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The impact of the Public Pension Program on the elderly's medical expenditures: A regression discontinuity approach

Journal of Applied Economics

Provided in Cooperation with: University of CEMA, Buenos Aires

Suggested Citation: Si, Xu; Chu, Fu-Ling (2022) : The impact of the Public Pension Program on the elderly's medical expenditures: A regression discontinuity approach, Journal of Applied Economics, ISSN 1667-6726, Taylor & Francis, Abingdon, Vol. 25, Iss. 1, pp. 178-196, https://doi.org/10.1080/15140326.2021.2021748

This Version is available at: https://hdl.handle.net/10419/314158

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Journal of Applied Economics

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/recs20

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To cite this article: Xu Si & Fu-Ling Chu (2022) The impact of the Public Pension Program on the elderly's medical expenditures: a regression discontinuity approach, Journal of Applied Economics, 25:1, 178-196, DOI: <u>10.1080/15140326.2021.2021748</u>

To link to this article: <u>https://doi.org/10.1080/15140326.2021.2021748</u>

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Published online: 03 Mar 2022.

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The impact of the Public Pension Program on the elderly's medical expenditures: a regression discontinuity approach

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ABSTRACT

The surge in aging societies has increased the relevance of retirement as a research topic. Utilizing the public data obtained from the China Family Panel Studies, this paper applies a regression discontinuity approach to assess the impact of China's current Public Pension Program on the medical expenditures of the elderly. The results reveal that the Public Pension Program increases out-ofpocket medical expenditures, hospitalization expenditures, and other injury and illness expenses. The results also report that being insured by Basic Social Health Insurance has a mitigating effect on the medical expenditures of the elderly; furthermore, there are significant differences in the use of medical resources between regions and urban and rural areas in China. Therefore, ensuring the sustainability of pension funds and social health insurance funds and developing customized private insurance according to areas can play a positive role in improving the use of medical resources and relieving the medical burden on the elderly population.

ARTICLE HISTORY

Received 17 May 2021 Accepted 19 December 2021

KEYWORDS

Public pension program: medical expenditures: regression discontinuity approach; aging; social security

1. Introduction

More and more countries are falling into the category of "aging societies"; consequently, retirement has attained great significance as an area of study. Retirement is an important milestone and a determinant of a vast population's quality of life. It also reflects the state of public health and the utilization of health care resources in a country (Levi & Kène, 2018). The pension provided by the Public Pension Program in China is about 50% of the pre-retirement salary on the national average. Owing to a gradual decline in birth rates and a simultaneous increase in life expectancy rates, over 12% of China's population is aged 60 years or older, exceeding the 10% threshold set by the United Nations for an aging society. By 2019, China's elderly population dependency ratio had already spiraled to 17.8% (http://www.stats.gov.cn/). Traditional family care is gradually deteriorating in China as a result of the country's rapidly aging population, coupled with its underdeveloped pension system (Chen, Dennis, Tang, & Wu, 2017; Wu & Li, 2014).

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Although elderly people approaching retirement typically possess sufficient property, savings, and pension assets, unexpected fluctuations in health conditions, asset prices, and health insurance plans can pose challenges for retired senior citizens to retain their savings and assets (Dayaram & Mcguire, 2019). The incentive benefits offered upon retirement are typically more inclined toward those from the lower income groups as well as individuals with limited access to annuity entitlements and supplementary health insurance (Rust & Phelan, 1997). People without pensions are more likely to retire early, which places greater demands on pre-retirement savings. These savings are needed to meet various expenses after retirement. A surge in the aging population increases the number of pension payments, warrants the establishment of health and long-term care insurance programs, and exerts significant pressure on the health care system (Gong, Kendig, & He, 2016; Kumagai & Takabayashi, 2008).

The health conditions of individuals post retirement determine the medical expenses that need to allocated toward elderly healthcare. Although this study conducted an assessment of the impact of China's current Public Pension Program on the medical expenditures of the elderly, this evaluation is still incomplete. This research primarily applies the regression discontinuity approach to identify strategies to control the endogenous problems faced by the elderly in receiving their pensions. It also aims to verify whether pensions can play a role in the utilization of medical and health services for the elderly in China.

2. Literature review

As the rate of aging and medical expenditures continue to increase, understanding the medical expenditures of the retirees under public pension programs is crucial. Public pension programs not only provide basic security for workers after retirement but also resolve any inequalities in terms of health conditions and socioeconomic statuses that may have existed among employees before their retirement (Szabó, Allen, Stephens, & Alpass, 2018). Moreover, Kail (2016) found that individuals covered by stable insurance plans tend to be healthier upon retirement.

Social insurance contributions paid by employees finance the public social security system. However, controlling the increase in medical expenditures and reducing the burden on public pensions under the pay-as-you-go system and aging societies remains a concern for many scholars. Some studies have demonstrated that per capita medical expenditures on individuals aged 65 and above are higher than those incurred for other age groups (Olaniyan, Olayiwola, & Odubunmi, 2011), and out-of-pocket expenditures rise sharply for the elderly toward the end of life (Fahle, Mcgarry, & Skinner, 2016; Wei & Zhou, 2019). The increase in medical expenditures has put enormous pressure on the income of elderly households and forced them to reduce their spending in other areas. In addition, increased medical expenditures subsequently increase public pension benefits and social insurance burden rates (Kumagai & Takabayashi, 2008). Moreover, pensioners who have contributed less to the public health insurance system have higher health care expenditures (Fourcade, Duval, & Lardellier, 2013). Differences in the treatment and utilization of medical and health services among patients are overwhelmingly dependent on affordability (Xian et al., 1944; Zhao, Zhang, Fu, Wang, & Zhang, 2020). High out-of-

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pocket costs can limit people's access to health care (Krůtilová, 2016). Hence, the population in poverty often has limited access to health services and treatment due to financial constraints.

