The Impact of Retirement on Medical Utilization and Financial Burden

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Abstract

Based on the data of basic medical and endowment insurance for urban employees in Hubei Province of China, this paper studies the differences of medical utilization and financial burden of patients before and after retirement. The results of fuzzy Regression Discontinuity (hereinafter referred to as RD) show that daily hospital visits generally increase significantly after retirement except for female inpatient, with an increase of 23.7% in male outpatients, 25.9% in female outpatients, and 32.1% in male inpatients, respectively. But this increase has little to do with the proportion of medical insurance reimbursement, because although the basic medical insurance for urban employees provides a higher proportion of reimbursement for retirees at the policy level, in practical operation, due to factors such as the type of drugs, threshold and ceiling, etc., the fuzzy RD results show that the proportion of reimbursement remains basically the same, or even decreases after retirement. At the same time, there is no significant change in the average medical expenditure and the average length of inpatient stay per visit before and after retirement. Besides, the monthly income of men and women decreases significantly after retirement, which is 21.8% for men and 32.7% for women. According to the monthly average income and out-of-pocket medical expenditure, the proportion of out-of-pocket medical expenditure of men and women in their monthly income after retirement increases by 9 and 7 percentage points respectively, reaching 30.5% and 25.5% compared with that before retirement.

It can be seen that retirees don't really benefit more from the reimbursement ratio than on-the-job employees in China's medical insurance policy, which well prevents the overuse of medical resources after employees retire. However, due to the decline in the income level of employees after retirement, the proportion of medical expenditure in their income rises significantly, and the financial burden is quite heavy. Therefore, I suggest that the policy of medical insurance should consider the cost control and the rational utilization of medical resources, but at the same time, it should be inclined to the retirees.

Keywords: retirement, medical insurance, medical utilization, financial burden

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1. Introduction

The current social medical insurance system in China is mainly composed of three parts: basic medical insurance for urban employees (hereinafter referred to as MIUE) established in 1998, new rural cooperative medical insurance established in 2003, and basic medical insurance for urban residents established in 2007. The latter two have been merged into basic medical insurance for urban and rural residents in most provinces. The research object of this paper is MIUE, because only this insurance is related to on-the-job and retirees. The policy of MIUE for employees is different from that for retirees, including payment and treatment. The time cost, health preference and other factors of employees are also significantly different before and after retirement. The purpose of this paper is to analyze whether retirement has an impact on medical utilization, based on the MIUE data of Hubei Province. At the same time, based on the data of premium and pension payment of endowment insurance for urban employees (hereinafter referred to as EIUE) in Hubei Province, the income difference before and after retirement of employees is estimated, and then the change of medical financial burden brought by the change is analyzed.

(1) China's aging population and retirement system

Like most countries in the world, China's population is aging, labor supply is gradually reduced, and the peak of aging is accelerating. In 2018, Life expectation has increased to 74.6 years for men and 79.4 years for women in China; the population aged 60 and over was 249.49 million, accounting for 18% of the total population.[1] It is estimated that the proportion of the population aged 60 years and over will reach 35% in 2050.[2]

In addition to the aging population, China's low retirement age is another important issue. China's current legal retirement ages are 60 for men and 50 for women respectively. This standard was set in 1955, which has been used for 65 years, is at a very low level in the world.

It should be emphasized that although the retirement age of Chinese employees is statutory, it is not absolute. The retirement age of women cadres can be extended to 55. The retirement policies also allow workers of special types of jobs or those suffering from certain diseases to retire ahead of time. For example, for those who are engaged in high-risk (such as underground, high altitude, high temperature) or special types of work harmful to health, they can retire five years in advance. On the contrary, some people may retire later than the legal age, maybe because they are in important positions. So it is common for us to observe employees retire either before or after legal age, but the proportion may not be very high.

[1] Data from the website of the National Bureau of statistics of China.

[2] Estimated by WHO.

(2) MIUE

MIUE was established in China in 1998. All employees in cities and towns, including employed by enterprises (state-owned, collective, foreign-invested, private, etc.), organs, institutions, social organizations, and private non-enterprise units, are required to participate in MIUE. The premium shall be jointly paid by the employers and their employees. The employees shall take the wages of their own as the base (the upper and lower limits are respectively 60% and 300% of the average wages of local employees), and the payment rate is 2%, and retirees do not pay. The premium paid by the employees shall be recorded in their personal accounts which are used for the reimbursement of general outpatient service and drug purchase in pharmacies. The employers take the total wages of all employees as the base, and the payment rate is around 6%. The premium paid by the employers is divided into two parts. About three-quarters shall be managed and used uniformly as pooling fund, for the reimbursement of inpatient service and certain kinds of serious outpatient diseases; one-quarter shall be recorded into employees' personal accounts. In my opinion, the original intention of transferring part of the employer's premium into the employee's personal account for their own use is to encourage more employees to participate in MIUE. By the end of 2018, there were 316.8 million insured employees in MIUE, including 233.1 million on-the-job employees and 83.7 million retirees, with the insured rate of over 96%, basically achieving full coverage.[1]

As mentioned above, China's aging population is growing, while the retirement age is low. For medical insurance, because the employees no longer pay medical insurance premium after retirement, too many retirees will seriously affect the income of insurance premium; at the same time, the increase of the elderly population will bring the increase of medical demand and medical insurance fund expenditure. Although the design principle of China's medical insurance system is based on the balance of revenue and expenditure, the proportion of reimbursement itself has the rigidity of welfare, which is difficult to decline. To maintain the operation of the system, we need to increase the proportion of payment, or give more and more financial subsidy.

(3) EIUE

Basic endowment insurance system is a type of old-age insurance system which is enforced in accordance with the unified national policy to ensure the basic living needs of elderly people. China's current basic endowment insurance system is mainly composed of three parts: EIUE established in 1997, the basic endowment insurance system for urban and

[1] Data source: *China Health and health development statistical bulletin 2018.*

rural residents established in 2014, and the basic endowment insurance system for government agencies and institutions established in 2015. The covered people of EIUE are the same as those of MIUE, so this paper extracts the data of premium payment and pension payment from EIUE to analyze the difference of employees' income before and after retirement.

The endowment insurance premium shall be jointly paid by the enterprise and its employees. The enterprise takes the total wages of all employees as the base, and the payment rate is no more than 19%. The premium paid by the enterprise shall be managed and used uniformly across the province for basic pension payment; the employees shall take the wages of their own as the base (the upper and lower limits are respectively 60% and 300% of the average wages of local employees, which is the same as MIUE), and the payment rate shall be 8%. The premium paid by the employees shall be recorded in their own accounts to issue personal account pension.

The policy of EIUE stipulates that those who have paid for 15 years in total will be given pension on a monthly basis after retirement; those who have reached the retirement age but have paid for less than 15 years in total will not be given pension monthly; the amount stored in their personal accounts will be paid to them in one time to terminate the basic pension insurance relationship.

2. Literature review

(1) The impact of retirement on medical utilization

Up to now, many scholars have carried out relevant research. Some of them studied the health effects of retirement, because if retirement had an impact on health, it would therefore have an impact on medical utilization. At the level of physical health, Coe N B & Zamarro G (2011), Hessel (2016), and Che Y & Li X (2018) have done research, and reached the basically consistent conclusion: retirement will have a negative or uncertain impact on physical health in the short term, but a positive impact in the long term, and significant gender differences due to different working characteristics and retirement age. However, scholars hold different views on the impact of retirement on mental health. Dhaval Dave et al. (2008) believe that retirement leads to an increase of 4% - 6% in mental illness and a decrease of 6% - 9% in mental health. If a person marries, engages in physical exercise or continues to work in his spare time, the negative effect will be reduced. Belloni M et al. (2015) believed that retirement improved men's mental health, and pointed out that the impact may be caused by poor working conditions and job insecurity brought about by the economic downturn, in which retirement is a relief. In addition, Ehsan Latif (2013) used different methodologies to analyze the impact of retirement on mental health of Canadians, and obtained different results:

when using ordinary least squares (OLS) regression, retirement reduced the possibility of depression; when using fixed effect (FE) model, retirement promoted mental health, but the result was not strong; when using FE model with instrumental variables (IV), retirement affected negatively to mental health, but the result was also not.

For medical utilization before and after retirement, according to the theory of Life Cycle, individual spending on medical utilization should be continuous at all ages, and there should be no jumping point. However, studies have found that residents' utilization of medical services will change once they retire, which is called “retirement-health care utilization puzzle”. HE Qinghong et al. (2019) used IV model to analyze and draw the conclusion that after retirement, the outpatient service rate of men increased by about 14.4%, while the inpatient rate of women increased by about 30%. Bíró (2016) compared the difference of outpatient service utilization based on the survey of health and retirement in Europe (SHARE) and the health and retirement survey of the US (HRS). The results showed that after retirement, through the reduction of time cost and the enhancement of health preference, the utilization ratio of general outpatient service and specialized outpatient service increased by 3% - 10%. Dang (2017) found that retirement significantly increased outpatient utilization, but had little effect on hospitalization, according to Vietnam household living standard survey (VHLSS). Coe N B & Zamarro G (2015) found a significant reduction in outpatient visits after retirement. Thus, the utilization of medical services after retirement is uncertain. The increase of health preference and the decrease of time cost will increase the utilization, but the financial pressure will reduce it as well.

The research of the above scholars is mainly based on the decrease of time cost after retirement, the proportion of medical insurance reimbursement is not included in the research. According to the data of the patient survey of Japan, Hitoshi Shigeoka (2014) analyzed the effect of the difference of reimbursement ratio before and after the age of 70 on medical utilization of the elderly, and concluded that the significant decrease of out-of-pocket ratio led to the significant increase of medical utilization of the elderly over 70, but did not bring about significant improvement of health status.

As mentioned before, the composition of retirees is relatively complex in China, not all of them stop working at a certain legal age, so the traditional OLS method would easily lead to endogeneity problems. Firstly, there may be a causal relationship between health and retirement. Lei Xiaoyan, Tan Li and Zhao Yaohui (2010) pointed out that retirement has a negative impact on health, which may lead to the increase of family medical expenditure; while Zhang Su and Wang Jie (2013) believed that the national pension insurance has a promoting effect on the health of the elderly after retirement. Secondly, health condition itself is an important variable to determine retirement. Health condition, personal preferences and economic situation affect both the medical consumption and retirement decision-making of

the elderly, some unobservable variables are included as well, which easily lead to the bias of omitting variables. In recent years, the literature about social security mostly use IV method and Regression Discontinuity Designs (RDD) to solve the endogeneity problem. However, there are some differences between IV method and RDD. In most of the literature using IV method, the authors are fixing the trend of age in the whole control range, while the RDD method allows different age trends before and after the cutoff. Shigeoka's study mentioned above was based on the sharp RD analysis. Deng Tinghe and HE Xiurong (2016) set the age of 60 as a cutoff for male and did fuzzy RD analysis, finding that retirement had no significant effect on men's physical health, but had a positive effect on their mental health. Based on the diversity of retirement age in China, this paper uses the method of fuzzy RD, which can effectively control for the endogeneity problems of retirement age and health status.

