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Gender Differences In The Effects Of Retirement On Healthcare Utilization: New Insights From Healthcare Data In China

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By

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Abstract

Despite continuing debate about the impact of retirement on healthcare utilization, there has been mixed evidence. Understanding this relationship is important in considering the full costs of policies to increase the age of retirement, as countries such as China are considering. This study uses data from medical records on individuals who got treatment in 1348 Chinese hospitals. We take advantage of the fact that retirement is mandatory in China and that the age of retirement is 50 for blue-collar females, 55 for white-collar females and 60 for all males. This allows us to estimate the causal effects of retirement on healthcare use via a Regression Discontinuity Design approach. We find an increase of 8 percent in hospital admission rate at retirement for males but none for blue-collar female, and only 2 percent increase for white-collar female workers. The increase in the admission rate among males is largely due to treatment for respiratory diseases, while the increase among females is driven by treatment for external causes and mental illnesses. Moreover, we find that total medical expenses per hospital stay and expenses per patient day for males increases by 8 percent and 14 percent, respectively, but not for females. We find no effect of retirement on in-hospital mortality and proportion of Emergency Room admission. These findings are robust to several placebo tests, model specifications, and bandwidths, however, some limitations remain.

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1. Introduction

Retirement represents one of the most important transitions in one's work life, and is a critical social policy for countries. Change in medical use is a major impact of retirement. China, with its large population and growth in the formal sector, has one of the largest retirement population in the world. Also, health care is becoming more formal and institutional as the economy is moving from informal to the formal sectors. Thus, it is crucial to understand the impacts of retirement on health care in China.

The gender difference in the retirement effect on healthcare utilization is also compelling. Better understanding the difference in the changes of healthcare utilization around retirement and the underlying behavior patterns is valuable for informing more specific and effective strategies on disease prevention, diagnosis, and management. There are several factors leading to the gender difference in response to retirement in China. The first factor is the different retirement age. Currently, the mandatory retirement age is 50 for blue-collar women, 55 for white-collar women, and 60 for all men. Women have to retire 5 to 10 years earlier than men, but women's life expectancy is higher than men. Second, social norms also differentiate by gender. For example, women are expected to take more responsibility for taking care of family than men in China. These different shared social expectations shape different responses to retirement in health care utilization. In this paper, we take advantage of data from Chinese hospitals to explore causal links between retirement and healthcare by gender. Although we are not able to disentangle the impacts of age and gender due to the different mandatory retirement ages by gender, we are able to be the first paper that uses hospital claim data to document how worker's health care utilization is affected by the retirement policy, and how women and men vary from each other in an emerging market economy.

The aim of this study is to estimate the causal impact of the mandatory retirement system in China on various aspects of health care utilization. Because retirement is mandatory for the population that we study, the age of retirement is largely exogenously determined. We make use of a large data set of medical records to offer novel evidence on the causal effect of retirement on healthcare, by applying a Regression Discontinuity Design (RDD) methodological approach based on the continuity assumption framework. We focus on gender-related and occupation-related differences that occur due to the different ages set for mandatory retirement between males and females, and between blue-collars and white-collars.

The overall effect of retirement on healthcare utilization must be empirically estimated, because its impact on utilization is ambiguous a priori on theoretical grounds. On one hand, the demand for healthcare may increase after retirement because of the reduction in the value of time; medical utilization can be time-intensive. There may also be pent-up demand due to time constraints while working that are lowered after retirement. On the other hand, the demand for healthcare may decline after retirement due to negative income effects, more time for self-care and less mental and physical stress after when not working.

Most literature on this topic has used survey data to examine the impact of retirement on health and healthcare utilization, and the empirical evidence is mixed. The predominant empirical identification method uses of Instrumental Variable (IV) approach, where the mandatory retirement age acts as the instrumental variable. Based on this identification method, some studies from developed countries show that retirement reduces healthcare utilization in several aspects, such as the number of doctor visits (Eibich, 2015; Norma B. Coe, 2015), and this reduction is heterogeneous across populations. Particularly, the likelihood of hospitalization for low SES population decreases most (Maja Weemes GrØrring, 2018). However, other studies show that the effect of retirement is insignificant on a number of factors, including length of stay (Norma B. Coe, 2015), acute hospitalization (Maja Weemes GrØrring, 2018), and inpatient incidence (Eduardo F´e, 2011). The evidence from developing countries, however, is very limited. Research from China using China Health And Health Longitudinal Study (CHARLS) found that mandatory retirement increases the number of doctor visits for both males and females, as well as inpatient cost for males (Zhang, Salm, & van Soest, 2018). No effect on length of stay is observed.

This study contributes to the existing literature in three aspects. First, the self-reported data used in these studies is often subject to recall error on times of hospital visits, medical expenditure, and the limited information on diagnosis and treatment. The measurement error could bias the estimation toward both directions. Instead of using self-reports of medical services received, our dataset makes use of medical information that is categorized using the ICD-10 codes. Additionally, we make use of the system-recorded expenditures for both each episode of hospitalization and total expenditure over years for each patient, which complements the metric of expenditure per inpatient day as a measurement of medical expenses. Therefore, we can analyze the impact of retirement on medical care use and its composition with low measurement error.

Second, previous literature has limitations in their model in addressing the aging effect at retirement. Due to insufficient sample size of survey data, previous literature mostly conducts their estimation using Instrument Variable (IV) or RDD with a sample whose age coverage is more than 10 years old. A longer coverage of age risks involving the aging effects in the model and biased the estimation. This is because the model with a long coverage of age use observation who are much younger or older than the cutoff age in estimating effects exactly around the cutoff. The observation farther away from the cutoff would affect the parameters of the fitted model. One of the common ways to deal with this problem is to add age in different functional forms as covariates to adjust for the aging effect and increase the precision of estimation. However, long coverage of age across various data panels also means that a wider range of birth cohorts were involved in their research. A longer birth cohort risks biasing the estimation by some significant early life circumstances the birth selection because several social events took place in China between 1940 and 1970 (including the Civil War in the 1940s, the Great Famine in the 1960s, and the Cultural Revolution in the 1960-1970s). In our study, we deal with this problem in an agnostic way by taking the advantage of a large sample size and restrict our sample to a narrow coverage of age to 2 to 4 years in order to better isolate the retirement effect from the aging effect and significant changes in early life circumstances.

Third, the relatively high labor force participation rate among Chinese women enables us to precisely estimate the retirement effect for women. The urban employment rate among females is

60.1% in 2010[1], which is higher than in other developing countries. Previous retirement studies in China using national survey data seldomly examine the retirement effect for white-collar women because currently available survey data covers few white-collar females (Zhang et al., 2018). The high labor participation rate among Chinese women and the advantage of our data makes it possible to estimate retirement effects for both blue-collar and white-collar female workers. Also, these factors strengthen our identification strategy, since there are more observations of hospital visits around the mandatory ages of retirement for each gender and occupational type. Our results from the women's sample contribute to understanding how retirement affects white- and blue-collar women's demand for healthcare services and the difference between them.

We observe several gender-specific differences in healthcare utilization after retirement. First, we find an increase of eight percent in the hospital admission rate at retirement for males, while no such effect is observed for the two female groups. The increase of 14 percent in admission rate among males is largely due to a rising diagnosis of respiratory disease. For women, we find an increase of 17 percent in admission rate, while is driven by the growth of external causes and mental illnesses. Moreover, we find an increase of 8 percent in total medical expenses (per hospital stay) and an increase of 10 percent in expenses per patient day for males after retirement, but not for females. We detect no distinguishable effect of retirement on hospital mortality rate for males and females.

