The Effect of Retirement on Health

BY

YUANRONG XU
B.S., Iowa State University, 2012
M.S., University of Illinois at Chicago, 2017

THESIS

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Defense Committee:

Darren Lubotsky, Chair and Advisor
Ben Ost
Marcus Casey
Joseph Persky
Anthony LoSasso, Public Health

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SUMMARY

This dissertation estimates the effect of retirement on health. In response to increased longevity and tighter public budget constraints, the general trend in developed countries is for Social Security systems to be modified to encourage people to remain in the labor force longer. Understanding the effect of retirement on health is important for predicting the consequence of these policies. This dissertation estimates the effect in two countries, the United States and China. These two countries provide a broader picture of the effect from different perspectives. The estimation in the United States focuses on voluntary retirement, and the estimation in China uses the mandatory retirement.

To estimate the effect of retirement on health and mortality in the U.S., I study the 1983 reforms to the United States Social Security System that raised the retirement age for cohorts born after 1937. Combining IV and difference-in-difference methods, I find that retirement has a positive effect on self-reported bad health and decreases the probability among men of experiencing limitations in daily activities. However, retirement also increases the mortality rate by 0.46 percentage points for men and 1.4 percentage points for women. Heart disease contributes most to the effect on mortality. I also study the time use change after retirement in the U.S., and find that people spend most of their extra time on sleep and eating.

SUMMARY (continued)

To estimate the effect of retirement on health in China, I use the mandatory retirement policy in the public sector. With the difference-in-difference method between workers in public sector and private sector, I find that retirement has a negative effect on self-reported bad health and increase the hospitalization spending. It also increases the probability of reporting diabetes and heart disease. Several variables from physical examination and blood test result, that are related to these disease, such as personal BMI, High Density Lipoprotein (HDL), triglyceride also become worse after the retirement.

1 INTRODUCTION

Health and economic status are intertwined. Healthier people tend to work and earn more. To what extent do work and retirement decisions affect health status? The importance of understanding whether work sustains health, or whether it wears it down, is crucial for evaluating the consequences of falling labor force participation and reforms to old-age pensions around the world.[1] Eleven out of thirty-five OECD countries plan to increase the pension age sometime between 2010 and 2050 (Chomik et al. 2010)[2].

Retirement could improve or worsen an individual's health status. Case and Deaton (2005) suggest that manual work that imposes a high demand on bodies has a negative effect on health. Aguiar and Hurst (2005) show retired people spend more time preparing food at home, potentially enabling healthier eating habits. On the other hand, Bossé et al. (1991) and Palmore et al. (1979) find people rate retirement as a stressful event, which could be accompanied by depression and loneliness. Sugisawa et al. (1997) and Bradford (1979) claim that retirement is associated with a reduction in social interactions.

Disentangling the causal effect of retirement on health from the effect of health on retirement, or from the effects of third factors that influence both health and retirement, is difficult. To understand this effect, I examine the health change after

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[1] The labor force participation rate has been declining since 2008 (Bureau of Labor Statistics 2017).

[2] Countries without increases in pension age implement other reforms. France and Turkey increased the required years of contribution to be eligible for the pension. Hungary, Belgium, and Greece restrict the access to early retirement.

retirement in two countries, the United States and China. Chapter 3 estimates the effect of retirement on health and mortality in the U.S. Chapter 4 estimates the effect on health in China.

In this dissertation, I first discussed the potential mechanisms that link retirement to health using the Grossman model. The Grossman model suggests that the health capital depends on the investment in health in each period. The investment in health has the benefit of increasing earnings with better health and has the cost of time and money. With retirement, the opportunity cost of time becomes lower, which lead to a reduction in the cost of investment in health. However, the retirement also decreases the benefit of investment in health because better health will no longer increase earnings. Therefore, in the Grossman model, the effect of retirement on health is ambiguous.

Then, in chapter 3, I empirically estimate the effect of retirement on health and mortality in the U.S. I use the reform of Social Security policy that intended to delay the retirement of cohorts born after 1937. By comparing cohorts born before and after 1937, I find that retirement increases the mortality rate for both men and women. However, retirement also has a positive effect on some health outcomes, such as <fill in>. These results suggest that the retirement may have a heterogeneous effect on different people. To understand the mechanism of this effect, I also take a look the change in time use with the retirement. I find that retirement increases the time spent on sleep, and eating and drinking, but are not related to health-specific activities.

Last, in chapter 4, I estimate the effect of retirement on health in China. Given the mandatory retirement policy in China's public sector, I implement a difference-in-difference model by comparing workers in public sector and in private sector. I find that retirement has a negative effect on health in China, where it is associated with a higher risk of diabetes and heart disease.

2 THE RELATIONSHIP BETWEEN RETIREMENT AND HEALTH: THEORY AND EXISTING EVIDENCE

People in the labor force tend to have better health. Figure 1 plots the self-reported health against age by labor force status. The data are from the National Health Interview Survey (NHIS). The graph plots the fraction of people who reported fair or poor health on a five scale self-reported health, by gender and labor force status at each age.[3] About 10 percent of men and women in the labor force report being in fair or poor health. By contrast, at any age both men and women who are out of the labor force report being in worse health than those in the labor force. The health status of people out of the labor force appears to improve with age, though much of this simply reflects compositional change due to the retirement of people who tend to be in worse health.

[3] The five classifications in the self-reported health scale are excellent, very good, good, fair, and poor. I use the fraction of people reporting fair and poor health as an indicator of health status here.

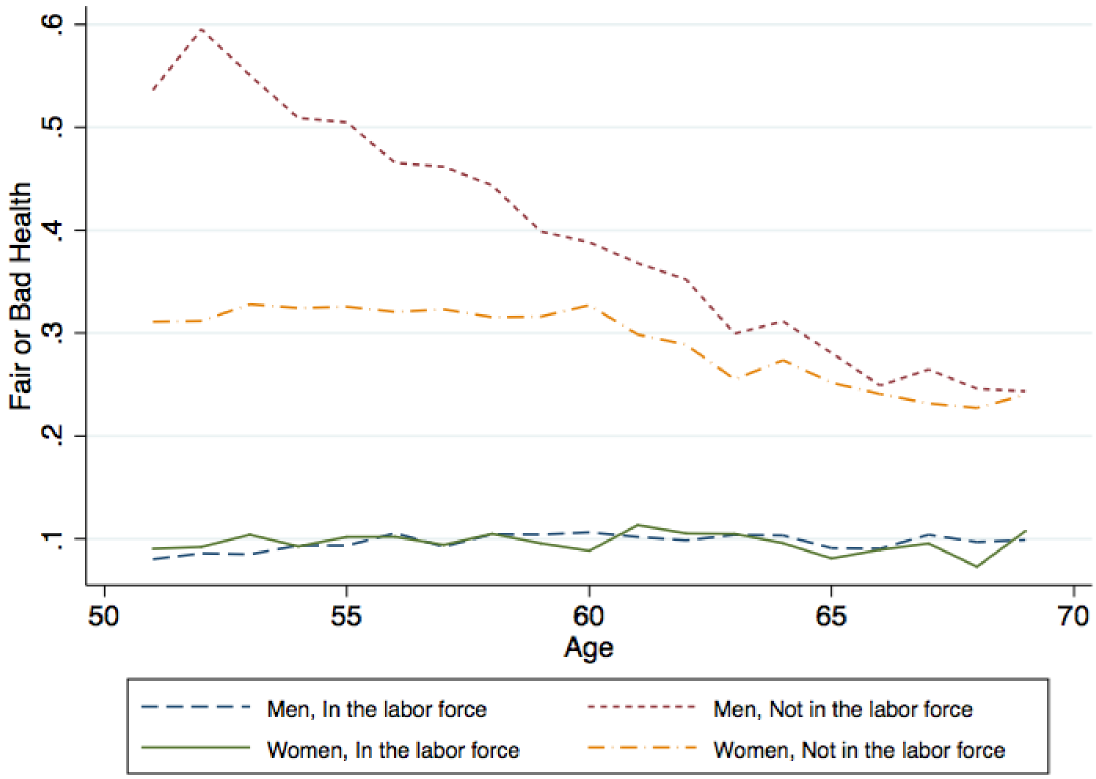

Figure 1. Self-reported bad health by age, gender, and labor force status

This correlation between health and labor force status could be the result of a causal effect that runs from health to labor force status, from labor force status to health, or reflect third factors that influence both health and labor force status. A large literature studies the effect of health on labor force participation (McGarry and Kathleen 2004; Dwyer, Sabatini, and Mitchell 1999). My focus is on the effect of labor force participation on health.

The well-known Grossman (1972) model is a useful starting point for thinking about the incentives to invest in health capital. In the model, an individual's demand for health is determined by the cost and the benefit of being in good health. Retirement will reduce both the benefit and the cost, which makes the change in health status ambiguous. The benefit of being in good health includes the utility of being healthy and the earning benefit of reduced sick days. The cost of maintaining health includes both the direct outlays on health care and the cost of time spent on these health investment activities. After retirement, the cost of maintaining health will decrease. The time spent on the investment for health will no longer affect earnings because it will not conflict with work time anymore. However, retirement will also decrease the benefit of health. After retirement, the benefit of reducing sick days as a means to increase earnings disappears.

Formally, the effect of missing the monetary benefit from health investment and the reduction in value of time can be illustrated using the Grossman model as follows:

A consumer maximizes a utility function:

$$\mathrm{U_t = U_t(h_t, Z_t)} \qquad (1)$$

which contains health, h_t, and the consumption of other goods, Z_t. A consumer faces budget and time constraints:

$$\mathrm{\sum_t \frac{P_tM_t+F_tX_t}{(1+r)^t} = \sum_t \frac{W_tL_t}{(1+r)^t} + A_0} \qquad (2)$$

$$\mathrm{L_t + TH_t + T_t + S_t = \Omega} \qquad (3)$$

The budget constraint equates the sum of the present value (adjusted by the market rate of interest, r) of health spending (the quantity of medical care, M_t times the price of medical care, P_t) and the spending on other goods (the amount of other goods, X_t times the price of other goods, F_t) to the present value of total earnings (wages, $W_{t,}$ times hours of work, L_t) plus initial assets, A_0. Initial assets, A_0 is considered to be exogenous.

The time constraint is that the total time, Ω, equals the sum of hours of work, L_t, the time spent on health investment, TH_t, the time spent on other goods, T_t, and the sick time, S_t.

The model assumes that the sick time, S_t, is inversely related to the stock of health, H_t, which indicates that earnings, W_tL_t, which are positively related to hours of work, L_t, is also positively related to the stock of health, H_t

Therefore, the optimal stock of health at time t, is determined as,

$$\frac{\partial h_t}{\partial H_t}\left[W_t + \left(\frac{\partial U}{\partial h_t}\frac{1}{\lambda}\right)(1+r)^t\right]$$

$$= \frac{\partial(P_{t-1}M_{t-1}+W_{t-1}TH_{t-1})}{\partial I_{t-1}}\left(r - \frac{\frac{\partial(P_tM_t+W_tTH_t)}{\partial I_t}}{\frac{\partial(P_{t-1}M_{t-1}+W_{t-1}TH_{t-1})}{\partial I_{t-1}}} + 1 + \delta_t\right) \qquad (4)$$

The left-hand side of the equation is the marginal product of the stock of health capital at age t, which is a combination of the monetary return of being able to work more days $\frac{\partial h_t}{\partial H_t}W_t$ and the psychic return of enjoying health $\frac{\partial h_t}{\partial H_t}\left(\frac{\partial U}{\partial h_t}\frac{1}{\lambda}\right)(1+r)^t$. The right-hand side of the equation is the supply price of the stock of health capital. It depends on the interest rate, r, depreciation of health, δ_t, the marginal cost of investment in health $\frac{\partial(P_{t-1}M_{t-1}+W_{t-1}TH_{t-1})}{\partial I_{t-1}}$, and the change in the marginal cost of investment between two periods $\frac{\frac{\partial(P_tM_t+W_tTH_t)}{\partial I_t}}{\frac{\partial(P_{t-1}M_{t-1}+W_{t-1}TH_{t-1})}{\partial I_{t-1}}}$.

If the individual decides to retire at time t-1, the wage rate W_{t-1} and W_t becomes zero. After the retirement, the marginal product of the stock of health will reduce to $\frac{\partial h_t}{\partial H_t}\left(\frac{\partial U}{\partial h_t}\frac{1}{\lambda}\right)(1+r)^t$, with the absence of earning benefit. Meanwhile, the supply price of the stock of health capital will also become smaller. The opportunity cost of time spent on the investment in health will no longer conflict with the work time. The new marginal cost function at time *t* becomes

$$\frac{\partial(P_{t-1}M_{t-1}+C_{t-1}TH_{t-1})}{\partial I_{t-1}}\left(r-\frac{\frac{\partial(P_tM_t+C_tTH_t)}{\partial I_t}}{\frac{\partial(P_{t-1}M_{t-1}+C_{t-1}TH_{t-1})}{\partial I_{t-1}}}+1+\delta_t\right),$$

where C_t is the new opportunity cost of time that is lower than W_t. Hence, the change in the stock of health capital is dependent on the psychic return on health $\frac{\partial h_t}{\partial H_t}\left(\frac{\partial U}{\partial h_t}\frac{1}{\lambda}\right)(1+r)^t$, and the new marginal cost of health investment $\frac{\partial(P_{t-1}M_{t-1}+C_{t-1}TH_{t-1})}{\partial I_{t-1}}\left(r-\frac{\frac{\partial(P_tM_t+C_tTH_t)}{\partial I_t}}{\frac{\partial(P_{t-1}M_{t-1}+C_{t-1}TH_{t-1})}{\partial I_{t-1}}}+1+\delta_t\right)$. If the psychic return on health is higher, then the stock of health will increase; otherwise, health should decrease.

Besides the mechanism stated in the Grossman model, retirement may also affect health through other channels. In several studies (Bossé et al. 1991, Palmore et al. 1979), participants rated retirement as a stressful event, which could be accompanied by depression and loneliness. Other studies (Sugisawa et al. 1997, Bradford 1979) find that retirement leads to a reduction in social interactions, and social interaction has been shown to have a strong effect on health (Gary 2009, Cohen 2004). However, Case and Deaton (2005) demonstrate that low-paid or manual work has a negative effect on health; therefore, from this view retirement should slow the deterioration of health.

Recent works estimate the causal effect of retirement on health and mortality using the eligibility age in pension or Social Security system as an instrumental variable to address the endogeneity problem between health and retirement. The results are mixed. Coe and Zamarro (2011), Eibich (2013), and Johnston and Lee (2009) use the eligibility age of pension plans in European countries as instruments for retirement. They find a positive effect of retirement on health. However, Charles (2002), and Neuman (2007) use the eligibility age of Social Security program in the U.S. as instrument for retirement. They find no effect on objective measures of health.

In the literature on mortality, Fitzpatrick and Moore (2016), use a regression discontinuity design at the early retirement age in the U.S. Social Security system and find that retirement can increase mortality by 20 percentage points for men. They find death caused by cancer, heart disease, and external causes increases after retirement. However, Coe and Lindeboom (2008) using the early retirement window that is offered by employers as an instrumental variable for retirement, find no effect of retirement on mortality in the U.S. Kuhn, Wuellrich, and Zweimüller (2010) use the early retirement rule in Austria, find that the probability of dying before age 67 increases by 2.4 percentage points for men. Cardiovascular diseases are responsible for the increase in the mortality rate. However, Bingley and Pedersen (2011), using the introduction of early retirement in Demark, find retirement will reduce the mortality rate.

3 THE EFFECT OF RETIREMENT ON HEALTH AND MORTALITY IN THE UNITED STATES

3.1 Introduction

In this chapter, I study the 1983 reforms to the United States Social Security System that raised the retirement age for cohorts born after 1937 to estimate the causal effect of retirement on health and mortality. If retirement has a beneficial effect on health, delaying retirement may have the perverse effect of worsening individuals' health.

I exploit exogenous variation in retirement decisions caused by the 1983 Social Security amendments, which changed the retirement benefits formula of the birth cohort after 1937 to motivate older workers to stay in the labor force. At the same age, cohorts born after 1937 are expected to have a lower probability of retirement than their predecessors.