In terms of reducing medical expenditures, Zhang, Nikoloski, and Mossialos (2017) found that the expansion of health insurance coverage had a positive effect on lowering out-of-pocket expenditures for inpatients. However, Bruno and Melanie (2013) argue that the expansion of coverage may also reduce the technical efficiency of healthcare services. Moreover, private health insurance can play an essential role in transferring the risk of illness, specifically by reimbursing the medical expenses incurred by the insured person for the treatment of illnesses during the insurance period, which is more beneficial for middle-aged and older people (Baggio et al., 2018; Kwon, Park, & Mcbride, 2018). Studies have also confirmed that supplementary health insurance can play a crucial role in providing the low-income populations with access to health services (Carré, Thomas, Jusot, Wittwer, & Christelle, 2019). Our study focuses on the impact of the Public Pension Program on the medical expenditures of the elderly and adopts a different research methodology from existing studies to draw empirical conclusions and provide a valuable reference for policy reform.

3. Materials and methods

3.1. Data

The analysis was based on the most recently obtained data from the 2018 survey public data conducted by the China Family Panel Studies (CFPS). The CFPS is implemented by the Chinese Social Science Survey Center (ISSS) of Peking University. It aims to track and collect data at three levels – namely, the individual, familial, and community levels – to evaluate the changes in China's society, economy, population, education, and health. Any researcher can use the relevant questionnaire and data after applying through the website (https://opendata.pku.edu.cn/dataverse/CFPS). The purpose of our paper was to explore the impact of the Public Pension Program on the medical expenditures of the elderly. Therefore, individuals who had been receiving their pensions from the Public Pension Program were included in the study, followed by other screening variables and samples. The final study comprised 7,303 samples.

3.2. Method

The ordinary least squares (OLS) is the general method used to estimate the impact of pension income on the medical expenditures incurred on the elderly:

$$Y_i = \alpha + \beta D_i + X_i \theta + \varepsilon_i \tag{1}$$

where Y_i is medical expenditure for the elderly, and D_i indicates whether an individual is eligible for pension; that is, when individuals receive pension, D_i takes the value of 1, otherwise, the value of D_i is 0. $X'_i\theta$ represents the effect of control variables. Individuals are not random in terms of pension receipts and medical expenditures. Income and expenditure are influenced by a wide range of factors such as individual characteristics and socioeconomic status. This makes it hard to control for all variables that may affect both pension receipts and medical expenditures. Moreover, the estimate of the coefficient β is biased in the case of the omission of variables. To study the impact of China's current Public Pension Program on the medical expenditures of the elderly, this paper uses the regression discontinuity approach, a technique widely used in recent years to identify causal effects.

Under the statutory retirement age of 60, the pension was available after retirement, so the probability of receiving the pension near the age of 60 increased abruptly. Using the statutory retirement age as a breakpoint, we selected a control group and an experimental group near the breakpoint and identified the effects of treatment on the experimental group (comprising the individuals who receive the pension). China's current retirement system allows for an early retirement scheme for employees who are seriously ill as well those grappling with disabilities or total incapacitation. Therefore, the retirement system only makes an exogenous jump in the probability of receiving the pension does not necessarily change from 0 to 1 at the breakpoint. The individual's age only increases the probability of receiving the pension, so our paper uses the fuzzy regression discontinuity (FRD) regression model to estimate the average effect of the policy on "compilers" (i.e., those individuals whose forcing variable is above the threshold and have received the policy treatment) around the threshold:

$$D_i = \begin{cases} 1 i f pension_i > 0\\ 0 i f pension_i = 0 \end{cases}$$
(2)

Where D_i is the treatment variable indicating whether an individual is eligible for pension, i.e., when individuals receive their pensions, D_i takes the value of 1, otherwise, its value is 0. Although satisfying the age condition $T_i = 1(z_i \ge 60)$ does not necessarily result in receipt of pension, it can be introduced into the health expenditure equation as an instrumental variable for pensions to control for the endogeneity of retirement decisions. z_i is the assignment variable (or the driver variable), wherein *i* represents the age of the individual.

$$Y_i = \alpha + \beta D_i + f(z_i) + \varepsilon_i \tag{3}$$

Equation (2) represents the causal effect of pension income on Y_i (medical expenditure), which is mentioned in Equation (3). β explains the local average treatment effect of pensions around the age breakpoint, and $f(z_i)$ is a polynomial function of z_i .

In this study, FRD is estimated by two-stage least squares (2SLS). Specifically, the onestage regression equation can be expressed as:

$$D_i = \gamma + \delta T_i + f(z_i) + \mu_i \tag{4}$$

where $T_i = 1(z_i \ge 60)$ is the instrumental variable for processing state D_i . In the empirical analysis section, different bandwidths and multiple $f(z_i)$ forms are used to ensure the robustness of the results.

3.3. Variable descriptions

As delineated in Table 1, the explained variables include out-of-pocket medical expenses, hospitalization expenses, and injury and illness expenses. The explanatory variables include gender, residence in urban/rural areas, family size, household income, whether the individuals were insured for social health insurance, and regional variables.

