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The Effect of Tax Policy Change on Private Pension Contribution : The Evidence from South Korea

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INDEX

I. Introduction

- The importance of retirement preparation in South Korea
  - Rapid aging of population
  - High level of poverty among elderly persons
    - The relative poverty rates of 66 to 75 year-olds was 42.7% and that of persons over 76 year-olds was 60.2%; these were the highest among OCED countries (OECD, 2017)
  - Deteriorating stability of public pension
  - Self-employed individuals who do not have a retirement pension sponsored by the employer made up 15% of Korean population

- Tax policy change in 2014
  - Changed from a tax deduction system to a tax credit system
  - Low-income households encountered an increase in tax subsidy of private pension contributions, while middle- and high- income households experienced a decrease in tax subsidy.

- Research Question
  - To identify the effect of tax subsidy change on
    (1) the dichotomous decision of private pension contribution &
    (2) the decision of the contribution amount

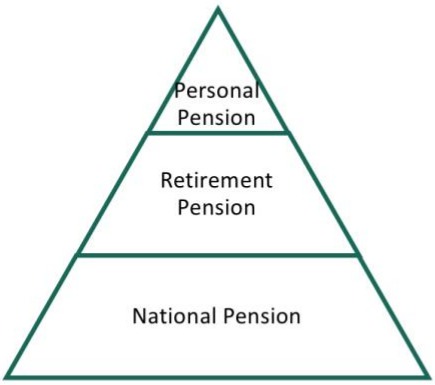
I. Introduction

Quick Summary

- Data
  - National Survey of Tax and Benefit(NaSTaB) by the Korea Institute of Public Finance
  - 16,538 observations from 2010 to 2015 are used for analysis
- Methodology
  - The first model, to identify the effect of tax subsidy on whether or not to contribute to a private pension, is estimated by the linear probability model
  - The second model, to identify the effect of tax subsidy on contribution amount, is estimated using Tobit model.
- Results
  - Tax subsidy had a statistically significant and positive effect on the discrete decision about whether to contribute, and on the decision about the amount of contribution.
  - A difference exists in the likelihood of contribution and the amount of contribution by income tax level.

II. Literature Review

Pension System of South Korea



Three-tiered Pension System

- National Pension Scheme(Public)
  - Contributors can receive a pension from 65 years old
  - Average income replacement rate of the National Pension is 40%
- Retirement Pension Scheme(Private)
  - Pension service provided for employees with the support of employers(DB, DC)
- Personal Pension Scheme (Private)
  - Participants contribute to banks, investment companies, and insurance companies, and receive return in the form of pension

II. Literature Review

Tax System Change of South Korea (2014)

- Change from Tax Deduction system to Tax Credit System
- **Before:** Private pension contribution were deducted from taxable income up to 4 million KRW
- **After:** Tax credit for private pension contributions was given at the fixed rate of 15% (12% in 2014) up to 7 million KRW

Table 1. Tax Policy Change 2010~2015

	Tax Deduction System(Before)				Tax Credit System(After)	
	2010	2011	2012	2013	2014	2015
Tax subsidy – Private Retirement pension	Deduction for 100 % of contribution			Deduction for 100 % of contribution up to 4,000,000 KRW	Credit for 12% of contribution up to 4,000,000 KRW	Credit for 15% of contribution up to 7,000,000 KRW
Tax subsidy – Other	Deduction for 100 % of contribution up to 2,400,000 KRW					

II. Literature Review

Tax System Change of South Korea (2014)

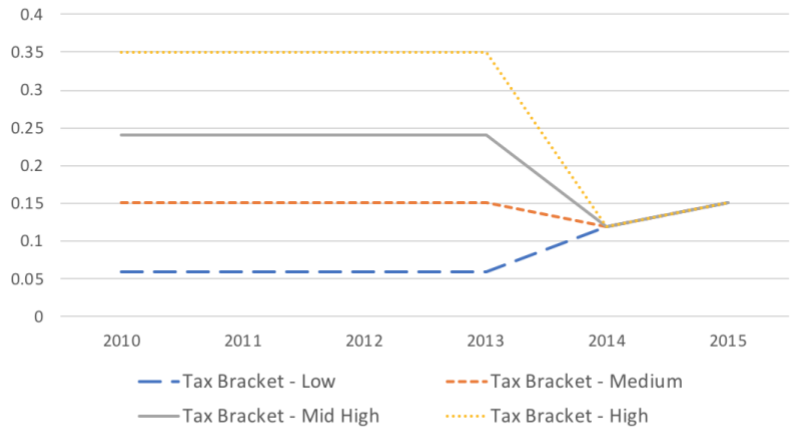
Table 2. Change of tax subsidy before and after the tax reform for 1 KRW contribution (based on year 2014)

Tax Bracket	Income tax rate	Tax Deduction System *(Income tax rate)*	Tax Credit System *(12%)*	Change
~12 million KRW	6%	0.06	0.12	▲0.06
12~46 million KRW	15%	0.15	0.12	▼0.03
46~88 million KRW	24%	0.24	0.12	▼0.12
88~150 million KRW	35%	0.35	0.12	▼0.23
150 million KRW ~	38%	0.38	0.12	▼0.26

II. Literature Review

Tax System Change of South Korea

Figure 1. Tax subsidy per 1 KRW private pension contribution by income tax bracket 2010~2015



II. Literature Review

Research of the effect of tax system change of South Korea

- Kim and Cha(2016):
  - Pointed out that the tax system change resulted in increasing the tax liability of individuals
  - The tax system change was only beneficial for households in the lowest income tax bracket, but these households did not contribute at all or contribute a very little amount to the private pension to gain significant tax benefit.
  - Most of the low-income and middle-income households, as well as high-income households, had to pay an increased amount of tax.
- Chung and Moon(2016):
  - Found that, while high-income households maintained their level of contributions, low and middle-income households rather decreased the amount of contribution.
- However, those studies are limited in their implications because no causal analysis using actual individual-level data was conducted to prove the effect of tax policy change on private pension contribution.

II. Literature Review

Research of the effect of tax subsidy

- Some researchers conducted causal analysis to identify the actual effect of tax subsidy change based on the quasi-experiment data related to tax policy change
- Woodbury and Hamermesh (1992) focused on the effect of tax on employee benefits. The research showed that the change of marginal tax rate had a significant effect on individuals' demand for benefits.
- Tax Reform Act(TRA) of 1986 provided tax subsidy for health insurance. The study by Gruber and Poterba(1994) suggests that an increase in tax price leads to decrease in the probability of purchasing insurance.
- Power and Rider(2002) identified that the effect of tax incentives for tax-deferred saving had a statistically significant effect on dichotomous decision, as well as the amount of contribution. Tax price had negative and significant price elasticity.
- Heim and Lurie(2012) analyzed the effect of EITC(Earned income Tax Credit) and Saver's Credit program to a tax-preferred savings account. The research presented evidence of a negative relationship between tax price and contribution on the extensive margin.
- The studies listed above used tax price elasticity or after-tax price as a tool to examine the effect of the tax on pension contribution; this turned out to be useful and robust to various estimations and samples.

III. Methodology

Research Question

- The purpose of this research is to find whether the change of tax subsidy due to tax system change in South Korea has effect on;
  (1) the dichotomous decision of private pension contribution, and
  (2) the amount of private pension contribution of individuals in Korea

Data

- National Survey of Tax and Benefit(NaSTaB) by the Korea Institute of Public Finance
- Panel data but used as cross sectional

Sample

- Only the individuals who filed for tax report(labor income and general income tax) were used.
- Individuals without responses for 2010(base year) survey were dropped.
- 16,538 observations from 2010 to 2015 were used for analysis

III. Methodology

Variables

Tax Subsidy

- Before the tax system change, the rate of tax subsidy per 1 KRW was equal to individuals' marginal income tax rate.
- After the tax system change, the rate of tax subsidy per 1 KRW was fixed at 12% in 2014 and 15% in 2015.

$$Tax\ Subsidy = \begin{cases} if\ year \leq 2013 & \tau_I \\ if\ year > 2013 & \tau_P \end{cases}$$

τ_I : Individuals' marginal income tax rate
τ_P : Tax credit rate

Income Tax Bracket

- Income tax bracket is computed based on 2010(base year)
- Income tax bracket is divided into four categories;
  (1) Low(6%): ~12 million KRW, (2) Medium(15%): 12~46 million KRW
  (3) Mid High(24%): 46~88 million KRW, (4) High(35%): 88 million KRW~

III. Methodology – Model

(1) Dichotomous decision of private pension contribution

$$\mathrm{P}(Contribution_{it} = 1) = \alpha_0 + \alpha_1 TaxSubsidy_{it} + \alpha_2 TaxBracket_{it} + \alpha_3 TIME_t + \gamma X_{it} + \epsilon_{it}$$

- Linear probability model is used for analysis

(2) Amount of private pension contribution

$$\ln(\mathrm{C_{it}}) = \beta_0 + \beta_1 TaxSubsidy_{it} + \beta_2 TaxBracket_{it} + \beta_3 TIME_t + \gamma X_{it} + \epsilon_{it}$$

- Tobit model is used for analysis

- Tax Subsidy: Private pension contribution tax subsidy rate
- Tax Bracket: Income tax bracket based on year 2010
- Time: Time fixed effect
- X: Vector of control variables
  - Age, age squared, gender, marital status, number of dependents under 18, status of home-ownership, status as of primary filer

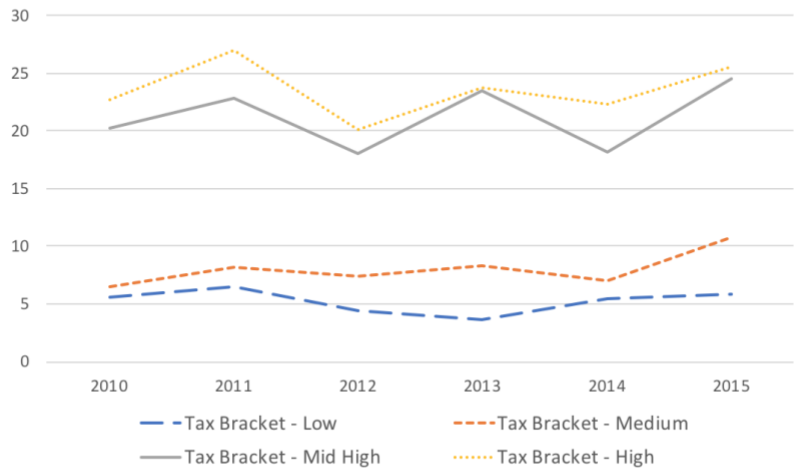
IV. Results – Summary of Data

Table 3. Summary Statistics

	Total	Bracket 1	Bracket 2	Bracket 3	Bracket 4
Observations	16,538	1,840	9,505	4,297	896
Age	44.7 (9.8)	45.9 (11.1)	42.7 (10.1)	47.4 (7.5)	50.1 (7.6)
Female=1	27.82%	56.85%	31.61%	11.59%	5.80%
Married	84.47%	78.86%	79.43%	95.11%	98.33%
Number of kids	0.9 (1.0)	0.8 (1.0)	0.7 (1.0)	1.1 (1.0)	0.9 (1.0)
Primary Filer	72.77%	53.32%	67.11%	89.34%	93.30%
Homeownership	65.72%	59.89%	63.67%	70.77%	75.11%
After-tax income (10,000 KRW)	4297.6 (4044.8)	1518.7 (1630.1)	3235.3 (1619.9)	6377.1 (2480.0)	11300.4 (11904.8)
Tax Subsidy per 1 KRW	0.16 (0.06)	0.10 (0.05)	0.14 (0.03)	0.19 (0.06)	0.25 (0.10)

IV. Results – Change in Private Pension Contribution

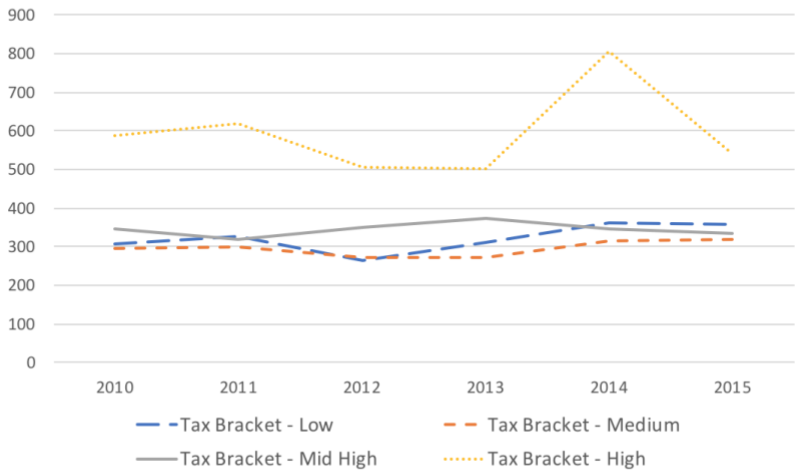
Figure 2. Private pension contributors by income tax bracket 2010~2015 (%)