(2) The impact of medical insurance on medical utilization

Pan Jie & Qin Xuezheng (2014) believed that medical insurance improved the financial access of individuals to medical treatment and increased the utilization of health services; at the same time, medical insurance made individuals face lower marginal cost in the utilization of medical services, resulting in moral hazard that may lead to waste of medical resources. Cutler & Vigdor (2005) used panel data to compare the differences of medical behavior and health between people aged 51 to 65 who were insured by Medicare and those who were not. This paper uses the methodology of difference-in-difference (DID) to distinguish the impact of disease into chronic and acute. It is found that the health of uninsured individuals is worse than that of uninsured individuals after the impact of chronic disease, but there is no significant difference between the two groups under the impact of acute disease. Card et al. (2008) used age 65 as a cutoff point, applied RD to point out that the U.S. medical insurance for the elderly is conducive to improving the utilization of medical services for the elderly over 65. Trivedi et al. (2010) analyzed the impact of the increase in out-of-pocket proportion of first aid programs in Medicare on the elderly in the United States. They found that the medical expenses of the elderly increased, and estimated the differences in income level and disease types. According to Huang Feng & Gan Li (2010), if medical insurance can effectively improve personal health, more expenditure will be effective consumption, otherwise it will be excessive demand. Cutler & Zeckhauser (2000) believes that medical insurance may affect medical utilization by changing personal health behaviors. As the insured reduces the medical expenses borne by the individual, the insured may conduct more health-threatening behaviors, which leads to the increase of medical utilization. In this aspect, some scholars hold a opposite view. For example, Baker et al. (2001) believed that because the insured can enjoy more preventive medical services, individuals may adjust their own

health behaviors, such as correcting behaviors harmful to health such as smoking and drinking, which is conducive to promoting the improvement of personal health level and reducing the medical utilization. Chandra et al. (2007) studied the effect of increasing the out-of-pocket ratio of outpatient and prescription drug on the elderly in California. The results showed that the number of outpatient services of the elderly decreased after this initiative, but the inpatient rate of the elderly increased. Buchmueller et al. (2005) pointed out that medical insurance plays a positive role in promoting outpatient medical treatment, but there are many challenges in assessing its impact, such as the different impacts of different types and levels of medical insurance and the unobservable heterogeneity of samples. Winkelmann (2004) used the methodology of DID to make an empirical study on the influence of the co-payment system of prescription drugs on the number of outpatients in Germany, and found that this measure would reduce the number of outpatients. Wang Zhen et al. (2019) took the change of the proportion of inpatient reimbursement of urban employees before and after retirement in Shanghai as a policy cutoff point, identified the impact of the increase of the proportion of medical insurance reimbursement on the medical utilization for the elderly. The results showed that for every 1% decrease in the proportion of out-of-pocket inpatients, the number of inpatients would increase by about 0.35%, but there was no significant effect on the average inpatient cost per visit.

Generally speaking, many scholars studied the impact of medical insurance on medical utilization. Most of them adopt the methodology of empirical research and establish econometric models for analysis. Most frequently used models are RD, IV and DID. The view that medical insurance promotes medical utilization is the majority, but some scholars hold the opposite view. Different results may be due to the differences in living habits of people in different countries, or they may also depend on the data quality and the ability of scholars to exclude interference items and control the effectiveness of the model during analysis.

3. Research data and methodology

(1) Data used

I chose Hubei Province as my research object. Hubei is a central province of China. In 2018, among 31 provinces in China (excluding Hong Kong, Macao and Taiwan), Hubei ranked 9th in population, 7th in GDP and 8th in the growth rate of GDP, all at the upper and middle level. Its per capita GDP and disposable income were almost equal to the national average. Moreover, its economic development is not balanced, which has Wuhan City, one of top 10 big cities in China, as well as 16 national poverty counties. Thus, the economic and demographic situation of Hubei Province is similar to that of China as a whole, which makes it an interesting and relevant case to study.

As mentioned above, the insured rate of MIUE is higher than 96%, basically covering all urban employees. Therefore, the medical treatment and settlement data extracted from the data of MIUE system can fully reflect the medical treatment situation of the staff group basically in China. That is to say, the proportion of employees whose medical behavior is not included in the observations because they do not participate in MIUE is very low.

The main analysis data I use is the MIUE data, which comes from the Healthcare Security Administration of Hubei Province, collected by the Audit Office of Hubei. I use this data to analyze medical utilization of employees before and after retirement, including hospital visit times, per visit expenditure, as well as reimbursement ratio. Outpatient and inpatient data are recorded in 2 data sets. Each data set records the medical behaviors of employees one by one, and one outpatient or inpatient is one record. Since the legal retirement age is used as a cutoff in my RD analysis, I set the age range of the sample to within 36 months before and after the legal retirement age. At the same time, due to the huge amount of data, and in order to eliminate the time trend of medical price and other factors, I limit the time range of medical treatment to January to June 2016.

I adopt the methodology of systematic sampling, and the specific sampling process can be summarized as the following steps: (1) rank and number the outpatients and inpatients who meet the above-mentioned age conditions by age; (2) calculate the sampling interval according to the sample size I need, and randomly generate the starting sample number; (3) form the patient number data by systematic sampling at intervals; (4) According to the selected patient numbers, all their outpatient and inpatient records between January and June 2016 are selected to form the final sample.

Due to the policy of MIUE, patients suffering from certain chronic diseases may enjoy the inpatient reimbursement policy when having a second visit or prescribing medicine, although they do not need to be hospitalized. This kind of situation is reflected in the inpatient record in MIUE data, which is characterized by discharge on the day of admission, and the same patient's medical record cycle and consumption amount are stable. In order to analyze the inpatient behavior more accurately, I excluded this part of medical records from the inpatient data. The rejection rule is that the same patient was discharged on the day of admission, and the number of such cases was more than 3 times in half a year. At the same time, in order to get the logarithm of the total and insured expenditure conveniently, I removed the amount of less than 1 yuan (accounting for less than 5% of the samples). The final selected sample has 157,487 observations, including 129,186 records of 33,939 outpatients, as well as 28,301 records of 19,710 inpatients, accounting for about 10% of the data of Hubei Province in the above age group and treatment period. The descriptive statistics of variables in the sample are shown in Table1.

Table1: Descriptive Statistics of sample from MIUE

Variable	Label	Obs	Mean	Std.Dev.	Min	Max
1. Outpatients						
id	Used to identify patients	129,186				
BirthDate	Date of birth	129,186				
RetDate	Date of retirement	67,823				
VisDate	Date of hospital visit	129,186				
TotalExp	Total medical expenditure	129,186	207.495	464.109	1	60000
DrugExp	Expenditure of drugs	129,186	119.736	334.485	0	60000
ExamExp	Expenditure of examinations	129,186	87.759	322.986	0	38267.8
AccExp	Expenditure paid by personal account	129,186	143.437	197.249	0	9400.52
FundExp	Expenditure paid by pooling fund	129,186	31.105	302.34	0	34441.02
SelfIn	Expenditure covered by MIUE but paid by individuals	129,186	165.54	296.016	0	60000
SelfOut	Expenditure not covered by MIUE and paid by individuals	129,186	10.851	86.154	0	9100
ReimExp	Reimbursed expenditure, equals to FundExp+AccExp	129,186	31.113	302.34	0	34441.02
SelfExp	Out-of-pocket expenditure, equals to SelfIn+SelfOut	129,186	32.963	244.811	0	59915.17
InExp	Expenditure covered by MIUE, equals to TotalExp-SelfOut	129,186	196.645	448.722	1	60000
Female	Dummy variable, equals to 1 if the patient is female	129,186	.5001084	.5000019	0	1
LegalVis	Cutoff, Dummy variable, equals to 1 if this visit is after legal retirement	129,186	.536	.499	0	1
Retired	Treatment variable, dummy, equals to 1 if this visit is after retirement	129,186	.504	.5	0	1
R	Running variable, age centralized by legal retirement age (in months)	129,186	1.836	21.896	-36	36
Rsq	Square term of R	129,186	482.821	399.34	0	1296
IR	Interaction of LegalVis with R	129,186	10.576	12.447	0	36
IRsq	Interaction of LegalVis with Rsq	129,186	266.787	384.941	0	1296
Retiredhat	Predicted value of Retired, used in 2SLS regression	129,186	.479	.289	.087	.876
2. Inpatients						
id	Used to identify patients	28,301				
BirthDate	Date of birth	28,301				
RetDate	Date of retirement	17,097				
TimeIn	Date of inpatient admission	28,301				
TimeOut	Date of inpatient discharge	28,301				
TotalExp	Total medical expenditure	28,301	8843.395	15479.63	1	530763.8
DrugExp	Expenditure of drugs	28,301	3371.723	7546.764	0	
ExamExp	Expenditure of examinations	28,301	5471.672	10712.67	0	377482.8
AccExp	Expenditure paid by personal account	28,301	235.92	567.836	0	9849.79
FundExp	Expenditure paid by pooling fund	28,301	5834.988	8794.476	0	216368.6
BigInsExp	Expenditure paid by serious illness insurance	28,301	177.169	2804.685	0	181292.6
SelfIn	Expenditure covered by MIUE but paid by individuals	28,301	1881.735	3196.072	0	149812.3
SelfOut	Expenditure not covered by MIUE and paid by individuals	28,301	949.503	4929.812	0	343269.8
ReimExp	Reimbursed expenditure, equals to FundExp+AccExp	28,301	6012.157	9778.505	0	253855.5
SelfExp	Out-of-pocket expenditure, equals to SelfIn+SelfOut	28,301	2595.318	6775.238	0	363933.7
InExp	Expenditure covered by MIUE, equals to TotalExp-SelfOut	28,301	7893.891	12554.61	1	324950.3
Female	Dummy variable, equals to 1 if the patient is female	28,301	.4403025	.4964322	0	1
LegalVis	Cutoff, Dummy variable, equals to 1 if this visit is after legal retirement	28,301	.551	.497	0	1
Retired	Treatment variable, dummy, equals to 1 if this visit is after retirement	28,301	.58	.494	0	1
R	Running variable, age centralized by legal retirement age (in months)	28,301	2.686	21.808	-36	36
Rsq	Square term of R	28,301	482.798	400.288	0	1296
IR	Interaction of LegalVis with R	28,301	11.002	12.573	0	36
IRsq	Interaction of LegalVis with Rsq	28,301	279.114	391.816	0	1296
Retiredhat	Predicted value of Retired, used in 2SLS regression	28,301	.58	.283	.136	.926

Data Source: MIUE data collected from the Healthcare Security Administration of Hubei Province

Another important data I use is the EIUE data, which comes from the Hubei Endowment Bureau, used to analyze the income of employees before and after retirement, also collected by the Audit Office of Hubei Province. 296,330 insured persons (124,790 on-the-job and 171,540 retired) with the age within 20 years before and after the legal retirement age were randomly selected from the whole population as a sample. Each individual has 2 records of insurance premium (on-the-job employees) or pension (retirees) payment of April 2017 and April 2018. According to the policy of EIUE, the premium base is the total wage of employees, so the payment base can be extracted as the monthly income. I chose two records one year apart to eliminate the time effect of natural income growth. The descriptive statistics of variables in the sample are shown in Table2.

Relevant data such as annual reports published by statistics, social security departments are also used in this paper.