I start with a simple two-groups comparison by combining multiple birth cohorts based on their Social Security benefit level. Individuals who were born between 1934 and 1937 are not affected by the Social Security policy change and individuals born between 1943 and 1946 faced a benefit reduction. Using a difference-in-difference model, I estimate the difference in the probability of retirement between two groups that is caused by the benefit reduction. I use this estimated effect of the policy on retirement as a first stage in an instrumental variables framework to estimate how this variation in retirement affects the difference in health and mortality between the two groups. Furthermore, to address the concern that some fundamental difference between the two groups is not controlled for by the difference-in-difference model, I expand the model by including all birth cohorts with different benefit levels and estimate the difference in health and mortality across cohorts. This allows me to verify whether the effect is consistent across cohorts.

I find that a one percentage point decrease in Social Security benefits decreases the probability of retirement by one percentage point. This decrease in the probability of retirement leads to worse health but a lower mortality rate. Retirement increases the mortality rate by 0.46 percentage points for men and 1.4 percentage points for women. This increase is mainly accounted for by the death caused from heart disease. However, retirement also has a significant effect on reducing the self-reported bad health and lowering the probability of experiencing limitation in daily activities. The different effects on health and mortality indicate the effect of retirement on health may vary for different people.

My paper compliments an existing literature on the effect of retirement on health. Early studies suggested that retirement has a negative effect on health (Tuomi 1991, González 1980). Recently, several studies have argued that retirement can benefit health (Coe and Zamarro 2011, Eibich 2013, Zhao 2012, Johnston and Lee 2009). However, Kuhn, Wuellrich, and Zweimüller (2010), as well as Fitzpatrick and Moore (2016) find that retirement can increase mortality.

This paper complements the previous literature in several ways. First, most of the recent literature on this topic uses the eligibility age of the pension or Social Security system as an instrument for retirement (Hernaes et al. 2013, Coe and Zamarro 2011, Neuman 2007). These papers make the assumption that health and retirement have a linear or quartic relationship with age. However, the real relationship between health, retirement, and age is not clear and may be quite complex because Medicare eligibility at age 65. My paper relaxes this assumption and makes no assumption about the relationship between age and health or retirement.

Other papers avoid the relationship between age and health by using a regression discontinuity design at the pension or Social Security eligibility age cutoff (Fitzpatrick and Moore 2016, Johnston and Lee 2009). The discontinuity in health or mortality after the eligibility age shows the immediate effect of retirement whereas this paper provides more information on the long-term effect of being retired.

3.2 The change in Social Security

Social Security benefits have been shown to be an important incentive in an individual's retirement decision. According to French (2003), the Social Security system and pensions are the key determinants of the labor force non-participation rates, and so a decline in Social Security benefits would presumably result in an increase in labor supply.

In the U.S., workers become entitled to their full retirement benefits when they reach the full retirement age (which depends on the year in which they were born). Workers may also choose to claim the retirement benefit as early as age 62. The amount of monthly benefit one can receive depends on the expanse of time between claiming the benefit and one's full retirement age. If the person chooses to retire early, the monthly benefit will be lower than the full retirement benefit, and if one chooses to retire late, the monthly benefit will be higher than the full retirement benefit.

Due to the financial pressure on the Social Security system, the Social Security Amendments of 1983 introduced several changes to the Social Security benefits formula to encourage people to delay retirement. The full retirement age of the cohorts who were born in 1938 or later increase from 65 to 67 gradually by cohort. Because of the increase in full retirement age, the benefit and penalty for early and late retirement will also adjust. For every year after the full retirement age that a person delays claiming the benefit, the incremental benefit is 3% for the 1924 cohort. It will gradually increase to 8% for cohorts born after 1924.

Table I shows the full retirement age and the benefit changes by birth cohort. For people who were born in 1937 or earlier, the full retirement age is age 65, and the reduction for early retirement at age 62 is 20%. Beginning with the 1938 cohort, the full retirement age will increase by two months for every cohort. When the retirement age reaches age 66, which is for people who were born in 1943, it will remain at age 66 for the next 12 birth cohorts, and the reduction for early retirement at age 62 increases to 25%. Then the full retirement age and the reduction in benefit for early retirement will increase again from the 1955 cohort to the 1960 cohort until the full retirement age becomes 67. The reduction for early retirement increases to 30% for these cohorts. The increase in the benefit for each year of delayed retirement after full retirement age starts earlier than the increase of full retirement age. It increases from 5.5% for the 1933 cohort to 8% for all cohorts born after 1942. The increase in the delayed retirement benefit offsets part of the reduction in benefit in old age that is caused by the increase in full retirement age. Although this paper uses the variation in the benefit that is caused by all these changes, the main variation is contributed by the increase in full retirement age.

TABLE I. FULL RETIREMENT AGE AND REDUCTION OF BENEFIT BY YEAR OF BIRTH

Year of birth	Full (normal) retirement age (FRA)	At age 62, the retirement benefit is reduced by	Credit for each year of delayed retirement after FRA
1933-34	65	20.00%	5.50%
1935-36	65	20.00%	6.00%
1937	65	20.00%	6.50%
1938	65 and 2 months	20.83%	6.50%
1939	65 and 4 months	21.67%	7.00%
1940	65 and 6 months	22.50%	7.00%
1941	65 and 8 months	23.33%	7.50%
1942	65 and 10 months	24.17%	7.50%
1943-54	66	25.00%	8.00%
1955	66 and 2 months	25.83%	8.00%
1956	66 and 4 months	26.67%	8.00%
1957	66 and 6 months	27.50%	8.00%
1958	66 and 8 months	28.33%	8.00%
1959	66 and 10 months	29.17%	8.00%
1960 and later	67	30.00%	8.00%

Source: Social Security Administration

Figure 2 shows the relationship between claiming age and benefit level as a percentage of the full retirement benefit for selected birth cohorts. Cohorts before 1937 have full retirement at age 65, and cohorts between 1943 and 1954 have full retirement at age 66. If a person born in 1943 chooses to retire before age 66, the monthly benefit will be reduced by around 5% compared to a person born in 1937 who retires at the same age. The difference in the monthly benefit between these two people will be reduced if they retire after age 66, but the difference will not be eliminated until age 70. This benefit reduction provides strong incentives for young cohorts to stay in the labor force.

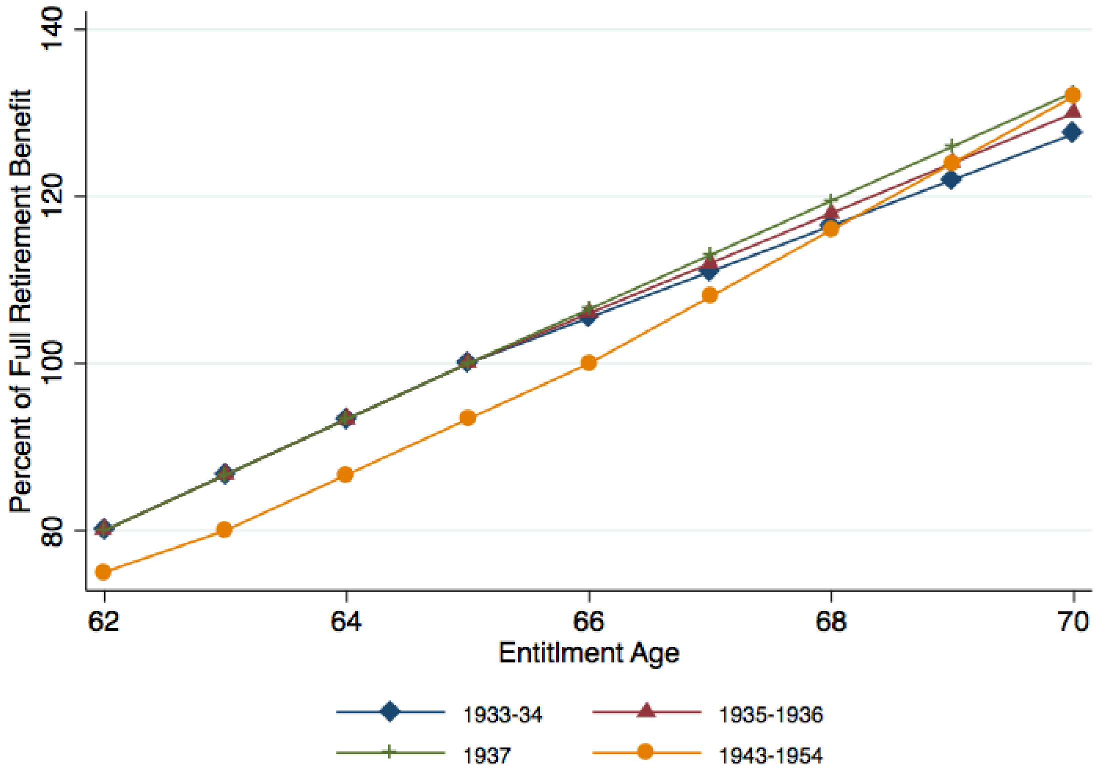

Figure 2. Social Security benefit as a percentage of the full retirement benefit, by birth year and entitlement age

The previous literature has shown that this change in Social Security policy leads to a reduction in retirement. Song and Manchester (2006), using Social Security Administration data, find a 4 percentage points increase in the labor supply for men and a 2 percentage points increase for women at age 62 to 65 in the 1938 to 1940 cohort. Mastrobuoni (2009), using Current Population Survey (CPS) data, finds the average retirement age increases by one month for every two-month increase in the full retirement age for cohort 1938 to 1941. Blau and Goodstein (2010), using the labor force participation rates from 1988 to 2005, argue a more conservative estimation than Mastrobuoni (2009). They find the change in Social Security benefits accounts for a 1.2 percentage points to 2.4 percentage points increase in the labor force participation rate of men aged 55 to 69. I replicate this finding using labor force participation data from the National Health Interview Survey in Figure 3, which shows the percentage of the population who are not in the labor force by age and gender for the 1934 to 1937 cohorts and the 1943 to 1946 cohorts. Consistent with the findings in the previous literature, the 1943 to 1946 cohorts have a lower labor force non-participation rate than the other group between age 62 and age 65 for men. The difference for women is stable at all ages.

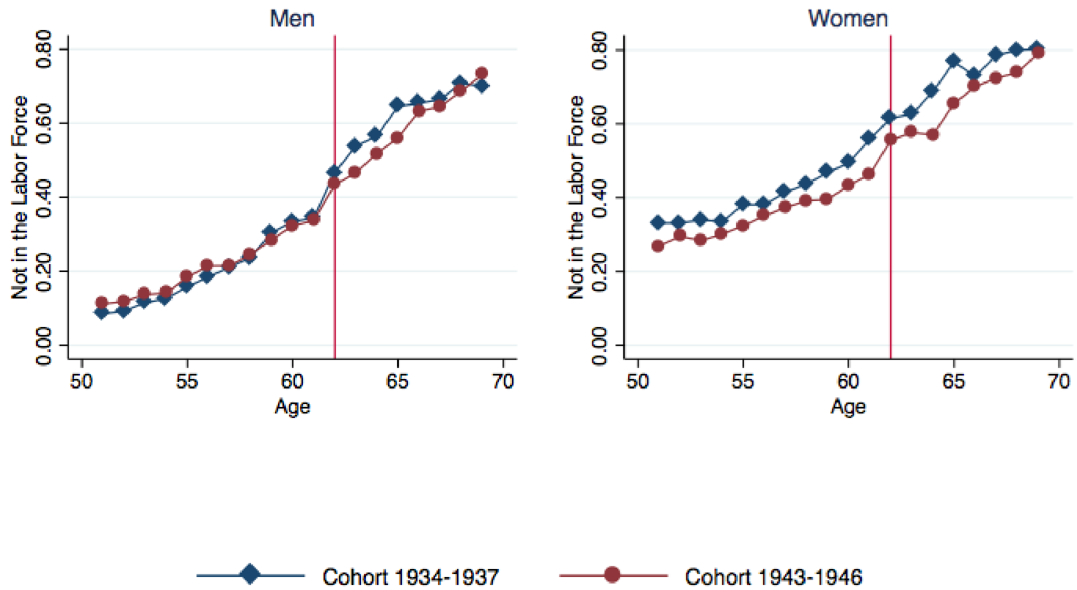

Figure 3. The percentage of people not in the labor force by cohort group and gender

3.3 Data

The data in this paper are from two sources. The mortality data are from the National Center for Health Statistics (NCHS), and health outcomes and retirement status are from the National Health Interview Survey (NHIS). The mortality data from the NCHS provide the mortality rate by age and year in the United States along with the underlying cause of death.[4] The mortality rate is measured by the number of deaths per 1,000 population.

This paper focuses on the total mortality rate and the mortality rate from the five leading causes of death that are published by the NCHS. The five leading causes are heart disease, malignant neoplasms, cerebrovascular diseases, chronic lower respiratory diseases, and accidents. These five leading causes constitute more than 70% of all deaths each year.

Table II provides the descriptive statistics for these causes. The total mortality rate is 13.63 deaths per 1,000 population for men and 8.51 deaths per 1,000 population for women. Of the total mortality, malignant neoplasms account for about 4 deaths. Although it is the second leading cause in total population, it causes the most death in this sample, which only contains people between age 51 and 69. The mortality rate for heart disease, the second leading cause in this sample, is 3.92 per 1,000 population for men and 1.71 for women. The rest of the causes have a relatively smaller mortality rate. In a population of 1,000 men, cerebrovascular diseases cause 0.52 deaths, chronic lower respiratory diseases cause 0.63 deaths, and accidents cause 0.47 deaths. The mortality rate of these causes for women is slightly lower.

[4] The cause of death is classified using the International Classification of Diseases (ICD). The ICD has been revised periodically. Data from 1999 to 2015 is coded in the tenth revision (ICD-10). Data before 1999 has been converted to the ICD-10 using the comparability ratio provided by NCHS.

TABLE II. DESCRIPTIVE STATISTICS

	Men	Women
Age	58.90	58.94
Not in the labor force	0.33	0.49
Self-reported bad health	0.19	0.20
Limitation in daily activities	0.04	0.06
The number of hospital visit in the last two weeks	0.29	0.35
Days in bed due to illness in the last twelve months	0.32	0.38
Race		
White	0.83	0.81
Black	0.11	0.14
Other	0.06	0.06
Hispanic	0.11	0.11
Marital status		
Married	0.80	0.65
Widowed	0.03	0.12
Divorced	0.11	0.15
Separated	0.02	0.03
Never married	0.05	0.05
Education		
Less than high school	0.20	0.21
High school	0.33	0.39
Some college and associate degree	0.20	0.22
College and above	0.27	0.18
Region		
Northeast	0.19	0.19
Midwest	0.23	0.23
South	0.37	0.37
West	0.22	0.21
Mortality rate (per 1,000 population)	13.63	8.51
Heart disease	3.92	1.71
Malignant neoplasms	4.63	3.49
Cerebrovascular diseases	0.52	0.39
Chronic lower respiratory diseases	0.63	0.53
Accidents	0.47	0.20
Other reasons	3.45	2.20

Note: The mortality data are from the National Center for Health Statistics (NCHS), and health outcomes, retirement status, and individual characteristics are from the National Health Interview Survey (NHIS).

The health outcomes and the retirement status are from the NHIS, which is an individual level nationally representative cross-sectional health survey that is conducted annually. The data contain information about health status, employment status, and socio-demographics. However, given the revisions of the survey over the years, only a few health outcomes have been consistently included in the survey that can be served as a dependent variable. Table II provides the descriptive statistics for these health outcomes and the socio-demographic variables that I use here.

The self-reported bad health is the indicator of the respondent reporting “fair health” or “poor health” in the self-reported health. The survey asks participants to grade their health on a scale of 1 to 5, with 1 being “excellent”, then “very good,” “good,” “fair,” and 5 being “poor”. To focus on those who are in particular bad health, I created an indicator ‘bad health’ that is equal to 1 if the respondent reported their health in the last two classifications of the scale, “fair” or “poor,” and zero otherwise. In the sample, about 20% of respondents reported fair or bad health for both men and women. Although the self-reported health can be subjective, literature has shown that it has significant relation with mortality (Miilunpalo et al. 1997, McGee et al. 1999).

The daily limitation indicates whether the individual has limitations in any daily activities, such as personal care or routine needs. The proportion of respondents in the sample who experience limitations is 4% for men and 6% for women. The variable excludes the limitation in work activities. The limitation in work activities is measured separately so that the absence of working should not affect how people respond to this variable.

The number of hospital visits in the last two weeks provides an objective measurement of health status. However, the variable could be influenced by the person's willingness and ability to visit the hospital. With a flexible schedule after retirement, a person could be more willing to go to the hospital than before, even with the same health level. On average, men had visited the hospital 0.29 times in the last two weeks and women had visited 0.35 times.