15/25

IV. Results – Change in Private Pension Contribution

Figure 3. Private pension contribution amount among contributors by income tax bracket 2010~2015 (10,000 KRW)



16/25

IV. Results – (1) Dichotomous decision of contribution

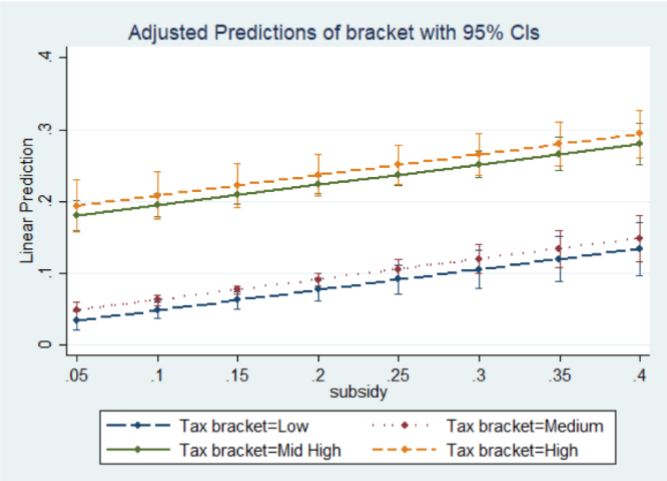
Table 4. Estimation Results – Dichotomous decision of private pension contribution

Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

	Model 1			Model 2			Model 3		
	Coeff.	(Std.Err)		Coeff.	(Std.Err)		Coeff.	(Std.Err)	
Tax subsidy	0.77	(0.05)	***	0.25	(0.06)	***	0.29	(0.06)	***
Tax bracket									
Low				-0.02	(0.01)	*	-0.01	(0.01)	*
Medium									
Mid high				0.13	(0.01)	***	0.13	(0.01)	***
High				0.15	(0.02)	***	0.15	(0.02)	***
Time									
2010									
2011							0.02	(0.01)	*
2012							-0.01	(0.01)	
2013							0.02	(0.01)	*
2014							0.01	(0.01)	
2015							0.05	(0.01)	***
Age	0.01	(0.00)	***	0.01	(0.00)	***	0.01	(0.00)	***
Age-squared	0.00	(0.00)	***	0.00	(0.00)	***	0.00	(0.00)	***
Female	0.03	(0.01)	***	0.04	(0.01)	***	0.04	(0.01)	***
Married	0.02	(0.01)	**	0.02	(0.01)	*	0.02	(0.01)	**
Number of children	-0.01	(0.00)	***	-0.01	(0.00)	***	-0.01	(0.00)	***
Primary filer	0.02	(0.01)	*	0.01	(0.01)		0.01	(0.01)	
Home ownership	0.03	(0.01)	***	0.03	(0.01)	***	0.03	(0.01)	***
Constant	-0.29	(0.04)	***	-0.07	(0.04)	*	0.29	(0.06)	
Observation		16,538			16.538			16,538	
Model chi-square		59.22***			74.13***			52.80***	
R^2		0.03			0.05			0.05	

IV. Results – (1) Dichotomous decision of contribution

Figure 4. Predicted probability of contribution by tax bracket and tax subsidy level



IV. Results – (1) Dichotomous decision of contribution

Findings

- Increase in tax subsidy leads to increase in the likelihood of private pension contribution
  - The effect of tax subsidy is still significant when controlling for tax bracket and time fixed effect
- There was statistically significant difference in the likelihood of contribution by tax bracket
  - Individuals in the lower income bracket were less likely to contribute than the ones in the middle income bracket.
  - Individuals in medium high or high-income brackets tend to contribute relatively more.
- Based on the results from table 4, there is strong evidence to support the effect of tax subsidy on individuals' decision to contribute.
- It indicates that the individuals who fall into the categories of medium-high and high-income tax brackets would decrease their contribution after the tax system change due to the decrease in tax subsidy

IV. Results – (2) Amount of contribution

Table 5. Estimation Results – Decision about the amount of private pension contribution

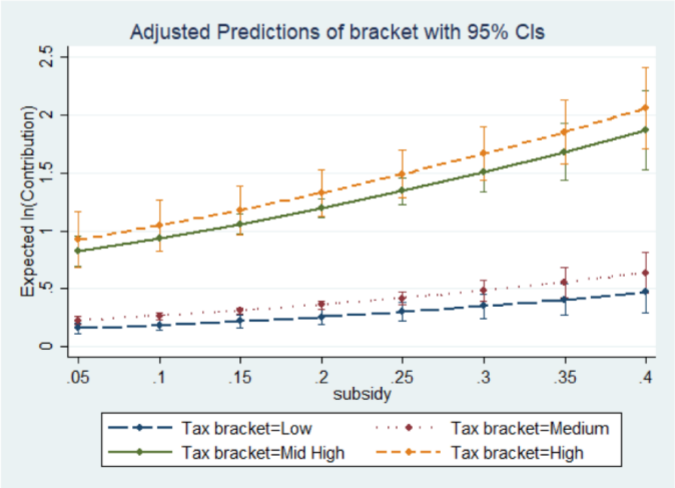
Robust Standard errors in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

	Model 1				Model 2				Model 3			
	Coeff	(Std.Err)		Marginal Effect	Coeff	(Std.Err)		Marginal Effect	Coeff	(Std.Err)		Marginal Effect
Tax Subsidy	32.13	(1.79)	***	3.72	9.05	(2.20)	***	0.98	12.45	(2.46)	***	1.13
Tax bracket												
Low					-1.54	(0.49)	**	-0.15	-1.37	(0.49)	**	-0.13
Medium												
Mid high					5.65	(0.28)	***	0.81	5.57	(0.28)	***	0.79
High					6.39	(0.51)	***	1.17	6.14	(0.52)	***	1.10
Time												
2010												
2011									0.99	(0.38)	**	0.10
2012									-0.18	(0.39)		-0.02
2013									0.83	(0.38)	*	0.08
2014									0.89	(0.43)	*	0.09
2015									2.35	(0.39)	***	0.27
Age	0.92	(0.11)	***	0.11	0.62	(0.11)	***	0.07	0.56	(0.11)	***	0.06
Age-squared	-0.01	(0.00)	***	-0.00	-0.01	(0.00)	***	-0.00	-0.01	(0.00)	***	-0.00
Female	1.35	(0.41)	***	0.17	2.03	(0.42)	***	0.24	1.99	(0.41)	***	0.23
Married	1.17	(0.40)	**	0.13	0.96	(0.41)	*	0.10	1.00	(0.40)	*	0.10
Number of children	-0.74	(0.15)	***	-0.09	-0.81	(0.15)	***	-0.09	-0.80	(0.15)	***	-0.09
Primary filer	0.80	(0.42)		0.09	0.30	(0.42)		0.03	0.22	(0.42)		0.02
Home ownership	1.48	(0.26)	***	0.16	1.18	(0.26)	***	0.12	1.16	(0.25)	***	0.12
Observation	16,538				16,538				16,538			
Model chi-square	63.00***				96.39***				67.73***			
R^2	0.02				0.04				0.04			

- Marginal effects conditional on being uncensored

IV. Results – (2) Amount of contribution

Figure 5. Expected contribution amount by tax bracket and tax subsidy level



IV. Results – (2) Amount of contribution

Findings

- According to the result of Tobit analysis, an increase in tax subsidy leads to an increase in the amount of private pension contribution. The result after controlling for time fixed effect was consistent as well.
- There was a statistically significant difference in the contribution amount by tax bracket
  - Households in low tax bracket contribute less compared to the ones in medium tax bracket, while the ones in medium-high or high tax brackets contribute more
- The result is consistent with that of Table 4.
- The results in table 5 corroborate the effect of tax subsidy on households' decision about the amount of contribution.

V. Implication and Limitation

Summary

- Tax subsidy for private pension had a positive effect on the dichotomous decision of pension contribution
- Tax subsidy also had a statistically significant positive effect on the decision about the amount of contribution.
- Individuals' income level(tax bracket) consistently had a positive effect on the decision to contribute and the amount of contribution.

Implication

- The current result could mislead to believe that the governments' implementation of new tax system was beneficial. However, considering the changes of tax subsidies that individuals went through, the tax system change may not be advantageous.
- As was previously discussed, the individuals in Korea who belong to tax bracket of 15% and higher all experienced a decrease in tax benefit.
- A change in tax system leads to a significant decrease in contribution, as tax subsidies have positive effect on both decision to contribute and decision about how much to contribute.
- Only a small portion of population(those in low tax bracket) benefited from the policy, and individuals who belong to other categories experienced increase of burden.

V. Implication and Limitation

Limitation

- The limitation of this study is that it did not examine the lagged effect of tax policy change

Contribution

- In this research, empirical analysis was applied in order to identify the effect of tax reform on private pension contributions.
- The major transition of tax law in South Korea from a system of tax deductions to a system of tax credits provided an opportunity to examine the quasi-experiment of tax system change. The analysis was able to determine whether the tax benefit holds a positive effect on pension contributions and provides implications for future policy

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Gender, Political Connection, and Tax Avoidance in China

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Introduction

A large body of literature in psychology and sociology indicates that women are more risk averse, less aggressive, and more anxious than men.

Gender differences in attitudes toward risk and in risk-related decisions also have been examined in economics and finance settings.

Introduction

However, much of the literature on women in leadership does not adopt appropriate gender-based theories to reflect both male and female perspectives. Mirchandani (1999) indicates that approaches to women in leadership would benefit from theoretical insight on the gendered processes in work settings developed within feminist theory.

Introduction

This paper extends the concept of socialist/Marxist feminism to propose that female and male CEOs in China will perform equally on tax avoidance decisions because they experienced the same socialization processes under one-child policy.

Hypotheses

Income tax reporting involves a high degree of complexity and discretion; the potential space to adopt tax avoidance is associated with the attitude of managers toward risk tolerance.

The tools of tax avoidance include subsidiaries located in tax havens, foreign-source income, transfer pricing, and inconsistent book-tax treatment (e.g., Graham and Tucker, 2006; Lisowsky, 2010).

Hypotheses

Francis et al. (2014) examine whether there are systematic differences in the choice of tax aggressiveness between female and male executives. They find that female CFOs are associated with less tax aggressiveness as compared to their male counterparts.

Hypotheses

In contrast with the western evidence, we expect that female CEOs in China are not more risk averse than male CEOs and they will perform indifferent from male CEOs on tax avoidance. Thus, our first hypothesis in the null form is as follows:

H1: Female CEOs engage indifferent level of tax avoidance activities compared with male CEOs.

Hypotheses

With respect to the political-related of CEOs, Wu et al. (2012) argue that hiring politically connected managers can allow firms to overcome the market and state-level disadvantages and seek government-related benefits.
Their finding shows that tax burdens of private firms with political connected managers are lower than that of private firms without such managers, indicating that the managers with political connections can help their firms to attain tax benefits

Hypotheses

Based on the foregoing analyses, we present the following hypotheses:

H2: Female CEOs with political connections are more likely to be associated with tax avoidance activities compared with female CEOs without political connections.