Variables	Description
cost_oop	Out-of-pocket medical expenses (Unit: Thousand Yuan/year)
cost_hos	Hospitalization expenses (Unit: Thousand Yuan/year)
cost_ill	Other injury and illness expenses (Unit: Thousand Yuan/year)
gender	Male = 1, $Female = 0$
urban	Urban = 1, $Rural = 0$
fml_count	Family or Household size
fincom	Household income (Unit: Thousand Yuan/year)
social_ins	Whether or not insured for social health insurance: insured $= 1$, uninsured $= 0$
region	Regional variables: East = 0, middle = 1 and West = 2

Table	1	Description	م ر	variables
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Table	2.	Descriptive	summary.
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	All Samples		Receive the Pension		Not Receive the Pension	
Variables	mean	sd	mean	sd	mean	sd
cost_oop	2.837	9.115	3.213	8.279	2.586	9.625
cost_hos	3.041	13.928	3.733	14.588	2.579	13.452
cost_ill	1.979	7.650	2.469	5.703	1.653	8.695
gender	0.585	0.493	0.567	0.496	0.597	0.491
urban	0.440	0.876	0.509	0.808	0.394	0.916
fml_count	3.617	1.941	3.322	1.944	3.814	1.913
fincom	58.566	71.238	60.075	80.361	57.560	64.435
social_ins	0.933	0.251	0.944	0.230	0.925	0.263
region	0.822	0.814	0.769	0.796	0.860	0.824

Table 2 depicts the results of the descriptive statistics for the sample, reporting the means and Standard Deviation (SD) for all samples, receiving or not receiving pensions, respectively. The age range of the sample was 45–93. As indicated in Table 2, in the overall sample, there were more males than females and more individuals from rural than urban areas. In terms of family size, on average, most households were made up of 3–4 members. It was found that in terms of medical expenditure, individuals who received the pension spent more, on an average, on out-of-pocket medical expenses, hospitalization expenses, and other illness and injury expenses as compared to individuals without pensions. The rural population accounted for a relatively high proportion of the non-pensioned individuals. Individuals with pensions participated more actively in social health insurance than those without pensions.

4. Results

4.1. The relationship between age and pension receipt

Figure 1 illustrates visually the relationship between the assignment variable (age) and the treatment variable (whether an individual is eligible for pension), which is also a onestage regression in the FRD estimation. We concluded that in China, there has been a significant increase in the retirement rate of individuals having attained the statutory retirement age (Feng, Li, & Smith, 2020), with a clear jump point around age 60. Specifically, this jump point occurs at age 60.5, which is largely consistent with the general policy of pension being offered to individuals having completed 60 years of age. The slight deviation between 60 and 60.5 may be due to seasonality in the actual payment of pensions. For example, some local governments have the tendency to provide pensions to the current year's retirees in the middle or at the end of the year.



Figure 1. Age and pension status.

The regression adds an age interaction term. *D* represents the general treatment status, 1 for over 60.5 years and 0 for under 60.5 years. The age control functions are *age_left = age-60.5*, and *D_age_left = D*× *age_left*, wherein the polynomials represent the age breakpoint difference. As reported in Table 3, regressions (1), (2), and (3) were performed using the rdrobust¹ command in Stata to obtain the optimal bandwidth of 5.311. To check the robustness of our results, we set up three bandwidths: optimal bandwidth, 50 % optimal bandwidth, and double optimal bandwidth. The hypothesis that reaching retirement age increases the probability of receiving the pension is well-supported by the fact that almost all variables are highly significant at different bandwidths. At the optimal bandwidth, reaching age 60 increases the probability of receiving the pension by 35% and is highly significant at the 1% level.

Dependent variable: whether receiving a pension (=1, Yes; = 0, No)										
(1) (2) (3)										
OBW		5.311								
Age Bandwidths	±100%OBW	±50%OBW	±200%OBW							
Age Range	[55.19, 65.81]	[57.84, 63.16]	[49.88, 71.12]							
D	0.350***	0.314***	0.433***							
	(0.000)	(0.000)	(0.000)							
Age Functions	Yes	Yes	Yes							
Control Variables	Yes	Yes	Yes							
_cons	0.293***	0.338***	0.272***							
	(0.000)	(0.000)	(0.000)							
Ν	2185	1280	5032							
AIC	2260.0	1454	3913							
R-squared	0.346	0.278	0.482							
F	143.7	61.28	583.5							

Table 3.	Impact of	policy age	on receiving	pension
Tubic 5.	impact of	policy uge	on receiving	pension

OBM = optimal bandwidth sizes. P-values are in parentheses. The asterisks ***, **, and * denote a significance of 1%, 5%, and 10%, respectively.

¹The default triangular kernel function was used to construct the local polynomial estimators.

4.2. Pensions and medical expenditures

The study used a two-stage least squares approach to estimate the causal effect of pension income on medical expenditures. First, graphical analysis was used to determine whether the outcome variable jumps at the breakpoint. As shown in Figure 2, out-of-pocket medical expenses, hospitalization expenses, and other injury and illness expenses jumped at the breakpoint.

Next, Table 4 reports the estimated results for the second stage with regard to different bandwidths (optimal bandwidth, 50% optimal bandwidth, and double optimal bandwidth). Regression controls other variables and polynomial functions of age. Overall, on a yearly basis, receiving pension can increase the out-of-pocket medical expenditure of the elderly by 1,942 yuan, hospitalization expenditures by 2,538 yuan, and other injury and illness expenses by 1,203 yuan under the optimal bandwidth. All increases are significant at the 1% level. The regression results under the 50% optimal bandwidth imply that pensions encourage the elderly to spend more each year on health care than the optimal bandwidth estimates. This is possibly because the effect is more significant as



Figure 2. Impact of pensions on medical expenditures: (a) cost_oop; (b) cost_hos; (c) cost_ill.