Days in bed is an indicator that an illness or injury kept the person in bed in the last 12 months. The variable is an approximation of whether the respondent has been sick in the last 12 months. Of the respondents, 32% of men and 38% of women reported they had stayed in bed for at least a day. Everyone in the sample was surveyed for this variable before 1997. After 1997, only a subset of randomly selected adults was asked this question. Therefore, the variable has a much smaller number of observations after 1997 than it did in the previous survey. However, since the selection of respondents is random after 1997, the point estimation should not be affected by the change in sample size.

Retirement is measured by labor force status. If the respondent is not in the labor force, then the person is considered to be retired. More generally, the definition of retirement can be subjective. People may claim they are retired after they end a long-held career, even if they still work other part-time jobs. Since this paper focuses on the effect of work status, labor force status is a more accurate measurement than self-report retirement status. Given the age of the sample, the exit from the labor force should mainly be accounted for retirement.

To accommodate the comparison between birth cohorts affected by the change in Social Security policy, I pool all the data from 1984 to 2016. With the repeated cross-sectional data, I cannot track individuals over time, but I can track people from the same birth cohort at each age. To obtain a sufficient number of birth cohorts and long enough age range, I restrict the sample to the individuals who were born between 1934 and 1946 and aged 51 to 69 at the time of the survey.[5]

The mortality data is aggregated to the age and year level. Thus, for my analyses of the relationship between retirement and mortality, I also aggregate retirement data by age and year.

3.4 <u>Empirical estimation</u>

The econometric relationship between health and retirement can be written as:

$$Health_{it} = \alpha_1 + \alpha_2 Retirement_{it} + \alpha_3 X_i + \varepsilon_\mathrm{i} \qquad (5)$$

where $Health_{it}$ is the health outcome of individual *i* at year *t*. $Retirement_{it}$ is a dummy variable indicating the retirement status of the individual. $Retirement_{it}$ equals 1 when the individual is not in the labor force and zero otherwise. X_i is a set of individual characteristics such as gender, age, race, and education. The coefficient of interest is α_2, indicating how being retired affects health.

However, estimating equation (5) using ordinary least square (OLS) will lead to biased result since retirement is correlated with the unobserved determinants of health, ε_i. The estimation could be biased for a couple of reasons, the first of which

[5] Because I can only observe a certain number of birth cohorts in the same age range, the more birth cohorts that are included in the sample, the smaller age range that can be observed. For example, if only the 1937 cohort is included in the sample, I am able to observe them from age 47, but if the 1936 cohort is added, I only can observe both cohorts from age 48.

is the reverse causality of health on retirement. Previous studies have shown that a person's health plays an important role in retirement decisions and that health problems lead to early retirement (Dwyer, Sabatini, and Mitchell 1999). This negative correlation between retirement and initial health conditions may exaggerate or offset the actual change in health caused by retirement. Secondly, unobserved factors such as family background may influence both the retirement decision and health, which will bias the result.

I address the endogeneity problem by taking advantage of the change in Social Security policy to generate exogenous variation in retirement status. The reduction in the Social Security benefits for cohorts born after 1937 provides incentives for them to postpone the retirement. Therefore, at the same age, these cohorts will have a smaller probability of retirement than previous generations. I use this policy change as an instrument for retirement.

First, I implement a two-groups comparison between birth cohorts whose full retirement age is 65 and birth cohorts whose full retirement age is 66. I compare their probability of retirement, health, and mortality as follows:

$$Retirement_{iagt} = \gamma_1 + \gamma_2 Cohort\ Group_g + \gamma_3 Age_a + \gamma_4 Age_a * Cohort\ Group_g + \gamma_5 \text{Survey Year Trend}_\text{t} + \gamma_6 Age * Cohort\ Group_g + \gamma_7 X_i + e_{iagt} \quad (6)$$

$$Health_{iagt} = \beta_1 + \beta_2 Cohort\ Group_g + \beta_3 Age_a + \beta_4 Age_a * Cohort\ Group_g + \beta_5 Survey\ Year\ Trend_t + \beta_6 Age * Cohort\ Group_g + \beta_7 X_i + e_{iagt} \quad (7)$$

$$Mortality_{agt} = \delta_1 + \delta_2 Cohort\ Group_g + \delta_3 Age_a + \delta_4 Age_a * Cohort\ Group_g + \delta_5 Survey\ Year\ Trend_t + \delta_6 Age * Cohort\ Group_g + e_{agt} \quad (8)$$

where $Retirement_{iagt}$ and $Health_{iagt}$ are the retirement status and health status of individual *i* at age *a,* belongs to cohort group g, and surveyed in year *t*. Since the mortality data can be used only on the aggregate level, I compare the mortality rate of two groups on the birth cohort and age level. $Mortality_{agt}$ is the mortality rate at age a*,* belongs to cohort group g, and surveyed in year *t*. $Cohort\ Group_g$ is the indicator of the birth cohort of the individual. It equals 1 if the individual was born between 1943 and 1946, and it equals 0 if the individual was born between 1934 and 1937. Age_a is a set of age dummies. X_i is a set of individual characteristics such as region, race, and education.

I restrict the time trend with the linear-year effect by "Survey Year Trend_t", instead of a set of year dummies. Given the sample size, too many fixed effects will result in loss of statistical power. Although the linear time trend is a strong assumption, it provides more statistical power for the estimation. Moreover, it becomes clear that the result is not sensitive to the parameterization of the time trend.

To control for any possible change of the difference in retirement between two groups in the absence of policy reform, the interaction between linear age and cohort groups ($Age * Cohort\ Group_g$) is added into the model. This is particularly important for the estimation of mortality, but it does not have a significant effect on retirement and health outcomes.

The interaction term between age dummies and cohort group allows the difference in retirement, health outcomes, and mortality between two cohort groups to change with age. This interaction term will test the assumption of the pre-trend by revealing whether the difference in these outcomes between two cohort groups is changing with age before age 62.

To estimate the effect of retirement on health and mortality, I modify the model by replacing the interaction between age dummies and cohort group in equation (6) with the Social Security benefit level. Therefore, the probability of retirement can change with the Social Security benefit, and only the variation in the probability of retirement after age 62 will be contributed to the effect of policy change. For the first stage, to estimate the effect of the policy change on the probability of retirement, I apply the difference-in-difference method as follows:

$$Retirement_{iagt} = \gamma_1 + \gamma_2 Cohort\ Group_g + \gamma_3 Age_a + \gamma_4 SSB_{ag} + \gamma_5 \text{Survey Year Trend}_{\text{t}} + \gamma_6 Age * Cohort\ Group_g + \gamma_7 X_i + e_{iagt} \quad (9)$$

SSB_{ag} is the Social Security benefit level associated with the cohort group g at age a. The Social Security benefit level is measured as the percentage of the full retirement benefit. It equals 0 before age 62 but equals the corresponding benefit level for each cohort group when age is greater than 62. The 1943 to 1946 cohorts have the identical Social Security benefits at every age. The 1934 to 1937 cohorts have the same benefit before the full retirement age, but the late retirement benefit within the group are slightly different. The group average benefit level is assigned to ages greater than 65.

The identification assumption of this model is that the difference in the probability of retirement between two cohort groups has a linear relationship with age in the absence of the policy reform. γ_2 represents the birth cohort effect, which is the difference in the probability of retirement between two cohort groups at the base age group, age 61. γ_3 represents the age effect, which captures a general upward trend in the probability of retirement as individuals age. γ_5 is the survey year effect or period effect, which captures the time trend that affects all people simultaneously. γ_6 estimates differences in age pattern of retirement between two groups in the absence of the policy reform. If γ_6 equals 0, then it indicates that the probability of retirement of two cohort groups follow the common trend before age 62. The effect of the Social Security policy change on the probability of retirement is identified by γ_4, which is the coefficient of the Social Security benefit level. It captures the nonlinear change in the difference in the probability of retirement across cohorts after age 62.

Then, the effect of retirement on health can be estimated as:

$$Health_{iagt} = \beta_1 + \beta_2 Cohort\ Group_g + \beta_3 Age_a + \beta_4 \widehat{Retirement}_{iagt} + \beta_5 Survey\ Year\ Trend_t + \beta_6 Age * Cohort\ Group_g + \beta_7 X_i + u_{iagt} \quad (10)$$

where $Health_{iagt}$ is the health indicator of the individual. $\widehat{Retirement}_{iagt}$ is the projected probability of retirement of individual *i* from equation (6). β_2 identifies the difference in health between two cohort groups before age 62. β_3 identifies the health change at each age. β_5 estimates the health trend over time. β_6 captures the linear relationship between the difference in health and age. The parameter of interest, β_4, identifies the effect of retirement on health. It implies how much of the change in health between two groups can be explained by the change in retirement that is generated by the policy.

I estimate the effect of retirement on mortality on the birth cohort and age level. The aggregate model is derived from the individual model by averaging the individual responses in a cohort-age-year group. In particular, I estimate

$$Retirement_{agt} = \gamma_1 + \gamma_2 Cohort\ Group_g + \gamma_3 Age_a + \gamma_4 SSB_{ag} + \gamma_5 Survey\ Year\ Trend_t + \gamma_6 Cohort\ Group_g * Age + \gamma_7 X_{agt} + e_{agt} \quad (11)$$

$$Mortality_{agt} = \beta_1 + \beta_2 Cohort\ Group_g + \beta_3 Age_a + \beta_4 \widehat{Retirement}_{agt} + \beta_5 Survey\ Year\ Trend_t + \beta_6 Cohort\ Group_g * Age + \beta_7 X_{agt} + u_{agt} \quad (12)$$

where $\mathrm{Retirement}_{agt}$ is the average retirement rate of cohort group *g* at age *a* in year *t*, and $\mathrm{Mortality}_{agt}$ is the mortality rate (deaths per 1,000 population) for the same group. Considering that the treatment of the Social Security benefit level is on age and cohort level, the aggregate and individual level estimations should yield the same result.

I also estimate a model that includes all birth cohorts between 1934 and 1946. This model treats every birth year as a single cohort group[6]. If there are no threats to the internal validity of the model, and the effect of Social Security benefits on retirement is the same across cohorts, then the estimation of the multi-groups model should be consistent with the two-groups model.

There are a few potential threats to validity of my estimation strategy. First, if the difference in mortality, health, or retirement between cohorts does not have a linear relationship with age in the absence of the policy reform, then the model might misestimate the cohort effect and attribute part of the cohort effect to the effect of retirement. Although the difference in mortality, health, or retirement between cohorts after age 62 cannot be directly tested, I use the trend before age 62 as an approximation of the difference between cohorts after age 62. Only a few outcomes show any difference between cohorts before age 62, and in the robustness check section, I show that, with all the controls, the difference between cohorts before age 62 is stable.

Second, if the policy change can affect health through other channels other than retirement, then the estimation will be upward biased. Given the foreseeable reduction in Social Security benefits, people may increase their savings by reducing the consumption or investing in their health to prepare for more work years. These actions could affect their health status. However, the model only uses the change of the difference in health between cohorts in the estimation. Any reactions to the

[6] In the mortality data, the birth year is constructed by subtracting age from the survey year. The multi-group model in this case will have a perfect collinearity between age, birth year, and survey year. The estimation is obtained by eliminating two age groups. The omitted group in the control variables will not affect the estimation of the parameter of interest.

policy change that have an impact on health at all ages will be controlled by the cohort effect. It is less likely that these reactions become effective on health only after age 62.

Finally, the estimation assumes that the effect of Medicare on health is captured by the age effect or the age-cohort interaction. However, with improvements in medical science, one might worry about an age-year interaction in which the deterioration of health with age is becoming slower over time. This would downward bias the estimation because the age-year interaction will offset the impact of retirement on health. Moreover, in the robustness check section, I will show that the difference in health and mortality between two groups starts around age 62, rather the eligibility age for Medicare, age 65.

3.5 Results

3.5.1 The effect of the Social Security policy change on retirement

Figure 4 plots the coefficients of the interaction term from equation (6). It shows the difference in the probability of retirement between two cohort groups at each age. After controlling for the cohort groups, the age dummies, the linear year trend, and the interaction between linear age and cohort groups, the difference in retirement between two cohort groups is almost zero before age 57. Between age 57 and 61, there is a slight drop, suggesting the younger cohort has a slightly lower probability of retirement even before age 62. Given the stable trend before age 57, this drop is more likely to be caused by the indirect effect of the policy change rather than any health-related reason. As a result of the reduction in total benefit, people who wish to retire before age 62 may need to save more money than earlier generations. This may lead to the drop in the probability of retirement before age 62.

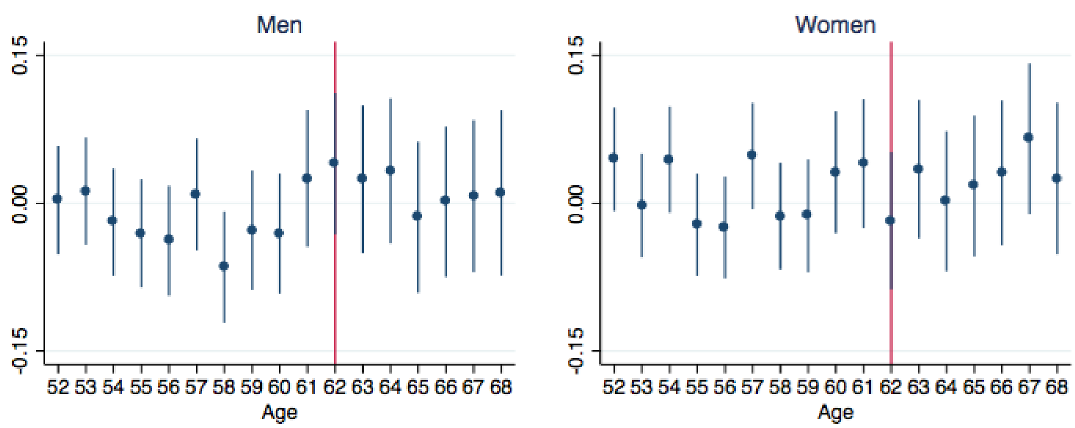

Figure 4. Coefficients of interaction between age and cohort group on retirement, with 95 percent confidence interval

Tables III and IV provide the estimation results from equation (9), separately by gender, and shows that the policy change had a significant effect on retirement.

The coefficients indicate the impact of a one percentage point rise in Social Security benefit levels on the probability of retirement. Patterns of labor supply in old age are different between men and women, which may lead to a difference in responding to the Social Security policy change. I therefore stratify all results by gender.

The estimation is consistent across all models. With a one percentage point increase in Social Security benefit level, the probability of retirement will increase by one percentage point for men, and 0.4 percentage points for women. Therefore, compared to the 1934 to 1937 cohorts, the 5 percentage points reduction in Social Security benefit level for the 1943 to 1946 cohorts before their full retirement age will lead to a 5 percentage points decrease in the probability of retirement.

TABLE III. FIRST STAGE, THE EFFECT OF BENEFIT REDUCTION ON PROBABILITY OF RETIREMENT FOR MEN

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Two-groups Model				Multi-groups Model			
Dependent Variable	Individual level			Aggregate level	Individual level			Aggregate level
Retirement	0.011***	0.011***	0.010***	0.010***	0.010***	0.010***	0.009***	0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Survey year		x	x	x		x	x	x
Linear age*cohort group			x	x			x	x
Number of observation	56,634	56,634	56,634	152	89,770	89,770	89,770	247
R-Squared	0.227	0.227	0.227	0.984	0.224	0.225	0.225	0.985
F-stat	36.945	35.969	15.794	19.942	35.716	36.569	15.957	18.493

Note: * p<0.1; ** p<0.05; *** p<0.01. The displayed coefficients are the coefficients of the Social Security benefit level. Standard errors in parentheses. Standard errors in IV model are clustered at birth year by age level. All estimations control for individual characteristics: race, education level, marital status, and region.