Our findings have significant policy implementations. Due to the declining fertility and growth in life expectancy, not only China but also many other countries around the globe are aging quickly. Thus, it becomes a key policy question to understand and then design the better-targeted retirement policy to encourage healthy workers to work longer so as to relax the burden in the social security system and avoid adverse effects brought by delayed retirement. Currently, the mandatory retirement age in China is among the earliest in the world. The government in China established the basic rules of retirement in 1978, when the life expectancy is less than 50 years old. Without significant changes over years, the mandatory retirement ages, especially for blue-collar women, are among the earliest retirement age in the world. The mandatory and early retirement policy environment provides us an opportunity to document the healthcare utilization changes by gender after retirement and clarify the potential effects brought by early retirement. These consequences of retirement at different ages are valuable for not only China but also many other countries that are also facing the same challenge of aging.

The remainder of the paper is organized as follows: Section 2 introduces the conceptual framework. Section 3 introduces the institutional background of the retirement policy in China, as well as related pension policy and health insurance programs. Section 4 describes the dataset we use and the main variables. Section 5 outlines the empirical approaches. Section 6 presents the main results in four aspects and a robustness check. Section 7 discusses potential explanations of the various retirement effect across gender and occupation and policy implementation.

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[1] For more details of urban employment, see the official website of Sixth National Population Census of the People's Republic of China http://www.stats.gov.cn/tjsj/pcsj/rkpc/6rp/indexch.htm

2. Conceptual Framework

In China, it is mainly the demand side, rather than the supply side, that drives changes in healthcare utilization after retirement, since there are few incentives in the health system that change the behavior of providers. Three potential mechanisms from the demand side could explain how retirement affects healthcare utilization: change in health status as individuals age the effect of reduced income, and the reduced opportunity cost of time.

The first channel involves the deterioration or improvement of health and changes in health behaviors after retirement. Theoretically, retirement could both improve and worsen the health status. On the one hand, retirement releases the physical and mental pressure from work, which might lead to better health status. On the other hand, retirement suddenly changes people's routine schedule, brings about more social isolation, and reduces intellectual activities. These factors could worsen one's health status. Empirically, the evidence of the retirement effect on health status is also mixed, across a variety of indicators used to measure health status. For example, researchers have found both a positive effect (Che & Li, 2018; Coe & Zamarro, 2011; Eibich, 2015; Gorry, Gorry, & Slavov, 2018; Hessel, 2016; Insler, 2014; Nishimura, Oikawa, & Motegi, 2018; Zhu, 2016) and a negative effect (Behncke, 2012; Shai, 2018) of retirement on self-assessed health status. The population with low SES has been found to suffer more from employment at an older age (Mazzonna & Peracchi, 2017; Shai, 2018). Mixed effects are also found on health outcomes like BMI (J. Feng, Li, & Smith, 2020; Godard, 2016); limitation of activities of daily living (Hessel, 2016); diagnosis of specific diseases, such as chronic conditions, metabolic syndrome, and fibrinogen levels (Behncke, 2012); cognition (Heller-Sahlgren, 2017; Lei & Liu, 2018); and mental health (Nishimura et al., 2018). However, changes in health status and health behaviors are not likely to be the dominant mechanism in our case, since our focus will be much narrower than the studies mentioned above. The narrower timeframe of this study means that the impact of the aging effect is likely to be more modest. We also provide suggestive evidence for this argument by testing the discontinuity of the mortality rate within hospitals and the proportion of ER admissions.

The second possible channel is through the income effect (Conde-Ruiz, Galasso, & Profeta, 2013). Retirees are likely to reduce their healthcare utilization, especially for unnecessary health, if their income significantly decreases after retirement. The reduction of income largely depends on the replacement ratio, which varies based on occupation and years contributing to the pension system. The average replacement ratio is 80 to 90 percent of the wage before retirement for people working in the public sector. However, a previous study that used survey data, the China Health and Retirement Longitudinal Study (CHARLS), showed that the income does not dominate the retirement effect on healthcare utilization, as there is no significant discontinuity in income pre- and post-retirement for males and blue-collar females (Zhang et al., 2018).

The third channel is the reduced opportunity cost of time for healthcare utilization after retirement. On the one hand, the value of time decreases significantly after retirement, since retirees tend to have more discretionary leisure time. Healthcare seeking, especially for inpatient services, is time-consuming. The lower opportunity cost of seeking healthcare services immediately after retirement is likely to induce people to utilize more healthcare services. On the other hand, self-care and family care are more available for people after retirement due to the lower opportunity cost. However, these two types of care are mainly for non-urgent care, less severe medical conditions, and chronic diseases requiring long-term care. In China, the gender difference in providing care for grandchildren after retirement is likely to contribute to the gender difference in healthcare utilization through this potential mechanism. One study shows that females in China provide more care for grandchildren than males; the increase in the probability of providing childcare after retirement is 29 percentage points for females, which is 8 percentage points higher than that for males (J. Feng & Zhang, 2017). Thus, the reduction in the opportunity cost of time for females is smaller for males, which could restrict the increase of healthcare utilization among women after retirement.

3. Institutional Background

The mandatory retirement age in China is 60 for males, 50 for blue-collar workers and 55 for white-collar workers, and a bigger proportion of women retire at 50 (Zhang et al., 2018). This basic rule was first introduced in the 1950s for urban employees in public sectors, and it was expanded to urban employees in private sectors in the 1980s. The retirement rules are enforced more strictly in public sectors than private sectors, due to the wage flexibility (Jia, 2017), although the pension eligibility age provides some financial incentives to retire for those working in formal private sectors. Retirement has not been applied to rural residents, which means farmers could continue working as long as their health is good enough (Giles, 2015). That allows us to use the sample of rural residents as the placebo test.

Although retirement is generally mandatory at a specific age, there is still some flexibility in early retirement and delayed retirement. People with certain occupations are allowed to retire up to five years earlier than the mandatory retirement age. First, workers whose jobs are physically demanding or harmful for health are eligible for early retirement. Also, workers who become disabled due to work are allowed to retire early if they have worked for more than ten years and reach a minimum age (50 for men and 45 for women). Delayed retirement is permitted for specific occupations, such as full professors, advanced researchers, and civil servants with positions above the provincial level. These workers could retire up to five years later than the mandatory age. Additionally, individuals can participate in the labor force informally after retirement while still receiving their pension income, although with dramatically lower opportunity for work. These rules are not a big concern for our identification, as previous research shows a majority of employees comply with the basic rules of retirement policy (Q. Feng, Yeung, Wang, & Zeng, 2019).

Compared with other developed and developing countries in the world, the mandatory retirement ages in China, especially for women, are relatively lower. Alongside the fast-aging demographic file of China due to the one-child policy and the growing life expectancy, the Chinese pension system faces great pressure by the largest number of retirees in the world. The pension systems for private sectors and public sectors were different for the historical reasons lying in economic reform and pension reform, but two systems were merged into one in 2015 (Jia, 2017). The amount and composition of pension income depend on the type of pension programs, years of contribution, and occupational adjustment (J. Feng, He, & Sato, 2011). It is possible for the actual pension income to be either higher or lower than the income before retirement. Employees are eligible to receive the pension income at the first day of the next month after they reach retirement age.

Urban employees in formal sectors are covered by the Urban Employee Basic Medical Insurance (UEBMI) program for enterprise employees, and the Government Employee Health Insurance Program. Thus, we are able to identify the people who are eligible for retirement by the insurance type. Workers will stay in the same public health insurance program, but they don't have to pay for the insurance premium after retirement. The general benefits and copayment rates stay stable before and after retirement, although generosity of insurance varies across regions and occupations. The stability of staying in the same insurance program and constant generosity of insurance allow us to make a reasonable assumption that the changes in healthcare utilization are not driven by the financial incentives of health insurance.