Table2: Descriptive Statistics of sample from EIUE

Variable	Label	Obs	Mean	Std.Dev.	Min	Max
id	Used to identify persons	592,660				
Female	Dummy variable, equals to 1 if the person is female	592,660	.563	.496	0	1
Age	Age in years	592,660	55.373	11.6	30	80
Year2018	Dummy variable, equals to 1 if this payment is in 2018	592,660	.5	.5	0	1
Income	Monthly income (premium base for on-the-job employees and pension for retirees)	592,660	2765.572	1581.614	500.5	28573.92
Retired	Treatment variable, dummy, equals to 1 if the person is retired	592,660	.579	.494	0	1
Legal	Cutoff, Dummy variable, equals to 1 if the person is older than legal retirement age	592,660	.586	.493	0	1
R	Running variable, age centralized by legal retirement age (in years)	592,660	1.002	11.13	-20	20
Rsq	Square term of R	592,660	124.884	117.223	0	400
IR	Interaction of Legal with R	592,660	5.331	6.141	0	20
IRsq	Interaction of Legal with Rsq	592,660	66.14	101.7	0	400
Retiredhat	Predicted value of Retired, used in 2SLS regression	592,660	.579	.464	.045	.957
LIncome	Log of income	592,660	7.835	.387	6.216	10.26

Data Source: EIUE data collected from the Hubei Endowment Bureau

(2) Research methodology

The analysis of this paper is divided into two parts. The first part is the analysis of the difference of medical utilization before and after retirement of employees. Based on the estimation of the difference of the actual reimbursement ratio, the analysis includes daily number of outpatient and inpatient visits, the average cost per visit, the average length of hospitalization per visit, etc.; the second part is the analysis of the difference of income before and after retirement of employees, which is mainly based on the premium base of EIUE (i.e. total monthly wages of employees) and the monthly pension of retirees. Both parts of the analysis are carried out by the methodology of RDD. There are two kinds of RDD: sharp RD

(SRD) and fuzzy RD (FRD). The former means that at the cutoff, the probability of treatment variable being treated jumps from 0 to 1; the latter means that at the cutoff, the probability does not jump from 0 to 1 completely, but an obvious jump occurs.

As mentioned above, retirement behavior may have subjective choice due to individual health status, which will affect medical utilization, so there will be endogeneity problems when using retirement as a cutoff. But the legal retirement age is exogenous for individuals. so I decided to use the legal retirement age to explain the impact of retirement on medical behavior. At the same time, under the retirement system in China, the legal retirement age although does not completely determine the retirement behavior, but the probability of retirement at the legal age obviously jumps. So I take the legal retirement age as an IV of treatment variable, which is retirement, to do the analysis by FRD.

The key of applying RD is that the research needs to meet the internal validity of RD, which mainly includes the following conditions: (1) the running variable (in my case it's the age of individuals centralized by legal retirement age) is not affected by the treatment variable (in my case it's whether an individual is retired or not), that is, it can be measured without the treatment variable or it is constant; (2) the cutoff is not affected by the running variable, is exogenous, and whether an individual is treated or not is completely determined by the value of its running variable and the cutoff; (3) the function between the running variable and the dependent variable is continuous; (4) except for the treatment variable, there is no jump in other independent variables at the cutoff. The former two conditions can be judged according to the whole research design, and the latter two conditions can be proved by relevant tests. McCrary test is used to test the continuity of running variable at the cutoff.[1] The regression of covariates on running variable can be used to test the continuity of covariates at the cutoff, and the result can be judged according to the coefficient of each covariate.

Because FRD is essentially 2SLS regression with IV, I mainly report the results of 'rd' or 'rdrobust' commands in Stata analysis, but at the same time, I test and show the results by 2SLS regression.

4. Research process

(1) Model construction

According to the idea of RD, the samples on both sides of the cutoff are similar. Therefore, if retirement is taken as a cutoff, the difference of medical utilization of individuals near the cutoff is mainly attributed to retired or not, so RD method becomes an effective

[1] Justin McCrary, 'Manipulation of the Running Variable in the Regression Discontinuity Design: A Density Test', *Journal of Econometrics*, Vol. 142 of 2008, No. 2: 698-714.

random experiment. As mentioned before, not all people in China retire at the legal retirement age, and there are other factors that affect the retirement decision. Therefore, the retirement system only makes the possibility of retirement take an exogenous jump at the legal age specified by the policy, but not from 0 to 1. In this paper, I use legal retirement age as an IV to estimate the difference in medical utilization before and after retirement. In general, the proportion of women retiring at the age of 50 is large, so I set 60 as a cutoff for men and 50 for women.

FRD model defines the explained variable Y, which represents the individual's medical utilization (frequency of hospital visit, expenditure per visit, etc.) or income (wage or pension), as well as the treatment variable retire, which indicates whether the individual has retired at the time of hospital visit or income distribution:

$$retire_i = \begin{cases} 1 & if \ \ i\ is\ retired \\ 0 & if\ i\ is\ not\ retired \end{cases} \quad (1)$$

When $retire_i$= 1, it means that individual i has retired, while $retire_i$= 0 means that individual i has not retired. I study the relationship between retirement and medical utilization or income under equation (2):

$$Y_i = \beta_0 + \beta_1 retire_i + f(age_i - legalage) + \beta_2 retire_i * f(age_i - legalage) + \gamma X_i + \varepsilon_i \quad (2)$$

In equation (2), age_i represents the actual age of individual i at the time of hospital visit or earning his income, and $legalage$ is the legal retirement age of individual i, which takes 60 for male and takes 50 for female. So $age_i - legalage$ then defines the distance between the actual age and the legal retirement age of individual i at the time of hospital visit or earning his income, which is also age centralized by legal retirement age, the running variable in my research. $f(age_i - legalage)$ is a polynomial function of $age_i - legalage$. In this paper, I mainly use $age_i - legalage$ itself and the square of it. $retire_i * f(age_i - legalage)$ is the interaction term of $retire_i$ with $f(age_i - legalage)$. X_i is a set of covariates of individual i. In my study, due to the limited information available, I just use the dummy variables of the month of hospital visit and the year of income distribution as covariates. Although individual i is not necessary to retire when $Lage_i = 1$ (which means $age_i - legalage \geq 0$), but $Lage_i$ can be used as an IV in equation (2) to control the endogeneity of retirement decision. In order to accurately estimate the parameters in equation (2), equation (3) needs to be estimated first to investigate the correlation between legal retirement age and actual retirement:

$$retire_i = \alpha_0 + \alpha_1 Lage_i + f(age_i - legalage) + \alpha_2 Lage_i * f(age_i - legalage) + \mu_i \quad (3)$$

α_1 explains the local average treatment effect (LATE) of retirement near the legal retirement age cutoff. Equations (2) and (3) constitute the FRD model, which can be estimated by parameter 2SLS.

(2) Data analysis

a. The impact of legal retirement age on retirement

I analyzed the proportion of male and female retirees in each month within 36 months before and after the legal retirement age (male 60, female 50). The results are shown in Figures 1 to 4.

Figure1: Male outpatient

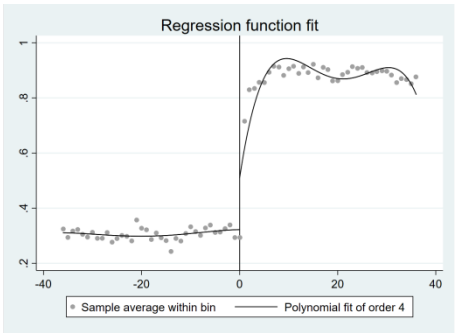


Figure2: Female outpatient

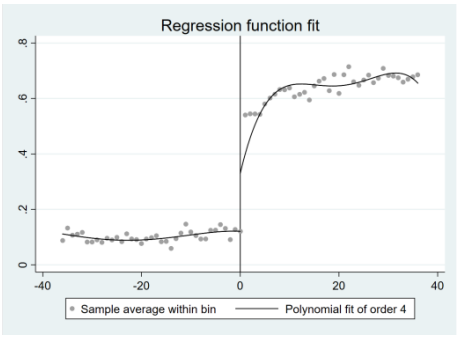


Figure3: Male inpatient

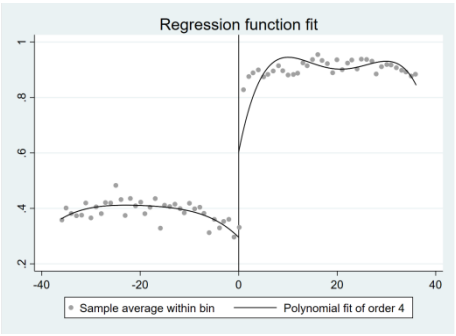
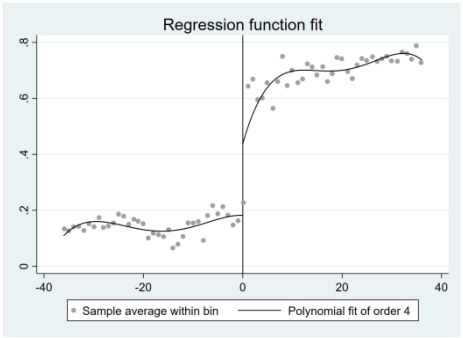


Figure4: Female inpatient



Note: The x-axis of the four figures is the running variable, that is, the individuals' age centralized by legal retirement age (in months), so its range is (–36, 36). The y-axis is the proportion of the retired people in each interval corresponding to the running variable.

It can be seen clearly that, no matter it is men or women, outpatient or inpatient, the proportion of retirees shows a significant jump at the cutoff of legal age, indicating that the legal retirement age can be a good IV for retirement behavior. Therefore, according to equation (3), I take the dummy variable $retire_i$ as the explained variable, the dummy variable $Lage_i$ as the explanatory variable, and $age_i - legalage$ as the running variable

(in months), and do regression analysis by gender. When $Lage_i$ is used in equation (2) as an IV of retired or not for individual i, the more the distance between the sample point and the cutoff, the more obvious the nonlinear relationship of the model is. Therefore, it is necessary to add interactions, then fit the sample points on both sides of the breakpoint, and explain the difference between the intercept and the slope of interaction. Based on this, I get the regression results as shown in Table3 (RD) and Table4 (2SLS).

Table3 : RD results of retirement on legal age (MIUE data)

	Outpatient		Inpatient	
	Male	Female	Male	Female
lwald	0.4221***	0.4197***	0.4964***	0.4161***
	(0.0211)	(0.0221)	(0.0422)	(0.0544)
lwald200	0.3696***	0.4132***	0.4549***	0.3952***
	(0.0347)	(0.0425)	(0.0642)	(0.0953)
Obs.	64579	64607	15840	12461
R-squared	.z	.z	.z	.z

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Table4: 2SLS regression results of retirement on legal age (MIUE data)

	Outpatient		Inpatient	
	Male	Female	Male	Female
LegalVis	0.4875***	0.4011***	0.5310***	0.4281***
	(0.0101)	(0.0108)	(0.0200)	(0.0256)
R	0.0018*	0.0036***	-0.0089***	0.0047**
	(0.0010)	(0.0007)	(0.0021)	(0.0019)
Rsq	0.0000	0.0001***	-0.0002***	0.0001**
	(0.0000)	(0.0000)	(0.0001)	(0.0000)
IR	0.0081***	0.0062***	0.0162***	0.0015
	(0.0012)	(0.0013)	(0.0025)	(0.0030)
IRsq	-0.0003***	-0.0002***	0.0000	-0.0002**
	(0.0000)	(0.0000)	(0.0001)	(0.0001)
Obs.	64579	64607	15840	12461
R-squared	0.3469	0.3107	0.2991	0.3130

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

From the results of both RD and 2SLS, we can see that the coefficient of dummy variable of whether reaching the legal retirement age is about 0.4 to 0.5 at the cutoff, which is statistically significant. This means that people are 40 to 50 percent more likely to retire when they reach the legal retirement age than before. Table3 reports the estimated coefficient of the optimal bandwidth (lwald) calculated by LATE and its twice (lwald200), the results are quite similar, indicating that the bandwidth has little effect on the coefficient. Table3 reports the estimation result of triangle kernel, I also tried rectangle kernel and the result was similar.