Dependent variables	Cost_oop			Cost_hos				Cost_ill		
	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
OBW		3.851			3.933			3.267		
Age	±100%	±50%	±200%	±100%	±50%	±200%	±100%	±50%	±200%	
Bandwidths	OBW									
Age Range	[56.65,	[58.57,	[52.80,	[56.57,	[58.53,	[62.63,	[57.23,	[58.87,	[53.97,	
	64.35]	62.43]	68.20]	64.43]	62.47]	68.37]	63.77]	62.13]	67.03]	
D	1.942**	4.506***	0.633	2.538*	5.294***	0.829	1.203**	1.546**	0.441	
	(0.035)	(0.004)	(0.309)	(0.072)	(0.006)	(0.372)	(0.016)	(0.030)	(0.544)	
Age functions	Yes									
Control	Yes									
variables										
_cons	4.172***	3.286	4.805***	4.707**	0.730	4.211***	2.732***	3.323***	3.296***	
	(0.001)	(0.102)	(0.000)	(0.012)	(0.767)	(0.000)	(0.000)	(0.000)	(0.001)	
Ν	1680	862	3708	1680	862	3708	1280	862	3242	
AIC	12,313	6535	26,906	13,742	6894	29,874	7451.2	5169	24,106	
R-squared	0.0120	0.0270	0.00500	0.00800	0.0190	0.00300	0.0170	0.0220	0.00600	
F	2.289	2.673	1.920	1.449	1.812	1.131	2.508	2.088	2.071	

Table 4. Impact of pensions on medical expenditures.

OBM = optimal bandwidth sizes. P-values are in parentheses. The asterisks ***, **, and * denote a significance of 1%, 5%, and 10%, respectively.

Dependent									
variables	Cost_oop			Cost_hos			Cost_ill		
	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
OBW	3.851			3.933			3.267		
Age	±100%	±50%	±200%	±100%	±50%	±200%	±100%	±50%	±200%
Bandwidths	OBW	OBW	OBW	OBW	OBW	OBW	OBW	OBW	OBW
Age Range	[56.65,	[58.57,	[52.80,	[56.57,	[58.53,	[62.63,	[57.23,	[58.87,	[53.97,
	64.35]	62.43]	68.20]	64.43]	62.47]	68.37]	63.77]	62.13]	67.03]
D	2.199**	2.702*	0.480	3.841*	4.041	1.441	4.059***	2.864	0.0120
	(0.028)	(0.088)	(0.519)	(0.064)	(0.145)	(0.295)	(0.002)	(0.142)	(0.993)
Age functions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
variables									
_cons	4.059***	2.864	4.762***	7.080***	2.535	5.451***	2.313***	2.628**	3.379*
	(0.002)	(0.142)	(0.000)	(0.008)	(0.457)	(0.002)	(0.004)	(0.012)	(0.053)
N	818	437	1792	818	437	1792	634	437	1574
AIC	5550.2	3013	12,384	6745	3501	14,587	522.1	2462	12,636
R-squared	0.0190	0.0260	0.0140	0.0180	0.0260	0.0100	0.0190	0.0300	0.00500
F	2.011	1.400	3.095	1.841	1.454	2.164	1.541	1.656	1.002

 Table 5. Impact of pensions on medical expenditures: Urban.

OBM = optimal bandwidth sizes. P-values are in parentheses. The asterisks ***, **, and * denote a significance of 1%, 5%, and 10%, respectively

Table 6. Impact of pensions on medical expenditures: Rural.

Dependent									
variables	Cost_oop			Cost_hos			Cost_ill		
	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
OBW	3.851			3.933			3.267		
Age	±100%	±50%	±200%	±100%	±50%	±200%	±100%	±50%	±200%
Bandwidths	OBW	OBW	OBW	OBW	OBW	OBW	OBW	OBW	OBW
Age Range	[56.65,	[58.57,	[52.80,	[56.57,	[58.53,	[62.63,	[57.23,	[58.87,	[53.97,
	64.35]	62.43]	68.20]	64.43]	62.47]	68.37]	63.77]	62.13]	67.03]
D	2.321	6.142**	1.191	1.825	6.111**	0.596	1.715**	1.948*	0.877*
	(0.118)	(0.017)	(0.222)	(0.334)	(0.017)	(0.633)	(0.030)	(0.095)	(0.086)
Age functions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
variables									
_cons	2.805	2.385	4.086***	0.840	-2.541	2.231	3.212***	3.928**	3.149***
	(0.164)	(0.484)	(0.002)	(0.744)	(0.454)	(0.182)	(0.002)	(0.011)	(0.000)
Ν	848	420	1892	848	420	1892	637	420	1647
AIC	6438.4	3310	14,110	6848	3305	15,044	855.7	2643	9933
R-squared	0.00500	0.0290	0.00400	0.00400	0.0330	0.00200	0.0230	0.0310	0.0160
F	0.517	1.540	0.957	0.425	1.742	0.397	1.811	1.648	3.278

OBM = optimal bandwidth sizes. P-values are in parentheses. The asterisks ***, **, and * denote a significance of 1%, 5%, and 10%, respectively

the optimal bandwidth decreases and the sample size on either side of the breakpoint decreases. According to the sample, the median monthly pension payment is 950 yuan, and the average is 1,475.66 yuan. According to the income of 950 yuan, the annual pension income is 11,400 yuan, which can cover the annual increase in medical expenditures.