4. Data and Variables

We use a new data set that is a national dataset of inpatient claims in hospitals. Hospital visits are recorded by the hospital electronic medical records (EMR) system in 1348 hospitals in 28 provinces from 2017-2019. The dataset includes patient's demographic information (such as birthdate, gender, insurance type, occupation and current address), admission and discharges information (such as total listed expenditure, admission and discharge date, admission source, leave status) as well as medical information (such as diagnosis and surgery/procedures). The main disadvantage of this dataset is the lack of some social-economic indicators of patients, such as education and income, and the fact that we could only observe those who went to hospitals and were actually hospitalized.

We first restrict our sample to urban employees who are subject to mandatory retirement under the UEBMI aged between 58 to 61 for males, between 48 to 51 or between 53 to 56 to females. The age information is accurate to dates and calculated by the difference between admission date and the end day of their birth month. We didn't calculate the biological age (admission date – birth date) because retirement officially starts on the first day of the month after people become 60 years old. We exclude the people with the occupation of "self-employment", "freelance" or "other occupations" since these occupations are not required to comply with the mandatory retirement policy. We apply the self-reported retirement status as the definition of retirement. Few retirees would continue to work as full-time in the informal sector since their competition in the labor market fall of a cliff. Although We further exclude the observations with missing value in gender, birthdate, and retirement status.

Our main outcome variables include 1) log total number of hospitalizations, 2) log number of hospitalizations for major diagnosis, 3) proportion of major diagnosis among all inpatients, 4) total medical expenses per hospital stay, 5) total medical expenses per hospital day, 6) length of stay (LOS), 5) mortality in hospitals and 7) sources of admission, including the admission from Emergency Room (ER) and admission from Outpatient department (OP). The major diagnosis is recorded by the International Statistical Classification of Diseases and Related Health Problems (ICD -10). We exclude the outliers in expenses (defined as <0.1% or >99.9%) and length of stay (defined as >99.9%).

Appendix Table 1 shows the summary statistics for each group. The effective sample for analysis consists of 321,500 male observations, 264,133 female observations around the cutoff of 50, and 199,600 female observations around the cutoff of 55. The average of expenses and average of LOS for males are slightly higher than females, which is reasonable due to the aging effect. Table 2 shows the proportion of each disease category. The t-test results indicate the significance of the difference for each variable between the sample above and below age cutoffs. The proportion of circulatory system diseases is noticeable, which accounts for the largest proportion of disease in each group. Although the female samples are younger than the male sample, the proportion of neoplasms and mental and behavioral disorders among females are higher than males. The sample of females age between 48 to 51 has the highest proportion of these two disease categories.

5. Empirical Approach

To estimate the causal effect of retirement on individual's healthcare utilization, we could start with a simple linear regression

$$Y_i = \alpha R_i + \beta X_i + \varepsilon_i$$

where Y is the outcome variable that measures the healthcare utilization, R is the retirement status. X is a vector of covariates, including the age, health insurance, health status, etc. and ε is the error term. The value of α is the effect of retirement. However, the retirement decision and outcomes could be endogenous to the observed covariates and unobservable, such as health status and family changes. Thus, the OLS estimation on α is biased and not a consistent estimator of the causal effect of retirement.

To address the endogeneity of retirement decision, we make use of the exogeneity of the mandatory retirement policy in urban China to conduct the causal inference. The mandatory retirement ages are determined by gender and occupation, regardless of the income and other social economics status. This means the retirement decision among these urban workers is exogenous to the covariates in the estimation.

We implement a fuzzy Regression Discontinuity Design (RDD) to correct the potential endogeneity and estimate the causal effect of retirement on healthcare utilization for urban workers (Lee & Lemieux, 2010). The main idea of this design is that those just below and above the age cutoffs are good comparison to each other in terms of the observed and unobserved covariates. The treatment, retirement, is fuzzy since there are some exemptions that allow a small group of urban workers retire earlier than the MRA under certain conditions (See Institutional Background). We examine the causal relationship between retirement and several variables measuring healthcare utilization for each of the three retirement age cut-offs separately using 1-year and 2-year as bandwidths. To our knowledge, the 1-year and 2-year bandwidths we use are among the narrowest being applied to evaluations of the retirement effect.

As a first step, we verify if the Chinese urban population around retirement age cut-offs are smooth in density. The purpose is to rule out the possibility that the changes in hospital visits around retirement age are driven by the size of the underlying population. We use a large random sample of the 2005 China Census data and a subsample with the same coverage of cities in our medical records dataset to show smooth age distribution at each retirement cut-offs (Appendix Figure 2).

In the second step, we use fuzzy RDD to estimate the local average treatment effect (LATE) of retirement on health care utilization. The fuzzy RDD exploits the mandatory retirement age as a source of the exogenous variation for retirement status. The LATE can be expressed as Eq. (1)

$$\tau_{LATE} = \frac{\lim_{\varepsilon \downarrow 0} E[Y|\, z=0+\varepsilon] - \lim_{\varepsilon \uparrow 0} E[Y|\, z=0-\varepsilon]}{\lim_{\varepsilon \downarrow 0} E[R|\, z=0+\varepsilon] - \lim_{\varepsilon \uparrow 0} E[R|\, z=0+\varepsilon]} \quad (1)$$

where z denotes the age centered at each mandatory retirement age cutoffs, R denotes the retirement status and Y represents several health outcomes. The LATE estimated in Equation (1) is the estimated average effect of retirement on outcome variable Y for the compliers, those who retire exactly at mandatory retirement age. Following previous research (Gelman & Imbens, 2018; Zhang et al., 2018), we apply a non-parametric method by using local linear regression (Fan, 1992) with a triangle-weight kernel function.

To deal with the challenge that we observe only those who are hospitalized in our dataset, we follow the method in Card et al. (2008) to estimate the probability of admission. The key assumption is that the underlying population who are at the risk of hospitalization doesn't have significant changes with age within a very small band width, which could be expressed as

$$\log(N_a) = h(a) \quad (2)$$

where a represents different age groups and N_a represents the total number of populations of age a. Also, the simple reduced form model of P_a, which is the probability of admission for a specific age group and expressed as

$$\log(P_a) = g^P(a) + D_a\pi^P + v_a^P \quad (3)$$

where $g^P(a)$ represents a smooth age profile, D_a is a dummy variable representing whether the age is above mandatory retirement age, and v_a^P is a specification error component. After combing (2) and (3), the log of the number of hospital admission at age a could be expressed as

$$\log(A_a) = [g^P(a) + h(a)] + D_a\pi^P + v_a^P + \varepsilon_a \quad (4)$$

where ε_a represents the sampling error in the observed admission ratio. Given the assumption and equations above, the degree of discontinuity in the log of the number of admissions at each retirement age cut-offs could be interpreted as the estimated percentage discontinuities in admission rates (Card, Dobkin, & Maestas, 2008). Thus, we apply RDD on the log number of hospitalization cases to estimate the discontinuity of admission rate at retirement age based on our empirical result showing that the underlying population varies smoothly by ages.

To test the validity of identification, we first checked the discontinuity in the first stage, which is the discontinuity of retirement rates at the mandatory retirement age. Appendix Table 3 and Appendix Figure 1 both show significant jumps in retirement rates immediately after each of the three mandatory retirement ages, indicating that mandatory retirement age cut-offs strongly predict retirement status. The jump of retirement rate at the cutoff for men is 28 percentage points, which is more pronounced than that for both white-collar and blue-collar women.