The results show that the coefficients of the dummy variable $Lage_i$ is highly significant at the level of 1% for both men and women, which means that the legal retirement age is an important condition affecting retirement decision-making. For individuals within 3 years from the legal retirement age, the probability of retirement increases by 42%, 42%, 50% and 42%, respectively, for male outpatients, female outpatients, male inpatients and female inpatients once they reach the legal retirement age. The main reason why men's coefficient is slightly larger than women's is that the legal retirement age of female cadres is 55 years old. Although the proportion of those who participate in MIUE is relatively low, it still has a certain impact on the coefficient.

Table3 and Table4 are the regression results using the data of MIUE. I also used the data of EIUE to do similar regression, where the explained variable is 'Retired', the explanatory variable is whether the employee reaches the legal retirement age when receiving salary or pension. The quadratic and interaction terms of running variable are also introduced, and the results are shown in Table5 and Table6. It can be seen that the results are basically the same as those in Table3 and Table4, indicating that the probability of retirement has a significant jump at the legal retirement age, proving the legal retirement age is a good IV for retirement.

Table5 : RD results of retirement on legal age (EIUE data)

	Retired	
	Male	Female
lwald	0.3784***	0.3260***
	(0.0079)	(0.0101)
lwald200	0.3634***	0.2883***
	(0.0081)	(0.0110)
Obs.	259032	333628
R-squared	.z	.z

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Table6 : 2SLS regression results of retirement on legal age (EIUE data)

	Retired	
	Male	Female
Legal	0.4579***	0.4431***
	(0.0052)	(0.0040)
R	0.0667***	0.0338***
	(0.0008)	(0.0005)
Rsq	0.0025***	0.0013***
	(0.0000)	(0.0000)
IR	-0.0360***	0.0338***
	(0.0009)	(0.0007)
IRsq	-0.0038***	-0.0040***
	(0.0000)	(0.0000)
Obs.	259032	333628
R-squared	0.9114	0.8623

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

In the first stage of 2SLS (as shown in Table4 and Table6), I generate the predicted value of the treatment variable 'Retired' as 'Retiredhat' based on the regression results, which would be used in the second stage of 2SLS regression.

b. The impact of retirement on medical utilization

b_1: The change of reimbursement proportion after retirement

Since in some literature, scholars believe that the reimbursement proportion of medical insurance will have a greater impact on medical utilization (Hitoshi Shigeoka, Wang Zhen et al.), in this part, I first study the difference of the reimbursement proportion of medical expenditure before and after the retirement of the employees participating in MIUE. Before that, I think it is necessary to briefly introduce the reimbursement policy of MIUE.

In China, the insurance premium and other income raised by MIUE are managed and used by provinces themselves or even cities within a province, and each province or city balances the fund revenue and expenditure within its jurisdiction. Therefore, provinces and cities determine their own reimbursement policies according to local funds. Under this situation, the threshold, the ceiling, and the proportion of reimbursement in different provinces and cities can be quite different. Generally speaking, the threshold and the ceiling are linked to the local average wage level, while the reimbursement proportion is mainly determined according to local fund income, and also refers to other regions with similar

economic development level. Taking Hubei Province in my paper as an example, since MIUE funds are managed by cities, there are quite a lot of different reimbursement policies within the whole province. Because the majority of medical records in my data is from Wuhan, the capital of Hubei Province, Table7 lists the MIUE reimbursement policies of Wuhan.

Table7 : MIUE reimbursement policy of Wuhan (inpatient and certain outpatient)

Level of hospital	Threshold (RMB yuan for each visit)	Reimbursement Proportion		Ceiling (RMB yuan for each year)
		On-the-job	Retired	
Community Health Centre	200	92%	93.6%	240,000 (exceeded amount may partially reimbursed by serious illness medical insurance)
Level 1	400	92%	93.6%	
Level 2	600	89%	91.2%	
Level 3	800	86%	88.8%	

10% out-of-pocket for Class B drugs before reimbursement

Annual expenditure: 100,000-200,000 yuan, 94% paid by MIUE fund

Annual expenditure: 200,000-240,000 yuan, 98% paid by MIUE fund

In addition to the reimbursement proportion stipulated by the policy, another factor that affects the actual reimbursement proportion is the reimbursement catalog, that is, which drugs and medical services are included in the reimbursement scope. MIUE has 3 kinds of catalogs, namely, drug catalog, diagnosis and treatment project catalog, as well as medical service facility standard. Here I take the drug catalog as an example to give a brief introduction. Before 2019, the Central Committee would update the national drug catalog once in a while, and requiring provinces to refer to it, but each province can increase or decrease the drugs to a certain extent according to its own situation. In 2019, the Central Committee issued a new drug catalog, and requires all provinces to implement it from 2020, no more right to adjust themselves. Drugs in the catalog are divided into two categories: A and B. Drugs A are fully covered by MIUE, while drugs B are partially covered, and the coverage ratio of different drugs B is different. On this basis, the payment shall be made according to the reimbursement proportion policy. Table8 selects some national and Hubei provincial drug catalogs since 2009, and lists the quantity of drugs in each catalog.

Table8 : National and Hubei provincial drug catalogs of MIUE

	Drug catalog of MIUE			
	Class A	Class B	Total	Note
National catalog 2009	503	1624	2127	provinces can adjust Class A no more than 5% and Class B no more than 25%
Hubei catalog 2010	517	2000	2517	
National catalog 2017	594	1994	2588	provinces can adjust Class B no more than 15%
Hubei catalog 2017	594	2271	2865	
National catalog 2019	640	2003	2643	no adjust by provinces, those different from this catalog should be removed in 3 years

Class A 100% reimbursed, Class B 60%-90% reimbursed

No difference between on-the-job and retired

As mentioned above, MIUE adopts the mode of “pooling fund plus personal account”, in which the pooling fund is used for reimbursement of inpatient and certain outpatient diseases, while the personal account is responsible for general outpatient services. Some people think that the money in personal account is their own money, so paying by personal account should be considered as out-of-pocket expenditure. I don't think so, because the individual pays the MIUE premium, regardless of whether medical expenditure occurs or not. The essence of employee’s premium and part of employer’s premium transferred into personal account is medical insurance fund. The establishment of personal account is to prevent excessive use of outpatient service. Therefore, whether it is the payment of pooling fund or personal account, it should be regarded as the reimbursement of MIUE. The expenditure covered by neither polling fund nor personal account and afforded by the patients themselves is considered as out-of-pocket expenditure. Based on this definition, I get the regression results as shown in Table9 and Table10. Since the visit data I use is from January to June 2016, in order to eliminate the seasonal effect, I add the dummy variables of the month of hospital visit as covariates. In the two tables, the explained variable is the reimbursement proportion, the explanatory variable is the treatment variable ‘Retired’ in FRD, and its predicted value ‘Retiredhat’ in 2SLS. 'Fund' here refers to the expenditure covered by MIUE policy, that is to say, the above-mentioned expenditure included in the catalogs, 'Total' refers to the total expenditure, including the non-reimbursable parts outside the catalogs.

Table9 : Fuzzy RD results of reimbursement proportion on retirement

	Male Outpatient		Female Outpatient		Male Inpatient		Female Inpatient	
	Fund	Total	Fund	Total	Fund	Total	Fund	Total
lwald	-0.0468***	-0.0364	-0.0610**	0.0047	-0.0184	0.0108	0.0214	-0.0135
	(0.0179)	(0.0293)	(0.0256)	(0.0313)	(0.0117)	(0.0130)	(0.0266)	(0.0453)
lwald200	-0.0311	-0.0159	-0.0703**	0.0169	-0.0369**	-0.0048	0.0378	0.0088
	(0.0418)	(0.0473)	(0.0316)	(0.0420)	(0.0177)	(0.0169)	(0.0329)	(0.0537)
Obs.	64579	64579	64607	64607	15840	15840	12461	12461
R-squared	.z	.z	.z	.z	.z	.z	.z	.z

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Table10: 2SLS regression results of reimbursement proportion on retirement

	Male Outpatient		Female Outpatient		Male Inpatient		Female Inpatient	
	Fund	Total	Fund	Total	Fund	Total	Fund	Total
Retiredhat	-0.0524***	0.0161	-0.0422***	-0.0031	-0.0036	-0.0110	0.0226	0.0275
	(0.0131)	(0.0125)	(0.0140)	(0.0170)	(0.0121)	(0.0136)	(0.0143)	(0.0212)
R	-0.0002	-0.0020***	0.0018***	-0.0001	-0.0010**	-0.0001	-0.0006	-0.0012
	(0.0006)	(0.0005)	(0.0005)	(0.0006)	(0.0005)	(0.0006)	(0.0006)	(0.0009)
Rsq	-0.0000**	-0.0000***	0.0000***	-0.0000	-0.0000**	-0.0000	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
IR	0.0030***	0.0007	-0.0000	0.0013*	0.0031***	0.0018*	0.0005	0.0014
	(0.0008)	(0.0008)	(0.0006)	(0.0008)	(0.0008)	(0.0009)	(0.0008)	(0.0011)
IRsq	0.0000	0.0001**	-0.0001***	-0.0000	-0.0000	-0.0000*	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Covariates	i.month of visit	i.month of visit	i.month of visit	i.month of visit	i.month of visit	i.month of visit	i.month of visit	i.month of visit
Obs.	64579	64579	64607	64607	15840	15840	12461	12461
R-squared	0.0037	0.0021	0.0011	0.0005	0.0025	0.0011	0.0055	0.0096

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

It can be seen from Table9 that there is no significant change in total reimbursement proportion, no matter male or female, outpatients or inpatients, since the coefficients are not statistically significant at the level of 10%. While policy reimbursement proportion just stays quite the same among inpatients, but drops by 4.7% and 6.1% among male and female outpatients, respectively. The results of 2SLS regression shown in Table10 are quite similar.

It is not difficult to understand why the reimbursement proportion of the total outpatient expenditure has little changed. This is because the personal account is completely responsible for the outpatient service, that is to say, as long as there is money in the personal account, no

matter what proportion of reimbursement the drugs and treatment projects used is, the expenditure can be fully paid by the personal account.

After retirement, the actual reimbursement ratio within policy is lower than before, which seems to be the opposite of the policy. I have repeatedly verified the coefficients and tried to re extract the sample, and the conclusion is basically the same. I think the possible explanation for this phenomenon is that although the proportion stipulated by the policy should increase after retirement, the actual proportion also depends on the composition of the drugs and medical services used. It is possible that people's health preference after retirement is higher, and they tend to use more services such as physical examinations, as well as drugs, which are in category B, instead of those in category A.

The above reasons may also be applicable to explain the fact that there is no significant change in the actual reimbursement rate of inpatients. Although the policy stipulates an increase in the proportion of reimbursement, with the changes in the composition of the use of drugs and medical services, more drugs and medical services in category B or outside the catalogs may be used, and factors such as the threshold and ceiling of inpatient reimbursement should be taken into consideration. When Wang Zhen (2019) analyzed the inpatient data of Shanghai, she found that although the reimbursement proportion is supposed to increase by 7 percentage points (from 85% to 92%) after retirement, which is stipulated by the policy, the actual proportion only increase by 2.3 percentage points. Since the proportion of policy reimbursement in Hubei Province only slightly increase after retirement (as 1.6 to 2.8 percentage points in Wuhan), it is reasonable that there is no significant change in the actual reimbursement proportion after integrating various factors.