Research Design

$$TBTD_{i,t} \text{ or } PermBTD_{i,t} = \beta_0 + \beta_1 FemaleCEO_{i,t} + \beta_2 GovCEO_{i,t} + \beta_3 AccCEO_{i,t} + \beta_4 FemaleCEO_{i,t} * GovCEO_{i,t} + \beta_5 FemaleCEO_{i,t} * AccCEO_{i,t} + \beta_6 GovCEO_{i,t} * AccCEO_{i,t} + \Sigma\gamma_q (qth \text{ control variables}) + Industry\ Dummies + Year\ Dummies + e_{i,t}$$

Sample

Sample selection

Panel A: Full sample	Number of observations
Total sample of A-share firms (excluding Banking and Insurance)	14,264
Less: Firms lacking requisite ownership structure data	(649)
Less: Firms lacking requisite gender or background information of CEOs	(942)
Less: Firms lacking requisite accounting number data	(1,046)
Total firm-year observations	11,627

Panel B: Sample by year	# of obs.	percentage
2007	1,514	13.02%
2008	1,563	13.44%
2009	1,721	14.80%
2010	2,055	17.67%
2011	2,320	19.95%
2012	2,454	21.11%
Total firm-year observations:	11,627	100%

Regression Result

Regression results for TBTD/PBTD on women CEO and political background

Full Sample (N=11,627)

Variables	Parameter	Expected Sign	TBTD as dependent variable			PermBTD as dependent variable		
			Coefficient		t-value	Coefficient		t-value
Intercept		none	-0.106		-0.56	-0.097		-0.51
FemaleCEO	b1	none	0.071		1.61	0.068		1.59
GovCEO	b2	+	0.036	***	2.33	0.035	**	2.28
AccCEO	b3	none	-0.122	**	-2.11	-0.124	**	-2.15
FemaleCEO* GovCEO	b4	+	0.090	**	1.81	0.087	**	1.73
FemaleCEO*AccCEO	b5	none	0.134		1.04	0.127		0.98
GovCEO*AccCEO	b6	none	-0.002		-0.03	0.002		0.03
SOE		+	0.049		1.29	0.048		1.27


Thank You
Very Much!
按一下以新增子標題

The Effects of Retirement on the Nutrition of the Elderly in China

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Yuke Zhu，Southwestern University of Finance and Economics[2]

Abstract

While numerous studies have examined how retirement affects health, few have analyzed the impact of retirement on the nutrition. This article investigates the effects of retirement on the nutrient input and output about elderly Chinese with data from the China Health and Nutrition Survey (CHNS). In this study, the food index and nutrients intake are used to measure nutrient input, the body mass index (BMI) and calories are used for screening nutrient output. Using the Two Stage Least Square （2SLS）and Fuzzy Regression Discontinuity（FRD）methods, the results show that retirement does not make the nutritional status of elderly Chinese worse. Specifically, the effect of retirement was significantly negatively correlated with food index and BMI in all regression, and was also significantly negatively correlated with fats in 2SLS. Moreover, it can be found that the decline in food index is mainly due to a decrease intake of cereals and tubers. We show that moderate reductions in BMI and fats contributed to the health of the elderly.

Introduction

The report of the 19th CPC National Congress emphasized that China must implement a healthy China strategy. Health is an inevitable requirement for the all-round development of the people and to pursue a better life. At present, China has entered a period of rapid growth in the ageing population and the pressure on aging has increased. The health and care of the elderly have subsequently become the most prominent issue in the process of population aging. Retirement, as a key node, marks the starting point for older people to leave their jobs and enter the next new lifecycle. With the acceleration of the aging process in China, the issue of the elderly nutrition after retirement is directly related to the cost of medical and health system, which in turn affects the construction process of “Healthy China”. Adhering to the spirit of the “Healthy China 2030 Plan” and the “National Nutrition Plan (2017-2030)”, it enhances and promotes the health and nutrition of the elderly population from the perspective of life cycle, and prevents and reduces negative factors that affect the quality of life, which is undoubtedly an important measure for meeting the challenges of aging in China with high efficiency and low cost.

In fact, the issue of health and nutrition for the elderly has always been a hot topic in the academic community. Internationally, the research on nutrition and health of the elderly is mostly focused on public health, which is focused on the discussion of nutrition and health-related diseases. However, the economics field focuses on the effects of income and age on the nutritional health of the elderly, and the representative contribution is the efficiency wage model (Leibenstein,1957). Since then, based on this model, subsequent research had been mainly directed to two aspects.

The first type of literature is based on an expanded study of efficiency wage model (Strauss ,1986; Deolalikar, 1988; Thomas & Strauss; 1997; Croppenstedt and Muller, 2000; Schultz, 2002; Weil, 2007; Dalgaard and Strulik,2011). This kind of literature mainly studies whether the intake of nutrients will affect physical health and work efficiency, thus affecting wage income in the context of efficiency wages. The second was an expanded study based on the Engel curve framework and nutrition-income elasticity (Tiffin &Dawson, 2002; Dawson and Sanjuán, 2011; Salois, 2012). The Engle curve framework assumes that income will affect calorie intake, which is contrary to the assumption of the efficiency wage model. Under the Engle curve hypothesis, this type of research utilizes econometric methods to verify the impact of income on nutrient intake and to explain its impact through nutrition-income elasticity. For example, Ogundari, et al.(2017) found that increasing income by 10% in

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43 African sub-Saharan African regions will increase the supply of fat, protein, and calories by 0.90%, 0.87%, and 0.73% respectively..

In addition, some studies combine nutrition and health with economic growth or welfare to reflect the level of national development(Berg, 1968; Correa &Cummins, 1970; Neeliah and Shankar, 2008; Dube, 2014; Ogundari and Aromolaran, 2017) . There are still some scholars who studied nutrition industry (Nestle, 2007; Walls, Cornelsen, Lock, et al., 2016) and nutrition- health safety in consumer economy (Posner, Jette, Smith, et al., 1993; Vartanian, Schwartz & Brownell, 2007; Drichoutis,Lazaridis, Nayga, et al., 2008; Liu, Hoefkens and Verbeke, 2015; Oberlander, Disdier and Etilé,2017). These kinds of literature research focused on the development of national nutrition industry and food nutrition security and risk.

However, these studies rarely involve the relationship between retirement and nutrition health for the elderly. In addition to Schader (2017) and Hassen, et al. (2017), who studied the nutritional intake of the elderly in Germany and France before and after retirement respectively, other studies mostly discuss the relationship between retirement and consumption. The consensus of the study is that retirement inevitably leads to the decline of non-durable consumption of the elderly, which includes the drop of food consumption expenditure, that is the retirement-consumption puzzle (Hamermesh, 1984; Banks,1998; Bernheim, 2001; Schwerdt, 2005). Therefore, whether there is a certain connection between retirement, food consumption and nutritional health of the elderly, and whether the retirement will affect the consumption of food and then change the nutritional health of the elderly remains to be discussed further.

Through literature review, it has been found that the literature on retirement mainly focuses on the “retirement-consumption puzzle”, which rarely involves the relationship between retirement and nutrition. Although there are many literatures on nutrition intake, most of the literature focuses on the relationship between nutrition and human capital, and it mainly focuses on studying the age-nutrition or nutrition- welfare (Schultz, 2002; Weil, 2007; Dalgaard, Strulik, 2011; Salois, 2012; Ogundari, Okoruwa, 2016). But in terms of researching human capital and nutrition, calorie intake indicators are often used to measure nutrient intake , that is neither a specific distinction between food intake and nutrient intake, nor sufficient consideration of nutrient absorption and utilization. Although this study combines retirement and nutritional intake, such as Schader and Herrmann (2017) and Hassen et al. (2017), their nutrition indicators use nutrient intake directly rather than the composite index. At the same time, research on retirement and nutrition usually involves only a single aspect of nutrition input or output, and lack of comprehensive research on nutrition inputs and outputs, which lack of comprehensive research on nutrient input and output. This provides room for further research. In addition, nutritional indicators are mostly selected from self-assessed health indicators or anthropometric indicators (Dave, Rashad and Spasojevic. 2008; Neuman; 2008; Coe and Zamarro. 2011; Eibich. 2015; Nishimura, Oikawa, & Motegi. 2017). Considering the input and output of nutrition, on the other hand, it provides room for further research.

Indicator design and retirement system

Nutrient input

Nutrition refers to the process by which the body absorbs and uses food or nutrients, and it is also the process through which humans consume food to meet their physiological needs. Then, the measurement of nutrition needs to consider the source and use of nutrition, namely the nutrient “input” and “output”.

One of the indicators of nutrient input is the food index. Because individuals eat a variety of foods each day, they hope to measure the overall intake of food by constructing a food index. The "Chinese Residents Balanced Diet Pagoda" (referred to as "Diet Pagoda") divides food intake into eight categories: cereals and tubers, vegetables, fruits, poultry meat, aquatic products, eggs, milk and dairy products, soybeans and nuts, and set a reasonable range of daily recommended intake values. In addition, "Diet Pagoda" also includes daily drinking water, oil and salt intake and the amount of physical activity. Due to the difficulty of data acquisition and the main source of nutrition for food intake, the food index calculations were conducted only for the four major categories (cereals and tubers, vegetables, fruits, and meat, fish and eggs) .These four types of food choices are based on the 2007

version of "Chinese dietary guidelines" food classification standards[3]. And carbohydrates, fats and proteins which are the basic nutrient for humankind are basically available from four types of food .To measure food intake, food index are designed using human development index (HDI).[4]

$$CI_i = \frac{F_d - F_{min}}{F_{max} - F_{min}} \quad (1)$$

In formula (1), CI_i represents the Classification index of a certain type of food, and the Classification index is calculated for the four types of food. F_d represents the actual value of a person's food intake, and F_{min} and F_{max} represent the minimum and maximum daily food intake for the individual. If the recommended range of daily intake of fruit is 2000-350 grams, the average adult's actual fruit intake is 300 grams of fruit, while the index = (300-200)/(350-200) = 0.67. After the calculation of each type of food index is completed, the weights for each type of food are set and weighted average to become the individual food composite index. The weight W_i is the proportion of the mean amount of food consumption. The mean of all kinds of food intake is the median of the maximum and the lowest value, and the mean amount of food is added to the median of all kinds of food. Formula (2) is the calculation method for food index. The whole scope for food index is (-1.33 ,+∞), if the food index is the negative ,that means inadequate intake. If food index is greater than 1, that means excessive intake. Food index values range between the (0, 1) is normal. Excessive or inadequate food intake can have an impact on nutritional requirements, leading to a rise in health-related health problems.

$$Foodindex = \frac{\sum_{i=1}^{4} w_i index_i}{\sum_{i=1}^{4} w_i} \quad (2)$$

Another indicator of nutrient input is the intake of nutrients. According to the 2013 edition of “the Chinese residents' dietary nutrients intake quick reference manual”, sugars (carbohydrates), fats, proteins, vitamins, water and inorganic salt are six major nutrients the body needs. The first three are nutrients that can produce energy in metabolic processes, referred to as “energy source nutrient”. In addition to the essential nutrients, the energy source nutrient can also influence the absorption and utilization of trace elements. Therefore, this article uses carbohydrates, fats and proteins as a measure of nutritional input as another indicator

Nutrient output

In theory, indicators of nutrient output should be measured directly in terms of the efficiency of the body's use of food and nutrients or the specific absorption ratio. But considering the lack of data, we use the indirect index to measure the degree of nutrient absorption. One of the indirect indicators used in this paper is the amount of calories that nutrition converts in the body. The reason is because calories, which come from the absorption and utilization of food or nutrient elements, are the energy needed for all life activities. Calorie as the index of nutrient output can not only indirectly reflect the nutrition intake, but also can be measured indirectly by the absorption effect of food. Another indirect indicator is the Body Mass Index (BMI). Of course, there are also indicators such as height, weight, skinfold thickness, and BMI to measure the degree of nutrition absorption and physical health. We calculate BMI by BMI = weight (kg) ÷ height squared (m^2), to measure human obesity and health. The standard of BMI of the World Health Organization is between 18.5 and 24.9kg/m^2, while China's reference international standard sets a range of 18.5-23.9kg/m^2 that is suitable for China's local BMI[5]. Using BMI as an indirect indicator of nutrient output can reflect the human body's absorption and utilization of nutrition, and can measure the degree of obesity and health of the body.

Retirement system

Unlike other voluntary retirement policies in developed countries, our retirement system is a compulsory retirement system. Chinese retirement pension system covers mainly urban workers, and

[3] We chose the 2007 version because the article uses the food index for the period 1997-2011 and the year 2007 is in the middle of the year. At the same time, the 2007 version is used for a long time.