6. Results

6.1 Change in Hospitalization

We discuss two aspects of the change in hospitalization: the hospital admission rate and the proportion of five main disease categories among inpatients, which include disease of circulatory system, disease of respiratory system, disease of digestive system, mental and behavioral disorders, and external causes. Those are five main categories ranking among the highest Appendix Table 4 shows the changes in estimates of log hospitalization numbers. We found the largest increase in hospital admission rates in males, while there were much smaller increases for white-collar females and no change among blue-collar females. The number of admissions for males rises by 8 percent, which means the probability of admission rises around 8 percent at the retirement age of 60. For blue-collar females, who are expected to retire at 50, we observe no changes in the probability of admission. For white-collar female workers, there is a slight increase (2 percent) in the probability of admission.

We further examined the changes by disease category. We checked two type of changes: 1) the change of proportion of diseases categories, which is an indicator among inpatients representing the change in the structure of inpatient, and 2) the change of admission rate, which considers both health and unhealthy people and represents the changes in the general population. The two indicators don't necessarily move in the same direction.

To study the first type of change, we conducted RDD models on the log of hospital admissions for each disease category (Appendix Table 5, Panel A). For males at age 60, we observe the admission rate has a significant jump of 9 percent for circulatory, 14 percent for respiratory system diseases, and 11 percent for digestive system diseases, with the largest increase in respiratory system diseases. For females, the admission rate due to external causes increases by 17 percent among blue-collar female workers at 50, while the admission rate due to mental and behavioral disorders significantly increases by 17 percent among white-collar female workers at 55.

In terms of the second type of changes, we found that conditional on the hospitalized cases, the proportion of disease categories changes. Appendix Table 5, Panel B shows the RDD estimates of retirement on the proportion of disease category among all inpatient cases. An analysis of detailed disease categories finds that the proportion of diseases in the respiratory system among males rises by 3 percentage points after retirement. For blue-collar females, the proportion of external causes increases by 3 percentage points and the probability of admission due to mental illness and external causes increases 5 percentage points. These increases are unique to each group.

6.2 Change in Expenditure and Length of Stay

Appendix Table 6, Panel A shows the RDD estimate of expenditure change at retirement for each group. We find that medical expenses for male inpatients increase significantly after retirement. Male's total medical expenses per hospital stay, expenses per inpatient day, and total expenses by patient rise by 8 percent, 10 percent, and 13 percent, respectively, under the two-year bandwidth. However, we don't find a similar change in expenses for either blue-collar or white-collar female workers. Noted that although the t-test results in descriptive statistics show an opposite result (the expenditure above age cutoff is significantly for women, but not for men), it doesn't necessarily mean that the t-test result is contradictory to the RDD result. The simple t-test applies the same weight to each data points our RDD model applies different weight to each data points—higher weight is assigned to the data points that are closer to the cutoff through the kernel functional form and non-parametric regression adjustment.

Appendix Table 6, Panel B presents the RDD estimate for the inpatient LOS around retirement ages. The LOS for male retirees does not increase along with rising expenditure measures. However, the LOS for white-collar female retirees, whether receiving surgery/procedures or not, actually decreases significantly after age 55, by 2.72 hospital days. The LOS among white-collar female inpatients with surgery/procedure during the hospitalization drops by 3.24 days, which is 0.84 days more than that of those without surgery/procedures. We observe no changes in LOS among blue-collar female retirees.

6.3 Change in Mortality and ER admission

We find no distinguishable effect of retirement on the severity and urgency of patient's conditions, as measured by the mortality rate within hospital stay and the ER (Appendix Table 7). These results indicate a smooth trend in health status around retirement for both males and females. The smoothness regarding these two indicators in health status is not surprising, as we use two narrow bandwidths in estimation and the mortality rate hasn't started to rise rapidly rise among these age groups. The insignificant changes in mortality and proportion of ER admission indicate that the changes in health status with age, which are mainly driven by the aging effect, are trivial in a sufficiently narrow bandwidth. These results also provide evidence on the strength of our identification strategy that could avoid the confounding aging effect.

6.4 Robustness Check

Our main results are robust to a number of key tests. First, we implement placebo tests at the same age cutoffs (50, 55, 60) but using patients who were ineligible for the particular retirement schemes, specifically, a sample of rural residents with New Cooperative Medical Scheme (NCMS) insurance (Appendix Table 8). The rural residents with the same age with the urban workers in our sample are similar in terms of the trajectory process, but without the retirement shock. By comparing the health care utilization below and above the age cutoffs, we could address the concerns of the aging effect at the three retirement age cutoffs. By comparing the results between the two groups of the same ages but with different retirement eligibility, we find no significant effects around the retirement age cutoffs among the rural samples. These results indicate that the aging effects around each age cutoff are not likely to dominant and bias our estimated retirement effects.

Second, we conduct placebo tests at two pseudo age cutoffs for each group with the same bandwidth (Appendix Table 9). Two pseudo age cutoffs are 2 years before and after the real retirement ages, respectively, for each group. The first stage becomes very weak and not significant anymore under pseudo age cutoffs, with smaller and insignificant coefficients. The estimates also become not significant at all at pseudo cutoffs. The insignificance around pseudo cutoffs and significance at true age cutoffs confirm that the discontinuity around the retirement age cutoff doesn't happen occasionally.

Furthermore, we perform RDD estimates using two alternative bandwidths (Appendix Table 10). Although some results become not significant under the 1.5-year bandwidth due to higher variance as a result of the shrinking sample size, the point estimates are close to the results under 2-year bandwidth. The consistent results show that our estimation is robust to various bandwidth selection.

Finally, we test more flexible age functions around the retirement age cutoffs (Appendix Table 11). The results of adding age and age square as covariates for each bandwidth are similar and consistent with the main results. The consistency of estimations with different specifications demonstrates the robustness of our results and our advantage of using a narrower year bandwidth to eliminate the effect of aging, and further proves the internal validity of our model.

7. Summary, Discussion and Conclusion

In this study, we document the various changes in healthcare utilization around mandatory retirement age in China and to examine the heterogeneity across gender. Using a large dataset of medical records, we apply the fuzzy RDD approach to offer novel evidence of the causal effects of retirement on different aspects of healthcare utilization. The changes in healthcare utilization generally include two perspectives, extensive changes and intensive changes. Extensive change means changes in the number of people consuming healthcare services, while intensive change means the manner and choice of healthcare utilization, including the choice of treatment and hospital stays. Our results demonstrate that the mandatory retirement policy in China changes people's healthcare utilization in both aspects.

In terms of extensive changes, we find that the admission rate increases by 8 percent at retirement for males. There is no increase in the admission rate for blue-collar worker females. For white-collar workers, the admission rate increases by about 2 percent. This number is in line with the result from survey data (Zhang et al., 2018), which also finds an increase in inpatient incidence for males after retirement. Although their estimate is not significant, their point estimate of the change in inpatient incidence (0.10) is quite similar to our estimate (0.08). Thus, the insignificance might be due to insufficient sample size and, consequently, low statistical power. Our results are also consistent with some studies in European countries find that there's a decrease in extensive healthcare utilization, as measured by the number of doctor visits (Eibich, 2015) and home care in the long-term (Gorry et al., 2018).