All in all, RD and 2SLS results show that the actual reimbursement proportion of medical expenses after retirement has no significant change in general, and the reimbursement proportion of outpatients within the policy has slightly decreased. Therefore, the ratio of reimbursement may not be the motivation for the change of medical utilization after retirement, at least not the motivation for the increase of medical utilization, if such an increase exists.

b_2: The change of hospital visits after retirement

Then I analyzed the number of hospital visits per day within the range of running variable. The results of outpatients and inpatients analysis are shown in Table11 and Table12 respectively. In the two tables, the explained variable is the logarithm of daily visits, the explanatory variable is the treatment variable ‘Retired’ in FRD, and its predicted value ‘Retiredhat’ in 2SLS.

Table11: Fuzzy RD results of daily visits on retirement

	Log of daily outpatient visits		Log of daily inpatient visits	
	Male	Female	Male	Female
lwald	0.2365***	0.2590***	0.3211**	-0.0950
	(0.0298)	(0.0436)	(0.1478)	(0.1229)
lwald200	0.1906***	0.2021***	0.2896***	-0.1301
	(0.0439)	(0.0377)	(0.0863)	(0.1492)
Obs.	64579	64607	15840	12461
R-squared	.z	.z	.z	.z

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Table12: 2SLS regression results of daily visits on retirement

	Log of daily outpatient visits				Log of daily inpatient visits			
	Male		Female		Male		Female	
Retiredhat	0.2981***	0.2967***	0.3159***	0.3155***	0.2715***	0.2719***	0.0677	0.0700
	(0.0132)	(0.0132)	(0.0199)	(0.0199)	(0.0367)	(0.0366)	(0.0634)	(0.0634)
R	-0.0333***	-0.0333***	-0.0095***	-0.0095***	-0.0304***	-0.0304***	0.0054**	0.0054*
	(0.0006)	(0.0006)	(0.0008)	(0.0008)	(0.0016)	(0.0016)	(0.0027)	(0.0027)
Rsq	-0.0010***	-0.0010***	0.0002***	0.0002***	-0.0009***	-0.0009***	0.0004***	0.0004***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)
IR	0.0494***	0.0493***	0.0132***	0.0132***	0.0453***	0.0453***	0.0089***	0.0088***
	(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0025)	(0.0025)	(0.0033)	(0.0033)
IRsq	0.0005***	0.0005***	0.0002***	0.0002***	0.0006***	0.0006***	-0.0002**	-0.0002**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Covariates	—	i.month of visit	—	i.month of visit	—	i.month of visit	—	i.month of visit
Obs.	64579	64579	64607	64607	15840	15840	12461	12461
R-squared	0.1175	0.1181	0.4237	0.4237	0.0561	0.0566	0.2516	0.2521

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

It can be seen from Table11 that after retirement, male outpatient, female outpatient and male inpatient visits have increased significantly, with an increase of 23.7%, 25.9% and 32.1%, respectively, and the results are highly significant at the level of 1%, indicating that retired employees receive outpatient and inpatient treatment more frequently than before, except for female inpatients. The results of 2SLS regression shown in Table12 are quite similar. Figures drawn by the 'rdplot' command are shown below as Figure5 to Figure8.

However, according to the results above of b_1, neither total nor policy reimbursement proportion increases after retirement, so in my opinion, more hospital visits are not determined by the reimbursement proportion, but may be caused by other reasons such as reduced time cost after retirement.

Figure5: Daily visits of male outpatients

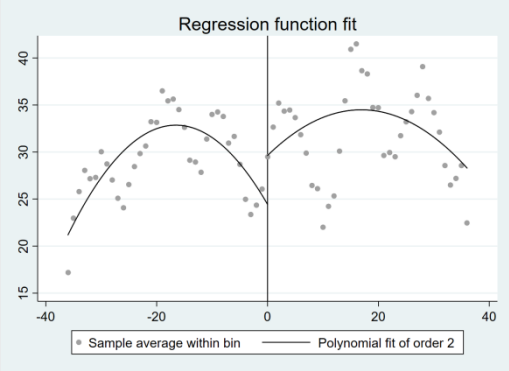


Figure6: Daily visits of female outpatients

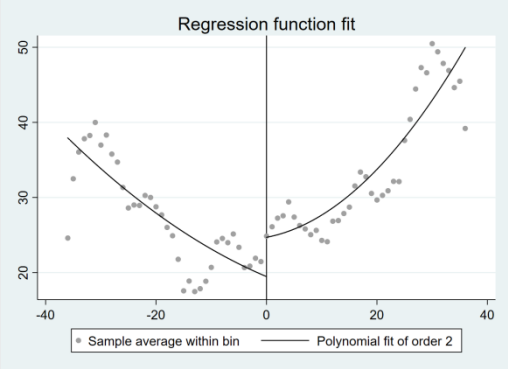


Figure7: Daily visits of male inpatients

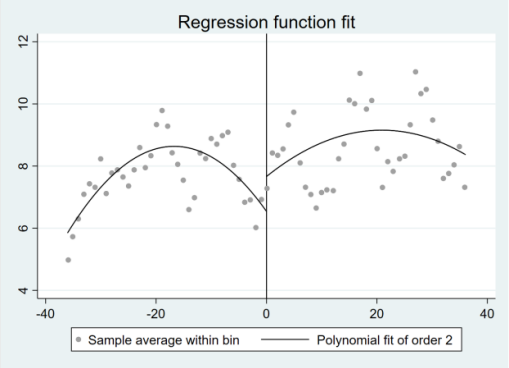
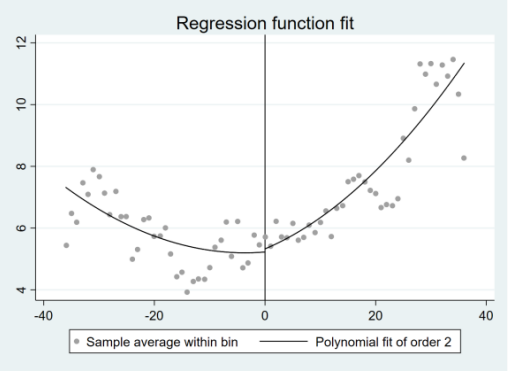


Figure8: Daily visits of female inpatients



Note: The x-axis of the four figures is the running variable, that is, the individuals' age centralized by legal retirement age (in months), so its range is (–36, 36). The y-axis is the number of average daily visits in each interval corresponding to the running variable.

It can be clearly seen that except for Figure8, the number of daily visits of the other three figures had a significant upward jump at the cutoff, which was consistent with the regression results of RD and 2SLS. It can also be seen from the figures that daily hospital visits of male and female presents different characteristics. The average number of daily visits of male in each interval of running variable fluctuated greatly, taking about one year as a cycle; while the average number of daily visits of female fluctuated about one year as well, but the fluctuation was much smaller than that of male. In addition, daily visits of female showed a significant decline before retirement, and continued to rise after retirement, so the goodness of fit of scatters was higher; while male did not show a significant difference before and after retirement, and the goodness of fit of scatters was lower.

As for the explanation that the decrease of time cost after retirement is the main reason for the significant increase of daily hospital visits, I have carried out verification by regression on weekdays and weekends respectively, and the results are shown in Table13 and Table14.

Table13: Fuzzy RD results of daily visits on retirement (weekdays and weekends)

	Outpatient_Male		Outpatient_Female		Inpatient_Male		Inpatient_Female	
	Weekdays	Weekends	Weekdays	Weekends	Weekdays	Weekends	Weekdays	Weekends
lwald	0.2903***	0.1649***	0.2805***	0.2147**	0.3338**	0.5575	-0.4248	-0.2442
	(0.0366)	(0.0502)	(0.0342)	(0.0871)	(0.1507)	(0.5994)	(0.2958)	(0.2829)
lwald200	0.2570***	0.1218*	0.0504	0.3554	0.3045***	0.1850	0.0190	-0.0452
	(0.0517)	(0.0696)	(0.0541)	(0.2810)	(0.0874)	(0.2087)	(0.1103)	(0.2832)
Obs.	51153	13426	50628	13979	13312	2528	10495	1966
R-squared	.z	.z	.z	.z	.z	.z	.z	.z

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Table14: 2SLS regression results of daily visits on retirement (weekdays and weekends)

	Outpatient_Male		Outpatient_Female		Inpatient_Male		Inpatient_Female	
	Weekdays	Weekends	Weekdays	Weekends	Weekdays	Weekends	Weekdays	Weekends
Retiredhat	0.4063***	0.2430***	0.3170***	0.2380***	0.3070***	0.0662	0.0397	0.2342
	(0.0142)	(0.0285)	(0.0224)	(0.0432)	(0.0395)	(0.0981)	(0.0695)	(0.1556)
R	0.3114***	-0.0293***	-0.0099***	-0.0079***	-0.0303***	-0.0312***	0.0058*	0.0033
	(0.0148)	(0.0013)	(0.0009)	(0.0016)	(0.0017)	(0.0043)	(0.0030)	(0.0066)
Rsq	-0.0344***	-0.0009***	0.0002***	0.0003***	-0.0009***	-0.0010***	0.0005***	0.0004**
	(0.0007)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0002)
IR	-0.0011***	0.0477***	0.0139***	0.0105***	0.0425***	0.0602***	0.0102***	0.0003
	(0.0000)	(0.0019)	(0.0011)	(0.0021)	(0.0027)	(0.0065)	(0.0036)	(0.0081)
IRsq	0.0499***	0.0004***	0.0002***	0.0001**	0.0006***	0.0003	-0.0003***	0.0001
	(0.0010)	(0.0001)	(0.0000)	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0002)
Covariates	i.month of visit	i.month of visit	i.month of visit	i.month of visit	i.month of visit	i.month of visit	i.month of visit	i.month of visit
Obs.	51153	13426	50628	13979	13312	2528	10495	1966
R-squared	0.1193	0.1147	0.4217	0.4322	0.0560	0.0671	0.2480	0.2779

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

As for the phenomenon that daily visits of female inpatients does not jump significantly after retirement, my explanation is that inpatient is generally the demand of relatively major diseases, while the legal retirement age of Chinese women is 50, and the average life expectancy is 79.4, so the majority of women are still in good health at the legal age. Their

inpatient needs will not increase significantly at retirement. Even if there are chronic diseases, most of them are not serious, and can be hospitalized within a few years after retirement.

As for the overall trend that daily visits of female, both outpatients and inpatients, continue to decline before retirement and to rise after it, my explanation is that women have to take care of the family besides their jobs, so have less disposable time before retirement. Therefore, before retiring, female patients who should be treated outpatient may choose to take medicine on their own, and those who should be hospitalized may choose to be treated after retiring.

It can be seen from Table13 that the growth rate of daily visits after retirement is significantly higher on weekdays than on weekends. During the weekdays, the growth of male outpatients, female outpatients and male inpatients were 29%, 28% and 33% respectively, while the corresponding data of weekends were 16%, 21% and no significant change. Although the 2SLS regression results in Table12 are slightly different, the overall trend is the same. The figures drawn by the 'rdplot' command is shown in Figure9 to Figure16.