Dependent									
variables	Cost_oop			Cost_hos			Cost_ill		
	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)
OBW	3.851			3.933			3.267		
Age	±100%	±50%	±200%	±100%	±50%	±200%	±100%	±50%	±200%
Bandwidths	OBW	OBW	OBW	OBW	OBW	OBW	OBW	OBW	OBW
Age Range	[56.65,	[58.57,	[52.80,	[56.57,	[58.53,	[62.63,	[57.23,	[58.87,	[53.97,
	64.35]	62.43]	68.20]	64.43]	62.47]	68.37]	63.77]	62.13]	67.03]
D	1.296	3.679**	0.526	2.000	4.860**	1.000	3.094***	1.255	0.217
	(0.146)	(0.013)	(0.380)	(0.142)	(0.014)	(0.279)	(0.000)	(0.362)	(0.776)
Age functions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
variables									
_cons	3.094***	1.255	3.456***	2.232*	-1.062	2.654***	2.148***	2.373***	3.050***
	(0.000)	(0.362)	(0.000)	(0.086)	(0.564)	(0.002)	(0.000)	(0.000)	(0.000)
Ν	1576	809	3476	1576	809	3476	1199	809	3044
AIC	11,349	5974	24,731	12,682	6445	27,733	6827.8	4722	22,741
R-squared	0.0120	0.0300	0.00500	0.00600	0.0180	0.00300	0.0150	0.0160	0.00600
F	2.420	3.120	2.010	1.116	1.878	1.167	2.206	1.665	2.173

Table	7	Impact	of	nensions	on	medical	expenditures.	Insured
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OBM = optimal bandwidth sizes. P-values are in parentheses. The asterisks ***, **, and * denote a significance of 1%, 5%, and 10%, respectively.

Table 8. Impact of pensions on medical expenditures: Uninsured.

Dependent									
variables	Cost_oop			Cost_hos			Cost_ill		
	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)
OBW	3.851			3.933			3.267		
Age	±100%	±50%	±200%	±100%	±50%	±200%	±100%	±50%	±200%
Bandwidths	OBW	OBW	OBW	OBW	OBW	OBW	OBW	OBW	OBW
Age Range	[56.65,	[58.57,	[52.80,	[56.57,	[58.53,	[62.63,	[57.23,	[58.87,	[53.97,
	64.35]	62.43]	68.20]	64.43]	62.47]	68.37]	63.77]	62.13]	67.03]
D	13.632**	17.43	2.363	13.69	13.24	-1.333	6.234*	7.900	3.737*
	(0.036)	(0.174)	(0.589)	(0.174)	(0.167)	(0.808)	(0.073)	(0.153)	(0.060)
Age functions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
variables									
_cons	1.221	8.871	4.973	3.495	9.969	10.171**	2.248	5.254	1.846
	(0.832)	(0.514)	(0.202)	(0.697)	(0.327)	(0.039)	(0.507)	(0.370)	(0.278)
N	104	53	232	104	53	232	81	53	198
AIC	878.2	480.9	1948	970.5	449.8	2055	564.7	391.6	1320
R-squared	0.0840	0.134	0.0160	0.0730	0.187	0.0220	0.0860	0.116	0.0370
F	1.088	0.851	0.462	0.929	1.264	0.634	0.849	0.725	0.902

OBM = optimal bandwidth sizes. P-values are in parentheses. The asterisks ***, **, and * denote a significance of 1%, 5%, and 10%, respectively.

4.3. Analysis of the heterogeneous treatment effect

4.3.1. Urban/rural residence

Owing to the differences in income, healthcare, and education levels between urban and rural areas in China, urban dwellers tend to have higher standards of living than individuals in rural areas. For the purpose of examining the effect of the Public Pension Program on the heterogeneity on health care expenditures between urban and rural households, the sample was divided into two sub-samples – urban and rural – for regression. As shown in Tables 5 and 6, in terms of out-of-pocket medical expenditures, the 50% optimal bandwidth is more than double the annual expenditure in rural areas (6,142 yuan) than in urban areas (2,702 yuan). A possible explanation for this disparity is that unequal social insurance coverage leads to differences in healthcare utilization and health outcomes across socioeconomic groups (David, Dobkin, & Maestas, 2008).

In China, the urban and rural populations have two systems of social health insurance, with urban populations paying higher premiums and obtaining higher reimbursement rates and, therefore, incurring lower out-of-pocket health expenditures than those residing in rural areas. In terms of hospitalization expenditure, the optimal bandwidth is higher for urban expenditures than for the rural ones; however, the coefficient for the rural population is not significant. Urban areas also incur twice the amount of expenditures incurred by rural areas in terms of medical expenses other than that incurred from hospitalization. Pension incomes also vary greatly between urban and rural areas. The sample analysis revealed that the median pension in urban areas was 2,075.50 yuan per month with a mean value of 2,213.66 yuan, while the median pension in rural areas was 100 yuan per month with a mean value of 566.38 yuan. Therefore, the urban population incurs higher hospitalization and other medical expenses as compared to those incurred by individuals in rural areas. Moreover, the urban population usually has the awareness and additional financial wellbeing to purchase commercial health insurance and provide themselves with a higher level of medical protection.

4.3.2. Different regions

The inequality in and the unbalanced distribution of healthcare resources in China not only exists between rural and urban areas but also among different regions of the country depending on their economic development levels. For the purpose of regression analysis, the sample was classified into three sub-samples – namely, the east, middle, and west regions – to investigate the regional differences in the medical expenditures of the elderly under the Public Pension Program. (The details of the regressions are shown in Appendix Tables A1–A3).