Furthermore, the RDD estimates on the log number of hospitalization and the proportion of different diseases suggest that the extensive changes are due to different types of diseases. These changes in diseases help us to rule out some common trends in aging, since the trajectory of individuals is continuous and disease prevalence is not supposed to change significantly at a specific age if there are no external incentives, such as retirement. More importantly, the changes in disease diagnosis provide suggestive evidence of changes in people's lives and behaviors. For males, the greatest increase comes from diseases of the respiratory system. This finding is in line with a previous study in the U.S. indicating that the mortality risk of respiratory system diseases increases after retirement (Fitzpatrick & Moore, 2018). The increase might be explained by the two important risk factors of the respiratory system, outdoor air pollution (Bousquet et al., 2010) and smoking (Godtfredsen et al., 2008). Exposure to outdoor air pollution is largely due to an increase in social interactions. A previous study in China shows that retirement increases the likelihood of social activities for males, including participation in sports clubs, household travel, and social interaction with friends (Lei & Liu, 2018). This pattern is also suggested by our finding that there is a significant increase in influenza, a sub-category of respiratory disease, for retired males, but not retired females. More frequent social interaction is likely to increase the probability of being exposed to outdoor air pollution. Moreover, the increase in respiratory system diseases may be partly explained by the consequences of long-term smoking. In China, the smoking rate for men was 54.0%, much higher than that of women (2.6%), as of 2010 (Liu et al., 2017). Also, research shows that labor participation is related to smoking behaviors and that the loss of job induces more smoking (Black, Devereux, & Salvanes, 2015; Falba, Teng, Sindelar, & Gallo, 2005). Since retirees also experience a transition in their employment status, the changes in their smoking behaviors, especially smoking intensity, might increase the risk of respiratory system diseases.

For females who retire at 55, we find white-collar women significantly use more health services in mental and behavioral illnesses, while such an effect doesn't appear among males and blue-collar females. This result is inconsistent with previous research which indicates that blue-collar workers and male workers suffer more from unemployment in mental health, compared with white-collar workers and females (Falba et al., 2005; Paul & Moser, 2009). One of the potential reasons for the different results is the different measurements of mental health. They use general screening method in form of questionnaires in the population to detect the changes in mental health while we use the changes in hospitalizations due to mental and behavioral illness as the outcome variable, which requires serious conditions of patients and is hardly captured by simple questionnaires. Thus, our results contribute to understanding the effect of leaving labor force on seeking health services for severer mental and behavioral illnesses. Future research is still needed to test and confirm the mechanisms behind diseases.

For the intensive changes, we examine two common factors that could be objective indicators of intensive changes: medical expenditures and LOS. For males, we find that the total medical expenditure per case and total medical expenditure per hospital day largely increase. Two possible reasons could explain these increases. First, since the admission rate increases for males, there are more patients who suffer from high-cost diseases going to hospitals after retirement. Consequently, the average expenditure per case increases. This hypothesis is supported by an increase of 8 percentage points in the probability of having surgery or procedures among males since patients with surgery/procedures are more likely to live longer in hospitals and thus, spend more. Another possibility is that the treatment intensity increases within each disease type. However, the latter possibility is not likely to be dominant, as treatment is usually regulated by the clinical path and the treatment guidance is not supposed to change significantly around age 60 for males. In spite of the increase in expenses, the LOS for males doesn't change significantly, which usually correlates with the severity of the patient's condition. It means that the intensity of treatment per hospital day is greater among males after retirement.

For females, we find that LOS—another measure of the intensity of healthcare utilization—declines among white-collar females after retirement, while it exhibits no change for blue-collar females after retirement. The change in LOS could be driven by two effects in opposite directions: the income effect and the opportunity cost of time. Generally, declining income after retirement leads to lower consumption of healthcare services, while more leisure time contributes to more healthcare utilization. For white-collar females, we observe that LOS for white-collar females decreases significantly immediately after retirement. This suggests that the income effect is more dominant than the effect of increasing leisure time. To further test this hypothesis, we explore the change in the proportion of inpatients with chronic diseases. The price elasticity of hospitalization demand for chronic disease is generally higher than that for other diseases, especially acute conditions. In other words, the hospitalization due to chronic disease is supposed to be more sensitive to price and income changes. Interestingly, we find this proportion significantly decreases by 17 percentage points among, and only among, white-collar females. It further indicates the existence of the income effect on the reduction in LOS for white-collar females.

Additionally, we observe no retirement effect on the in-hospital mortality rate and the proportion of ER admissions. These two are two common indicators to describe the severity and urgency of a patient's condition. Generally, the mortality rate among the age in our sample groups (aged from 48 to 61) is not supposed to sharply increase. Also, due to the narrow bandwidth we use in the identification model, the continuity of the mortality rate and the proportion of ER admission indicates a negligible aging effect and changes in health status, as we expect. However, in the long run, it is still not clear whether mortality is affected by retirement via the channels with mixed effects discussed above.

There are some potential limitations in this research. First, different mandatory retirement ages and gender are two confounding factors that we have limited ability to deal with. The different results for males and females are caused by both gender and different retirement age. This is potentially problematic because health declines systematically with age, which could affect health care utilization more for older men. Thus, we observe different patterns of the retirement effect for males and females, and it is hard to know how much of the effect is due to gender, age or occupation discrepancy in retirement age. However, this is a problem for all retirement studies in China, since the mandatory retirement age is different across genders and occupations. Second, we have very limited socio-economic variables for the individuals in the claims data. Thus, we cannot directly analyze the mechanisms behind our findings.

This paper provides novel evidence on the effect of retirement on health care utilization and the difference of the effect by gender using real medical records in China. Our results contribute to the ongoing policy conversations on reforming the retirement policy not only in China but also in many other countries with a growing aging population. As the population is aging and more people are working in the formal economy, a larger population of workers will retire in the near future. Understanding the difference in the changes of healthcare utilization around retirement and the underlying behavior patterns is valuable to inform and facilitate more targeted and effective strategies on disease prevention, diagnosis, and management for the aging population. Our finding of the increases in different disease categories at retirement age suggests that the primary care system should pay more attention to respiratory system diseases for male workers, mental illness and behavioral disorders and diseases due to external causes for female workers around retirement age.

Moreover, policymakers in China have been discussing whether the government should reduce the gender gap in retirement age. The decision making on this policy issue requires the understanding of how males and females react differently to retirement. Currently, females retire 5 to 10 years earlier than men while female's life expectancy is higher than men. Comparing the results for men and women, we found that men have an increase in health care utilization in terms of admission rate and expenditure but there are no such increases for women. Although we can't simulate the situation if women's retirement at 60, the current results reveal that the current retirement policy affects differently for men and women. Also, women are generally less affected by retirement in terms of the hospitalization rate and health expenditure. Narrowing down the gender gap in retirement age seems to be a feasible option. However, future works are needed to understand the long-term effect of retirement on health and health care utilization behavior to further facilitate the policy decision making.