Figure9: Male outpatients on weekdays

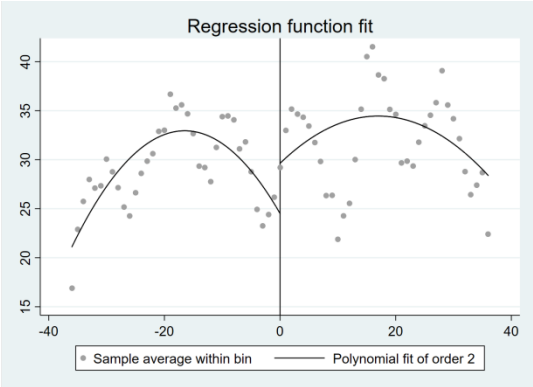


Figure10: Male outpatients on weekends

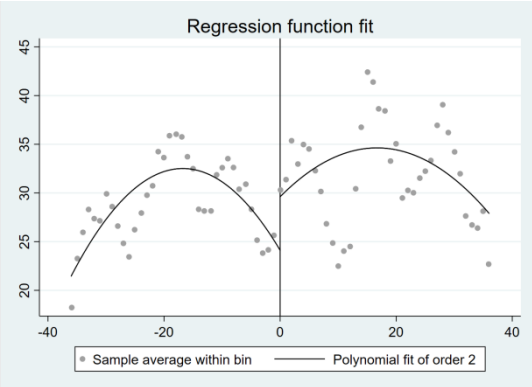


Figure11: Female outpatients on weekdays

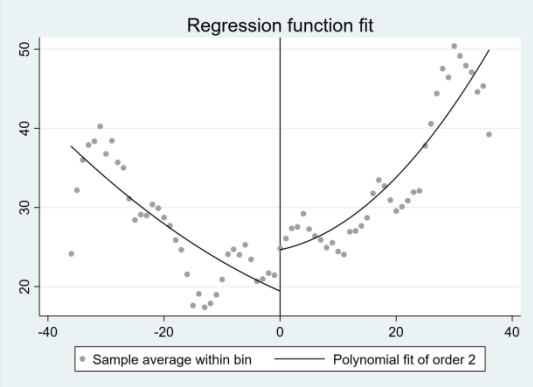


Figure12: Female outpatients on weekends

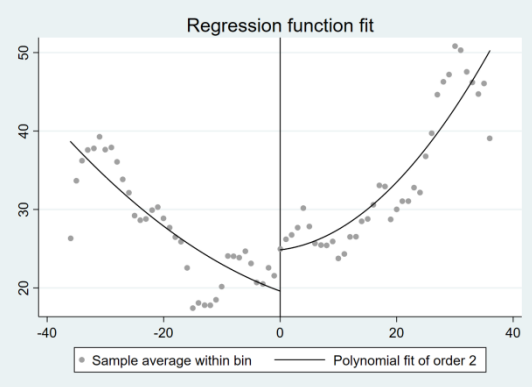


Figure13: Male inpatients on weekdays

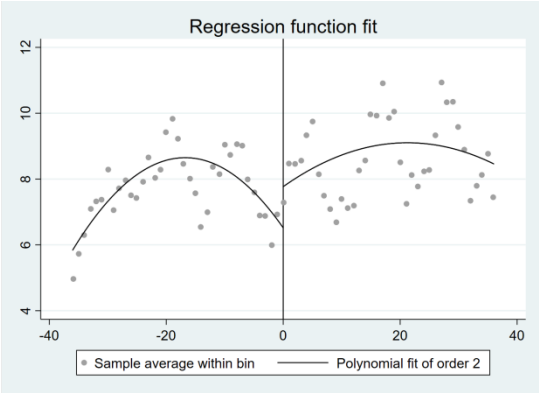


Figure14: Male inpatients on weekends

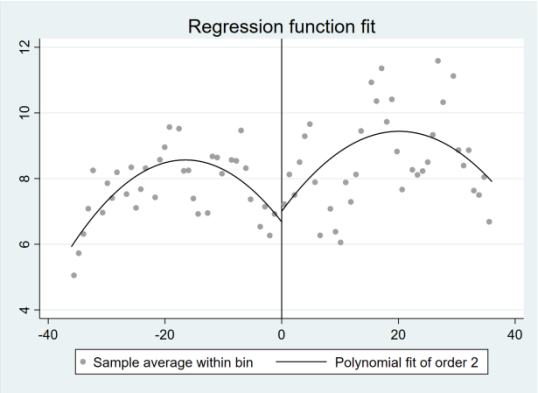


Figure15: Female inpatients on weekdays

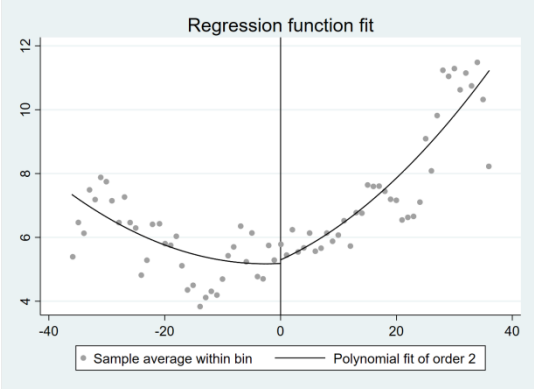
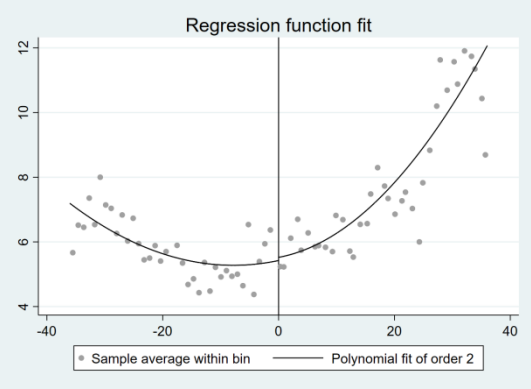


Figure16: Female inpatients on weekends



Note: The x-axis of the eight figures is the running variable, that is, the individuals' age centralized by legal retirement age (in months), so its range is (–36, 36). The y-axis is the number of average daily visits in each interval corresponding to the running variable.

To some extent, these regression results reflect that the decrease of time cost is one of the important reasons for the increase of daily visits. However, for female inpatients, no matter on weekdays or weekends, there is no significant change, which shows that the above explanation of the overall good health status of women at the legal retirement age is basically applicable.

Male inpatients should be paid more attention to. It can be seen that almost all of the growth came from weekdays, and the average number of daily visits on weekends did not change significantly. As hospitalization usually takes a certain number of days, in addition to the explanation of the decrease in time cost, a better explanation for this phenomenon can be found in Hitoshi Shigeoka (2014). He uses weekend admission of inpatients as an indicator of whether they are in an emergency or not, because hospitals usually do not accept regular inpatient registration at weekends. This practice is also applicable in China, where hospitals generally do not go through inpatient admission procedures at weekends, except for serious or urgent diseases. From this point of view, it can also be seen that emergency patients usually

can't choose to postpone treatment, so there is no significant jump before and after the cutoff, while the patients with chronic diseases can choose to postpone their treatment to retirement.

b_3: The change of expenditure per visit after retirement

Then I analyzed the average expenditure per visit within the range of running variable, including total expenditure and expenditure covered by MIUE, that is to say, expenditure within the catalogs. The results of outpatients and inpatients analysis are shown in Table15 and Table16 respectively. In the two tables, the explained variable is the logarithm of expenditure per visit, the explanatory variable is the treatment variable 'Retired' in FRD, and its predicted value 'Retiredhat' in 2SLS.

It can be seen from Table15 and Table16 that the average expenditure of outpatient and inpatient for male and female has no significant change before and after retirement, and each coefficient is not statistically significant at the level of 10%. This is consistent with the result of b_1 that the reimbursement ratio has not actually increased after retirement. This means that patients will not become price insensitive due to the increase of reimbursement ratio, so as to increase the medical expenditure.

Table15: 2SLS regression results of expenditure per visit on retirement

	Male Outpatient		Female Outpatient		Male Inpatient		Female Inpatient	
	LTotalExp	LInExp	LTotalExp	LInExp	LTotalExp	LInExp	LTotalExp	LInExp
Retiredhat	0.0015	-0.0122	-0.0544	-0.0515	-0.1145	-0.0750	-0.0438	-0.0524
	(0.0577)	(0.0593)	(0.0803)	(0.0831)	(0.1071)	(0.1071)	(0.0358)	(0.0350)
R	-0.0050*	-0.0050*	-0.0040	-0.0028	0.0003	-0.0001	0.0024	0.0026
	(0.0026)	(0.0027)	(0.0028)	(0.0029)	(0.0044)	(0.0045)	(0.0059)	(0.0057)
Rsq	-0.0001*	-0.0001*	-0.0001	-0.0000	-0.0000	-0.0001	0.0002	0.0002
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
IR	0.0120***	0.0136***	0.0075**	0.0073*	0.0000	-0.0008	-0.0046	-0.0056
	(0.0036)	(0.0037)	(0.0036)	(0.0037)	(0.0074)	(0.0074)	(0.0078)	(0.0076)
IRsq	-0.0001	-0.0001	0.0000	-0.0000	0.0001	0.0001	-0.0004	-0.0002
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0003)	(0.0002)
Covariates	i.month of visit	i.month of visit	i.month of visit	i.month of visit	i.month of visit	i.month of visit	i.month of visit	i.month of visit
Obs.	64579	64579	64607	64607	15840	15840	12461	12461
R-squared	0.0005	0.0005	0.0004	0.0004	0.0003	0.0002	0.0008	0.0006

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Table16: Fuzzy RD results of expenditure per visit on retirement

	Male Outpatient		Female Outpatient		Male Inpatient		Female Inpatient	
	LTotalExp	LInExp	LTotalExp	LInExp	LTotalExp	LInExp	LTotalExp	LInExp
lwald	0.3799	0.3589	0.1050	0.1164	-0.1516	-0.1201	0.3407	0.3221
	(0.2997)	(0.3075)	(0.2433)	(0.2355)	(0.2904)	(0.2991)	(0.5255)	(0.5172)
lwald200	0.2210	0.1860	-0.1014	-0.0423	-0.0851	-0.0404	0.3752	0.3352
	(0.1531)	(0.1334)	(0.1363)	(0.1396)	(0.1822)	(0.1872)	(0.2654)	(0.2553)
Obs.	64579	64579	64607	64607	15840	15840	12461	12461
R-squared	.z	.z	.z	.z	.z	.z	.z	.z

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

From another point of view, since the income of employees after retirement may have a significant decline (will be analyzed in the later part), they are likely to become more price sensitive, so the average medical expenditure per time should show a downward trend, but actually it doesn't. There may be two reasons for it.

On the one hand, MIUE may have done a good job in medical cost control. MIUE adopts various types of cost control measures, such as global budget, DRGs (Diseases Related to Groups), capitation, etc., which makes the problem of excessive medical utilization under good control, and there is basically little compressed space for medical expenses. Wang Zhen (2019) also proposed a similar explanation, saying that MIUE improved the accessibility of medical services, but did not lead to serious waste of medical resources and moral hazard. On the other hand, after retirement, the health preference is enhanced and the time cost is reduced. More examinations may be taken or more drugs may be purchased each time. Although people may be inclined to choose drugs and services with lower unit price, the increase of the quantity does not change the total cost significantly.

b_4: The change of average length of inpatient stay after retirement

At the end of this part, I analyzed the average length of inpatient stay. The results are shown in Table17 and Table18 respectively. In the two tables, the explained variable is the average length of inpatient stay, as well as its logarithm, the explanatory variable is the treatment variable 'Retired' in FRD, and its predicted value 'Retiredhat' in 2SLS.

It can be seen from Table17 and Table18 that the average length of inpatient stay for male and female has no significant change before and after retirement, and each coefficient is not statistically significant at the level of 10%. The explanation about MIUE taking a series of effective cost control measures to prevent the overuse and waste of medical resources is also applicable to explain the phenomenon here. Because the hospital has strict requirements and restrictions for all kinds of diseases and patients' hospitalization days, and the patients

themselves have no price motivation to ask for prolonging hospitalization days actively, it is reasonable that there is no significant change in hospitalization days.