In the regressions with the optimal bandwidth, 50% optimal bandwidth and double optimal bandwidth, the highest expenditures were found in the eastern region with the optimal bandwidth. However, the results were not significant in the central and west regions in terms of out-of-pocket expenditures and those on other injury and illness expenses. Moreover, the hospitalization expenditure, 50% optimal bandwidth, was higher in the west than in the central region. This may be explained by the fact that the east region is significantly at a better position than the central and western regions in terms of household income status and level of medical development. There are still other selection biases – including differences in social health insurance in the deductible, reimbursement ratio, and cap line – that differ within the same region and may cause the regression to be insignificant.

4.3.3. Social health insurance

Whether or not an individual is covered by social health insurance also has a significant impact on residents' medical expenditures. The impact of social health insurance on medical expenditure under the Public Pension Program was analyzed by dividing the sample into two parts according to whether the people were insured. As shown in Tables 7 and 8, the elderly individuals who were insured for social health insurance had lower

out-of-pocket medical expenses, hospitalization expenses, and other injury and illness expenses than those who were uninsured. However, only the expenditures on other injury and illness expenses were significant in both regressions under the optimal bandwidth (Model 37 and Model 46). This finding indicates that social health insurance could play a role in reducing residents' expenses when seeking medical treatment for illness or accidental injuries.

4.4. Validity test of regression discontinuity estimation

4.4.1. Age manipulation test

Through the above analysis, this study used a variety of bandwidth settings, all of which derive consistent estimation results, indicating the robustness of the regression discontinuity (RD) estimation. The validity of the RD identification strategy requires that economic individuals cannot (at least completely) manipulate the assignment variable (i.e., age), and if the assignment variable can be manipulated, then the RD estimation is probably biased. This study uses the rdcont test introduced by Bugni and Canay (2018), and the results are reported in Table 9. The p-value of the sample non-random test for breakpoint regression at the critical value is 0.307, which cannot reject the original hypothesis, indicating that the assignment variable (age) density function is a continuous function at the critical value and there is no human intervention.

4.4.2. Balance test of control variables

Another method to test the validity of the RD estimates is to assess the continuity of the control variables (Lee & Lemieux, 2010). Theoretically, if RD is valid, then the treatment variable (whether an individual is eligible for pension) should not be different before and after the breakpoint from the effect of other variables. First, the graphical analysis (Figure 3) demonstrates that the six control variables are continuous before and after the breakpoint.

Next, use the estimation method to find out whether the estimated specific coefficient is significant. The regression sets the control variables as the dependent variables for the age breakpoints and then estimates the parameter estimates for different age bandwidths. Table 10 reports the results of applying the first-order interaction term regression model to the covariate balance test. Column 5 shows the coefficients for the age breakpoints (age = 60.5 years). For these facts that have occurred before the age breakpoint and should not be restricted by pension age, the coefficient is not significant at the 10% level. This implies that the covariates in the model are not cut off near the driving variable and are not affected by retirement age, supporting the validity of the RD identification strategy. Three bandwidths were used to ensure the robustness of the test results.

Left of c	Right of c
4108	3195
74	88
-0.5	0.5
0.307	
	Left of c 4108 74 -0.5 0.307

Table 9. RDD non-randomized approximate sign tes	able 9. R	D non-rando	mized approx	imate sign test
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Figure 3. Continuity test of control variables: (a) fincom; (b) fml_count; (c) gender; (d) social_ins; (e) urban; (f) region.

Variables	OBW	Age Bandwidths	Age Range	Coefficient	P-Value
gender	6.668	±100%OBW	[53.83, 67.17]	0.030	0.406
-		±50%OBW	[57.17, 63.83]	-0.028	0.618
		±200%OBW	[47.16, 73.84]	0.028	0.278
urban	7.232	±100%OBW	[53.27, 67.72]	0.030	0.650
		±50%OBW	[56.88, 64.12]	-0.019	0.844
		±200%OBW	[46.04, 74.96]	0.022	0.629
fml_count	6.249	±100%OBW	[54.25, 66.75]	-0.160	0.336
		±50%OBW	[57.38, 63.62]	0.025	0.918
		±200%OBW	[48.00, 73.00]	-0.108	0.329
fincom_a	5.953	±100%OBW	[54.55, 66.45]	-5.455	0.367
		±50%OBW	[57.52, 63.48]	-5.417	0.412
		±200%OBW	[48.59, 72.41]	-3.562	0.369
social_ins	6.277	±100%OBW	[54.33, 66.78]	-0.008	0.677
		±50%OBW	[57.36, 63.64]	0.012	0.664
		±200%OBW	[47.95, 73.05]	0.002	0.857
region	5.537	±100%OBW	[54.96, 66.04]	0.125	0.049
		±50%OBW	[57.73, 63.27]	0.126	0.168
		±200%OBW	[49.43, 71.57]	0.031	0.516

Table 10. Continuity test of control variables.

OBM = optimal bandwidth sizes.

4.5. Placebo tests

To ensure the robustness of the results, a placebo test was also applied. The idea was that changing the age breakpoint should not have a significant effect on the elderly's medical expenditures. New age breakpoints of 65.5 years and 55.5 years, respectively, were set. If

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the effect of this breakpoint on medical expenditures was not significant, it would be more certain that the effect of changes in the elderly's medical expenditures on pension income is not due to the heterogeneity brought about by the ages change.