[4] HDI Index Source: United Nations Development Program, 2007 Human Development Report. Website: http://hdr.undp.org/en/

[5] National Health and Family Planning Commission of the People's Republic of China, "Health Industry Standard of the People's Republic of China" - Adult Weight Determination, April 18, 2013.
Website: http://www.moh.gov.cn/zhuz/yingyang/201308/a233d450fdbc47c5ad4f08b7e394d1e8.shtml

farmers have no obvious retirement age boundaries. According to “the labor insurance regulations” in 1953 and “the interim provisions on the workers and staff members retired processing (draft) ” in 1958, the retirement age of male workers is 60 years old, and those whom engaged in specific work or harmful health work can retire up to 55 years old in advance; Female employees engaged in management and scientific research work are retired at the age of 55, other employees are generally retired at the age of 50, and those who engage in special types of work or engaged in harmful health work can retire at the age of 45 in advance. “the state council on workers retire or resign interim measures ”in 1978 and “provisional regulations on state civil servants” in 1993 to each kind of crowd the retirement age has made the detailed provisions, the retirement age limits consistent with 1953 and 1958 documents.

However, not all urban workers will retire at the statutory retirement age. In addition to early retirement due to special types of work or physical conditions, China has also experienced internal retreat due to historical reasons. In the late 1990s, due to the difficult transition of state-owned enterprises and other issues, the State Council promulgated the "Circular on Issues Related to Piloting the Bankruptcy of State-owned Enterprises in Several Cities" in 1994. The document pointed out that employees working in bankrupt state-owned enterprise may apply for retirement if their retirement age is less than 5 years. However, some occupations have higher requirements for working experience, and the company will implement the reemployment system to delay the retirement age of employees, such as doctors and teachers. Comprehensive body, occupation, history and other factors can be seen that the structure of Chinese retirees is complex. However, most of the people in our country belong to the obedient [6]of the retirement system. Theoretically, there is a high possibility of breaking the point in the statutory retirement age.

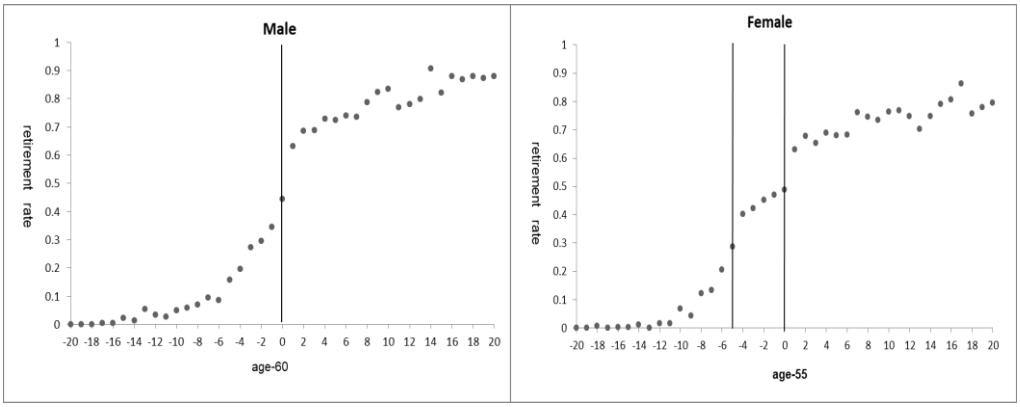

Figure 1 age and retirement rate

Figure 1 shows a scatter plot of age and retirement rate. The horizontal axis is the age difference (male: age-60, female: age-55), and the vertical axis is the retirement ratio. It can be clearly observed that the retirement rate for males at the age of 40 is 0, the retirement rate is close to 10% at 50, 44% at 60, 63% at 61. After the age of 61, the retirement rate gradually increases and approaches to 1. Obvious discontinuity occurred between the ages of 60 and 61. Similarly, women's retirement rates are close to zero at 45, 29% at 50, 40% at 51, 48% at 55, and 63% at 56. After the age of 56, the retirement rate gradually increases and approaches to 1. There are two discontinuities for female workers, one at 50 and the other at 55.There are obvious discontinuity in both male and female works, and women have a smaller jump in two discontinuities than the male. Therefore, the article can use the discontinuity of retirement system at retirement age to identify the causal relationship between retirement and nutrition.

Method

In this paper, the Regression Discontinuity Design (RDD) is used to analyze the nutritional

[6] There are four categories: 1, regardless of whether the retirement age to retire, that is always the participant; 2, regardless of whether they reach the retirement age are not retired, that is, non-participant; 3, over the statutory retirement age of retirement, not over does not retire, that is obedient; 4, more than the legal retirement age does not retire, did not exceed the legal age but retired, that is, rebel. The majority of employees of enterprises in our country retire at the statutory retirement age, so this article estimates the average effect of obedient.

problems of the elderly before and after retirement. “A Counterfactual Framework” which was put forward by Rubin (Rubin,1974), was the source of the idea of the Regression Discontinuity. For a system or a project, the dummy variable D_i is used to indicate whether or not to implement a certain system. If D_i=1, it means to execute the system, and vice versa is 0. This article selects the retirement dummy variable at the age of 60 for males. The age is greater than or equal to 60 years old with D_i = 1, and less than 60 years old with D_i = 0. Execution or not will have different effects on the objective variable which is the individual nutrition status (*N*) in this paper. The potential result of the individual nutrition of the implementation system is N_{1i}. The potential result of individual nutrition of the non-executive system is N_{0i}, and N_{1i}-N_{0i} is the causal effect or treatment-effect of the individual *i* execution system. Because the Treatment Effect is random variable, we focus on the Average treatment Effect, E (N_{1i} - N_{0i}). However, the reality is that we cannot simultaneously observe the same situation where the system is implemented and not implemented. That is to say, a person either retirees or does not retire, N_{1i} or N_{0i} cannot appear simultaneously on the same individual. For this reason, the Regression Discontinuity Design provides us with a good solution.

When no institution is introduced, we assume that variables are smooth. After the introduction of the institution, if there is a significant change in the variable, it is considered to be an exogenous change by institutional factors. The Regression Discontinuity Design is divided into the “Sharp Regression Discontinuity Design” (SRD) and “Fuzzy Regression Discontinuity Design” (FRD). The feature of Sharp Regression Discontinuity Design is that given a grouping variable x, a discontinuity occurs at the threshold x = c, and the probability that the individual gets processed jumps from 0 to 1. The feature of the Fuzzy Regression Discontinuity Design is that the jump at the discontinuity(x=c) is not from 0 to 1, but it jumps from a to b (0<a<b<1), which means that even if x>c it is not necessarily processed. Although our country adopts a compulsory retirement policy, individuals at the statutory retirement age may not retire on time due to physical conditions, historical problems, and occupational reasons. Therefore, the retirement rate will not jump from 0 to 1 at the breakpoint, but it will satisfy the basic characteristics of the FRD. We set the following equation:

$$0 < \lim_{x \uparrow c} \Pr(D=1 \mid x) < \lim_{x \downarrow c} \Pr(D=1 \mid x) < 1$$

The Fuzzy Regression Discontinuity Design assumes that the dummy variable *D* is determined by whether or not a grouping variable *x* exceeds a discontinuity. N_1 and N_0 are the value of the potential nutritional variables at different values of D. Given x, (N1-N0) is independent of D, N is nutrition level, and nutrition changes before and after retirement. As $N=N_0+D$ (N_1 - N_0), we take the expectation of both sides and then subtracted after the limit value is taken on both sides of the breakpoint c.

$$E(N \mid x) = E(N_0 \mid x) + E(D \mid x) \cdot E[(N_1 - N_0) \mid x]$$

$$\lim_{x \downarrow c} E(N|x) - \lim_{x \uparrow c} E(N|x) = [\lim_{x \downarrow c} E(D \mid x) - \lim_{x \uparrow c} E(D|x)] \cdot E[(N_1 - N_0) \mid x = c]$$

$$E[(N_1 - N_0) \mid x = c] = \frac{\lim_{x \downarrow c} E(N|x) - \lim_{x \uparrow c} E(N|x)}{\lim_{x \downarrow c} E(D \mid x) - \lim_{x \uparrow c} E(D|x)} = \frac{\lim_{x \downarrow c} E(N|x) - \lim_{x \uparrow c} E(N|x)}{\lim_{x \downarrow c} \Pr(D=1 \mid x) - \lim_{x \uparrow c} \Pr(D=1|x)}$$

The treatment effect of the FRD is estimated to be the average effect of the obedient being affected by the retirement system. In China, age is a very important indicator of retirement changes. Most employees will choose to retire at the legal retirement age. Therefore, the article uses dummy variable which represent whether the legal retirement age is met or not as a tool variable to identify the impact of retirement on the nutritional changes of the elderly. Study population is limited to people around the statutory retirement age, and the normal retired people who reached the retirement age were treated as the treatment group and the non-retired people as the control group. In the case of non-linear relationships, we consider the impact of retirement on retirement rates and the impact of retirement dummy on elderly nutrition.

$$N = \alpha_1 + \alpha_2 D + \sum_{s=1}^{k} [\gamma_s (x-c)^k] + \varepsilon \qquad (3)$$

(4)

In the formula (3) and (4), *k* is the exponent number, and the k value of this paper is considered as the second order nonlinear situation directly. x is the actual age, c is the statutory retirement age ,and R is the male retirement rate or retirement dummy variable in each year. In order to obtain an unbiased estimate of the retirement effect, refer to Battstin ’s study, we use the eligible status of retirement (D) as a tool variable, and the eligible status of retirement is represented by 1 (x-c) > 0(Battstin.2009). At the same time, to evaluate the effectiveness of the Regression Discontinuity, we also need to check the conditional density of the covariates at the breakpoint. Normally, the covariant

should be continuous on the premise that the bandwidth is small enough, so the following estimate is required.

（5）

In equation (5), Z is a covariate vector that represents the other demographic characteristics of the head of the household. The article selects educational level, marriage, and dietary knowledge as covariates. I In addition, factors such as the choice of the optimal bandwidth and whether or not to join the covariates need to be considered in the Fuzzy Regression Discontinuity Design, and we will discuss them in the robustness test section.

Data

Chinese Health and Nutrition Survey (CHNS) covers nine provinces (Liaoning, Heilongjiang, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi and Guizhou) that vary substantially in geography, economic development, public resources, and health indicators. A multistage, random cluster process was used to draw the samples surveyed in each of the provinces. The survey covers the tenants, nutrition, health, adult, children, community and related survey from 1989 to 2011. Given the lack of data on retirees in 1989, we deal with the data from 1991 to 2011. Due to lack of data and rotation, we only retained the cross-sectional data from 1991 to 2011. In addition, the food index has three figures of food code in the survey in 1991 and 1993, considering the efficiency of data utilization, and the year of the three-digit food code is discarded, so we use the data from 1997 to 2011. Because China's retirement system mainly covers urban workers, rural areas have no mandatory boundary for retirement, so this paper adopts the data of urban workers. Taking into account the sample size and the retirement interval, we used samples from 40 to 80 years old. Since retirement rate only have one discontinuity for male, and two discontinuities for female in figure 1, our study used only male samples for ease of analysis.

Table 1 shows the retirement ratio and working ratio of all samples and male samples of CHNS each year. The table shows that the male working ratio is higher than the total sample value every year, and the male retirement ratio is lower than the total sample value. It can also be observed that the ratio of working population before 2000 was above 77% and dropped significantly after 2000 in China, and the male sample showed the same trend. It means that population began to show the tendency of aging population after 2000 and become more severe in recent years. In 2011, the percentage of male workers for the total male population fell to 68.61%, while the percentage of all working people for the total sample was only 61.27%, approaching 50%, and the aging is becoming more serious.

Table 1 CHNS Data Sample Composition

Year	1991	1993	1997	2000	2004	2006	2009	2011
All samples								
[1]Retirement rate (%)	14.66	15.72	17.88	22.84	32.80	33.38	34.86	38.73
[2]Work rate (%)	85.34	84.28	82.12	77.16	67.20	66.62	65.14	61.27
Male samples								
[3]Retirement rate (%)	13.77	14.69	16.51	20.63	28.82	28.76	28.21	31.39
[4]Work rate (%)	86.23	85.31	83.49	79.37	71.18	71.24	71.79	68.61

Definitions of the indicators:
1 Percentage of retirement for the total population in CHNS
2 Percentage of working people for the total population in CHNS
3 Percentage of retired male for the total male population in CHNS
4 Percentage of male workers for the total male population in CHNS

To facilitate the analysis of data structures, table 2 provides a male retirement ratio in different ages. From the table, there is a clear positive relationship between retirement and age, that is, the older the age, the higher the retirement rate. Therefore, it is feasible to intuitively select the age dummy as a tool variable. As mentioned above, retirement is considered eligible for retirement after reaching the legal age, so it is necessary to observe people around the legal age. Although the regression discontinuity design is based on the potential statutory retirement age as a rule, positive retirement rates still exist before the legal age ,for example,34.53%(retirement rate) in 59 years old. These values are reported as negative (-1) in the regression analysis, which can be misleading as identifying errors. However, regardless of the statutory retirement age (60), the male retirement rate jumps from 34.53

percent at 59 to 63.21 percent at 61, with a change of about 29 percentage points. There are obvious jumps in the legal retirement age, which is in accordance with the characteristics of FRD.