Table17: Fuzzy RD results of average length of inpatient stay on retirement

	Male		Female	
	Inpatient days per visit	Log of inpatient days per visit	Inpatient days per visit	Log of inpatient days per visit
lwald	1.1260	0.0201	2.2808	0.1568
	(1.9842)	(0.2549)	(2.0709)	(0.3827)
lwald200	0.3994	0.0361	-0.0424	0.0923
	(1.1723)	(0.1367)	(1.4937)	(0.1840)
Obs.	15840	15840	12461	12461
R-squared	.z	.z	.z	.z

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Table18: 2SLS regression results of average length of inpatient stay on retirement

	Male				Female			
	Inpatient days per visit		Log of inpatient days per visit		Inpatient days per visit		Log of inpatient days per visit	
Retiredhat	-0.1621	-0.1117	-0.0766	-0.0743	-0.0885	-0.1735	-0.0221	-0.0293
	(0.8151)	(0.8078)	(0.0730)	(0.0720)	(0.2437)	(0.2426)	(0.0233)	(0.0232)
R	0.0137	0.0131	0.0026	0.0028	0.0546	0.0510	0.0064	0.0063
	(0.0330)	(0.0326)	(0.0031)	(0.0030)	(0.0427)	(0.0425)	(0.0039)	(0.0039)
Rsq	0.0004	0.0003	0.0001	0.0001	0.0017	0.0015	0.0002	0.0001
	(0.0009)	(0.0009)	(0.0001)	(0.0001)	(0.0011)	(0.0011)	(0.0001)	(0.0001)
IR	-0.0135	-0.0167	-0.0001	-0.0007	0.0396	0.0363	0.0023	0.0018
	(0.0563)	(0.0559)	(0.0051)	(0.0050)	(0.0549)	(0.0547)	(0.0052)	(0.0052)
IRsq	-0.0005	-0.0004	-0.0001	-0.0001	-0.0019	-0.0016	-0.0001	-0.0001
	(0.0014)	(0.0014)	(0.0001)	(0.0001)	(0.0016)	(0.0015)	(0.0001)	(0.0001)
Covariates	–	i.month of visit	–	i.month of visit	–	i.month of visit	–	i.month of visit
Obs.	15840	15840	15840	15840	12461	12461	12461	12461
R-squared	0.0000	0.0162	0.0001	0.0220	0.0000	0.0098	0.0001	0.0101

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

In part b, I analyzed the differences of the proportion of reimbursement, daily hospital visits, medical expenditure per visit, and the average length of inpatient stay before and after retirement. Two regression methods, FRD and 2SLS, are used for each explained variable, and the results under the optimal bandwidth and its twice are reported in FRD analysis. The results of triangle kernel are reported in this paper. I also use rectangle kernel, and the results are consistent. Finally, I come to the conclusion that in terms of reimbursement proportion, only female outpatients have a slight decline in the policy reimbursement proportion after retirement, and there is no significant change in other types. In terms of the number of daily visits, except for the female inpatients, which there was no significant change, the other types increased significantly after retirement. In this part, in order to verify the decrease of time cost, I analyzed the weekdays and weekends respectively, and found that the increase of male inpatient visits was almost entirely from the weekdays, and the increase of male and female outpatient visits on the weekdays was significantly greater than that on the weekends, which verified this guess. As for medical expenditure per visit, and the average length of inpatient stay, neither male nor female had significant change before and after retirement, and the effective implementation of cost control measures of MIUE may be the main reason for it.

c. The impact of retirement on medical financial burden

c_1: The change of monthly income after retirement

The change of individual's income (whether salary or pension) is often influenced by two factors. On the one hand, the overall income level generally increases with the development of economy and society; on the other hand, the income level is affected by the region, age, gender, occupation, etc. For on-the-job employees, the salary is changing with the increase of age, working proficiency, position and other factors; and for retirees, the payment base and payment period of EIUE will affect their pension level; at the same time, the pension will increase with the increase of age. In this paper, I study the LATE of income change at the point of retirement. Therefore, if I take the social average wage and the average pension level as my estimation basis, I would underestimate the wage level of employees just before retirement, and also overestimate the pension level of employees just after retirement. Therefore, I use premium payment data of EIUE of on-the-job employees, in which the payment base is the total monthly salary of the employees themselves; and the pension payment data of retirees in which their monthly pension can be clearly seen. The specific data structure and method of sample extraction have been reported in the previous part.

Table19 : Fuzzy RD results of monthly income on retirement

	Monthly Income		Log of Monthly Income	
	Male	Female	Male	Female
lwald	-894.5867***	-909.3224***	-0.2179***	-0.3274***
	(78.4210)	(110.4443)	(0.0185)	(0.0247)
lwald200	-731.9745***	-843.8573***	-0.2320***	-0.2950***
	(49.8245)	(136.1222)	(0.0242)	(0.0573)
Obs.	259032	333628	259032	333628
R-squared	.z	.z	.z	.z

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Table20 : 2SLS regression results of monthly income on retirement

	Monthly income		Log of Monthly Income	
	Male	Female	Male	Female
Retiredhat	-1054.4197***	-1280.5855***	-0.2376***	-0.3620***
	(56.5250)	(41.2865)	(0.0119)	(0.0107)
R	0.3449	9.4771***	0.0020	0.0048***
	(8.5009)	(2.5155)	(0.0017)	(0.0011)
Rsq	-0.2495	0.6938***	-0.0001	0.0002***
	(0.3507)	(0.1940)	(0.0001)	(0.0000)
IR	-10.9182	25.0585***	0.0033**	0.0405***
	(6.9583)	(3.5833)	(0.0014)	(0.0010)
IRsq	1.6420***	-2.5586***	0.0005***	-0.0016***
	(0.4399)	(0.3244)	(0.0001)	(0.0001)
Year2018	210.7950***	167.8558***	0.0681***	0.0691***
	(6.8145)	(4.2506)	(0.0014)	(0.0011)
Obs.	259032	333628	259032	333628
R-squared	0.0690	0.1321	0.0780	0.2178

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

In part a, I have reported the results of using EIUE data to verify the applicability of legal retirement age as a IV of the treatment variable ‘Retired’, and obtained the predicted value of ‘Retired’, which is ‘Retiredhat’, in the first stage of 2SLS regression. In this part, I take monthly income and its logarithm as the explained variable, while the explanatory

variable in FRD is ‘Retired’, and in 2SLS regression is ‘Retiredhat’. In order to eliminate the time trend of the natural growth of wages and pensions, I introduce the dummy variable 'Year2018' to distinguish the year of income. The regression results obtained using equation (2) are shown in Table19 and Table20, while the figures generated using the Stata command 'rd' is shown in Figure17 and Figure18.

Figure17: Monthly income of male

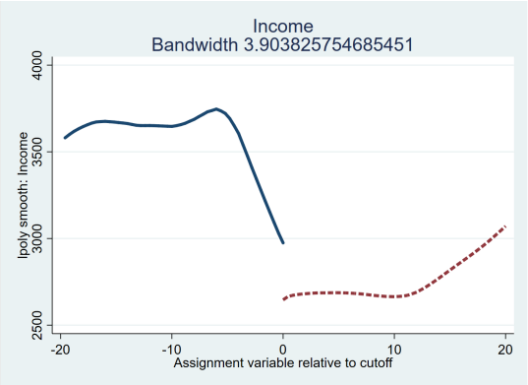
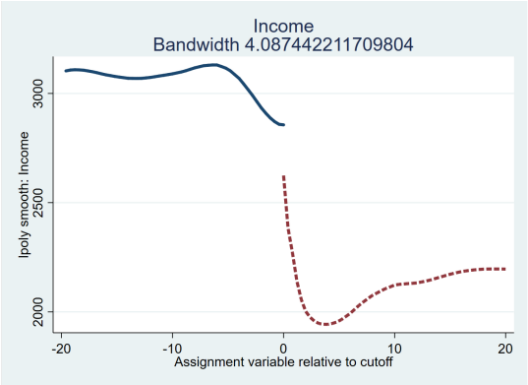


Figure18: Monthly income of female



Note: The x-axis of the eight figures is the running variable, that is, the individuals’ age centralized by legal retirement age (in years), so its range is (–20, 20). The y-axis is average monthly income (RMB yuan) in each interval corresponding to the running variable.

It can be seen from Table19 that the monthly income of men and women decreased significantly by 21.8% and 32.7% respectively after retirement, and the coefficients were statistically significant at the level of 1%. The results are basically consistent with those in Table18. However, from Figures17 and Figures18, the shape of the fitting lines on both sides of the cutoff is somewhat strange.

On the one hand, starting from 5 years before legal retirement age in Figure17, the average income level has suddenly declined. The main reason for this phenomenon is that male employees who are engaged in high-temperature, chemical and other jobs with high risk or damage to health can choose their own retirement days from the age of 55. Because of the high risk of their work, these people are usually at a higher level of income. But the pension after retirement largely depends on the social average level and their contribution years, and the average level of pension has been substantially lower than the on-the-job salary, so the early retirees with relatively short contribution years have a more significant decline in their income. With the increase of the proportion of early retirees, the trend of fitting line continued to decline between the age of 55 and 60. From Figure18, the fitting line of women between the age of 45 and 50 also shows a downward trend, but because the proportion of women in high-risk work is relatively low, the decline is more gentle than that of men.

On the other hand, in Figure18, women's income fitting line from 50 to 55 years old

shows a continuous downward trend, which is inconsistent with our daily cognition and the results reflected in the FRD and 2SLS regression. The main reason for this phenomenon is that the retirement age of Chinese female cadres is 55, and this part of them also belong to the middle and high-income groups when they are in office. Therefore, between the age of 50 and 55, there are some female cadres who are still on the job, and the proportion is decreasing year by year, so the income fitting line continues to decline. Until the age of 55, all female employees are basically retired, and the income rises year by year after reaching the lowest point.

In summary, since Figure17 and Figure18 show the general trend and jump of individual income on both sides of the legal retirement age, while the explanatory variable coefficients in Table19 and Table20 show the change range of the treatment variable 'Retired', so the jump range in the figures does not appear to be as large as the coefficient in the tables. However, according to the results of FRD, the monthly income of men and women after retirement decreased by 21.8% and 32.7% respectively. However, employees need to pay social insurance premium and personal income tax when they are on the job, of which 10.5% of the total wage is social insurance premium, and the monthly income at the starting point of personal income tax is 5000 yuan. When discussing the medical financial burden, this paper pays more attention to the middle and low-income groups, whose income can't reach the threshold of income tax, so personal income tax will not be considered here. After excluding social insurance premium, compared with the actual disposable income of employees after retirement, the male and female income decreased by 12.6% and 24.8% respectively. The main reason why the decline rate of women is larger than that of men is that the retirement age of women is 10 years earlier, which means that the payment period is 10 years shorter, so the pension level is also quite lower than that of men.

Some people may say that after retirement, in addition to the pension provided by EIUE, there may be supplementary pension income such as enterprise annuity. However, according to the statistics bulletin, by the end of 2018, only 87,400 enterprises in China had established enterprise annuity, with only 23.88 million employees, less than 6% of the employees participating EIUE.[1] Moreover, the enterprises that establish annuity are generally those with better benefits, and the income of the insured employees is usually higher. Similarly, there are very few high-income groups among Chinese employees who choose to buy commercial annuity insurance. But after retirement, the lower income group is more significant because of the decrease of income and the increase of medical financial burden. Therefore, other income such as enterprise annuity basically does not affect the conclusion of this paper.