Figure 4 illustrates the continuity of the dependent variables at the new age breakpoints. Out-of-pocket medical expenses, hospitalization expenses, and other injury and illness expenses are all continuous at the new breakpoint. Further regression estimates were performed using the age breakpoint as the main independent variable. Table 11 reports the results of the placebo test with *p*-values greater than 0.1 for each coefficient. The table shows that the location of the new breakpoint does not have a significant effect on medical expenditure and the consumption of medical changes smoothly with age, so the RD estimate with a breakpoint of 60.5 years is valid.

5. Discussion

Under the Public Pension Program, the elderly tends to spend pension more for medical consumption than before retirement. And our study found that the Public Pension Program increases out-of-pocket medical expenditures of the elderly by 1,942 yuan, hospitalization expenditures by 2,538 yuan, and other injury and illness expenses by 1,203 yuan, on a yearly basis. On the one hand, the increased demand for medical services may due to the physical condition of the elderly after retirement (Bíró & Elek, 2018; Calvo, Sarkisian, & Tamborini, 2012; Wallace, Haveman, & Wolfe, 2017); on the other







Figure 4. Placebo tests: (a) cost_oop; (b) cost_hos; (c) cost_ill; (d) cost_oop; (e) cost_hos; (f) cost_ill; (a)–(c) breakpoint age = 65.5 years; (d)–(f) breakpoint age = 55.5 years.

Variables	Cutoff	Coefficient	P-Value
cost_oop	c = 65.5	0.415	0.468
	c = 55.5	1.371	0.138
cost_hos	c = 65.5	0.831	0.459
	c = 55.5	1.051	0.374
cost_ill	c = 65.5	-0.773	0.130
	c = 55.5	2.424	0.214

Table 11. Placebo test.

OBM = optimal bandwidth sizes.

hand, the complex and variable disease spectrum and rising healthcare costs have led to medical consumption comprising a large percentage of household consumption expenditures (Shai, 2018).

Another important finding is that, considering the imbalance in the distribution of medical resources and the differences in the level of economic development between regions, urban and rural areas in China, we carried out a heterogeneity analysis and concluded that in terms of out-of-pocket medical expenditures, the annual expenditures in rural areas (6,142 yuan) is more than double in urban areas (2,702 yuan). We also found that hospitalization expenditures are higher in the western region than in the central region. These findings support the view of Xian et al. (1944) and David et al. (2008) that inequalities in healthcare are greater in less economically developed regions. Unequal social insurance coverage leads to differences in healthcare utilization across socioeconomic groups. Furthermore, we find that individuals with social health insurance have lower medical expenditures, which should be attributed to the mitigating effect of social health insurance in terms of the residents' medical expenditures.

Our study uses a regression discontinuity approach, which effectively avoids the problem of endogeneity and confirms the validity of the RD estimates through a series of tests. Undeniably, this study still has limitations. Although the RD regression has excellent internal validity, the findings cannot be generalized to other age groups in the population because only the elderly near the breakpoint are considered a part of the specific sample. The model yields only a local average treatment effect (Christelis, Georgarakos, & Anna, 2020).

The results of this study provide productive directions for the reform of Public Pension Programs and social health insurance systems. Increasing life expectancy, low fertility, and a growing ratio of retirees to the working population have plagued the pay-as-you-go social security systems in many countries (Roy, 2018; Schreiber, 2018). In addition to demographic factors, the low investment returns of China's pension funds have also shocked its sustainability. Increasing the investment return of pensions through innovative investment mechanisms could be an improvement measure. In response to regional differences in medical resources and the economy, the role of traditional family care and child support should be fulfilled, and the level of social security contributions should be appropriately increased within the acceptable range of rural residents to increase the health insurance fund and pension fund. Increasing the level of government subsidies for health insurance contributions in rural areas, improving the reimbursement ratio of medical reimbursement, and reducing the threshold of reimbursement reduce the medical expenses and pension burdens of rural residents. Other policy measures that can be considered

are that regions can explore the establishment of a contribution adjustment mechanism linked to the level of local economic development. Individuals should also improve their health to avoid excessive medical treatment and wastage of medical resources.

The findings also reflect China's high social health insurance coverage, but its guarantee level is low. Retirees have a higher burden of medical expenditures that cannot be met only by social insurance, especially for the elderly with lower economic levels. Private health insurance can provide broader health coverage and reduce financial burden on patients (Baggio et al., 2018; Paccagnella, Rebba, & Weber, 2013). Private health insurance can be customized according to different areas that include both the product and the relevant guarantee level at different rates. Correspondingly, as a supplement to social insurance, private pension insurance also needs to develop and design differentiated commercial pension insurance products for people with different life cycles. The government could consider raising tax benefits to incentivize individuals to purchase.

6. Conclusions

In the context of a rapidly aging population, the design of health insurance, the estimation of health care demands are important determinants of social welfare and economic development (Wang & Wang, 2020). The rising proportion of the aging population will bring a huge burden of pension and medical care to society. Studying the medical expenditures of the elderly after retirement and the utilization of medical resources is of practical significance for reforming and improving social endowment insurance and medical insurance. Accordingly, our study uses a RD approach to assess the impact of China's current Public Pension Program on the medical expenditures of the elderly. First, research has shown that China's current Public Pension Program has increased the cost of medical care for the retired elderly, that is, it has increased the use of medical resources by pensioners. Second, regional differences exist in the allocation and utilization of healthcare resources in China. Finally, financing for the intergenerational allocation of income remains an important issue in the future. Future research should include a broader range of key descriptive variables and explore more proven research methodologies to allow for more comprehensive analysis.