TABLE IV. FIRST STAGE, THE EFFECT OF BENEFIT REDUCTION ON PROBABILITY OF RETIREMENT FOR WOMEN

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Two-groups Model				Multi-groups Model			
Dependent Variable	Individual level			Aggregate level	Individual level			Aggregate level
Retirement	**0.005*****	**0.005*****	**0.005****	0.004*	**0.004****	**0.004****	**0.004****	**0.003***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Survey year		x	x	x		x	x	x
Linear age*cohort group			x	x			x	x
Number of observation	62,561	62,561	62,561	152	99,273	99,273	99,273	247
R-Squared	0.159	0.159	0.159	0.975	0.156	0.156	0.156	0.979
F-stat	7.213	7.096	4.275	3.677	5.264	5.337	3.68	3.036

Note: * p<0.1; ** p<0.05; *** p<0.01. The displayed coefficients are the coefficients of the Social Security benefit level. Standard errors in parentheses. Standard errors in IV model are clustered at birth year by age level. All estimations control for individual characteristics: race, education level, marital status, and region.

The result in column (1) only has the controls of age dummies, a cohort group dummy, and individual characteristics. Column (2), also includes the linear year effect to control for the time trend. In column (3), the interaction between linear age and cohort groups is added to allow the differentiation in pre-trend. In column (4), the estimation is based on the probability of retirement for the age and cohort level. The results are remarkably similar across specifications. The estimation of the multi-groups model is close to the two-groups model. These results are shown in columns (5) through (8).

The results of my study show the policy change was more effective for men, possibly because many women choose to claim Social Security benefits based on their spouse's earnings history rather than their own.

3.5.2 **The effect of retirement on mortality**

While the change of Social Security benefit shows a significant effect on reducing the probability of retirement, does the difference in the mortality rate between two cohort groups follow the same relationship? To find out, I plot the mortality rate at each age by cohort group and gender (see Figure 5). Although the difference in mortality rate between two groups increases with age, the difference seems much larger after age 62. This is more obvious for women than men.

Taking all the controls intro consideration as equation (8), the difference in the mortality rate between two cohort groups is shown in Figure 6. The difference between the two groups is consistent before age 62, and has a discrete change after that. This implies that any change after age 62 is a result of the change in Social Security policy.

Figure 5. Mortality rate by cohort group and gender

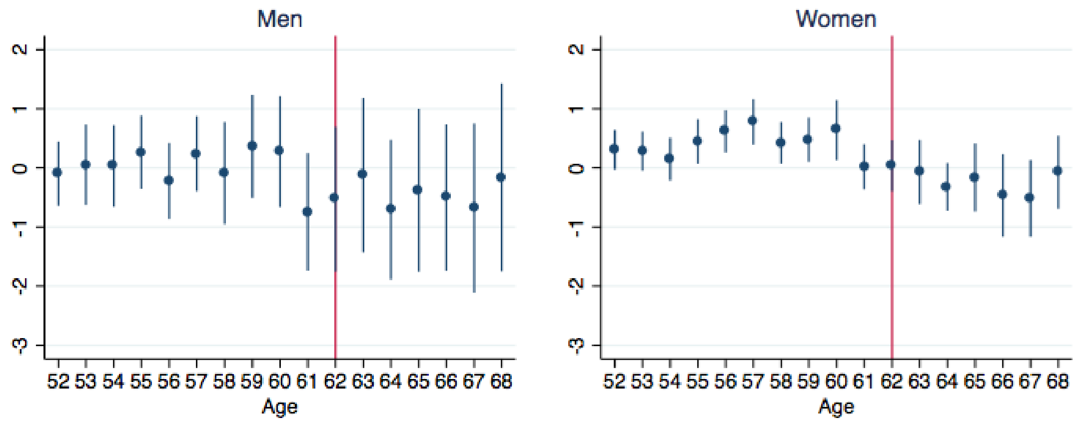

Figure 6. Coefficients of interaction between age and cohort group on mortality, with 95 percent confidence interval

Table V shows the estimated results. Column (1) shows the estimation from OLS. The OLS model is estimated on the age and cohort level, and it shows that a one percentage point increase in the probability of retirement is associated with a 0.43 percentage points increase in the mortality rate for men and a 0.11 percentage points increase for women. Only the former is statistically different from zero. Column (2) shows the IV result with neither the control of the linear year trend nor the control for the pre-trend differential. The estimated effect is much larger than the result from OLS for both men and women. The model suggests that being retired will increase the mortality rate by 2.4 percentage points for men and 3.9 percentage points for women. Figure 5 illustrates this large effect and suggests that the difference in mortality between two groups is increasing prior to age 62. In column (3) I add a control for a linear year trend, which does not alter the results, and in column (4) I add a linear age effect interacted with cohort. Estimates in column 4 therefore control for the pre-existing differences in the mortality trends across cohorts. In this model, being retired increases the mortality rate by 0.46 percentage points for men and by 1.6 percentage points for women. These are remarkably close to the OLS results. Column (5) shows the estimation of the multi-groups model. The estimation of the multi-groups model is consistent with the estimation from the two-groups model.

Then, I estimate the same model on the mortality rate from the five leading cause of death. The results are presented in Table VI. Retirement only shows a significant effect on the mortality that is caused by heart disease. For men, retirement can increase the mortality caused by heart disease by 0.37 percentage points, which is almost 90% of the total effect on mortality. For women, the effect from heart disease accounts for about half of the total effect on mortality. Being retired can raise the mortality caused heart disease by 0.6 percentage points.

Given the increase in mortality that is caused by the retirement, the attrition bias can be a concern for the estimation of the effect of retirement on health. However, since the retirement will only increase the mortality rate for men by 0.46 percentage points, and increase the mortality rate for women by 1.4 percentage points, the attrition bias should be insignificant. With a higher probability of retirement, older cohorts have a higher mortality rate than the younger cohorts. This higher mortality rate indicates that unhealthy individuals in older cohorts are more likely to drop out of the sample due to death. Therefore, the average health of remaining individuals in the older cohorts will improve relatively. However, this improvement is not caused by the improvement of individual's health but caused by the loss of unhealthy people. With about one percent more loss of the sample that is caused by the retirement, the change in the average health due to the loss is less worried here.

TABLE V. THE EFFECT OF RETIREMENT ON MORTALITY

Dependent Variable	(1) OLS	(2) Two-groups IV	(3)	(4)	(5) Multi-groups	(6) IV	(7)
	Men						
Mortality	4.331***	23.657***	20.735***	4.446*	18.047***	18.047***	4.681***
	(1.025)	(4.982)	(4.574)	(2.635)	(3.311)	(3.311)	(1.575)
	Women						
Mortality	1.077	39.784**	39.045**	16.571*	39.989**	39.989**	14.289**
	(0.735)	(19.945)	(19.909)	(9.286)	(19.046)	(19.046)	(6.518)
Survey year	x		x	x		x	x
Linear age*cohort group				x			x
Number of observation	247	152	152	152	247	247	247

Note: * p<0.1; ** p<0.05; *** p<0.01. Standard errors in parentheses. All estimations control for individual characteristics: race, education level, marital status, and region. Mortality is defined as the number of deaths per 1,000 population.

TABLE VI. THE EFFECT OF RETIREMENT ON THE LEADING CAUSE OF MORTALITY

	Men			Women		
Dependent Variable	OLS	Two-groups IV	Multi-groups IV	OLS	Two-groups IV	Multi-groups IV
Heart disease	2.344***	3.943***	3.652***	0.678**	7.333*	5.849**
	(0.434)	(1.239)	(0.898)	(0.339)	(3.899)	(2.533)
Malignant neoplasms	1.444***	-0.316	0.143	0.257	2.353	2.881*
	(0.423)	(0.846)	(0.505)	(0.239)	(1.866)	(1.597)
Cerebrovascular diseases	0.311***	0.295	0.229	0.082	0.133	0.174
	(0.093)	(0.197)	(0.159)	(0.077)	(0.382)	(0.305)
Lower respiratory diseases	0.163*	-0.253	-0.182	-0.032	0.964	0.824
	(0.091)	(0.198)	(0.209)	(0.075)	(0.784)	(0.591)
Accidents	-0.071	-0.031	0.001	0.018	-0.108	-0.104
	(0.063)	(0.188)	(0.166)	(0.035)	(0.269)	(0.240)
Other reasons	0.157	0.872	0.913	0.086	5.698*	4.523**
	(0.277)	(0.855)	(0.666)	(0.182)	(3.350)	(2.299)
Survey year	x	x	x	x	x	x
Linear age*cohort group		x	x		x	x
Number of observation	247	152	247	247	152	247

Note: * p<0.1; ** p<0.05; *** p<0.01. Standard errors in parentheses. All estimations control for individual characteristics: race, education level, marital status, and region. Mortality is defined as the number of deaths per 1,000 population.

3.5.3 The effect of retirement on health

For the health outcomes, I plot the average level of health outcomes at each age by cohort group and gender (Figures 7 through 10). In Figure 7, men from the 1943-1946 cohort group, who have a smaller probability of retirement between age 62 and 65 than the other group, have a smaller proportion of people in the report fair or bad health before age 62. Then, between ages 62 and 65, their probability of reporting fair or bad health becomes higher than the other group. In Figure 8, 1943-1946 cohort group have a higher probability of experiencing limitations in daily activities at the same age. In Figure 9, the men born between 1943 and 1946 show on average a higher number of hospital visits between age 63 and 65 than the other group, but there is no difference between the two groups before age 62. In Figure 10, the younger cohort of men is less likely to stay in bed due to illness and sickness than the older cohort group before age 61. Starting with age 61, the difference reversed.

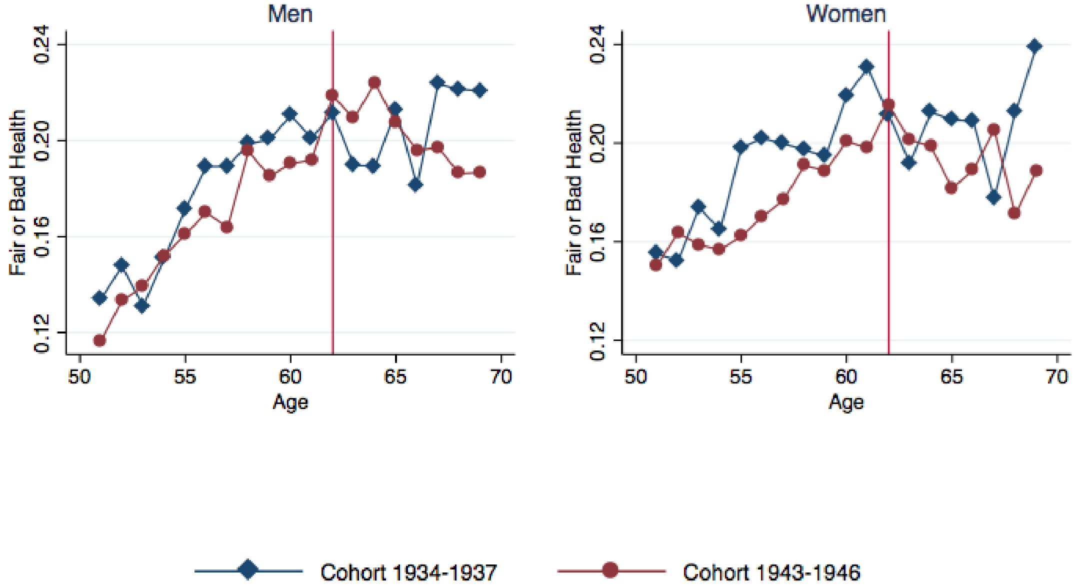

Figure 7. The percentage of people reporting fair or bad health by cohort group and gender

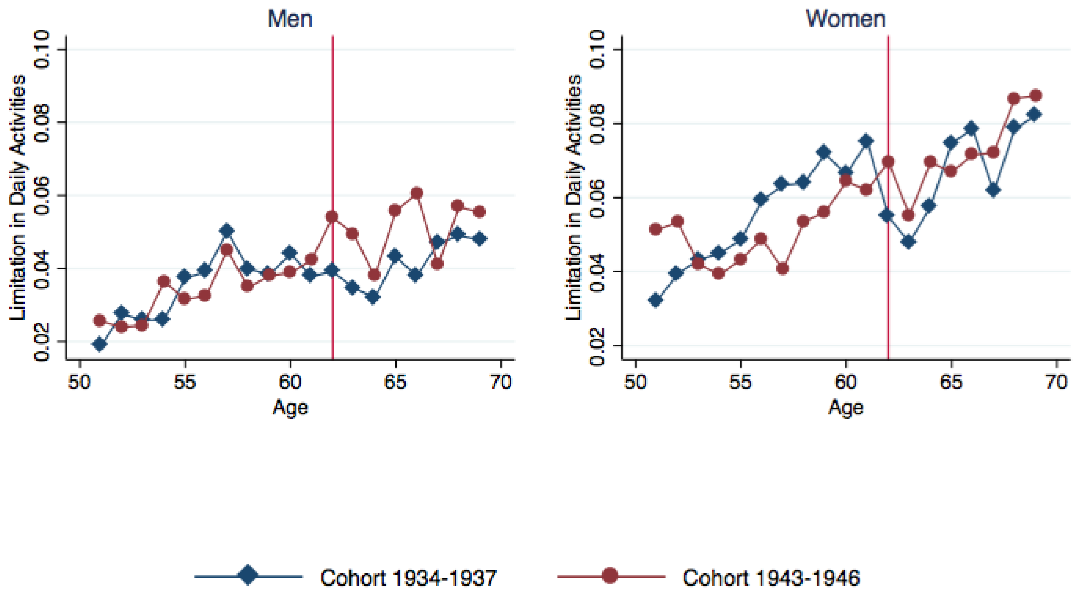

Figure 8. The percentage of people experiencing limitation in daily activities by cohort group and gender

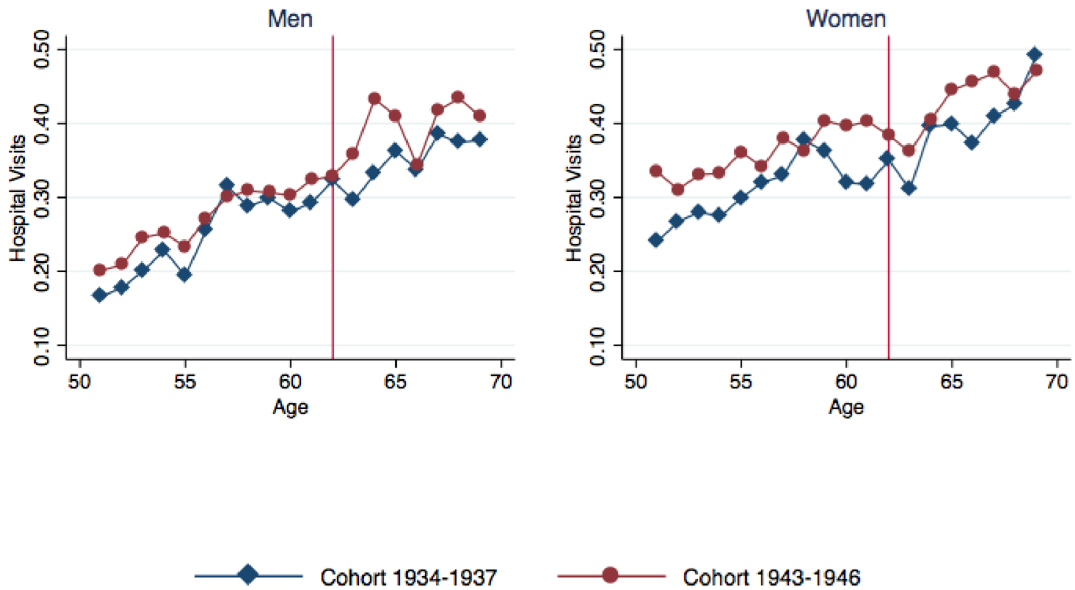

Figure 9. The number of hospital visits in the last two weeks by cohort group and gender

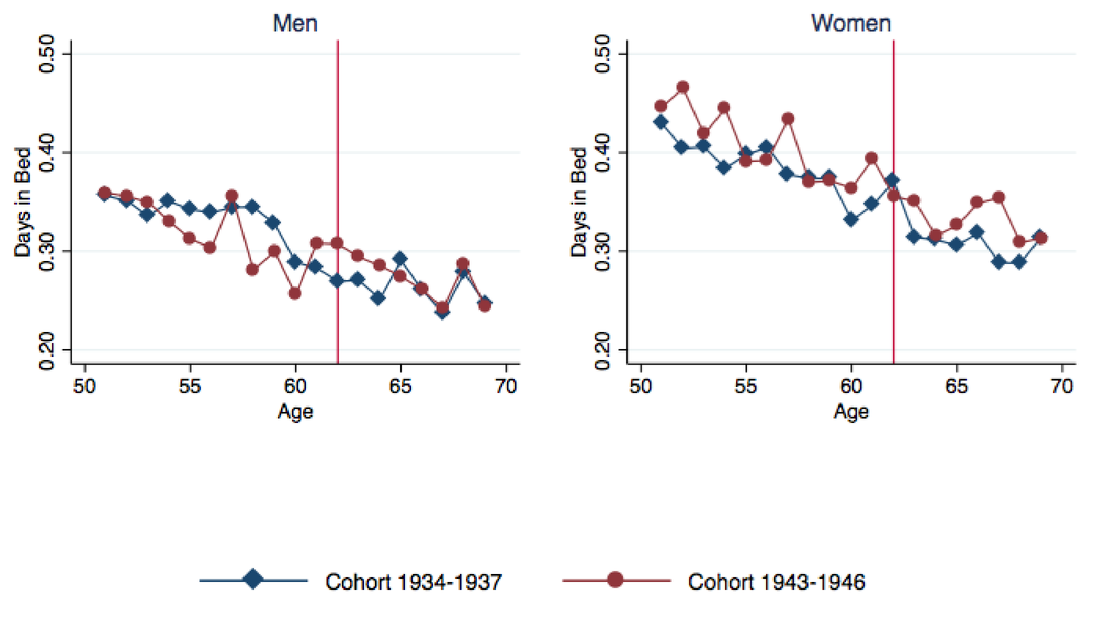

Figure 10. The percentage of people spending days in bed in the last year by cohort group and gender

Both the change in the difference in health indicators between the two cohort groups and that in the probability of retirement between the two groups occur within a similar age range for men. Given the large fluctuation within the health indicators, even though the age range is not an exact match with the retirement, evidence like this is highly encouraging in that it shows a connection between these two changes. For women, the difference between the two groups in health and retirement are less clear.