Table 2 The male retirement rate in different ages

age	Retirement rate (%)	age	Retirement rate (%)	age	Retirement rate (%)	age	Retirement rate (%)
40	0	51	5.86	62	68.60	73	79.82
41	0	52	6.87	63	68.71	74	90.59
42	0	53	9.50	64	72.73	75	82.00
43	0.37	54	8.48	65	72.28	76	87.84
44	0.35	55	15.79	66	73.86	77	86.90
45	2.28	56	19.59	67	73.47	78	87.93
46	1.43	57	27.35	68	78.74	79	87.23
47	5.43	58	29.46	69	82.24	80	88.00
48	3.38	59	34.53	70	83.46		
49	2.69	60	44.50	71	76.92		
50	4.92	61	63.21	72	77.98		

CHNS conducted a three-day meal record for family members. This article selected the first-day meal record to account for the food index. Although the first day does not represent all the averages, because the data is repeated cross-sectional data, each person has at least two days of food records, so it is feasible to select the first day meal record as the food index calculation standard. Daily intake of food varieties of CHNS records stored in the form of food code.[7] According to the food code, we add the daily intake of food to the cereals and tubers, vegetables, fruits, and meat, fish and eggs. Calculate the classification index according to equation (1), and then calculate the weight based on the recommended range value of each food for diet pagoda (cereals and tubers, 250-400g/day; vegetables, 300-500g/day; fruits, 200-400g/day; meat, fish and eggs, 125-225 g/day). After calculation, the weight W_i of the four categories of food are 0.27, 0.33, 0.25 and 0.15 respectively, and the food index is finally calculated by formula (2).

Regarding nutrient elements, CHNS provides three-day average intakes of carbohydrates, fats, and proteins for family members, which are directly available. At the same time, CHNS also directly provides the average physical energy calorie value for three days, which represents the energy index of nutrition output. Regarding the calculation of the BMI index, CHNS provided an adult basic physical examination form, which includes information on height, weight, and blood pressure. We can calculate body mass index based on adult height and weight. In order to improve the validity of the regression results, we have added the following control variables: educational level (0, illiteracy, 1, primary school, 2, junior high school graduation, 3, graduate from high school, 4, secondary technical or vocational school graduate, 5, college or university graduate, 6 or above, master), marital status(in marriage to 1 in the questionnaire, unmarried, divorced, widowed, and separation of 0), and whether or not we know Chinese residents' dietary guidelines. Table 3 is a statistical description of the main variables.

Table 3 The statistical description of the main variables

Variable(unit)	Mean value	S.D.	Min	Max	Number of samples
[1]coin(g)	461.202	224.785	0	4180	4342
Fruit(g)	65.022	155.116	0	2200	4342
vegetable(g)	373.218	238.727	0	3150	4342
[2]meat(g)	224.696	224.899	0	4650	4342
food index	0.482	0.721	-1.317	8.203	4342
[3]carbo(g)	310.141	110.196	27.080	1016.580	5550
fat(g)	83.297	41.935	2.560	938.860	5550
[4]protn(g)	75.096	26.437	10.860	441.910	5550
[5]kcal(g)	2339.863	681.157	192.220	9981.750	5550
BMI	23.533	3.467	12.685	57.344	5342

Definitions of the indicators:

[7] In the food index calculation process, the 2004-2011, six food code reference is 2002 version of Chinese food composition table, 1997-2000 five food code reference is 1991 Chinese food composition table (Wang Guangya, Shen Zhiping, Fan Wenyi et al., 1991; Yang Yuexin, 2002).

1 cereals and tubers; 2 meat, fish and eggs; 3 Carbohydrates; 4 Proteins; 5 Calories

Food index between 0 and1 is normal, and greater than 1 or less than zero is uneven diet. According to the table 3, the mean of the food index is 0.48, which is in the normal range. This shows that the average food intake of the population of 40 to 80 years in the sample is balanced, with a minimum value of -1.32 and a maximum value of 8.20. According to the classification, the recommended range of the valley potato in the Diet Pagoda was 250-400 grams per day. The mean of the cereals and tubers in the sample was 461.20g, which exceeded the recommended limit of intake, representing a large amount of intake. The standard deviation was 224.78 grams, indicating that there were significant differences in the amount of cereals and tubers intake between individuals; the recommended limit for fruits is 200 grams per day, with an average of 65.02 grams, indicating that the demand for fruit in the sample of 9 provinces is strictly less than the recommended value and should be supplemented with more fruits; the vegetable reference range is 300 to 500 grams per day, and the average is 373.22 grams, which is within normal range, but the standard deviation is larger than that, and there is a problem of individual differences as well as fruit; the recommended range of meat, fish and eggs is 125-225 grams, with an average of 224.69 grams, which is between normal values. But there is also a larger standard deviation, a larger problem of individual differences.

In the statistics of nutrients elements, the mean of carbohydrate was 310.14g, the standard deviation was 110.19 grams, and the difference between the maximum and the minimum was 38 times, and the individual difference was larger. The mean value of fat intake was 83.29 grams, and the difference between the maximum and the minimum was 367 times. The difference was the largest of the three elements. The "Recommended Nutrient Intake" (RNI) of protein for men aged 40-80 in the Manual for Reference Rates of Dietary Supplements to Chinese Citizens is 65 grams per day. In the study sample, the average value of the protein intake was 75.09 grams per day, 15.6% higher than the RNI. This shows that the protein intake is too much.

From the perspective of nutrient output, the mean value of calories is 2339.86 kcal daily, and the maximum value is 52 times, the standard deviation is 681.16 kcal, and the individual difference is greater. The normal range of BMI was 18.5-23.9 kg/m^2, with a sample BMI of 23.53 kg/m^2. It is in the normal range, but close to normal range upper limit, obesity is more stressful. The standard deviation of BMI is 3.47 kg/m^2, which is 4.5 times the difference between the maximum and the minimum, and the fluctuation of the BMI is relatively small relative to other indicators. To sum up, except food index, fat, protein, BMI, etc., the other indicators have the common characteristics of individual differences. Of course, this is related to individual differences, such as physical differences and good health. Given the unreliability of the results from individual differences, we study the average treatment effect rather than the horizontal effect about retirement policy.

Results

Regression Results

In recent years, scholars, such as Schader who studies the effects of retirement on various nutrient elements by using multiple linear analysis methods (Schader,2017), have begun to pay attention to nutritional problems after retirement. Since nutritional issues are directly related to physical health which is an important factor in determining whether to retire, there are serious endogenous problems in the analysis of multiple linear models. Multivariate linear analysis can lead to estimation bias because of reverse causation, and the RDD can solve endogenous problems. With reference to Battistin (2009), we chose age dummy as the instrumental variables of retirement rates or retirement dummy in different age groups (males older than 60 years to 1, otherwise 0). In order to enhance the validity of regression, we construct a nonlinear relationship through the quadratic term of age difference (standardized variable age, discontinuity is 0) to control the nonlinear continuous effect of age. Then we use 2SLS and RDD to estimate changes in retirement nutrition.

Table 4 reports the results of the age dummy on the retirement variables. The explained variable is the retirement dummy (retirement is 1, work is 0, and non-working men are excluded from retirement). The explanatory variable is an age dummy (1 for males older than 60 years and 0 for those under 60). Table 4 is equivalent to the first stage report in the 2SLS regression. We control region and time dummy. From Table 4 it can be seen that at the 1% level of significance, the age dummy has a significant positive correlation with retirement dummy. It indicates that most males retire after the age of 60 and the age growth trend is consistent with the retirement trend after crossing the retirement node. The value of the F test which measures the effectiveness of the tool variables is greater than 10, indicating that it is feasible to use the age dummy as the tool variable for the retirement or retirement

dummy.

Table 4 Impacts of retirement system on retirement

Variables	Retirement dummy	
	(3)	(4)
Age dummy	0.652***	0.652***
	(0.023)	(0.024)
Age -60	—	0.004
		(0.018)
(Age-60) ^{2}	—	0.00002
		(0.00004)
Area / Year	Yes	Yes
N	5550	5550
R^2	0.7176	0.6545
F value	211.64	175.26

Note: * p<.05. ** p<.01. *** p<.001.

Table 5 reports the estimation results of retirement impacts on nutrition inputs and outputs. As can be seen from the table, retirement showed a significant negative correlation with the food index. Retirement will reduce the food intake index, which is that retirement will reduce food intake by 22.78 percent compared to before retirement. This is consistent with most scholars' study of the "retirement consumption puzzle", which concludes that the reduction of food consumption after retirement (Fisher, et al. 2008; Agarwal, et al. 2015). The other side of the impact of retirement on nutrient input is from the perspective of nutrition elements. In Table 5, the estimated results of the three nutrient elements show that the retired variables have no significant effect on carbohydrates and proteins. But retirement showed a significant negative correlation with fat at 5% significant level, and retirement cause reduction of fats by 6.54 grams per day. According to the data description in the previous chapter, fat intake exceeds the RNI value of 15.6% during the period of 40-80 years. If it is reduced by 6.54 g, it will return to the normal recommended value range. Fat is an important factor that causes obesity, which comes from a lot of fatty food, such as lard, fat, snack, etc. The decrease in intake of fat foods by retired elderly people may indicate that older people pay more attention to their health after retirement. That may be related to the lifestyle of the elderly who have time to take exercise or cook food at home after retirement.

From the aspects of calories and BMI, Table 5 also reports on the impact of retirement on nutritional output. Retirement had a significant negative correlation with BMI, and the BMI after retirement fell by 2.7 kg/m2 before retirement. Body mass index is one of the indicators used to measure individual obesity, and its normal range is 18.5-23.9 kg/m2. The average sample BMI was 23.53 kg/m2, which was close to the upper limit of the normal range. When the body mass index dropped by 2.7 kg/m2 after retirement, the BMI approached the median range, indicating that the post-retirement obesity rate was lower than the pre-retirement obesity rate.

Table 5 Effects of retirement on nutrition

Variables	Food index	Carbon	Fat	Protn	Kcal	BMI
	(1)	(2)	(3)	(4)	(5)	(6)
Retirement	-0.228***	7.693	-6.537**	-0.859	-53.301	-2.703***
(IV=age)	(0.087)	(7.876)	(3.247)	(2.047)	(51.679)	(0.763)
Age -60	0.021***	-2.102***	-0.155	-0.387***	-11.712***	0.039
	(0.004)	(0.331)	(0.136)	(0.086)	(2.159)	(0.036)
(Age-60) ^{2}	0.0002	-0.026**	-0.011**	-0.007**	-0.267***	-0.004***
	0.0001	(0.013)	(0.005)	(0.003)	(0.082)	(0.001)
Area/Year	Yes	Yes	Yes	Yes	Yes	Yes
N	4342	5550	5550	5550	5550	5342
R^2	0.031	0.177	0.051	0.062	0.097	0.064

Note: * p<.05. ** p<.01. *** p<.001.

Table 6 shows the results of retirement and nutrient input and output estimation under the

Regression Discontinuity Design. There is a significant negative correlation between the food index and BMI, and the LPE estimates value were respectively: -0.453 and -3.947, indicating that the food index and BMI has a significant breakpoint jump at the age of 60, which once again showed the decrease in the total food intake of the elderly after retirement and the decrease in the obesity rate. Retirement has no significant effect on nutrient elements, which is inconsistent with the findings of authors Zhang & Jiang (2013). This is mainly because we select male samples between the ages of 40 and 80, but samples above article are all male and female samples of that age. There is a discrepancy between the RDD and 2SLS results in the fat element, which may be caused by the unsteady data, and we will make further analysis in the robustness.