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9. Appendix

Figure 1 Jump of retirement rate around the mandatory retirement age

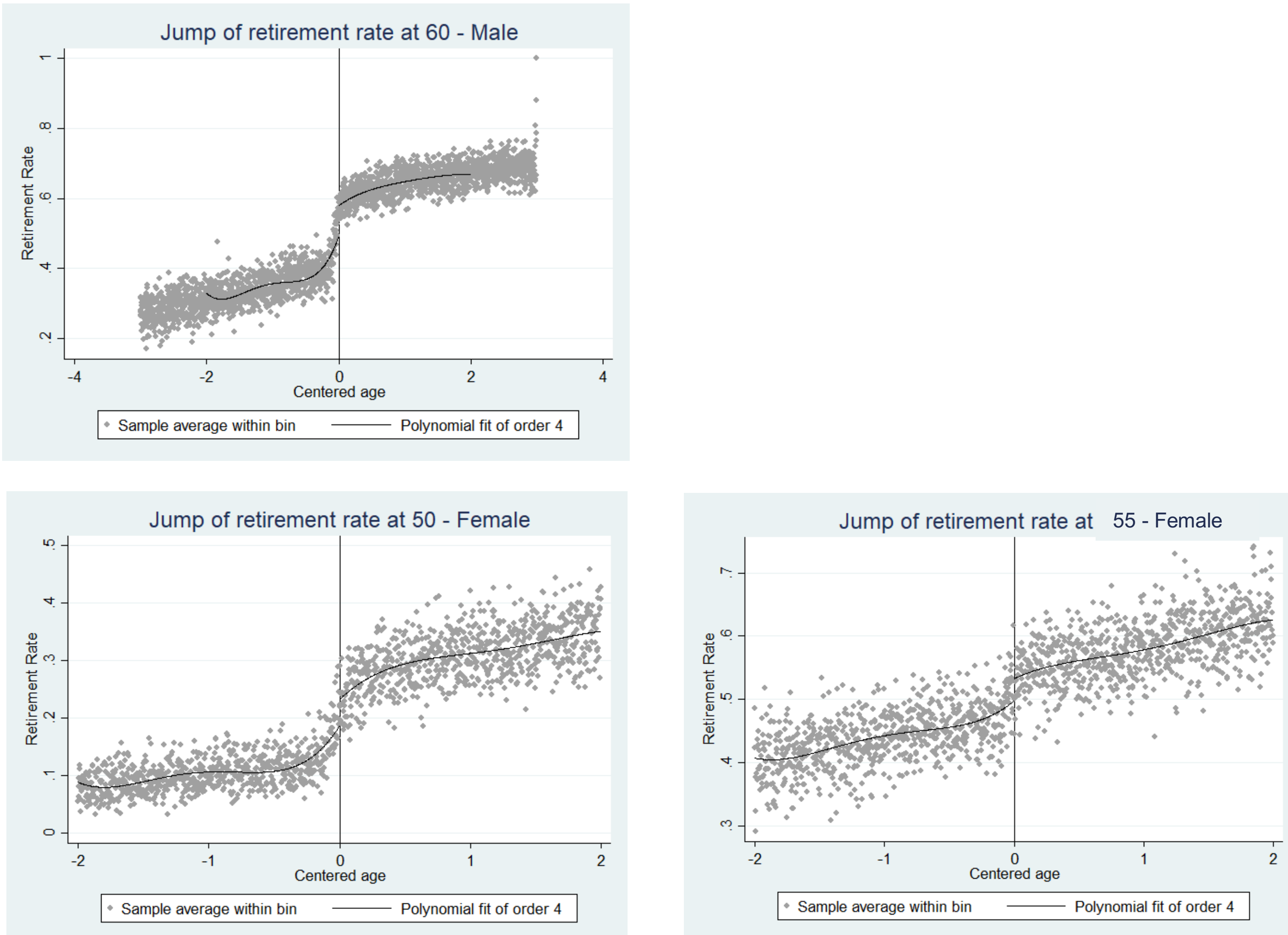
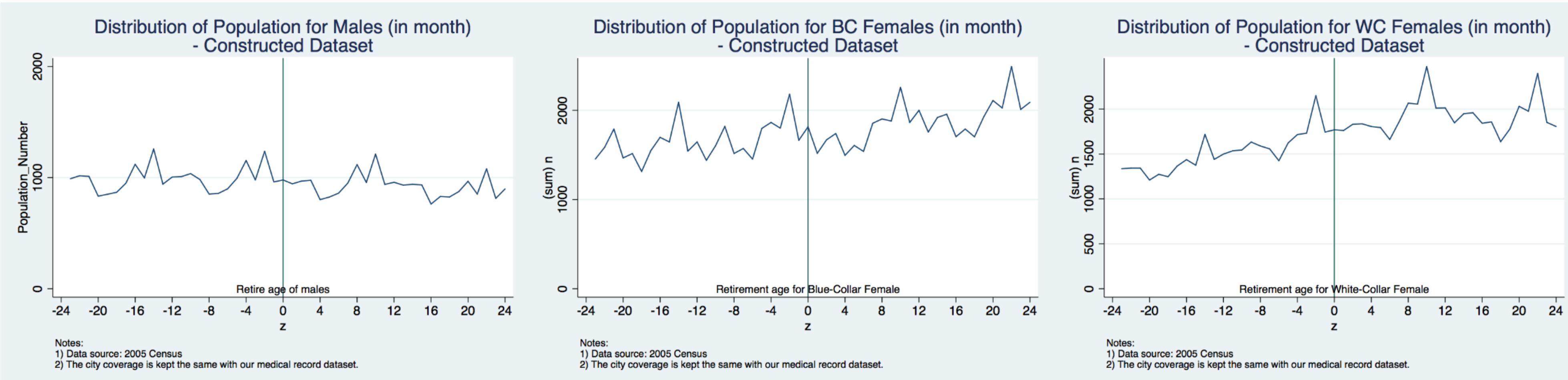


Figure 2 Test on the Smoothness of Underlying Population



Notes: 1) The data source is the 2005 Census, a small scale of a census. The dataset is processed in the following steps. First, we further restrict the Census data to the urban residents in 182 cities that are covered in our medical records dataset. Then, we keep the birth cohorts that are the same as our medical records. Next, we calculate their expected age in 2018, and center the age at the mandatory retirement age for each group. After that, to simulate the three-year coverage (2017-2019), we re-do the first three steps, calculated their expected age at 2017 and 2019, respectively, and center the age at the mandatory retirement age for each group (60 for male, 50 for blue-collar (BC) females and 55 for white-collar (WC) females). Finally, we add up three datasets based on the centered age and get a newly constructed dataset that is similar to the city coverage, birth cohorts, and centered age. 2) The vertical lines in this graph represent the age group in the 2005 Census dataset who are supposed to meet retirement age in 2017, 2018 or 2019. 3) We find that within the 2-year time window before and after retirement age, the number of underlying population (measured in the birth month) is stable in general, although there appear to be some seasonal fluctuations.

Table 1 Summary Statistics

Variables	Males				Female (50)				Female (55)			
	Below age cutoffs: [-2,0]		Above age cutoffs: [0,2]		Below age cutoffs: [-2,0]		Above age cutoffs: [0,2]		Below age cutoffs: [-2,0]		Above age cutoffs: [0,2]	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Age	59.05	0.58	61.00***	0.57	49.00	0.58	51.00***	0.58	54.03	0.58	55.90***	0.57
Retirement rate	0.36	0.48	0.64***	0.48	0.11	0.31	0.31***	0.46	0.44	0.50	0.58***	0.49
Total expense (CNY)	12688	16686	12705	16749	9777	11051	9890**	11184	10000	11606	10154***	11577
Expense per inpatient day	1412	2111	1410	2057	1268	1406	1248***	1486	1208	1381	1248***	1514
Length of stay (day)	10.25	6.97	10.16***	6.87	9.00	6.24	9.24***	6.31	9.43	6.18	9.33***	6.05
Proportion of ER admission	0.19	0.39	0.19***	0.39	0.16	0.36	0.16	0.37	0.16	0.37	0.16*	0.37
Proportion of OP admission	0.76	0.43	0.76*	0.43	0.79	0.40	0.79**	0.41	0.79	0.41	0.79	0.41
Sample size (BW=2 years)	140,684		180,816		99,640		99,960		142,332		121,801	