Figures 11 through 14 present the coefficients of the interaction term of equation (7). With the control of cohort group, age, year, and individual characteristics, the difference in health outcomes between two groups is consistent with the mean comparison from Figure 8 to 10. These figures verify the pre-trend assumption, that the difference in these outcomes between two cohort groups is stable before age 62. Moreover, for outcomes that show a significant effect of retirement, the difference between the two groups begin to change around age 62. This suggests that even if the effect of Medicare is different between these two groups, it does not make a major contribution to the difference in health between these two groups.

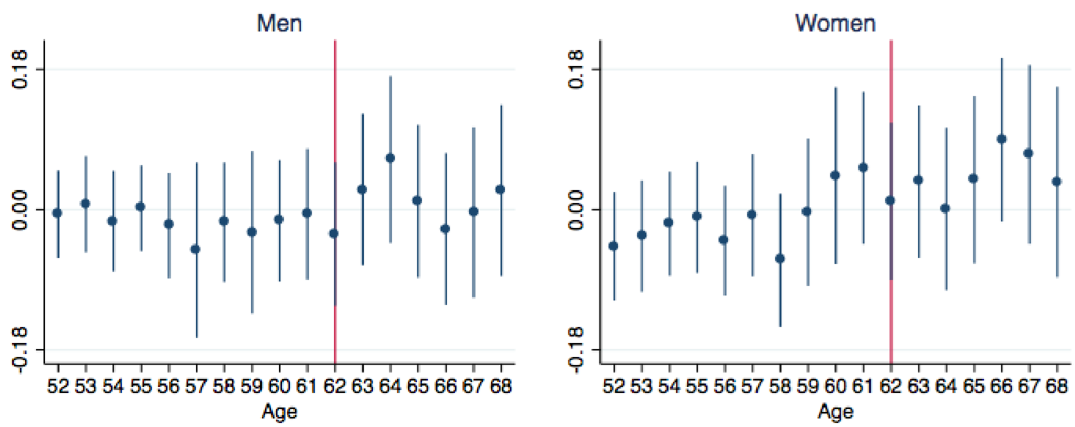

Figure 11. Coefficients of interaction between age and cohort group on reporting fair or bad health, with 95 percent confidence interval

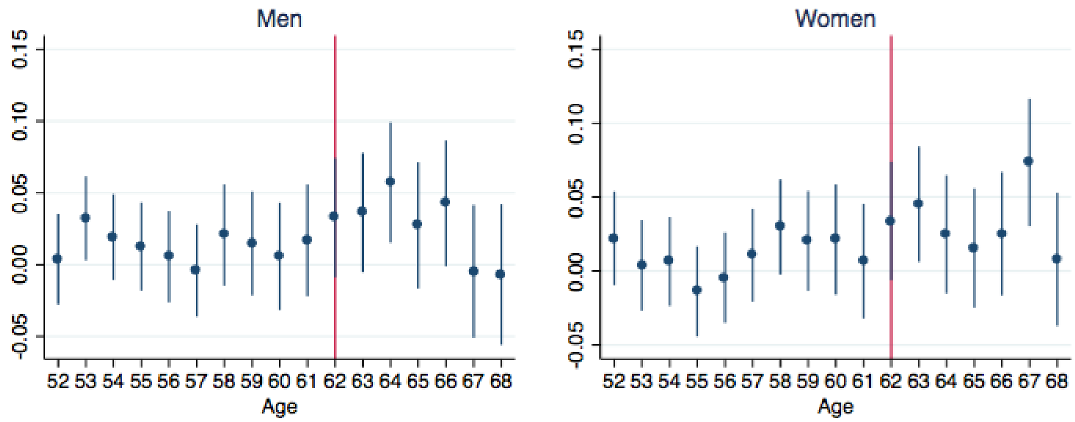

Figure 12. Coefficients of interaction between age and cohort group on Limitation in daily activities, with 95 percent confidence interval

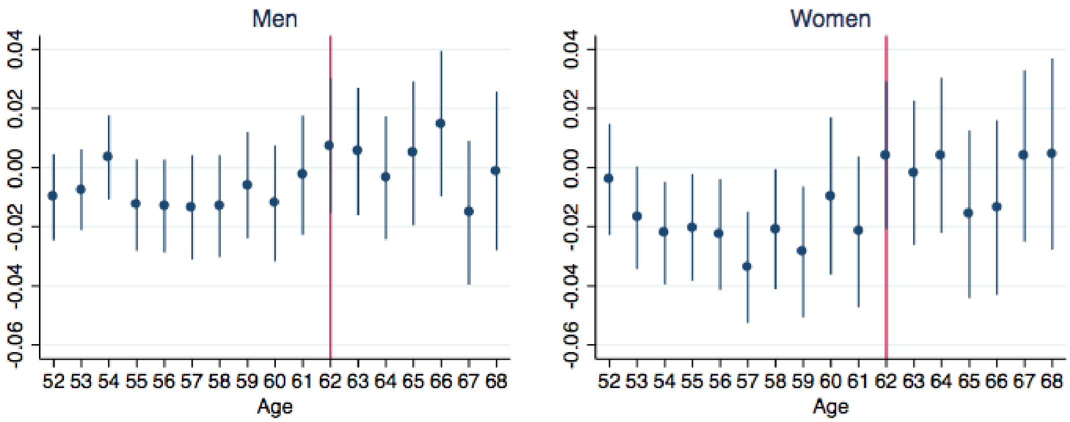

Figure 13. Coefficients of interaction between age and cohort group on hospital visits in the last two weeks, with 95 percent confidence interval

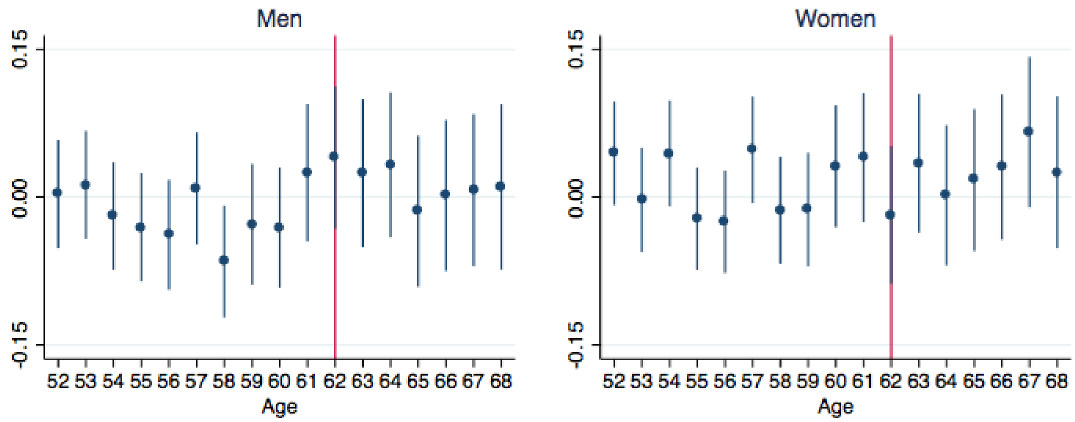

Figure 14. Coefficients of interaction between age and cohort group on spending days in bed in the last year, with 95 percent confidence interval

After observing the effect of the Social Security policy change on health and retirement, I estimate the effect of retirement on health by using the variation in retirement that is generated by the policy change. Table VII and Table VIII present the results from the OLS and instrumental variables estimation for men and women. The results of the two-groups model and the multi-groups model are very close to each other. Although the estimation of OLS could be biased because of the endogeneity problem between health and retirement, I report them here as a comparison with the IV results. The estimation includes controls of age dummies, cohort group dummies, and individual characteristics. The OLS estimation shows that the retirement has a negative effect on health with all four health indicators. Being retired increases the probability of reporting fair or bad health by about 20 percentage points for both men and women. Retirement is also associated with an increase of 0.19 hospital visits in the last two weeks, around a 9 percentage points increase in the probability of experiencing limitation in personal care and routine needs, and about a 10 percentage points increase in the probability of a stay in bed due to illness.

Table VII. The effect of retirement on health outcomes for men

Dependent Variable	OLS	Two-groups IV			Multi-groups IV
Self-report bad health	0.236***	-0.283**	-0.281**	-0.549**	-0.576**
	(0.004)	(0.129)	(0.127)	(0.226)	(0.232)
Daily limitation	0.092***	-0.170***	-0.168***	-0.173**	-0.188**
	(0.002)	(0.061)	(0.060)	(0.086)	(0.091)
Hospital visits	0.188***	-0.341	-0.337	-0.396	-0.406
	(0.009)	(0.230)	(0.229)	(0.300)	(0.340)
Days in bed	0.107***	-0.405**	-0.401**	-0.496	-0.429
	(0.006)	(0.201)	(0.201)	(0.317)	(0.301)
Survey year	x		x	x	x
Linear age*cohort group				x	x
Number of observation	89,770	56,634	56,634	56,634	89,770

Note: * p<0.1; ** p<0.05; *** p<0.01. Standard errors in parentheses. Standard errors in IV model are clustered at birth year by age level. All estimations control for individual characteristics: race, education level, marital status, and region.

TABLE VIII. THE EFFECT OF RETIREMENT ON HEALTH OUTCOMES FOR WOMEN

Dependent Variable	OLS	Two-groups IV			Multi-groups IV
Self-report bad health	0.166***	-0.152	-0.150	-0.653	-0.682
	(0.003)	(0.219)	(0.221)	(0.428)	(0.473)
Daily limitation	0.095***	-0.219	-0.220	-0.304	-0.397
	(0.002)	(0.167)	(0.166)	(0.234)	(0.299)
Hospital visits	0.149***	-0.014	0.004	-0.684	-0.641
	(0.007)	(0.612)	(0.552)	(0.703)	(0.895)
Days in bed	0.059***	-0.015	-0.016	-0.096	-0.191
	(0.005)	(0.357)	(0.355)	(0.592)	(0.584)
Survey year	x		x	x	x
Linear age*cohort group				x	x
Number of observation	99,273	62,561	62,561	62,561	99,273

Note: * p<0.1; ** p<0.05; *** p<0.01. Standard errors in parentheses. Standard errors in IV model are clustered at birth year by age level. All estimations control for individual characteristics: race, education level, marital status, and region.

As with the mortality estimation, I performed the instrumental variable method with controls for the year trend and the age-cohort interaction. The results are not affected by the year trend, but the results are slightly increased when I include the interaction between the cohort group indicator and linear age to control for the pre-trend differential.

Compared to the OLS estimation, the result of the IV method shows that retirement improves health. Retirement shows a significant effect on reducing the probabilities of experiencing limitation in daily activities for men and of self-reported bad health. It also shows a negative, but not significant, effect on the number of hospital visits and days' stay in bed. Retirements reduce the probability of reporting fair or bad health by 50 percentage points. It also can decrease the chance of experiencing limitation in daily activities by 18 percentage points. Retirement shows a significant effect on reducing the probability of staying in bed due to illness and sickness before the control for the pre-trend differential is added. However, the point estimation does not change much after adding the controls. Hence, the insignificant effect is more likely due to the lack of statistical power. Retirement does not show a significant effect on hospital visits either. If people are more willing to visit the hospital after retirement, then the reduction in hospital visits because of better health could be offset by more willingness to visit the hospital.

For women, although most of the estimation appears to be negative, which is consistent with the finding for men, none of them is significant. Women are less sensitive to the Social Security policy change than men. The result for women from the first stage only is half of the result for men. This weak first stage could contribute to the insignificant finding in IV estimates.

3.6 The change in time use after retirement

Given the positive effect of retirement on health in the U.S., the mechanism behind the effect is still unclear. In this section, I looked the relationship between time use in health-related activities and retirement. One of the major changes after retirement is extra free time. The Grossman model states that individuals can invest money and time to improve their health. Given the extra time, will people spend more time on health-related activities after retirement?

To show the relationship between the change in time use and retirement, I plot the probability of retirement and the average time used on a range of health-related activities at each age. The figures will show that if the change in time use with age in any activities has the same pattern as the change in the probability of retirement. I exploit the eligibility age of Social Security benefit at age 62. Since people can claim social security benefits in the U.S. between age 62 and 70, the probability of retirement is expected to rise much faster after age 62. Therefore, if there is any change in the time use that is linked to retirement, it should also have a sharp change after age 62 as well.

The data used here is from the American Time Use Survey between 2003 and 2016. The cross-sectional data set provides a record of time spent on different activities in last 24 hours. I focus on a set of activities that may have an effect on health.

Figure 15 shows the relationship between probability of retirement and age. Before age 62, the probability increases with age at a very slow rate. After age 62, the probability of retirement increases at a much faster pace. Figure 16 plots the average time spent on work. It follows the same pattern as retirement, but with a much smoother transition. It suggests that people may work on part-time jobs before completely step into retirement. With the absent of work, how will people relocate their time?

One of the major change is sleep. Figure 17 shows the average sleep time at each age. Before age 62, the time used on sleep is stable around 510 minutes for both men and women. But after age 62, when most people start to retire, the average sleep time starts to increase all the way to 540 minutes.

Another change is time spend on food. Figure 18 and 19 show the average time spent on eating and drinking, and the time spent on preparing food. Both men and women start to spend more time on eating and drinking after age 62. From age 40 to 62, the average time spent on eating and drinking is about 75 minutes every day. However, from age 62 to age 80, that number increases by 15 minutes. It is not clear if people start to eat more after the retirement, or eat better. Both of them lead to spending more time preparing the food. In Figure 19, the time spent on preparing food by women decreases with age before age 62, but start to increase after that. For men, it also shows a small increase after age 62.

Figure 20 plots the average time spent on caring for other members of the household. Men and women change in the opposite direction after the retirement age. It seems that, after retirement, men can participate more in taking care their partners, and women can relax themselves a little bit from this category.

Figure 21 and 22 plot the average time spent on sports and exercise, and health care. Given the improvement in health after retirement, one would expect that people may spend more time on exercise and health services. However, there is no clear change suggest that. The only sharp change is that, after age 62, women stop the decreasing trend of time spend on sports and exercise. The time spent on health care includes using health service, and health-related self-care. Both men and women spend more time on health care as the age increase. It does not increase at a higher rate after the retirement age. Therefore, it is safe to assume that the increase in the time spend on health care is driven by the age rather than the retirement.

These results show that people do not invest more time in activities that are considered specifically improving health, such as sports and exercise, medical care, and personal care after retirement. Most of the extra time after retirement contributes to sleep and eating-related activities. Therefore, the positive effect of retirement on health may come from simply living a more relaxed life.