[1] Data source: *China Health and health development statistical bulletin 2018.*

c_2: The change of medical financial burden after retirement

In part c_1, I got the decline rate of personal income after retirement. In this part, I want to get the proportion of medical expenditure in monthly income , and finally get the change of medical financial burden before and after retirement. I take monthly income as the explained variable, and use OLS regression to get the predicted value of the income of the employees and retirees at the legal retirement age respectively.

I initially included age and its square term as explanatory variables, but found that this would cause the coefficient of age or its square term to be not significant, or the directions of the coefficient to be abnormal in some results. After I remove the square term of age and keep only age itself, all the coefficients become significant and positive correlation. This shows that income and age are basically positive linear correlation. Since the annual growth rate of pension in China is based on the growth rate of average wage of on-the-job employees, the time trend of wage and pension is basically the same, so I use the data of the same year (2018) for regression. Although R-square in this case is very small, but a large enough sample size makes it still possible to measure a prediction of the average level. The results of OSL regression are shown in Table21.

Table21 : OLS regression results of monthly income on age

	Male				Female			
	On-the-job Wage		Pension		On-the-job Wage		Pension	
Age	-16.7568	8.3861***	-55.1768***	20.0882***	-185.3367***	15.2857***	313.2692***	31.5070***
	(33.7360)	(1.9382)	(9.8629)	(0.4437)	(16.6583)	(1.1885)	(5.5537)	(0.2626)
Agesq	0.2548		0.5456***		2.4636***		-2.3512***	
	(0.3416)		(0.0706)		(0.2085)		(0.0464)	
_cons	4021.8927***	3409.2118***	3993.7165***	1713.9322***	6636.5894***	2653.7244***	-8172.684***	594.4688***
	(825.3027)	(94.7473)	(342.9879)	(31.3580)	(326.4244)	(47.3745)	(165.0643)	(16.0420)
Obs.	58557	58557	70959	70959	66233	66233	100581	100581
R-squared	0.0003	0.0003	0.0276	0.0269	0.0058	0.0029	0.1349	0.1155

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

According to the regression coefficient and constant term in Table21, the monthly wage and pension of men and women at the legal retirement age are predicted as follows: 3912 yuan for wage and 2919 yuan for pension for men at 60 years old, 3418 yuan for wage and 2170 yuan for pension for women at 50 years old. This result is basically consistent with the result of 2SLS regression in Table20.

Then I use the data of MIUE again to measure the average out-of-pocket medical expenditure per person per month. But the problem of MIUE data is that outpatient and

inpatient records are separated in two data sets, and because of confidentiality requirements, I cannot obtain the patient's name or ID number, so I cannot associate outpatient and inpatient records. I can only consider that the substitution between outpatient and inpatient can be ignored, so the sum of monthly average out-of-pocket expenditure of outpatient and inpatient can be regarded as the total out-of-pocket expenditure.

Table22 : OLS regression results of monthly out-of-pocket expenditure on age (outpatient)

	Male				Female			
	On-the-job		Retired		On-the-job		Retired	
Age	-31.4069	-0.0289	-527.4610	-2.7491	-198.9388**	-3.3205	-134.2489**	-1.0779
	(75.4861)	(1.3693)	(465.6560)	(4.6085)	(91.1072)	(2.4958)	(60.6664)	(1.1283)
Agesq	0.2622		4.3346		1.9533**		1.3100**	
	(0.6276)		(3.8103)		(0.9077)		(0.5960)	
_cons	997.4076	59.2399	16094.0653	226.7349	5127.3382**	236.5209*	3485.5948**	104.7556*
	(2268.9987)	(82.0111)	(14220.0930)	(284.1112)	(2287.0282)	(126.7431)	(1542.9747)	(58.2984)
Obs.	13928	13928	21999	21999	20402	20402	14274	14274
R-squared	0.0000	0.0000	0.0006	0.0001	0.0002	0.0001	0.0004	0.0001

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

Table23 : OLS regression results of monthly out-of-pocket expenditure on age (inpatient)

	Male				Female			
	On-the-job		Retired		On-the-job		Retired	
Age	6223.2503	246.8886*	-3612.8943	-26.5177	-517.1828	35.6202	4052.2418*	-52.8654
	(6282.0556)	(141.2824)	(4098.7952)	(53.6677)	(2986.0242)	(53.3078)	(2344.2665)	(39.1307)
Agesq	-49.9902		29.6448		5.5198		-40.4289*	
	(53.1844)		(33.9011)		(29.8681)		(23.1532)	
_cons	-189524.1188	-11010.3963	112994.3201	4614.4300	14905.0803	1083.5422	-99072.6951*	5015.8397**
	(185482.879)	(8295.9043)	(123828.167)	(3264.8075)	(74567.7366)	(2631.4022)	(59266.3896)	(2029.9443)
Obs.	4647	4647	9430	9430	5639	5639	5409	5409
R-squared	0.0012	0.0010	0.0001	0.0000	0.0001	0.0001	0.0008	0.0003

Standard errors are in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

I did OLS regression for the on-the-job workers and retirees respectively, taking the total out-of-pocket expenditure of outpatient and inpatient in each month of each patient as the explained variable, age and its secondary term as the explanatory variables. The regression

results are shown in Table22 and Table23. Unfortunately, the coefficients of most explanatory variables are not significant, which means that in the range of 3 years before and after the legal retirement age, age is not the main factor affecting medical expenditure.

So I can't use the coefficients and constants in Table22 and Table23 to estimate the predicted value of medical expenditure. I can only use the mean of on-the-job workers and retirees at the legal retirement age. The mean under each category is shown in Table24.

Table24 : Mean of monthly out-of-pocket expenditure at legal retirement age

Variable	Outpatient	Inpatient	Total
On-the-job women at age 50	15.84	548.32	564.16
Retired women at age 50	18.45	535.08	553.53
On-the-job men at age 60	18.71	732.28	750.99
Retired men at age 60	22.99	866.83	889.82

It can be seen that the average monthly out-of-pocket medical expenditure of male 60-year-old employees, male 60-year-old retirees, female 50-year-old employees and female 50-year-old retirees are 751 yuan, 890 yuan, 564 yuan and 554 yuan respectively. After retirement, women's monthly medical expenditure has little change, while men's increased by 18.5%. The main reason is that outpatient expenditure is basically covered by personal accounts, so inpatient expenditure is the main part of out-of-pocket expenditure. There was no significant change in the frequency and average cost of inpatient for women before and after retirement, while the frequency of inpatient for men increased significantly after retirement.

Combining the results of Table24 and Table21, we can see that at the legal retirement age, the proportion of monthly out-of-pocket medical expenditure in the monthly income of male employees, male retirees, female employees and female retirees is 21.45%, 30.49%, 18.44% and 25.53%, respectively. That is to say, after retirement, the proportion of medical expenditure of men and women in their monthly income increased by 9 and 7 percentage points respectively.

5. Robust Test

(1) Validity test

As mentioned before, McCrary pointed out that an important assumption of RDD is that running variable cannot be manipulated. In my research it is very difficult for the urban employees to manipulate their age so as to influence retirement. Therefore, the possibility of the running variable here, which is age, being manipulated is quite low (Li Hongbin et al., 2015). But I still use McCrary's method to test the probability density function of the running

variable with the command "dcdensity" in Stata.

Another assumption that affects the validity of RD estimation is the continuity of control variables (Lee and Lemieux, 2010), which requires that the control variables at the cutoff are stable and continuous. However, the personal information of the data I have is limited. So I only introduce the dummy variables of the month of visit and the year of income as the control variables to eliminate the effect of time trend. Moreover, when the sample size is large enough, the individual heterogeneity such as education level, marriage status and nationality tend to be stable on the whole. So I skipped this part of test.

(2) Changing the demonstrating setting

In the empirical study, there is no uniform standard for the selection of the order of age polynomials. But quadratic and cubic are mostly used (Gelman and Imbens, 2018). In order to test the robustness of the results in this paper, I tried to add cubic polynomial of age and its interaction with the dummy ‘legal’ into the regression functions. The results are quite similar. Besides, I changed the age range to test the sensitivity. I adjusted the age range from 3 years before and after the legal retirement age to 2 years and 1 year before and after. The regression results show that the conclusions are basically stable.

(3) Changing the cutoff

Another robust test of RD is to verify that there are no other discontinuity in the range of running variable. Therefore, referring to the practice of Lei Xiaoyan et al. (2010), I randomly set other cutoffs (one year before and after the legal retirement age) to test whether the dependent variables such as number of daily visits and average monthly income have significant jump at the new cutoffs, and the results show no significant jump.

6. Research conclusions and shortcomings

(1) Research conclusions

This paper study the changes of medical utilization and financial burden of employees before and after retirement in China, using the data of MIUE and EIUE of Hubei Province, focusing on number of daily outpatient and inpatient visits, reimbursement proportion, average expenditure per visit, average length of inpatient stay, as well as monthly income and medical expenditure. FRD is used in this paper, the treatment variable is retirement. In order to solve the endogeneity problem of retirement decision, I take the legal retirement age as an IV of the treatment variable. Based on the differences of retirement policies between men and women, as well as physiology and life expectancy, all the analysis is conducted on the basis of gender.

According to the regression results of FRD, after retirement, daily hospital visits generally increase significantly after retirement except for female inpatient, with an increase of 23.7% in male outpatients, 25.9% in female outpatients, and 32.1% in male inpatients, respectively. But this increase has little to do with the proportion of medical insurance reimbursement, because although MIUE provides a higher proportion of reimbursement for retirees at the policy level, the proportion of reimbursement is basically the same, or even decreases in reality. In order to verify the hypothesis that the main reason for the increase of hospital visit after retirement is the decrease of time cost, I analyzed daily visits of weekdays and weekends respectively, and found that the growth rate of daily visits after retirement is significantly higher on weekdays than on weekends, which basically proved my hypothesis.

At the same time, there is no significant change in the average medical expenditure and the average length of inpatient stay before and after retirement. Besides, the monthly income of men and women decreased significantly after retirement, which was 21.8% for men and 32.7% for women. According to the monthly average income and out-of-pocket medical expenditure, the proportion of out-of-pocket medical expenditure of men and women in their monthly income after retirement increased by 9 and 7 percentage points respectively, reaching 30.5% and 25.5% compared with that before retirement.

The results show that retirees don’t really benefit more from the reimbursement ratio than on-the-job employees in China's medical insurance policy, which well prevents the overuse of medical resources after employees retire. However, due to the decline in the income level of employees after retirement, the proportion of medical expenditure in their income rises significantly, and the financial burden is quite heavy. Therefore, I suggest that the policy of medical insurance should consider the cost control and the rational utilization of medical resources, but at the same time, it should be inclined to the retirees.

(2) Shortcomings

First, although I observed a significant increase in daily outpatient and inpatient visits with retirement as the cutoff, I also came to the conclusion that this increase has nothing to do with the proportion of reimbursement, but I failed to analyze the specific reasons for this increase besides the decrease of time cost by data. Second, when estimating the monthly average medical expenditure, the regression coefficient of expenditure on age is not significant. So I have to give up the regression estimation and simply use the mean to estimate, which may cause the estimation value to be inaccurate. Third, the data used in this paper is the data of one province in China. Although the economic development and population structure of this province are similar with the overall level of China, the conclusions of this paper may not be applicable to the whole country.

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