Table 6 Local Polynomial Estimation Results

Variables		Retirement	The optimal bandwidth	A confidence interval	N
Food index	(1)	-0.453*** (0.151)	1.688	(-0.749 , -0.157)	4342
Carbo	(2)	9.198 (18.626)	9.237	(-27.307 , 45.704)	5550
Fat	(3)	-9.058 (6.461)	9.711	(-21.721 , 3.606)	5550
Protn	(4)	-5.042 (5.034)	8.773	(-12.222 , 2.250)	5550
Kcal	(5)	-18.775 (86.537)	13.258	(-188.384 , 150.833)	5550
BMI	(6)	-3.947*** (1.381)	2.112	(-6.655 , -1.239)	5342

Note: * p<.05. ** p<.01. *** p<.001.

In order to facilitate the intuitive analysis, figure 2 uses the local linear function to curve the local linear fitting on both sides of the retirement node. The following figure only lists the fitting plots for the food index and BMI with significant coefficients. Other insignificant variables are omitted for space reasons. The abscissa is the age difference (age -60), and the discontinuity is at 0. The ordinate is the mean value of each indicator of nutrition. We can more intuitively observe from Figure 2 that the food index and the BMI have a significant downward jump after the point of retirement policy (+/- 1 year old at 0).

Figure 2 Food Index and BMI Change Chart

Robustness test

This section tests the robustness of the results. The main tests include: the results of adding covariates; food index classification regression; whether the conditional density of the covariates is continuous at the discontinuity; results of different bandwidth choices. We used "Education", "Marriage", "Knowledge" (whether we know Chinese dietary guidelines) as a covariate in the questionnaire, and we did 2SLS and RD regression again. These covariates are chosen because education levels and marital status may be important factors affecting the heterogeneity of individual diet, while our nutritional criteria follows the diet pagoda standard, and the knowledge of the dietary pagoda will also affect the main variables.

Table 7 reports the 2SLS results of food index classification after joining the covariant. The purpose is to analyze the reasons for the decline in the food index. Table 7 shows that retirement has a significant negative correlation with food index and is consistent with table 5 results. From the perspective of classification, retirement significantly led to a reduction in the intake of cereals. After retirement, the intake of cereals was reduced by 87.59 times compared with that before retirement indicating that the elderly have reduced their consumption of staple foods such as pasta and rice after retirement. Whether it is an absolute reduction requires discussing whether it is possible to be replaced by other foods. However, from the other three types of food intake, retirement had negative correlation with fruits, vegetables, and meat, fish and eggs. But the coefficients were not significant, and no alternatives were found. It can be concluded that the reduction in the intake of cereals and tubers is the main reason for the decrease in the food index.

Table 7 Food classification regression with covariates

Variables	Food index	Coin	Fruit	Vegetable	Meat
	(1)	(2)	(3)	(4)	(5)

Retirement	-0.223**	-80.782***	-13.659	-16.577	-21.796
(IV=age)	(0.087)	(26.657)	(18.392)	(28.968)	(26.567)
Education	-0.006	-20.316***	8.312***	-4.869*	19.153***
	(0.008)	(2.318)	(1.599)	(2.519)	(2.310)
Marriage	0.0001	6.923	2.753	-6.360	-3.515
	(0.027)	(8.388)	(5.787)	(9.115)	(8.359)
Knowledge	-0.020	-17.776**	27.237***	-3.482	-11.126
	(0.026)	(7.976)	(5.503)	(8.667)	(7.949)
Age-60	0.021***	8.178***	-0.262	2.693**	1.331
	(0.004)	(1.200)	(0.828)	(1.304)	(1.196)
(age-60) ^{2}	0.0002	0.117**	-0.0326	0.057	-0.109***
	(0.000)	(0.042)	(0.029)	(0.045)	(0.041)
Area / Year	Yes	Yes	Yes	Yes	Yes
N	4342	4342	4342	4342	4342
R^2	0.032	0.066	0.066	0.069	0.073

Note: * p<.05. ** p<.01. *** p<.001.

Table 8 also shows that the impact of retirement on the main explanatory variables is consistent with Table 5, and there is a significant negative correlation between food index, fat, and BMI. In addition to the food index and calories, education shows a significant correlation with the other variables, indicating that education affects the input and output of nutrition to a certain extent. Dietary knowledge has significant influence on cereals and tubers, fruit and BMI, indicating that dietary knowledge acquisition can influence food intake structure and obesity. The marital status only affects the body mass index, while the other variables are not significant.

Table 8 Nutritional change regression with covariates

Variables	Carbo	Fat	Protn	Kcal	BMI
	(1)	(2)	(3)	(4)	(5)
Retirement	7.976	-6.649**	-0.926	-51.612	-2.543***
(IV=age)	(7.861)	(3.244)	(2.044)	(51.76)	(0.757)
Education	-7.435***	2.4381***	1.5053***	-7.9659	0.2361***
	(1.062)	(0.437)	(0.268)	(6.773)	(0.031)
Marriage	0.616	0.668	0.803	12.887	-0.299***
	(3.456)	(1.424)	(0.887)	(22.46)	(0.112)
Knowledge	2.015	0.058	0.915	18.517	0.313***
	(3.796)	(1.564)	(0.969)	(24.53)	(0.113)
Age-60	-2.297***	-0.0964	-0.3535***	-12.049***	0.063*
	(0.333)	(0.137)	(0.086)	(2.182)	(0.036)
(age-60) ^{2}	-0.0251**	-0.0117**	-0.0075**	-0.2685***	-0.0038***
	(0.013)	(0.005)	(0.003)	(0.083)	(0.001)
Area / Year	Yes	Yes	Yes	Yes	Yes
N	5550	5550	5550	5550	5342
R^2	0.1893	0.0594	0.0694	0.0976	0.0810

Note: * p<.05. ** p<.01. *** p<.001.

Table 9 reports the regression discontinuity results of retirement on major variables after joining covariates. It can be seen from the table that the LPE estimated values of the food index and BMI are basically consistent with the table 6, while other variables are not significant, and the results show stronger stability, indicating that the addition of covariance does not affect the overall trend of variables. The conclusion is that the total food intake and obesity rate of elderly people after retirement are reduced.

Table 9 The RD result with covariates

Variables		Retirement	The optimal bandwidth	Confidence interval	n
Food index	(1)	-0.377***	1.688	(-0.662 , -0.093)	4342
Carbo	(2)	11.975	9.237	(-24.269 , 48.219)	5550
Fat	(3)	-10.064	9.71	(-22.704 , -2.576)	5550
Protn	(4)	-5.508	8.773	(-15.391 , 4.373)	5550
Kcal	(5)	-20.277	13.258	(-190.24 , 149.686)	5550
BMI	(6)	-4.497***	2.112	(-7.569 , -1.426)	5342

Note: * p<.05. ** p<.01. *** p<.001.

The RD assumes that control variables are smooth and continuous at the discontinuity. It can be seen from Table 10 that the three covariates of educational level, marital status, and dietary knowledge are not significant at the 10% level. The P values were 0.301, 0.178, and 0.768, respectively, indicating that the covariates were continuously smooth at the breakpoints, which was consistent with the assumptions.

Table 10 Covariate continuity test

	coefficient	Standard deviation	P value	Confidence interval
Education	0.2778	0.2686	0.301	（-0.2487，0.8044）
Marriage	-0.0766	0.0569	0.178	（-0.1880，0.0348）
Knowledge	-0.0208	0.0706	0.768	（-0.1592，0.1177）

Different choices of polynomials, kernel functions, and bandwidth may produce different results in RD regression[8]。Table 11 reports the regression results of the above three categories. We only reported the regression results of the food index and body mass index that had a significant effect. Other variables were omitted due to space limitations. We report the results of local linear regression and local quadratic regression with different polynomial orders，the results of the Triangular and Epanechnikov with different kernel function, and the results of specifies one common mean squared error and specifies median(two different MSE, one common MSE, the difference thereof) for each side of the cutoff separately with different bandwidths methods. As can be seen from the table, food index and body mass index in a variety of options are significant, indicating that the regression results are robust.

Table 11 Effect on main outcomes selection procedures

	With different polynomial orders		With different kernel function		With different bandwidths methods	
	Linear	Quadratic	Triangular	Epanechnikov	A common MSE	Median(msetwo, mserd, msesum)
Food index	0.500***	-0.343*	-0.453***	-0.338*	-0.343*	-0.313*
	（0.065）	（0.178）	（0.151）	（0.188）	（0.178）	（0.183）
BMI	-3.974***	-3.974***	-3.974***	-19.327***	-3.974***	-3.979***
	（1.368）	（1.368）	（1.368）	（2.129）	（1.368）	（1.364）

Note: * p<.05. ** p<.01. *** p<.001.

Discussion

In practice, there is problem that China faces severe problems with its growing ageing population at present. So the nutritional problems of the elderly in the post retirement years directly influences the health care expenditure in China. Moreover, it will affect the construction process of healthy China. This article investigates the effects of retirement on the nutrient input and output about elderly Chinese with data from the China Health and Nutrition Survey (CHNS), using the method of Two Stage Least Square (2SLS) and Fuzzy Regression Discontinuity(FRD).The study found the following conclusions:

By the method of Two Stage Least Square, it is found that in terms of nutrient input, retirement

[8] Robustness tests use the “rdrobust” and “rdbwselect” commands

which would reduce food intake by 22.78% has a significant negative correlation with food index. Specifically, there is a significant decrease of 87.59 times in the consumption of cereals and tubers. There is no significant effect of retirement on the fruits, vegetables and meat fish and eggs, and no substitutive existence is found. It can be found that the decline in food index is mainly due to a decrease intake of cereals and tubers. Retirement has shown a significant negative correlation to the fats, which reduces fat intake by 6.54 grams per day, but it has no significant impact on carbohydrates and proteins in the "energy source nutrient". In terms of nutrient output, retirement has a significant negative effect on BMI, and has no significant effect on calories. The post-retirement BMI is 2.70kg/m^2 lower than before retirement, which is associated with a decrease in the intake of fatty foods. In the normal BMI range, because the BMI of 40- 80 year old group is close to the upper limit of normal range, moderate reductions in BMI and fats contributed to the health of the elderly.

From the perspective of RD estimation, the retirement of food intake and body mass index are showed a significant negative correlation relationship, coefficient of 0.453 and 3.947, respectively, and they also show the same relationship in the robustness test. The study supports the conclusion that the total food intake and obesity rate of the elderly after retirement are reduced. However, the significance of fat is not consistent in the RDD and the 2SLS regression. The robust test also shows that fats are not perform significantly at all ages and with no significant discontinuity at 60. Overall, fats show a downward trend within the range of 40-80 years, which was significantly reflected in the 2SLS regression.

Limitations

In summary, retirement not only does not make the nutritional status of elderly Chinese worse, but also make the elderly pay more attention to physical health after retirement. As with all research, the present study has its limitations. First, the food index data consists of the first day of the three days survey in the CHNS during the period from 1993 to 2011. Due to lack of average annual and monthly consumption data of food groups, this study cannot fully represent the overall food intake. Second, this study only selects male samples and does not analyze female samples. Future research can focus on reviewing the influence of nutritional intake to provide a more generalizable analysis.

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Main Determinants of Chinese Worker Delayed Retirement Decisions

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Abstract

Demographic changes in China and the shortfall of the Social Security Fund call for research on the determinants of delayed retirement decisions. The purpose of this research, which draws from the Chinese Household Finance Survey, is to identify the main economic factors that affect workers' decisions to delay retirement, even when eligible for the Social Security Retirement Benefit. The multivariate analysis undertaken consists of a logistic regression which compares respondents who decide to retire with those who choose to keeping working. Generally, the results show that respondents with more sufficient financial resources tend to retire after they have qualified for the Social Security Retirement Benefit. Variables related to earning ability seem to demonstrate 'income effects', in terms of the decision to delay.