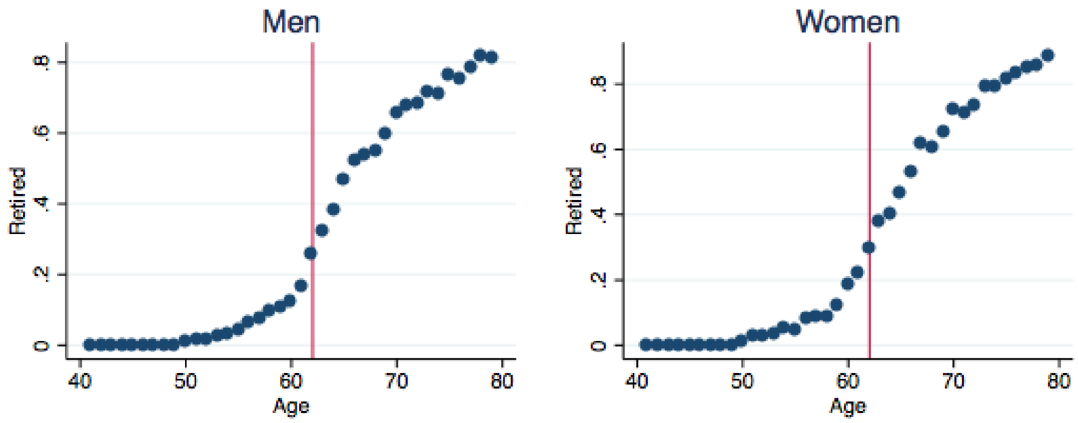

Figure 15. The percentage of people not in the labor force by gender

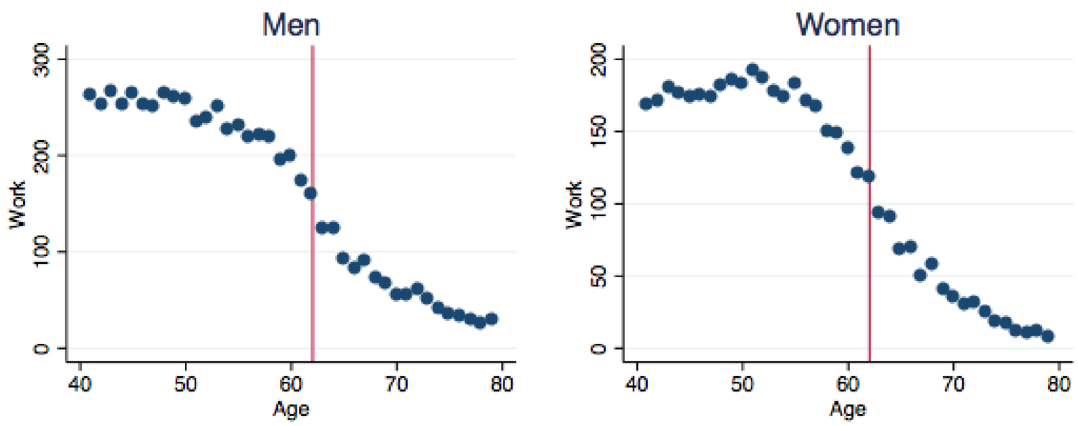

Figure 16. The average time used for work by gender

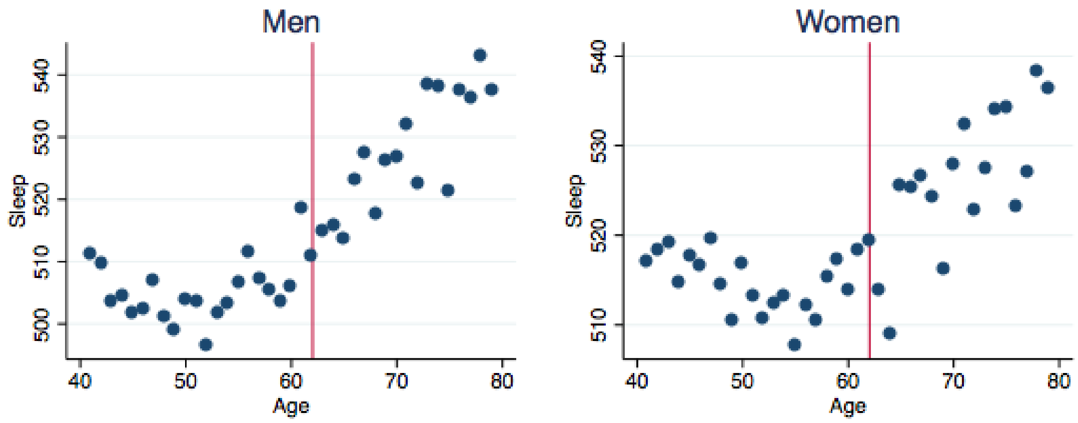

Figure 17. The average time used on sleep by gender

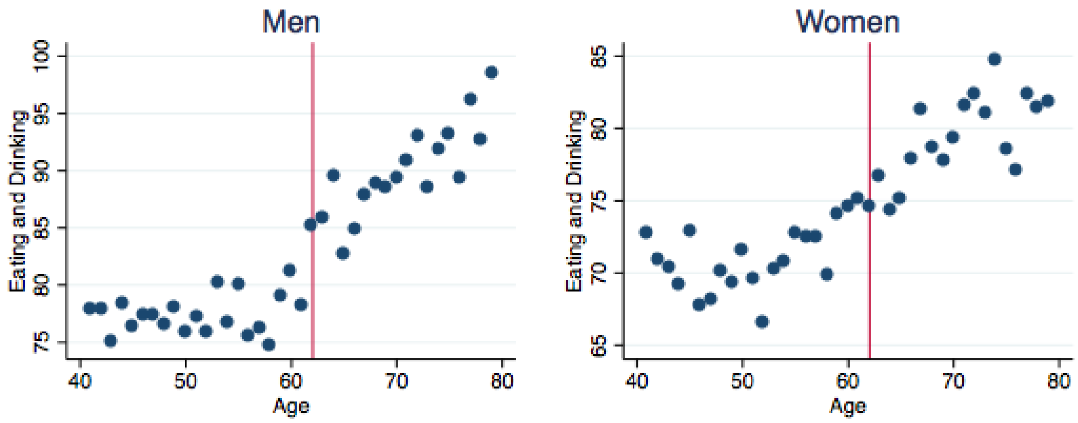

Figure 18. The average time used for eating and drinking by gender

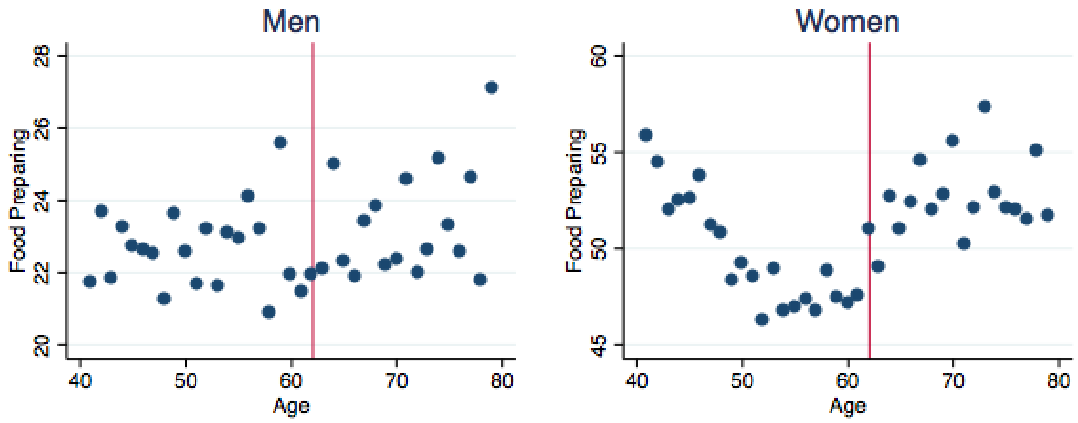

Figure 19. The average time used for food preparing by gender

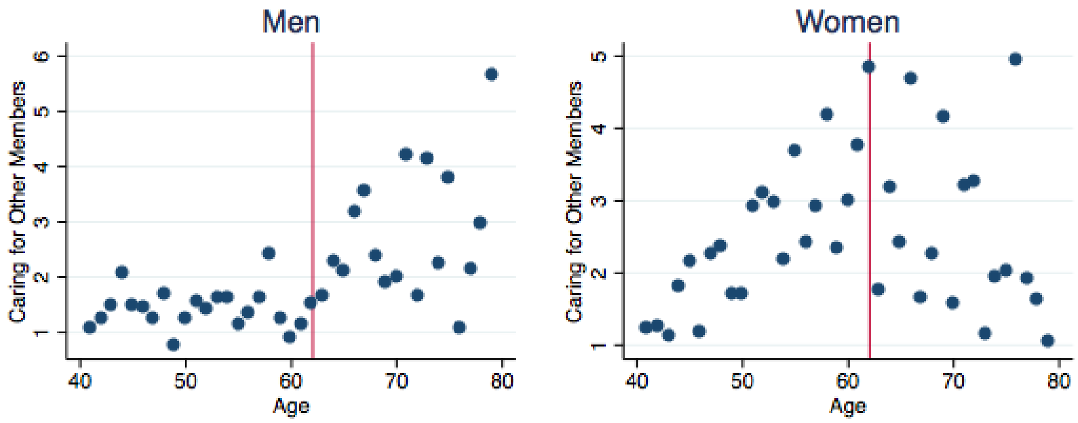

Figure 20. The average time used on caring for other members by gender

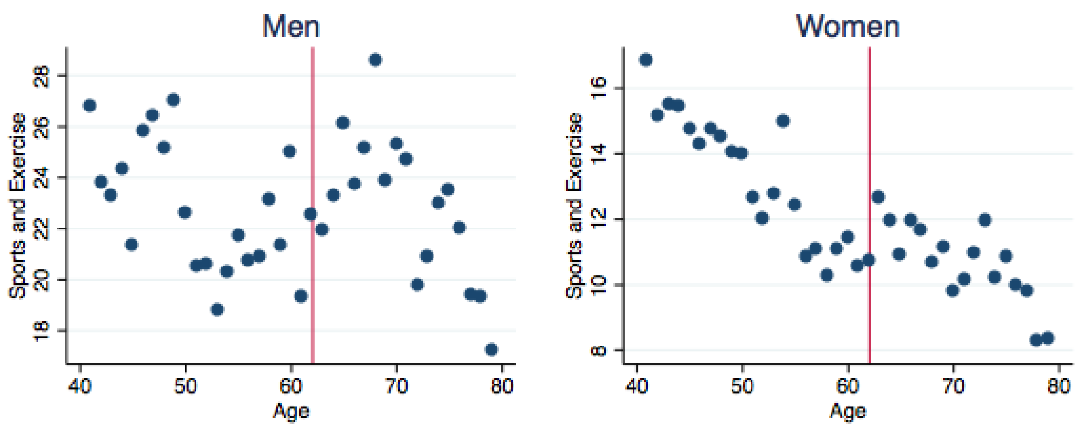

Figure 21. The average time used in sports and exercise by gender

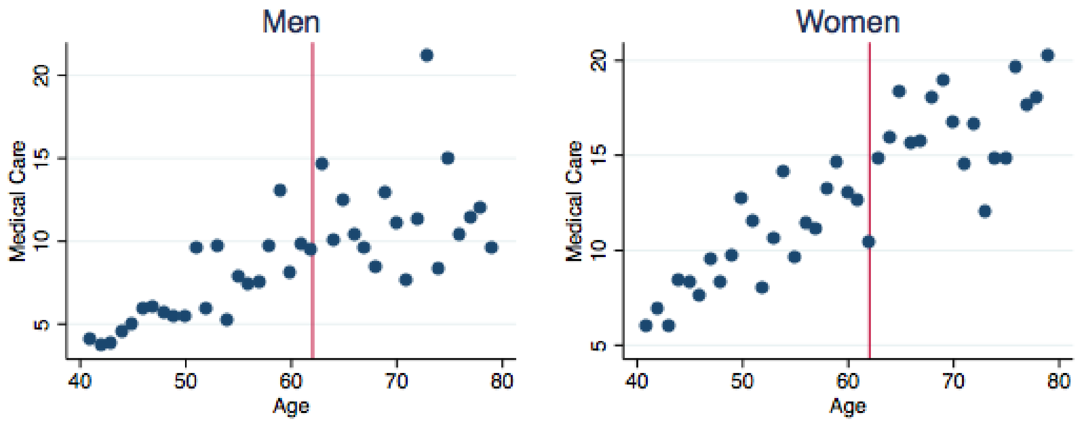

Figure 22. The average time used for health care by gender

3.7 Conclusion

I use the change in the Social Security benefit formula to isolate exogenous variation in retirement among older Americans. The estimates show that the probability of retirement decreases with the reduction in Social Security benefits. Then, using the decrease in the probability of retirement, I find that retirement can improve self-reported bad health and limitation in daily activities. However, it will also increase the mortality rate caused by heart disease.

The different direction of the effect on mortality and health is a puzzle. A possible explanation could be that retirement may only be able to reinforce people's choices in health investment. The mortality and health outcomes are distinct for two different groups. The health outcomes can only explain the difference between healthy and unhealthy, without addressing the severity of the conditions. On the other hand, mortality indicates a serious health risk. Therefore, the compliers in the mortality estimation should have worse health conditions than the compliers in the health estimations, which implies that the compliers in the mortality estimation may value health less. Without the restriction of work time, people who value health more may invest more time in their health, but those who value health less may spend more time on risky health behavior. This is consistent with the prediction from the Grossman model that the investment in health depends on an individual's value of time and his or her psychic return on health.

Another explanation could be that retirement does not worsen heart disease. However, being at home may reduce the chance for emergency treatment, since morbidity in the workplace can be more noticeable and a person with heart disease will have better access to medical treatment.

I also find that retirement does not link to any health-specific activities, but are correlated to more time spent on sleep, and eating and drinking. This finding suggests that retirement may not lead to an increase in the investment of time in health. However, it may still affect the health by sleeping more and eating more.

While this paper does not find a significant effect on the reduction in the usage of medical treatment, such as hospital visits, it does find significant improvement in health conditions. With limited measurement in health, the paper is not able to quantify whether the reduction in the probability of retirement leads to an increase in Medicare spending. However, the positive effect on health should raise the question of whether the reduction in Social Security benefit will transfer the cost to other government programs?

4 THE EFFECT OF RETIREMENT ON HEALTH IN CHINA

4.1 Introduction

China has relatively younger retirement age than most western countries and in recent years the government proposed to increase the retirement age to delay the retirement. In a public survey, 70 percent participants reject this proposal (Tang 2014). Financially, it is obviously a loss for them, but physically, will this proposal help them stay healthy or destroy their health? There are very few literature studies the effect of retirement on health in China. Literature also finds different results on the effect of retirement on health around the world.

There are a few reasons that the effect of retirement in China could be different with the other countries. Firstly, as mentioned above, China has relatively younger retirement age than most other countries[7]. Secondly, some workplaces in China implement the mandatory retirement, which means workers will have to leave the job after they reach the retirement age. The effect of mandatory retirement on health could be very different with the effect of voluntary retirement. Moreover, due to the cultural difference, how people spend their time after retirement can be varied across countries.

To estimate the effect of retirement on health in China, I exploit the mandatory retirement policy in public sector. The mandatory retirement policy leads to a much higher probability of retirement for workers in public sector than those works in private sector. Given the difference in the probability of retirement after the

[7] The average normal pension age is 64.3 years for men and 63.7 years for women in OECD countries in 2016 (OECD 2017). The pension age in China is 60 for men and 50 or 55 for women.

retirement age, I estimate the change in the difference in health between two groups. I find that retirement will worsen the self-reported bad health, and increase the hospitalization spending. It also increases the probability of having diabetes and heart disease. The cholesterol and triglyceride level also become worse after retirement. Moreover, the retirement may also lead to obesity.

Previous literature has shown that retirement has an immediate negative effect on health in China. Lei et al. (2011). They use regression discontinuity design with the mandatory retirement age as the cutoff point. With the One Percent Population Survey, they find a negative effect on self-reported health, but no effect on functional limitations. This chapter complements previous literature by providing the long-run effect of being retired on health. The estimated long run effect is similar to the immediate effect, which suggests that the negative effect of retirement will not only occur right after the retirement, and may last for a long time. These results contradict the findings in chapter 3. However, this chapter studies the mandatory retirement, while the retirement in chapter 3 is mainly voluntarily. Therefore, there is no reason to assume these two chapters find the same results.

4.2 The retirement policy in China

In China, employees have different retirement policies that depend on the type of their workplace. Employees in public sector face the mandatory retirement. When they reach the retirement age, they have to leave the job. Employees in the private sector can retire voluntarily.