Acknowledgments

The authors wish to thank the study participants for their contribution to the research.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix

Dependent	Cost con			Cost bos			Cost ill		
valiables	Cost_oob			COST_HOS			COSt_III		
OBW	3.851			3.933			3.267		
Age	±100%	±50%	±200%	±100%	±50%	±200%	±100%	±50%	±200%
Bandwidths	OBW	OBW	OBW	OBW	OBW	OBW	OBW	OBW	OBW
Age Range	[56.65,	[58.57,	[52.80,	[56.57,	[58.53,	[62.63,	[57.23,	[58.87,	[53.97,
	64.35]	62.43]	68.20]	64.43]	62.47]	68.37]	63.77]	62.13]	67.03]
D	2.742**	2.882	0.396	2.992	1.135	0.498	1.747*	1.988	0.912*
	(0.047)	(0.198)	(0.691)	(0.190)	(0.644)	(0.750)	(0.052)	(0.115)	(0.089)
Age Functions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
variables	C COOXXX	7 2 4 5 * * *		0 000***	C 224**	C 10CXXX		1 000	0.010*
_cons	6.689***	7.345***	5./30***	8.800***	6.221**	6.106***	1./4/*	1.988	0.912*
	(0.000)	(0.007)	(0.000)	(0.002)	(0.036)	(0.002)	(0.052)	(0.115)	(0.089)
Ν	783	412	1628	783	412	1628	599	412	1439
AIC	5819.4	3129	12,114	6607	3206	13,576	3767.3	2655	8762
R-squared	0.0320	0.0590	0.00800	0.0240	0.0480	0.00500	0.0140	0.0180	0.0150
F	3.172	3.156	1.632	2.334	2.518	0.964	1.057	0.939	2.764

Table A1. The impact of pensions on medical expenditures: East.

OBM = optimal bandwidth sizes. P-values are in parentheses. The asterisks ***, **, and * denote a significance of 1%, 5%, and 10%, respectively.

	Та	bl	e A2.	The	impact o	fp	pensions o	on	medical	ex	penditures:	Middle.
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Dependent variables	Cost oon			Cost hos			Cost ill		
valiables	cost_oop			COST_1103			CO3L_III		
OBW	3.851			3.933			3.267		
Age	±100%	±50%	±200%	±100%	±50%	±200%	±100%	±50%	±200%
Bandwidths	OBW	OBW	OBW	OBW	OBW	OBW	OBW	OBW	OBW
Age Range	[56.65,	[58.57,	[52.80,	[56.57,	[58.53,	[62.63,	[57.23,	[58.87,	[53.97,
	64.35]	62.43]	68.20]	64.43]	62.47]	68.37]	63.77]	62.13]	67.03]
D	1.221	4.842**	1.202	2.479	7.682**	1.221	0.371	1.255	-0.115
	(0.360)	(0.011)	(0.190)	(0.278)	(0.025)	(0.360)	(0.597)	(0.228)	(0.960)
Age Functions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Valiables	1 0 5 1	1.016	2 252*	0.007	2 252	1 051	1.045**	2 2 4 4	2 210
_cons	1.951	1.016	2.252*	0.607	-2.353	1.951	1.945**	2.244	3.210
	(0.284)	(0.696)	(0.061)	(0.846)	(0.615)	(0.284)	(0.041)	(0.116)	(0.277)
Ν	492	246	1135	492	246	1135	373	246	980
AIC	3314.5	1624	7696	3844	1913	8835	1923.4	1328	8273
R-squared	0.0120	0.0510	0.00900	0.0110	0.0330	0.00500	0.0320	0.0480	0.0110
F	0.727	1.581	1.274	0.670	1.002	0.713	1.483	1.504	1.301

OBM = optimal bandwidth sizes. P-values are in parentheses. The asterisks ***, **, and * denote a significance of 1%, 5%, and 10%, respectively.

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Dependent									
variables	Cost_oop			Cost_hos			Cost_ill		
OBW	3.851			3.933			3.267		
Age	±100%	±50%	±200%	±100%	±50%	±200%	±100%	±50%	±200%
Bandwidths	OBW	OBW	OBW	OBW	OBW	OBW	OBW	OBW	OBW
Age Range	[56.65,	[58.57,	[52.80,	[56.57,	[58.53,	[62.63,	[57.23,	[58.87,	[53.97,
	64.35]	62.43]	68.20]	64.43]	62.47]	68.37]	63.77]	62.13]	67.03]
D	0.888	6.236	0.430	1.210	9.512*	0.448	1.046	0.603	0.464
	(0.684)	(0.144)	(0.749)	(0.642)	(0.065)	(0.784)	(0.136)	(0.553)	(0.529)
Age Functions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Variables									
_cons	0.0970	-7.145	5.385***	-1.133	-11.42	4.269*	1.591	2.031	2.161**
	(0.975)	(0.230)	(0.004)	(0.763)	(0.112)	(0.061)	(0.112)	(0.153)	(0.036)
Ν	405	204	945	405	204	945	308	204	823
AIC	396.65	1663	6972	3239	1738	7340	1568.4	1077	4975
R-squared	0.0130	0.0600	0.00400	0.0100	0.0570	0.00200	0.0130	0.0250	0.0180
F	0.640	1.554	0.480	0.497	1.472	0.208	0.497	0.634	1.914

Table A3. The impa	act of pensions	on medical ex	penditures: West.
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OBM = optimal bandwidth sizes. P-values are in parentheses. The asterisks ***, **, and * denote a significance of 1%, 5%, and 10%, respectively.