JEL: D14(Household Saving; Personal Finance)**, J22(**Time Allocation and Labor Supply)**, J26(**Retirement • Retirement Policies)**, D12(**Consumer Economics: Empirical Analysis)**, J18(**Public Policy)

Introduction

The question of aging populations has become a topic of worldwide relevance. Under pressure from population aging, for example, the Chinese pension fund is facing a huge deficit. According to Rao Yudong, director of the Institute of Finance and Banking of the People's Bank of China, this deficit will reach 4.1 trillion (in RMB). Putting forward solutions to this issue has become a popular field of research. A large number of academic studies, for example, point out that delaying the age of retirement can be a feasible way to solve the demand on pension funding (Burtless & Quinn, 2002; Sin, 2005). In China, there have also been calls to delay the retirement age to relieve this problem, resulting in quantitative research which examines the amelioration of the pension problem through raising the legal retirement age. For example, studies by Sin (2005) have shown the significance of raising the retirement age for maintaining the balanced pension budgets. Sin (2005) concludes that the legal retirement age must be gradually raised to 65 years old, or the pension system will prove fundamentally unsustainable. This result is very much in line with the new age for drawing a pension published by Ministry of Human Resources and Social Security. In China today, one must finish retirement application before receiving either a social insurance pension or a pension given out from other sources. According to these rules, men are allowed to complete the retirement application, and receive a pension, when they are 60 years old. For women, those who are classified as workers can do likewise when they are 50 years old, while those who are classified as officials are allowed to apply at 55.

In the United States of America (USA), by contrast, the minimum age at which one can draw a pension is 62. Furthermore, this minimum is flexible for individuals and, as a result, the amount of the pension differs according to the age at which the pension is drawn. Generally, under such flexible retirement arrangements, people who delay their pensions will receive a larger sum of money at the beginning. For example, while it is allowable to draw a pension at 62 years of age, the pension received at this point will not be the full amount. Only by reaching full retirement age can one receive the maximum pension available. Therefore, the pension progressively increases within the range contained between 62 years and full retirement age. Full retirement age to 70 years of age is another relevant range. If someone older than the full retirement age still delays the drawing of pension, he or she can get a reward called 'delayed retirement

credit', which will again increase the pension received after the age of 70. Delayed retirement credit completely stops, however, at the age of 70. From this, then, we know that the age at which one can draw a pension in America is much higher than the age in China. Thus, one way to relieve problem of pension shortages may be to control and adapt the rules of drawing a pension from the state

In the USA, furthermore, people in employment must pay for social insurance if they want to keep working once they have received pensions. By contrast, in China, when people reach the legal retirement age of 60, they have no means by which to pay for social insurance, even if they continue to work. So far, China has not experimented with a flexible retirement policy and there is no policy of delayed retirement credit. Indeed, the measurement and calculation of an appropriate delayed retirement credit is a complicated topic. For example, the same form of delayed retirement credit will hold a different level of attractiveness for people in various careers. In addition, the action of granting delayed retirement credit adds a burden to national pension budgets. It is therefore not necessary for states, such as China, to follow this policy. Nonetheless, allowing people who have been receiving pensions, but who remain at work, to pay for endowment insurance is a more feasible policy. This kind of change would relieve the pension deficit problem to some extent. Furthermore, encouraging people who have been receiving retirement benefits, but who keep working and have not yet reached the legal retirement age, to pay for social insurance, is another method to relieve the pension deficit.

Literature Review

Relevant factors related to retirement behaviors have been identified by several studies, drawing from different perspectives in the U.S. and other countries. Generally speaking, however, both economic factors and non-economic factors contribute to retirement behavior. According to Leonesio et al. (2012), the percentage of people who would like to work past 62 years of age is rising. The main reasons associated with this stronger willingness to work include insufficient financial resources to support retirement, and other non-financial factors, such as number of dependents, leisure preferences, and ethnicity.

Financial Incentives

Financial variables are mainly divided into three categories: accumulated net worth, total income, and retirement benefit. Retirement benefits, in turn, include income from social security benefits, as well as income from defined-benefit (DB) and defined-contribution (DC) plans.

Current net worth and delayed retirement behavior. Current net worth is widely asserted to have a negative impact on expected retirement age (Delpachitra & Beal, 2002; Montalto, et al., 2000; Ooijen et al., 2010; Ozawa & Yeo, 2010), although Ozawa and Lum (2005) found net worth to have a positive impact on the probability of older workers being motivated to work over 70. This was explained by positing the 'income effect', leisure time is just like a normal good, one with higher financial resources can afford more of this type of good and therefore can enjoy more retirement time.

Other studies, although not directly addressing the impact of net worth on retirement behavior, do note the effect of wealth on labor force participation. For example, the stock market fluctuation of the 1990s was found to discourage labor force participation (Cheng & French, 2000; Gustman & Steinmeier, 2002; Lynn & Perozek, 2003). On average, workers tended to retire earlier after the bull market. Other forms of capital which can cause this wealth effect include large amounts of inheritance (Joulfaian & Wilhelm, 2001) and other "luck money" (Imbens et al., 2001), which has been found to reduce people's disposition to work. The negative impact of net worth on retirement behavior is also supported theoretically. For example, Hatcher (1997) constructed a model for retirement plans based purely on financial considerations, proposing the two concepts of permanent income and reservation wealth. Under the concept of permanent income, households can have an estimate of reservation wealth (retirement needs), and the household's retirement decision can then be based on whether the full wealth of the household matches the reservation wealth or not.

Retirement income and delayed retirement behavior. Retirement income typically refers to social security income, income from a defined-benefit plan income, and income from a defined-contribution plan. Health insurance will also count as part of the retirement income, because it mitigates the potential burden of medical expenses. Based on Hatcher's model, since retirement benefits also increase the full wealth, they thus imply a negative effect on delayed retirement behavior. The same effect was also observed in the model built by Van Ooijen et al. (2010) for the study of planned retirement age in the Netherlands. Many

empirical studies found a negative relationship between retirement income adequacy and early retirement behavior. Social security benefits, which can be considered as a government-supported annuity, are found to have strong income effects and dissuade people from the workplace (Colie, 2015; Frieze et al., 2010; Leimer, 1999). Besides social security, having a defined-benefit retirement plan is found to discourage workforce participation (Leimer, 1999; Munnell et al., 2003). However, strong implications for early retirement are not consistently found with regard to defined-contribution plans. Some studies indicate that defined-contribution plans negatively affect labor force participation (Beehr et al., 2004; Blundel et al., 2002; Giandrea et al., 2008; Phillipson & Smith, 2006). Other studies, however, do not give indication of a significant impact (Leimer, 1999; Munnell et al., 2003). In fact, Friedberg and Webb (2005) found that switching from a DB plan to a DC plan actually increases the median retirement age for workers. Health insurance, regardless of whether it is funded by the government or privately purchased, should be considered as an implicit retirement income because it reimburses medical expenses that would otherwise be a potentially large out-of-pocket expense for individuals. China has two types of medical insurance: one is government-funded insurance, which is a sub-category of social security benefits; the other is commercial health insurance, which is purchased by individuals. Lacking health insurance is generally found to deter workers from early retirement (Johnson et al., 2003) and, conversely, having sufficient health insurance coverage will encourage early retirement (French and Jones, 2007).

Earning ability. Earning ability is found to have contradictory effects on people's retirement decisions. The 'income effect' indicates that the higher the income, the more leisure time one could purchase, and will therefore retire earlier. This income effect is observed in some studies (Dynan et al., 2004; Fields & Mitchell, 1984), which found that the higher the income, the earlier one's retirement age. The substitution effect points to the opposite, whereby the higher the income, the more reluctant one is to withdraw from the labor force because, in this case, they will lose more. The substitution effect has also been observed in several studies (Delpachitra & Beal, 2002; Heijdra & Romp, 2009; Ozawa & Lum, 2005). In this study, lifetime income is employed because temporary income is not stable. Education, in turn, is an important indicator of a person's earning ability (Blundell et al., 2005; Psacharopoulos and Patrinos, 2004).

Although the economic or non-economic factors that are associated with retirement decisions have been extensively studied in Europe and the USA, few such studies focus on China. Sun and Wu (2009), using survey data from several major state-owned enterprises in Beijing, found that education level, age, and income are the major factors affecting employees' retirement decisions. Liu et al. (2014) surveyed residents of the NanKai district in Tianjin, a major city in China, and found that age, health status, and type of work unit are significant. However, there are still deficiencies in existing research into delayed retirement in China. The main contribution of this study is to fill these gaps. First, quantitative research on the main economic factors that affect the willingness to delay retirement is still relatively limited. Second, existing research on China does not use nationwide surveys, so the results may not be adequately representative. The main purpose of this study is to use a large nationwide sample to measure the impact of economic factors and demographic factors on delaying retirement decisions in China. Once these major economic and non-economic incentives have been identified and their impact effectively measured, policies can be introduced to adjust these economic incentives, encouraging qualified elderly populations to keep working. Furthermore, if China's policies allow these populations to continue to pay Social Security Retirement contribution the budgetary sustainability of pensions can be enhanced to some extent.

Theoretical Framework

Hatcher (1997) used the concept of permanent income to frame the retirement decision, whereby retirement occurs if the hypothetical potential income level at which an individual decides to retire can afford the value of reservation wealth. Hatcher proposed two concepts in his model: potential income and reservation wealth. Potential income refers to the permanent income, while reservation wealth refers to the accumulated wealth you need to afford retirement. Once the full wealth one can afford, in terms of permanent income, is less than one's reservation wealth, then people choose to work. Conversely, if potential income is equal or greater than reservation wealth, then people choose to retire.

Estimation of permanent income

In Hatcher's model, full wealth (FW_t) at time t is the sum of the initial assets at time t and present

value of future earnings at time t. Thus, the full wealth can be expressed as:

$FW_t = NW_t + \sum_{i=t}^{t+L} \frac{Income}{(1+r)^i}$ (2.1)

where FWt is full wealth at time t, NWt is the initial wealth at time t, income is non-investment income in time t, r is the interest rate, and L is life expectancy. Income here could include wage income before retirement, social security income, and pension income after retirement.

Permanent income, then, would be defined as follows:

Or $y = FW_t/\tau$ (2.2)

τ denotes an annuity factor that the full wealth should be divided by. The annuity factor is affected by the interest rate. The permanent income is an annuity stream that could be generated by full wealth.

The permanent income hypothesis indicates that people will consume a constant portion of their lifetime income. Thus, for those who voluntarily exit the labor force, permanent income at the time of retirement must equal the full wealth divided by the annuity factor.

Estimation of reservation wealth

Under Hatcher's hypothesis, reservation wealth is thought of as the "retirement needs". Hatcher put the definition of reservation wealth simply as, "If I had X dollars per year for the rest of my life, guaranteed, I would retire." The "X dollars per year" is estimated based on the individual or the household's labor and leisure preference. The labor and leisure preference, in turn, is determined by wage income before retirement, retirement income, and life expectancy. Thus, reservation wealth V* is the level of hypothetical unearned income such that the person would decide to work exactly zero hours. It is hard to obtain a stable number for wage income before retirement, because a person's wage can change over time. However, the consumption level could be a good measurement of the requirement for reservation wealth.

In sum, the permanent income hypothesis can be used to explain retirement decisions based purely on financial considerations. Retirement decisions are affected by the permanent income level and reservation wealth. The permanent income level, in turn, is affected by initial net worth, human capital, and discount rates. Human capital is a function of factors that could influence an individual's ability to earn income. Previous empirical studies have shown that human capital stock is determined by the skills and abilities of family members, with education being the most important measurement of one's long term earning ability. Reservation wealth is affected by leisure preferences, life expectancy, and unearned income after retirement. An important implication of the theory is that the faster one can make the permanent income level match the reservation wealth, the earlier one can retire. Since the main purpose of this study is to determine the effect of economic factors on delayed retirement decisions, the hypotheses inferred from the discussion can be summarized as follows:

Hypothesis 1: The greater the net worth of the respondent, the less likely they are to delay retirement. This is because a higher permanent income level is indicated, and thus the reservation wealth can be achieved faster;

Hypothesis 2: The greater the retirement income of the respondent, the less likely one will be to delay retirement, because the reservation wealth can be easier to achieve;

Hypothesis 3: The greater the earning ability (measured by the respondent's education level) of the household, the less likely it is one will delay retirement, because the permanent income level will be higher, and the reservation wealth can be achieved faster;

Hypothesis 4: The better the health of the respondent, the more likely he or she is to delay retirement, because better health indicates longer life expectancy;

Hypothesis 5: The expected interest rate will affect the delayed retirement decision, because it will affect the respondent's mental calculation of the future value of his or her full wealth, and thus their permanent income level;

Hypothesis 6: The higher the consumption level, the more likely he or she will delay retirement, because of the higher requirement of the reservation wealth.