The public sector includes government agency, public institutions, state owned firm, state controlled firm, collective owned firm, and collective controlled firm. In public sector, the statutory retirement age is based on the position. The government officials and administrator in other public firms have retirement age at 60 for men and 55 for women. The working-class in public sector have retirement age at 60 for men and 50 for women[8]. For workers with high physically demanding jobs, the retirement age is 55 for men and 45 for women.

The private sector includes privately owned firm, private controlled firm, foreign owned firm, joint venture, and self-employed. Although employees in private sector do not have to retire at the mandatory retirement age, they are provided the incentive to retire with the pension eligibility. The eligibility age for pension is same as the mandatory retirement age for workers in the public sector. Men can claim the pension at age 60, and women can claim the pension benefit when they reach age 50.[9] People can choose to work while receiving the benefit from the pension. Unlike the Social Security benefit in the U.S.,[10] there is no deduction on their benefit, if they have other income.

Figure 23 shows the difference in the probability of retirement between people whose first job is in a public sector and in a private sector at each age. For both men and women, the mandatory retirement age shows a strong effect on the probability of retirement. Before age 55 there is no difference in the probability of retirement between two groups for men. After age 55, workers in the public sector with high physically demanding jobs reach their mandatory retirement age. The difference in the probability of retirement also increases after age 55. After age 60, all the other

[8] Government officials can also choose to retire after work for at least 30 years.
[9] Besides the age requirements, workers also need to have at least 15 years payment into the pension account.
[10] The Social Security Benefit in the U.S. will be deducted by one dollar for every two dollars the person earns above the annual threshold before they reach the full retirement age.

workers in the public sector reach the mandatory retirement age, and the difference in the probability of retirement becomes even larger.

For women, the figure shows that the difference in the probability of retirement becomes much larger after age 50, but after that, the difference is fairly stable. This may due to that the number of workers in the administration position is relatively small compare to the number of workers in the working-class.

Figure 23. The percentage of people not in the labor force by workplace and gender

4.3 Data

In this chapter, I use the China Health and Retirement Longitudinal Study (CHARLS). The data contains a nationally representative sample of residents ages 45 and older in China. As a health survey, it not only contains questions on health status, but also provide the result of physical examination and blood test. The survey starts from 2011 and is conducted every two years, but the blood test is only available every four years.

In this chapter, I divide the data into three parts. The first part is the full sample, which includes the health survey questions, such as self-reported health, existing disease. The second part is physical examination result, which requires the interviewer provide several health exams during the interview. Some respondents refuse the examination. The non-response rate for these results is higher than 20 percent. Therefore, the data comes with a set of weight to adjust for this high non-response rate. The third part is the blood test result. The other two parts have already realized three waves so far. However, the blood test result only has one wave available. The blood test requires respondents go to the local hospital to draw the blood. Therefore, it also has a higher non-response rate than the full sample.

Although the survey is a panel data, each wave not only contains participants from baseline, but also the non-response sample and refresh sample. Many participants only available in one of the waves. Therefore, I treat the data as a cross-sectional sample. To focus on the health trend before and after the retirement age, I restrict the sample to individuals between age 45 and 75. Overall, the full sample size is about 40,000, the sample size of the physical examination is about 35,000, and the sample size of the blood test is around 10,000. Table IX provides the descriptive statistics for the demographic variables and health outcomes of the full sample by workplace and gender.

Retirement is defined in the same way as it is in chapter 3. If the respondent is not in the labor force, he or she is considered as retired. Although workers in China will file for official retirement when they retire, there are a large number of people in the sample are self-employed. It is hard to define their retirement status. Moreover, to avoid workers work on other jobs after retiring from their career position, the labor force status could be a more accurate measure of the retirement.

The type of workplace in this chapter is defined by the workplace of the participant's first job. Since workers can change their job through the career, it is hard to know what kind of retirement policy they are facing when they are at the retirement age. The first job is a good approximation on the type of workplace through the individual's career. In the sample, about eighty-three percent men and eighty-nine percent of women work in the same type of workplace with their current job or the last job before they withdraw from the labor force as their first job. More importantly, using the type of workplace of the first job instead of the current job or the job before retiring, will avoid the selection bias that, healthy workers in public sector may shift to the private sector before or after the retirement age if they want to work longer.

The characteristics of workers are very different between the public sector and the private sector. Workers in public sector have higher education level and more likely to live in the urban area.

For health outcomes, besides the physical examination and blood test result, I also use the self-reported bad health, hospitalization spending, and self-reported disease to provide a complete picture.

The self-reported bad health indicates the respondent reporting “fair”, “poor” or “very poor” in the self-reported health. The survey asks the respondent to grade their health from “very good”, “good”, “fair”, “poor” and “very poor”. I created an indicator ‘bad health’ that is equal to 1 if the respondent reported their health in the last three classifications of the scale, “fair”, “poor,” or “very poor”, and zero otherwise. This is similar to the self-reported bad health in chapter 3. Therefore, this variable can also be used as a comparison between the effect in the U.S. and China. In the sample, about 70% of respondents reported bad health for both men and women.

The hospitalization spending indicates whether the spending in last year is greater than 15,000 yuan. The survey asks the hospitalization spending in last year. The number is recorded on an interval scale. The exact number is not available, so I construct the variable to indicate whether the spending is larger than 15,000 yuan. This includes both the out of pocket spending and the spending that will be covered by the insurance. Most people did not have hospitalization last year, therefore, there is only 1 to 2 percent of sample spending more than 15,000 yuan.

The data asks to report a series of disease. I choose three major ones that are likely to be affected by the retirement, hypertension, diabetes, and heart disease. In the sample, about 25 percent men report having hypertension. The difference in hypertension between two workplaces is small. However, workers in public sector are more likely to have diabetes and heart disease.

Physical examination and blood test results should provide a more accurate measure of health than these self-reported variables. I provide the results that are related to these three diseases. Hypertension will be reflected through systolic and diastolic. Diabetes will be represented by the glucose. Heart disease is linked to cholesterol and triglycerides. I also report the waist of the person and if the individual is in the healthy BMI range[11] to see if any health risk that come with overweight or obesity is related to retirement.

[11] The healthy BMI range for Chinese is between 18.5 and 23.9, which is published by Chinese Center for Disease Control and Prevention.

TABLE IX. DESCRIPTIVE STATISTICS

	Men		Women	
	Public sector	Private sector	Public sector	Private sector
Age	59.25	58.18	57.37	57.64
Bad Health	0.66	0.73	0.71	0.79
Hospitalization Spending	0.02	0.01	0.02	0.01
Hypertension	0.29	0.22	0.28	0.25
Diabetes	0.10	0.04	0.11	0.06
Heart Disease	0.14	0.08	0.20	0.12
Systolic	131.91	129.65	127.21	128.84
Diastolic	78.04	77.16	75.22	75.53
Waist	89.38	85.30	88.04	86.26
Healthy BMI	0.42	0.56	0.38	0.44
Glucose	115.84	109.48	112.11	110.18
Triglyceride	140.65	126.39	145.57	136.53
High Density Lipoprotein (HDL)	47.62	50.95	48.85	51.66
Low Density Lipoprotein (LDL)	113.65	111.51	124.16	119.68
Marital status				
Married	0.94	0.91	0.84	0.86
Divorced or Separated	0.02	0.01	0.02	0.01
Widowed	0.04	0.06	0.14	0.13
Never married	0.00	0.02	0.00	0.00
Education				
No formal education	0.02	0.12	0.04	0.41
Less than high school	0.54	0.76	0.53	0.55
High school and above	0.44	0.12	0.43	0.04
Residence type				
Rural	0.26	0.90	0.17	0.91
Urban	0.74	0.10	0.83	0.09
Number of Observations	3511	15304	2608	17592

4.4 Empirical Estimation

In this chapter, I address the endogeneity problem between health and retirement by exploiting the mandatory retirement policy for workers in government and state sectors. Although self-employed workers and workers in the private sectors have the incentive to retire at the same age as the mandatory retirement age, because of the pension eligibility. However, the probability of retirement based on the voluntary decision is expected to be much smaller than the probability in the government and state sectors. The difference in the probability of retirement between these two groups can be estimated as:

$$Retirement_{iaw} = \delta_1 + \delta_2 age + \delta_3 age^2 + \delta_4 work_{ia} + \delta_5 retire\_age + \delta_6 work_{ia} * retire\_age + \delta_7 X_i + e_{iaw} \quad (11)$$

where $\mathrm{Retirement_{iaw}}$ indicates whether individual i at age a works in workplace w is retired. $\mathrm{work_{ia}}$ indicates the type of workplace of the individual's first job. It equals 1 if the individual works in a public sector, 0 otherwise. The quadratic term of age controls for the relationship between age and retirement. retire_age is a vector indicating that the individual reaches the retirement age. For men, there are two binary variables indicating whether he is at least 55 years old and whether he is at least 60 years old. For women, there are also two binary variables indicating whether she is at least 50 years old and whether she is at least 55 years old. $\mathrm{X_i}$ is a set of individual characteristics, which includes education level, marital status, and the type of residence location.

The identification assumption of this model is that the difference in the probability of retirement between two types of workplaces after the retirement age is contributed by the mandatory retirement policy. δ_4 represents the difference in the probability of retirement between two types of workplaces. Individuals choose to work in public sector may have a different preference for retirement. The model uses the difference in the probability of retirement before the retirement age as an approximation of that difference in preference. δ_5 represents this discrete change in the probability of retirement after the statutory age. Given mandatory retirement age at 55 and 60 for men, and 50 or 55 for women, a discrete change in the probability of retirement is expected for ages greater than these statutory ages. Although women have three different retirement ages, and the youngest retirement age is 45. However, the youngest age in the sample is also 45. Therefore, the model needs to use people who are between age 45 and 50 as the base group and can only use the other two retirement age to estimate the difference in the probability of retirement. δ_6 captures the difference in the probability of retirement between two types of workplaces after the retirement age. Workers in public sector face the mandatory retirement policy, while workers in the private sector can retire voluntarily. Although both the mandatory retirement policy and the pension system have the same statutory age, the mandatory retirement is expected to be more effective on the probability of retirement. With the control of the preference for the retirement and the overall relationship between age and retirement, the remaining difference in the probability of retirement between two workplaces should solely depend on the difference in the effectiveness of retirement policies in these workplaces.

Given the exogenous variation in the probability of retirement, the effect of retirement on health can be estimated as:

$$\text{Health}_{iaw} = \theta_1 + \theta_2\text{age} + \theta_3\text{age}^2 + \theta_4\text{work}_{ia} + \theta_5\text{retire\_age} + \theta_6\widehat{\text{Retirement}}_{iaw} + \theta_7 X_i + e_{iaw} \qquad (12)$$

where Health_{iaw} is the health status of individual i at age a works in work place w. $\widehat{\text{Retirement}}_{iaw}$ is the projected probability of retirement from equation (11). Same as equation (11), θ_6 is the estimates of interest. The equation controls for the quadratic age trend, the difference in health between two groups with the absent of retirement, and the health to change after the retirement age. θ_6 represents the difference in health between two workplaces after the retirement age.

There are a few potential threats to the validity of my estimation strategy. First, as a difference-in-difference model, the common trend assumption needs to be satisfied. I use the pre-trend as a control for the difference in health between two workplaces after the retirement age with the absent of retirement. However, one argument is that some health problems only start to show up when people are getting older. Therefore, the pre-trend may not be able to control all the difference in health between two groups. Workers in public sector have higher education than workers in private sector, which suggests that they should be relatively healthier at a older age. This will bias the estimation upwards. However, since I find that workers in public sector become worse in health after the retirement age, this threat is less concern in this situation.

Secondly, if there is simultaneous treatment then the result could be biased. One concern is the health insurance eligibility. Given the health insurance system in China, workers in public sector are more likely to have health insurance coverage than workers in private sector after retirement age. The type of health insurance in China depends on the person's residence type. Workers in the urban area will have free health insurance after retirement age if they have purchased the insurance for at least 15 years[12]. Workers in the rural area will purchase a lower cost health insurance, which requires payment every year, even after the retirement age. Therefore, before retirement age, the coverage rate for urban residents tend to be lower because some of them stop the payment after they reach the number of years required. However, after the retirement age, everyone who reaches the requirement become eligible for the free health insurance. Since most workers in public sector come from the urban area, the same change in the insurance coverage rate should be expected.

Thirdly, the effect of retirement on mortality may lead to attrition bias. As discussed in chapter 3, the retirement can have an effect on mortality. With the change in mortality that is caused by the retirement, the estimation of the effect of retirement on health can be biased. Although, in this section, I won't provide the estimation on mortality, given the results from chapter 3, the attrition bias is expected to be insignificant.

[12] The number of years required for the free insurance after retirement is decided by the local government.

Figure 24 provides the health insurance coverage rate by workplaces. For both men and women, the insurance coverage rate increases after the retirement age in the public sector, but has no change in the private sector.

Given the increase in the difference of health insurance coverage rate between two workplaces after the retirement age, the estimation could be upward biased. The effect of health insurance will be contributed to the effect of retirement as well. However, with more people covered by health insurance after retirement age, workers in public sector show worse health than the other group. Therefore, the estimated results could be a lower bound of the actual effect.

Figure 24. The percentage of people who are covered by health insurance by workplaces and gender

4.5 Result

4.5.1 The difference in the probability of retirement between public sector and private sector

Table X shows the effect of mandatory retirement policy on the probability of retirement. The effect is represented by the estimation result from the first stage of the model. It shows the difference in the probability of retirement between two workplaces after the statutory retirement age. Since the sample size varies across the health outcomes, Table X shows the first stage estimation result from three different samples. In the full sample, after age 55, male workers in the public sector are 14 percentage points more likely to retire than male workers in the private sector. After age 60, that probability increases by another 17 percentage points. For female workers, the difference in the probability of retirement between workplaces is 17 percentage points after age 50, and after age 55, the difference increases another 10 percentage points. In the samples of physical examination, and blood test, the result changes. However, the sum of the difference in the probability of retirement after age 55 and age 60 are consistent across samples. Overall, work in the public sector will increase the probability of retirement by about 35 percentage points for men, and about 30 percentage points for women.

TABLE X. FIRST STAGE, THE EFFECT OF WORKPLACE ON PROBABILITY OF RETIREMENT

	(1)	(2)	(3)	(4)	(5)	(6)
	Men			Women		
	Full Sample	Physical Examination	Blood Test	Full Sample	Physical Examination	Blood Test
Age>50				0.175***	0.166***	0.079
				(0.043)	(0.056)	(0.087)
Age>55	0.142***	0.184***	0.053	0.097**	0.052	0.252***
	(0.047)	(0.042)	(0.082)	(0.043)	(0.045)	(0.072)
Age>60	0.174***	0.179***	0.306***			
	(0.038)	(0.032)	(0.101)			
Number of observation	18641	16450	4766	19820	18134	5168
R-Squared	0.242	0.261	0.222	0.227	0.228	0.297
F-stat	44.161	54.868	11.230	58.291	8.989	24.880

Note: * p<0.1; ** p<0.05; *** p<0.01. Standard errors in parentheses. Standard errors in IV model are clustered at workplace by age level. All estimations control for individual characteristics: residence type, education level, and marital status.

4.5.2 The difference in health outcomes between public sector and private sector

From Figure 23 and the estimation above, working in public sector shows a significant effect on increasing the probability of retirement. Next, I plot the result of some health survey questions to see if the health shows the same difference between workplaces after retirement age.

Figure 25 is the result of self-reported bad health. Before retirement age workers in public sector are less likely to report fair, poor, or very poor health than workers in private sector for both men and women. After the retirement age, that difference seems to be reduced. In Figure 26, I plot the percentage of people spending more than 15,000 yuan in hospitalization last year. There is almost no difference between public sector workers and private sector workers before the retirement age. However, the hospitalization spending is much higher from people worked in public sector after the retirement age. Of course, this does not necessarily mean that the health worsens after the retirement. Being retired will lower the opportunity cost of staying hospital. Although nobody would want to spend more time and money in hospitalization, the lower time cost may encourage people to become more cautious about their health. Therefore, I plot three common diseases for elderly from Figure 27 to 29. Figure 27 shows the percentage people who report diabetes in the sample. For both men and women, the percentage increases much more quickly for workers in public sector than those in private sector. Figure 28 shows the percentage people having the heart disease. For men, the difference between two workplaces is stable over the age. However, women in the public sector become much more likely to report heart disease after the retirement age. Figure 29 is the percentage people reporting hypertension. For both men and women, there is a very small increase after retirement age in the difference in the percentage of reporting hypertension between two workplaces.