Notes: 1) Bandwidth = 2 years; 2) The t-test for the mean of each variables for those below age-cutoff and above age-cutoff was conducted. The null hypothesis is that there is no difference about the mean of outcomes variables between those above age-cutoff and those above age-cutoff. *** represent p<0.01. ** represents p<0.05. * represents p<0.1

Table 2 Summary statistics – Proportion of Each Disease Categories (%)

	Male (60)	Female (50)	Female (55)
1. Certain infectious and parasitic diseases (A00-B99)	2.39	2.30	2.29
2. Neoplasms (C00-C97; D00-D48)	8.74	12.63	9.44
3. Diseases of blood and blood forming organs and certain disorders involving the immune mechanism (D50-D89)	0.45	0.84	0.61
4. Endocrine, nutritional and metabolic diseases (E00-E90)	7.76	5.27	6.90
5. Mental and behavioral disorders (F00-F99)	0.78	1.76	1.68
6. Diseases of nervous system (G00-G99)	5.22	5.53	6.26
7. Diseases of eye and adnexa (H00-H59)	2.47	1.84	2.34
8. Diseases of ear and mastoid process (H60-H95)	1.34	2.50	2.49
9. Disease of the circulatory system (I00-I99)	30.75	14.83	20.04
10. Disease of respiratory system (J00-J99)	9.64	7.59	7.85
11. Diseases of digestive system (K00-K93)	12.78	12.71	12.94
12. Diseases of skin and subcutaneous tissue (L00-L99)	1.11	1.20	1.02
13. Diseases of musculoskeletal system and connective tissue (M00-M99)	6.13	14.49	13.95
14. Diseases of genitourinary system (N00-N99)	5.86	11.08	7.03
15. Pregnancy, childbirth and the puerperium (O00-O99)	0.00	0.09	0.01
16. Certain conditions originating in the perinatal period (P00-P96)	0.00	0.00	0.00
18. Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	1.91	2.14	2.15
19&20 External causes	2.66	3.20	2.99

Notes: The statistics is based on a 2-year bandwidth. The classification of disease categories is according to ICD-10. The ICD-10 code for each disease category is noted in the form.

Table 3 First-stage result

BW: 2 years

	Male 60	**Female 50**	**Female 55**
Dependent variable: Retirement			
I (age>mandatory retirement age)	0.28***	0.20***	0.14***
	(0.00)	(0.00)	(0.00)
Number of observations	321,499	199,600	264,133
R-square	0.08	0.06	0.02
F	27149.02	13426.68	4924.02

BW: 1 year

	Male 60	**Female 50**	**Female 55**
Dependent variable: Retirement			
I (age>mandatory retirement age)	0.23***	0.17***	0.10***
	(0.00)	(0.00)	(0.00)
Number of observations	164,800	100,142	144,727
R-square	0.05	0.04	0.00
F	9376.28	4433.31	1368.31

Notes: 1) Std. Err is included in parenthesis. 2) *** represents p < 0.01. ** represents p < 0.05. * represents p < 0.1.

Table 4 Estimated Discontinuity in The Log of The Number of Admissions at Retirement Age

Gender	Discontinuity estimate (log difference in height)			
	All sample		First-time hospitalization	
	BW=2 years	BW=1 year	BW=2 years	BW=1 year
Male	0.08***	0.05***	0.08***	0.06***
	(0.01)	(0.01)	(0.01)	(0.01)
Female (50)	-0.02*	0.00	-0.01	0.00
	(0.01)	(0.01)	(0.01)	(0.01)
Female (55)	0.01*	0.02**	0.02**	0.03**
	(0.01)	(0.01)	(0.01)	(0.01)

Notes: Std. Err. is included in the parenthesis. *** represents $p < 0.01$. ** represents $p < 0.05$. * represents $p < 0.1$.

Table 5 Retirement effect on Disease Spectrum

	Male		Female (50)		Female (55)	
	BW=1	BW=2	BW=1	BW=2	BW=1	BW=2
Panel A. Estimated Discontinuity in the Log of The Number of Admissions						
Mental and behavioral disorders	-0.04	-0.04	0.15	0.08*	0.18***	0.17***
(F00-F99)	(0.09)	(0.09)	(0.11)	(0.05)	(0.04)	(0.03)
Disease of the circulatory system	0.05***	0.09***	-0.01	-0.01	0.03	0.01
(I00-I99)	(0.02)	(0.02)	(0.05)	(0.05)	(0.04)	(0.05)
Disease of respiratory system (J00-	0.12***	0.14***	0.01	-0.02	0.06*	0.01
J99)	(0.02)	(0.01)	(0.07)	(0.08)	(0.04)	(0.03)
Diseases of digestive system (K00-	0.09***	0.11***	-0.00	-0.06**	-0.00	-0.01
K93)	(0.03)	(0.02)	(0.04)	(0.03)	(0.04)	(0.05)
External causes	0.04	0.02	0.15**	0.17***	-0.09	-0.06
	(0.03)	(0.03)	(0.08)	(0.05)	(0.06)	(0.05)
Panel B. Retirement Effect on the Probability of Diseases (%) among Inpatients						
Mental and behavioral disorders	-0.01	-0.01	0.03	0.01	0.04	0.04**
(F00-F99)	(0.01)	(0.00)	(0.02)	(0.01)	(0.03)	(0.02)
Disease of the circulatory system	0.00	0.02	-0.02	0.01	0.00	-0.02
(I00-I99)	(0.04)	(0.02)	(0.05)	(0.03)	(0.08)	(0.06)
Disease of respiratory system (J00-	0.05**	0.03**	0.01	-0.00	0.04	-0.01
J99)	(0.02)	(0.01)	(0.04)	(0.02)	(0.05)	(0.04)
Diseases of digestive system (K00-	0.04	0.02	0.00	-0.04	-0.06	-0.04
K93)	(0.03)	(0.01)	(0.05)	(0.03)	(0.07)	(0.05)
External causes	-0.01	-0.00	0.05*	0.05***	-0.05	-0.02
	(0.01)	(0.01)	(0.03)	(0.01)	(0.03)	(0.02)

Notes: 1) The definition of each disease is according to the ICD-10. The responding ICD-10 is listed for each disease categories. 2) Std. Err. is included in the parenthesis. *** represents $p < 0.01$. ** represents $p < 0.05$. * represents $p < 0.1$.

Table 6 Retirement Effect on Expenditure and Length of Stay

	Male		Female (50)		Female (55)	
	BW=1	**BW=2**	**BW=1**	**BW=2**	**BW=1**	**BW=2**
Panel A. Expenditure						
Total hospital list charges per hospital stay	0.14**	0.08**	0.07	0.02	0.04	0.09
	(0.07)	(0.04)	(0.13)	(0.07)	(0.17)	(0.12)
Total hospital list charges per inpatient day	0.14**	0.10***	-0.09	-0.09	0.10	0.30***
	(0.06)	(0.03)	(0.11)	(0.11)	(0.14)	(0.10)
Total hospital list charges per patient	0.20***	0.13***	0.05	0.05	0.12	0.17
	(0.07)	(0.04)	(0.13)	(0.13)	(0.18)	(0.12)
Panel B. Length of Stay						
Length of stay	-0.71	-0.54*	1.49	0.19	-1.83	-2.72***
	(0.55)	(0.41)	(0.97)	(0.53)	(1.35)	(0.93)
Length of stay for those with	-0.31	-0.88	1.14	0.00	-1.49	-3.24**
surgery/procedures	(0.87)	(0.54)	(1.34)	(0.80)	(2.04)	(1.44)
Length of stay for those without	-0.99	-0.38	1.75	0.35	-2.06	-2.40**
surgery/procedures	(0.71)	(0.40)	(1.37)	(0.70)	(1.76)	(1.19)

Notes: 1) Total hospital list charges per patient represents the sum of expenses for each patient in each hospital in our dataset. We link different hospital visits of the same patients (within each hospital) by using their unique inpatient ID. 2) Std. Err. is in the parenthesis. *** represents p < 0.01. ** represents p < 0.05. * represents p < 0.1.