Methodology

This study uses the 2011 Chinese Household Finance Survey (CHFS), published by the South West University of Finance and Economics, in coordination with the Finance Research Branch of People's Bank of China. It is an authoritative national survey, published every three years, covering respondents from 25 provinces, 320 communities and 8,438 households. Among existing datasets in China, the CHFS is considered to be the one with the highest response rate (Gan et al., 2013). The overall response rate of the CHFS is around 88%. However, the response rate differs substantially between urban areas and rural areas, with the overall response rate for urban areas being far greater than rural ones (Gan, et al., 2013). Moreover, the CHFS provides detailed information regarding respondents' financial status, subjective attitudes, and demographic characteristics. Variables can be easily coded and calculated based on the CHFS, and this is another reason that the CHFS is chosen for this study. In terms of sample selection, only respondents that are eligible to receive Chinese Social Security Retirement Benefit (SSRB) are selected. In China, as noted above, both men and women are eligible to receive SSRB at the age of 60; thus, in terms of sample selection, only those aged 60 and over, and those who are eligible for the SSRB, are selected. Another advantage of the CHFS is that this survey provides imputed values for many of the financial variables with missing values. These imputed values are included in calculating respondents' net worth and retirement income. Finally, the CHFS is the most comprehensive dataset in terms of surveying respondents' consumption levels. Consumption levels are a very important independent variable in this study.

The definitions of both dependent variables and main economic variables (independent variables) are as follows:

Dependent variables: I

f an individual still chooses to work full-time or part-time on reaching 60 years of age, such a person is defined as still working; otherwise, he is defined as having stopped working. The reason to choose age 60 as the age threshold is because almost all participants of the Social Security Retirement Benefits are qualified for the benefits regardless of gender, title and type of organizations they work for. The main purpose of the research is to predict whether the main economic variables will increase or decrease the possibility of delayed retirement for an individual. Since the dependent variable is a binary dependent variable, a binary logistic regression model is appropriate here.

Independent variables:

Financial variables: Household net worth is one of the financial variables. Household net worth in this study comprises all asset values, minus liabilities. Household assets include the market value of real estate, cars and other durable goods, savings and the market value of financial assets. Liabilities include mortgages, car loans, credit card debts, education loans, and loans for the purchase of financial products and durable goods. Whether or not the household owns a house is the other financial variable. Net worth should be the best financial variable to reflect the economic resources available to a household head. Education, further, is the major indicator of earning ability. Retirement income is another important financial variable in this research, and includes all kinds of retirement benefits, whether from the SSRB or other sources of retirement benefits, such as defined-benefit or defined-contribution plans. In China, the age eligibility for defined-benefit plans is the same as the SSRB. Government employees, as well as those of state-owned enterprises, public schools, and public hospitals are still covered by the DB plan. Defined-contribution plans do not have as many varieties as offered in the USA, however; employees of non-stated-owned enterprises save for their own retirement by deducting part of their paycheck and making contributions to a defined-contribution plan. The age eligibility to withdraw payment from the defined-contribution plan is the same as the age eligibility for SSRB. The relatively uniform age eligibility of all kinds of retirement benefits once again confirms the robustness of restricting the sample to respondents aged 60 and over. The consumption level of respondents is the third financial variable that should be taken into account, given that consumption level is the best proxy of one's desired reservation

wealth. Consumption here includes various kinds, including meals, clothing, transportation, and so forth. The expected discount rate is also a financial variable to consider, because in an economic environment with a high interest rate, a higher discount will be applied when doing a mental calculation of the present value .

Demographic variables: Education is the main indicator of earning ability. Other demographic variables include age, gender, health status, self-employment status, and interest rate change. Self-employment status indicates the job access one could have, with self-employed individuals suffering less than employees from job access limitations, as noted above. It is also reasonable to expect that health status also affects one's ability to work beyond retirement age. Hatcher's model also indicates that leisure preferences affect one's estimation of reservation wealth. In this study, work hours per week are used as a proxy for respondents' leisure preferences.

Results

Descriptive Results

[Insert Table 1 about here]

Table 1 presents the descriptive results of each predictor, according to work-or-retire decisions. Of the 2,047 respondents aged 60 and over eligible for SSRB, 42.46% of them chose to keep working, while the remainder of them chose to stop working. Those who keep working are younger, with an average age of 66.08, and those who chose to retire had an average age of 70.31. Those who retired have a much higher average net worth (RMB 67,517) than those keep working (RMB 24,443). When considering retirement income, those who chose to stop working have a much higher average yearly retirement income then those who keep working (RMB 2,153 versus RMB 181). Half of those who continued to work do not have any retirement income. Consumption level represents one's desired living standard after retirement, and it is reasonable to use the consumption level to proxy one's reservation wealth, as described in the model. From the descriptive results, those who stopped working had a mean consumption level of RMB 5,931 per year, while those who kept working had mean consumption level of RMB 3,519 per year. Among those who kept working, males comprised a much higher percentage than females. Most elderly Chinese people are married, regardless of whether they stop working or continue in their jobs. Furthermore, most elderly Chinese people are not in poor health, and do not hold a high school diploma. Among those who stopped working, a higher percentage of them have a high school diploma. Regarding ethnicity, Han comprise the absolute majority of elderly Chinese people. Interestingly, most elderly Chinese people (standing at more than 85%) are homeowners.

Multivariate Analysis Results

As stated above, the dependent variable in this research is whether the worker keeps working or stops working. This is therefore a binary variable. Logistic regression is the proper method to use here. If the respondent says "he or she is still working," then "retired" equals to 1; otherwise, "retired" equals to 0. The binary logistic regression model employed here measures how one unit of change of the dependent variable will affect the change of the probability of working or not working.

Table 2 presents the results for the logistic regression, a p-value with a significance level less than 0.05 is used throughout the research. In this research, a variance inflation factor (VIF) test is performed to ensure that there is no serious multicollinearity problem. Also, the adjusted R^2 square is tested to see the goodness-of-fit of the regression model. The adjusted R^2 of the regression model is about 65.25%, which is quite acceptable when considering the sample size. The impacts of each independent variable are summarized as follows:

Financial variables: First, net worth is found to be negatively related to the decision to keep working (with a standardized coefficient of -0.1831). Second, respondents' monthly retirement income is also negatively related to the decision, as the hypothesis 1 assumed (with a standardized coefficient of -1.0313). This result is understandable, based on the model, because both the higher net worth and higher

retirement income will raise the permanent income level, and thus make the reservation wealth more achievable. Once the reservation wealth is achieved, one should stop working. Third, consumption level has a negative impact on the respondent's likelihood to keep working (with a standardized coefficient of -0.226). A possible explanation is that those with higher consumption also have a higher net worth or retirement income. When considering net worth and retirement income, those who choose to stop working can better afford their consumption than those who keep working. Based on the model, interest rate expectations should have an impact on the retirement decision, because it affects one's mental calculation of the permanent income level. The permanent income level is calculated as the full wealth divided by an annuity factor, while interest rate change will alter the annuity factor. From the regression result, using "rising interest rate expectation" as the reference group, those who expect interest rates to remain the same will be more likely to keep working. A possible explanation would be that both the denominator and the numerator of the annuity factor are affected by the interest rate, thus it is hard to say the direction of the effect. Moreover, the survey respondents' interpretation of interest rate might be quite different from the conceptual perspective as stated in this paper.

Demographic variables: Age is negatively related to the decision to keep working; the older the respondent, the less likely they are to keep working. This seems to be natural and understandable. Furthermore, males are more likely to keep working than females. A plausible reason for this is that, for most families, the male acts as the household breadwinner. Education, in this research, is used to proxy a respondent's earning ability and, consistent with the hypothesis, it is negatively significant in the results. This indicates that respondents with a greater earning ability (e.g. higher education) will be less likely to keep working after they are eligible for retirement benefits. Based on the model, earning ability was supposed to demonstrate a negative effect, because a higher earning ability will make the reservation wealth easier to achieve. It is also expected that self-employment will increase the likelihood of staying at work, because there is no job access limitation. However, the effect is not significant.

Conclusion and Implications

Financial variables are all significant. Net worth, retirement income, and consumption level all negatively affect the choice of older people in China to stay at work. Education levels, which are used as a proxy for respondents' earning abilities, also lower the propensity to work longer. An income effect, rather than substitution effect, is observed in the empirical results. Furthermore, the results are consistent with what was expected in the theoretical model outlined. Respondents who can achieve their reservation wealth easier and faster will be less likely to keep working after reaching the eligible age for retirement benefit. The main conclusion is that those with more financial resources to support their desired retirement tend to stop working. Financial reasons are the most crucial considerations for respondents when making a "work-or-retire" decision. Gender and age are also significant, with males much more likely to delay retirement after reaching the age for retirement benefit. Elderly populations are much less likely to keep working due to worsening health status and limited job access.

These observations have many implications for policymakers. China's elderly population, just like their US peers, tend to retire earlier if they are richer and have greater retirement income or earning ability. Standard estimates in the logistic regression model show the quantified impact of the main financial variables on delayed retirement decisions in China. Policymakers can thus utilize the research outcomes from this study to adjust delayed retirement behaviors, if they hope to keep retirement-age populations working. For example, this could be implemented by raising the tax rate on retirement income, or implementing a consumption tax, as the USA has done. Delaying retirement appears imperative, because China is facing an aging society and a shortfall of the social security fund. In addition, from the descriptive results we can see that a sizeable percentage of the population who reached retirement age remain in good health. If more job access is provided, they can continue to serve the labor market. Finally, new policies could be enacted to allow those individuals who keep working to keep making Social Security benefit contributions, thus further enhancing the sustainability of the SSRB.

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Table 1: Descriptive Results by "Work-or-Retire" Decision.

		Retirement Decisions	
Variables		Keep Working	Retire
		42.46%	57.54%
Current age (mean)		66.08	70.31
Net worth (in RMB)	Mean	24,443	67,517
Yearly retirement income (in RMB)	Mean	2,180	25,846
Yearly consumption level	Mean	3,519	5,931
Gender	Male	73.91%	55.19%
	Female	26.09%	44.81%
Married status	Married	86.56%	75.04%
	Not married	13.44%	24.96%
Health condition	Good	35.23%	34.87%
	Average	37.19%	47.86%
	Bad	27.58%	17.27%
Han ethnicity	Han	2.07%	3.61%
	Not Han	97.93%	96.39%
Education	High school or less	95.23%	75.47%
	High school diploma	4.77%	24.53%
Expectation of interest rate	Rise	88.80%	82.99%
	The same	8,81%	12.24%
	Reduce	2.30%	4.77%
House owner	Yes	96.14%	85.48%
	No	3.86%	14.52%

Results in Table1 are based on the 2011 CHFS. Among the 2,047 respondents who are 60 and over (meaning that they qualify for SSRB in China), 1,178 of them stopped working, and 869 of them kept working.

Table 2: Logistic Regression Results: Delayed Retirement of Household Heads.

Parameter		Estimate	Standard Error	P-Value	Odds Ratio	VIF Score
Intercept		8.6009	1.387	**<0.0001**		
Financial Variables						
Log (net worth)		-0.0813	0.0249	**0.0011**	0.922	1.2113
Log (retirement income)		-0.3155	0.0178	**<0.0001**	0.729	1.5312
Log (consumption)		-0.3315	0.0811	**<0.0001**	0.718	1.3013
Have insurance	Yes (ref)					
	No	-0.1175	0.1676	0.4832	0.791	1.0203
Own house	No (ref)					
	Yes	0.2194	0.2032	0.2802	1.551	1.0266
Demographic Variables						
Age		−0.0778	0.0146	**<0.0001**	0.925	1.1452
Education	Less than high school (ref)					
	High school or above	−0.5874	0.1248	**<0.0001**	0.309	1.249
Household type	Not Married (ref)					
	Married	-0.0125	0.1238	0.9195	0.975	1.1099
Health status	Non-poor (ref)					
	Poor health	0.057	0.1039	0.5833	1.121	1.4571
Expected interest rate	Rise (ref)					
	The same	0.34	0.193	0.0718	1.531	
		Estimate	**Standard error**	**P-VALUE**	**Odds Ratio**	**VIF Score**
	Reduce	-0.2542	0.3059	0.4059	0.845	1.10722
Gender	Female (ref)					
	Male	0.5157	0.0993	**<0.0001**	2.805	1.0624

Race	Han (ref) Not-Han	0.0247	0.3292	0.9402	1.051	1.0243