)	(4)
Date	Whole sample	7-7 Window	7-14 Window	7-30 Window
09.26-10.02	0.023	0.724	0.377	0.152
	-0.060	-1.500	-0.270	-0.161
09.27-10.03	0.075	3.144***	0.557***	0.370***
	-0.057	-0.874	-0.215	-0.126
09.28-10.04	0.067	0.308	0.631***	0.371***
	-0.057	-0.531	-0.185	-0.127
09.29-10.05	0.061	0.664*	0.526***	0.274*
	-0.056	-0.363	-0.183	-0.147
09.30-10.06	0.050	0.343	0.155	-0.018
	-0.056	-0.273	-0.185	-0.163
10.02-10.08	0.010	-0.209	-0.187	-0.389
	-0.057	-0.299	-0.280	-0.271
10.03-10.09	-0.010	0.132	0.215	0.026
	-0.058	-0.413	-0.400	-0.393
10.04-10.10	-0.019	0.311	0.269	0.056
	-0.059	-0.603	-0.592	-0.588

10.05-10.11	-0.059	-0.245	-0.153	-0.274
	-0.061	-0.978	-0.966	-0.966
10.06-10.12	-0.067	0.002	-0.020	-0.114
	-0.062	-1.448	-1.439	-1.440

Note: For each explanatory variable, the upper part is the coefficient estimation value, the lower part is the standard error, ***, **, * means significant at 1%, 5%, and 10% respectively.

However, whether the National Day holiday rather than other periods around September or October keeps the status of the driver for weight gain still needs further exploration. As discussed in Table 2.7, if we assume that the week-long holiday is changed from the real starting date to hypothetically ten nearest dates, that is, from September 26th, September 27th up to October 6th, we find that the hypothetical holidays under any window give us no significant results, except for the placebo holiday starting from September 27th, September 28th and September 29th. One possible explanation is that some people go traveling in advance and return home early for their National Day holiday plan, which makes the real holiday that they endure slightly ahead. Thus, putting the hypothetical starting date slightly in advance is consistent with those people's behavior.

7. Conclusion

Our study uses the regression discontinuity model and CHNS (China Health and Nutrition Survey) data, to study the weight gain effect of the National Day holiday in China. We find that Chinese adults tend to gain 1.561 kg during the National Day holiday in China. The effect could remain for about one or weeks and disappear in one month. It implies that holiday weight gain could be reduced in one month and has no long-run health and nutrition effects. The Golden Week policy is not that health unfriendly in terms of weight gain risks. Besides, richer people and older people have a significantly higher chance to gain weight during the National Day Holiday.

Compared to previous research with no more than 200 subjects, data used in this study is a relatively large survey. We find that people increase body weight on average by 1.56 kg although the length of the holiday is only set up to 7 days. With the assumption of random sampling held, we estimate the average weight gain of the National Day holiday in China. Also, the time trend effect, the influence of the control variable and the problem of window specification are all considered. Our study will help shed light on holiday weight gain and further nutritional dynamics in the emerging country. In conclusion, we argue that although people will gain body weight shortly after the holiday. Meanwhile, in the long run (in one month), we observe the gained weight will only be kept partly. Thus, the 7-days-long National Day Holiday imposes a significant short-term but rather small long-term effect on body weight. By classifying our sample to three age groups, we find that middle-aged residents are most fragile in terms of holiday weight gain risk. Gender difference plays an important role as well: young and middle aged males accumulate more body weight during the holiday, while for the old group, the females suffer more from holiday weight gain compared to males, which hints the gap in the lifestyles of men and women for different age groups.

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