Table 7 Retirement Effect on Mortality and Admission Source

	Male		Female (50)		Female (55)	
	BW=1	**BW=2**	**BW=1**	**BW=2**	**BW=1**	**BW=2**
Panel A. Mortality Rate						
Mortality rate	0.0026	0.0009	-0.0163**	-0.0045	-0.0011	0.0020
	(0.0072)	(0.0043)	(0.0078)	(0.0042)	(0.0122)	(0.0080)
Panel B. Proportion of Admission Source (RDD results)						
Proportion of ER admission	-0.00	-0.00	0.06	0.03	0.11	0.06
	(0.03)	(0.02)	(0.06)	(0.03)	(0.08)	(0.05)
Proportion of OP admission	+0.03	-0.00	-0.10	-0.04	-0.04	-0.02
	(0.03)	(0.02)	(0.06)	(0.04)	(0.09)	(0.06)

Notes: Std. Err. is in the parenthesis. *** represents $p < 0.01$. ** represents $p < 0.05$. * represents $p < 0.1$.

Table 8 Placebo Test – Rural Patients with New Cooperative Medical Scheme (NCMS) insurance

	Male 60	Female 50	Female 55
Panel 1: Expense, LOS and Admission Sources			
Expense	0.00 (0.01)	-0.01 (0.01)	0.00 (0.01)
LOS	-0.06 (0.06)	-0.05 (0.06)	-0.01 (0.05)
Proportion of ER admission	0.01** (0.00)	-0.01*** (0.00)	-0.00 (0.00)
Proportion of OP admission	-0.01 (0.00)	0.01*** (0.00)	0.00 (0.00)
Number of surgeries	-0.00 (0.01)	-0.01 (0.01)	-0.01 (0.01)
Proportion of patients with at least one surgery/procedures	-0.00 (0.00)	-0.01 (0.00)	0.00 (0.00)
Panel 2: Proportion of each disease categories			
Neoplasms (C00-C97; D00-D48)	0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)
Mental and behavioral disorders (F00-F99)	0.00 (0.00)	-0.00 (0.00)	-0.00** (0.00)
Disease of the circulatory system (I00-I99)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)
Disease of respiratory system (J00-J99)	0.00 (0.00)	-0.01** (0.00)	-0.00 (0.00)
Diseases of digestive system (K00-K93)	-0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)
External causes	0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)
Sample size (2 years)	233,383	255,375	261,364

Notes: Std. Err. is in the parenthesis. *** represents $p < 0.01$. ** represents $p < 0.05$. * represents $p < 0.1$.

Table 9 Placebo test – Pseudo Age Cut-offs

	Male 58	Male 62	Female 48	Female 52	Female 53	Female 57
Panel 1: Retirement rate						
Probability of retirement	-0.01 (0.00)	0.00 (0.00)	0.00 (0.00)	0.01 (0.00)	-0.00 (0.00)	0.01** (0.00)
Panel 2: Main outcomes						
Total expenditure per inpatient time	-1.16 (1.76)	-1.00 (2.18)	-4.27 (8.13)	0.48 (1.18)	7.36 (25.77)	0.23 (0.71)
LOS	3.51 (13.21)	16.27 (23.69)	-82.12 (143.53)	-1.49 (9.44)	28.59 (107.44)	4.83 (5.19)
Proportion of ER admission	1.71 (2.35)	0.61 (1.73)	-1.92 (4.63)	-0.01 (0.44)	3.13 (6.79)	1.21** (0.62)
Proportion of OP admission	2.14 (2.85)	-0.01 (1.52)	-0.45 (3.10)	-0.30 (0.52)	-2.27 (5.10)	-1.04* (0.58)
Probability of having at least surgery	-0.77 (0.97)	-1.72 (2.03)	6.64 (10.84)	-0.34 (0.70)	-0.29 (3.35)	-0.47 (0.46)
Number of Surgery/procedures	-0.06 (2.18)	-1.08 (3.13)	11.86 (20.20)	-1.14 (1.90)	2.56 (12.56)	-1.40 (1.28)
Sample size	182,312	369,792	190,068	226,652	252,063	225,533

Notes: Std. Err. is in the parenthesis. *** represents $p < 0.01$. ** represents $p < 0.05$. * represents $p < 0.1$.

Table 10 Robustness Check – Alternative Bandwidth (1.5 years and 2.5 years)

Outcome variables	Male		Female 50		Female 55	
	BW=1.5	BW=2.5	BW=1.5	BW=2.5	BW=1.5	BW=2.5
Total Expense	0.10** (0.05)	0.06* (0.03)	0.04 (0.09)	0.02 (0.06)	0.10 (0.13)	0.11(0.10)
LOS	-0.63** (0.27)	-0.58 (0.40)	0.80 (0.66)	0.11 (0.45)	-1.91* (1.06)	-3.34*** (0.87)
Proportion of ER admission	0.01 (0.02)	-0.01 (0.02)	0.05 (0.04)	0.02 (0.03)	0.09 (0.06)	0.02 (0.05)
Proportion of OP admission	0.00 (0.03)	0.00 (0.02)	-0.07 (0.04)	-0.03 (0.03)	-0.02 (0.07)	-0.01 (0.05)
Number of Surgery	0.23*** (0.08)	0.16*** (0.05)	-0.01 (0.14)	-0.05 (0.09)	0.23 (0.21)	0.49*** (0.17)
Probability of surgery/procedure	0.07*** (0.03)	0.06*** (0.02)	0.01 (0.05)	0.01 (0.03)	0.13*** (0.06)	0.13 (0.08)

Notes: Std. Err. is in the parenthesis. *** represents $p < 0.01$. ** represents $p < 0.05$. * represents $p < 0.1$.

Table 11 Robustness Check – Alternative Age function

Outcome variables	Male		Female 50		Female 55	
	BW=1	BW=2	BW=11	BW=2	BW=1	BW=2
Total expense	0.14** (0.07)	0.08** (0.04)	0.07 (0.13)	0.02 (0.07)	0.04 (0.16)	0.09 (0.11)
LOS	-0.70 (0.55)	-0.53 (0.32)	1.49 (0.97)	0.19 (0.53)	-1.78 (1.29)	-2.68*** (0.91)
Proportion of ER admission	-0.00 (0.03)	-0.00 (0.02)	0.06 (0.06)	0.03 (0.03)	-0.11 (0.08)	0.06 (0.05)
Proportion of OP admission	0.03 (0.03)	-0.00 (0.02)	-0.10 (0.06)	-0.04 (0.04)	-0.04 (0.08)	-0.02 (0.06)
Number of surgeries/procedures	0.28*** (0.10)	0.19*** (0.06)	0.04 (0.21)	-0.05 (0.11)	0.16 (0.26)	0.32*(0.18)
Probability of surgery/procedure	0.08** (0.04)	0.06*** (0.02)	0.05 (0.08)	0.01 (0.04)	0.10 (0.10)	0.15** (0.07)

Notes: Std. Err. is in the parenthesis. *** represents $p < 0.01$. ** represents $p < 0.05$. * represents $p < 0.1$.

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