Figure 25. The percentage of people reporting fair, poor, or very poor health by workplace and gender

Figure 26. The percentage of people spending more than 15,000 yuan in hospitalization last year by workplace and gender

Figure 27. The percentage of people reporting diabetes by workplace and gender

Figure 28. The percentage of people reporting heart disease by workplace and gender

Figure 29. The percentage of people reporting hypertension by workplace and gender

Given the results from Figure 25 to 29, I estimate the effect of retirement on these health outcomes using equation (12). The estimation results in Table XI is consistent with the figures. I report the OLS estimation as a comparison with the difference-in-difference results. Although the OLS could be biased due to the endogeneity problem between health and retirement, since the majority of the retirees are mandated, the OLS estimation is not that different with the result of the difference-in-difference model. The OLS results are similar between men and women. It shows that being retired can increase the probability of reporting bad health by 7 percentage points, and increase the hospitalization spending that is more than 15,000 yuan by 2 percentage points. It also increases the probability of having diabetes, heart disease, and hypertension by 3 to 8 percentage points.

Compared to the OLS estimation, the DID estimations have the same direction of effect, but are less significant and with larger standard errors. It shows that being retired can increase the probability of reporting bad health by 14 percentage points for men, but has no significant effect on women. Both men and women's hospitalization spending and the probability of suffering diabetes increase after retirement. The effect of retirement on having heart disease is positive for both genders, but only significant for women. Retirement also shows a positive but insignificant effect on the probability of having hypertension for both genders.

TABLE XI. THE EFFECT OF RETIREMENT ON HEALTH OUTCOMES

	Men		Women	
Dependent Variable	OLS	DID	OLS	DID
Bad Health	0.078***	0.139*	0.069***	0.107
	(0.018)	(0.074)	(0.011)	(0.101)
Hospitalization Spending	0.023***	0.065***	0.014***	0.058***
	(0.003)	(0.020)	(0.002)	(0.022)
Diabetes	0.037***	0.090***	0.034***	0.179***
	(0.006)	(0.033)	(0.006)	(0.058)
Heart Disease	0.063***	0.066	0.073***	0.549***
	(0.009)	(0.043)	(0.007)	(0.106)
Hypertension	0.080***	0.084	0.084***	0.161
	(0.018)	(0.068)	(0.011)	(0.112)
Number of observation	18641	18641	19820	19820

Note: * p<0.1; ** p<0.05; *** p<0.01. Standard errors in parentheses. All estimations control for individual characteristics: residence type, education level, and marital status. The OLS estimation also includes the quadratic of age.

4.5.3 The difference in physical examination and blood test results between public sector and private sector

The self-reported health can be subjective, and the estimation in health spending and reported disease could be affected by retirement if people have more time to get a health check after retirement. Therefore, I plot the result from physical examination and blood test result from Figure 30 to 37.

Figure 30 and 31 shows the systolic and diastolic of blood pressure. There is no significant effect of retirement on hypertension, therefore, there is no expectation of the change in the difference of systolic and diastolic between two groups after retirement. Figure 30 is the average systolic level by workplace and gender, and it increases with age. As the expected, two groups are very close to each other for men. However, women in public sector show a lower systolic level than those in private sector before retirement age and catch up after the retirement age. In Figure 31, the diastolic level decreases with age, and men from public sector decrease faster than those from private sector.

Figure 32 and 33 plot the waist and the percentage of people with healthy BMI at each age by workplace. Retirement does not seem to have a significant effect on either of them for men. However, after the retirement age, there is a relative increase in waist and a decrease in healthy BMI of women in public sector.

Figure 30. The average systolic by workplace and gender

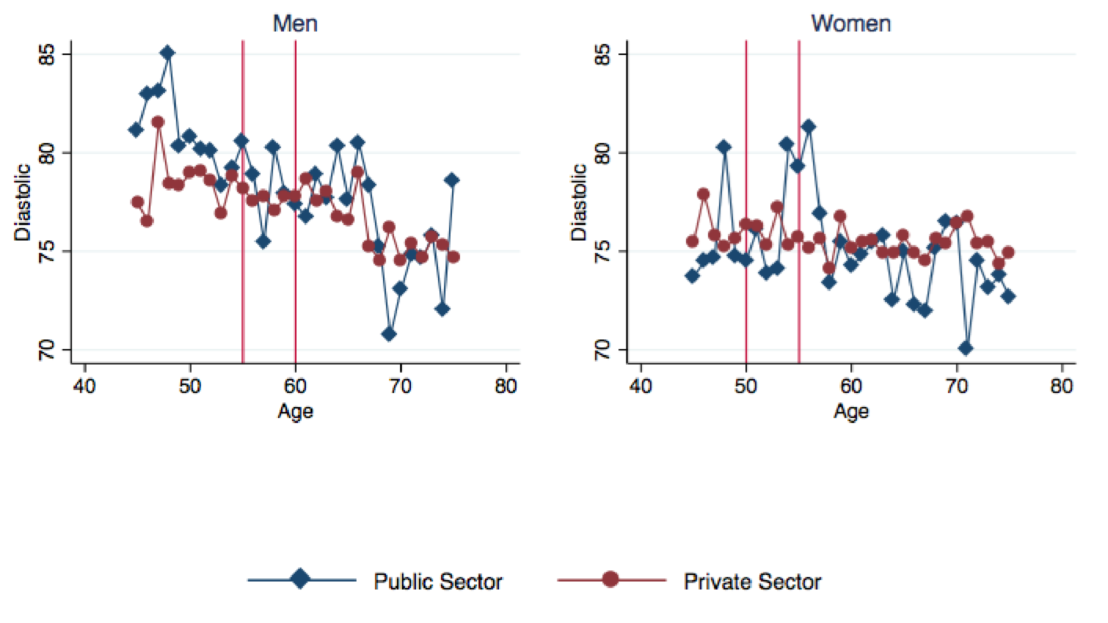

Figure 31. The average diastolic by workplace and gender

Figure 32. The average waist by workplace and gender

Figure 33. The percentage of people in the healthy BMI range by workplace and gender

Figure 34 to 35 are the cholesterol and triglycerides level from the blood test result. They measure the amount of fatty substances in the blood. They are often used as an indication of the risk of heart disease. Figure 34 plot the high density lipoprotein (HDL). It helps move cholesterol out of the body. A high level indicates a lower risk of heart disease. In Figure 34, both men and women show a similar HDL level before retirement age between two groups. After reaching the retirement age, people in public sector have a lower HDL level than people in private sector.

Figure 35 is showing the low density lipoprotein (LDL). LDL carries fat from the liver to other parts of the body. A high level of LDL indicates a higher risk of heart disease. In Figure 35, there is no significant difference in LDL between the public sector and the private sector. Triglycerides are another type of fat in the body, and a high level of it is also linked to a higher risk of heart disease. Figure 36 shows that after the retirement age the triglycerides become much higher for both men and women in the public sector. Besides the indication of heart disease, I also plot the glucose level in Figure 37, which is the indication of diabetes. Although I showed that being retired can increase the probability of having diabetes, there is no effect on glucose.

Table XII and XIII show the estimation results. The OLS indicates that almost all outcomes will become worse after retirement, except the glucose, which is negative and insignificant. The DID model is consistent with the figure. The systolic increases by 22 mmHg for women, but the diastolic decreases by 5 mmHg for men. This indicates that retirement may increase the risk of having hypertension for women. Retirement will increase the waist increase 7 cm for men, and 13 cm for women, while also decreasing the probability of having healthy BMI by fifty-seven percentage points for men. This suggests that after retirement may also increase the probability of obesity or overweight.

The estimation in Table XIII shows that retirement can decrease the HDL by 9.4 mg/dl for men and 15.5 for women. It also increases the triglyceride by 59.5 mg/dl for men and 71.1 mg/dl for women. The effects on LDL and glucose are negative and insignificant. Although being retired make people more likely to have diabetes, there is no effect or even could be a negative effect on glucose. This could be that people who have diabetes have received the treatment to lower the glucose level.

Figure 34. The average high density lipoprotein (HDL) level by workplace and gender

Figure 35. The average low density lipoprotein (HDL) level by workplace and gender

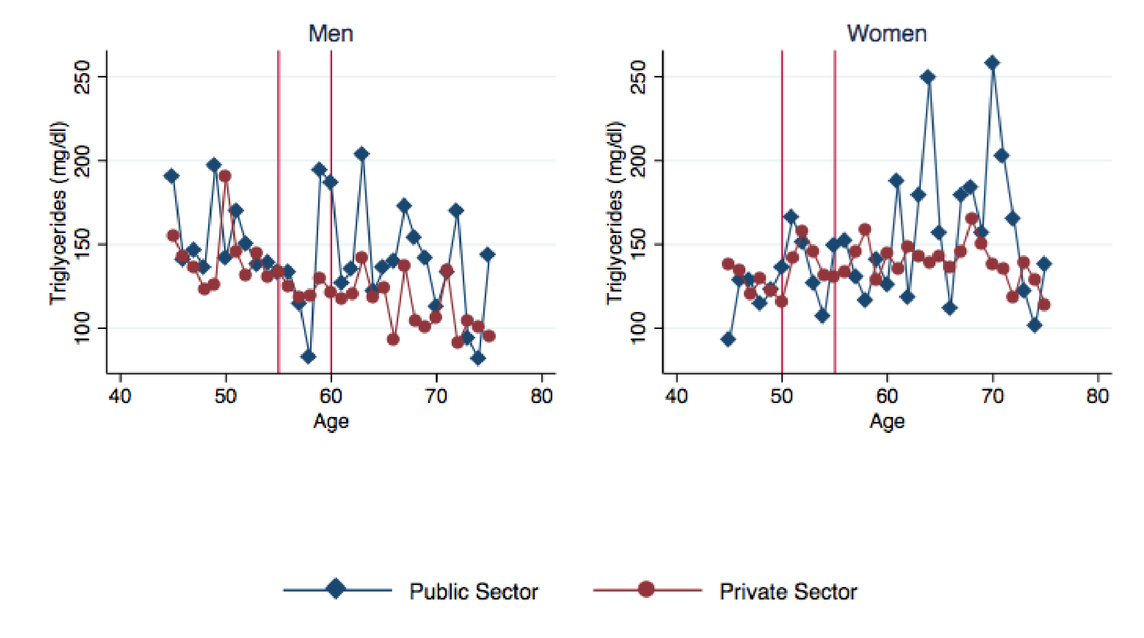

Figure 36. The average triglyceride level by workplace and gender

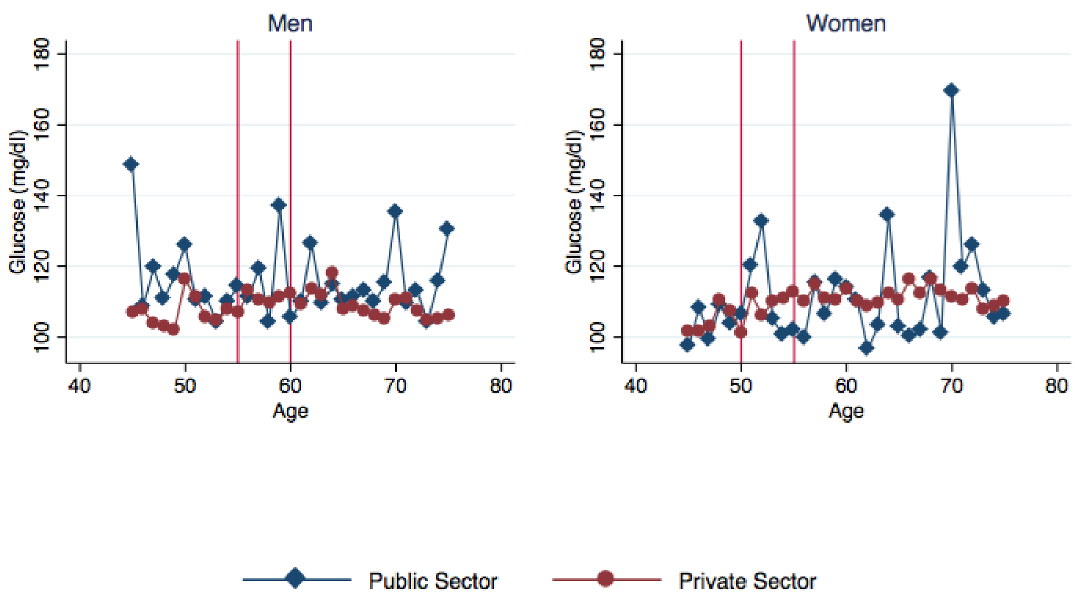

Figure 37. The average glucose level by workplace and gender

TABLE XII. THE EFFECT OF RETIREMENT ON PHYSICAL EXAMINATION RESULT

	Men		Women	
Dependent Variable	OLS	DID	OLS	DID
Systolic	1.801**	-1.639	3.006***	22.213**
	(0.736)	(3.705)	(0.824)	(10.007)
Diastolic	2.096***	-5.423**	1.799***	-0.356
	(0.494)	(2.588)	(0.462)	(7.720)
Waist	1.868***	7.300**	3.026***	13.227***
	(0.380)	(3.025)	(0.378)	(3.122)
Healthy BMI	-0.047**	-0.172	-0.100***	-0.573***
	(0.021)	(0.132)	(0.016)	(0.210)
Number of observation	16450	16450	18134	18134

Note: * p<0.1; ** p<0.05; *** p<0.01. Standard errors in parentheses. All estimations control for individual characteristics: residence type, education level, and marital status. The OLS estimation also includes the quadratic of age.

TABLE XIII. THE EFFECT OF RETIREMENT ON THE BLOOD TEST RESULT

	Men		Women	
Dependent Variable	OLS	DID	OLS	DID
High Density Lipoprotein (HDL)	-3.906***	-9.470*	-3.392***	-15.569*
	(0.898)	(5.077)	(0.688)	(7.998)
Low Density Lipoprotein (LDL)	3.543	-7.202	3.578**	-21.321
	(4.036)	(11.003)	(1.731)	(19.174)
Triglyceride	13.863	59.575*	19.321***	71.165**
	(8.686)	(34.401)	(5.205)	(34.444)
Glucose	-0.056	-8.583	1.277	-5.195
	(2.102)	(11.807)	(1.352)	(14.146)
Number of observation	4766	4766	5168	5168

Note: * p<0.1; ** p<0.05; *** p<0.01. Standard errors in parentheses. All estimations control for individual characteristics: residence type, education level, and marital status. The OLS estimation also includes the quadratic of age

4.6 Conclusion

I use the different retirement policies in public sector and private sector in China to identify the difference in the probability of retirement between these two workplaces. Given the difference in the probability of retirement, I explore the difference in health between these two groups. I find that retirement has a negative effect on health in China. Being retired will increase the hospitalization spending, and the probability of reporting bad health, diabetes, and heart disease. Retirement will also increase the person's waist, HDL, and Triglyceride level and decrease the probability of having healthy BMI. This suggests that after retirement, people could be lack of exercise, which may lead to obesity and high HDL and triglyceride level in the blood.

Another contribution in the chapter is that the subjective measurement in health is consistent with the medical result. This will increase the confidence on the result from other related literature that lack of actual medical measurement on health. The limitation of this study is that the retirement is mainly contributed by the mandatory retirement. Whether the voluntary retirement has the same effect on health in China requires further research.

5 CONCLUSION

This dissertation aims to understand the effect of retirement on health. Given the financial stress in the pension budget, many countries have proposed to modify the retirement policy to delay the retirement. Understanding the effect of retirement on health may help the government predict the consequence of such policy change. Previous literature finds different results on this effect. This dissertation suggests that retirement may not have a homogenous effect among all groups. First, I find retirement has a positive effect on health in the U.S., but it will also increase the mortality rate. Then I find retirement has a negative effect on health in China.

In chapter 3, I use the same framework to estimate the effect of retirement on health and mortality. The exogenous variation in retirement comes from the change in Social Security benefit. The cohort born after 1937 faces a lower Social Security benefit than previous generations. This change in financial incentive leads to a lower probability of retirement for cohorts born after 1937. However, with the same change in retirement, I find self-reported health has improved after retiring, but mortality rate has increased. This can be explained in two ways. Firstly, the self-reported health could be subjective. Without the work stress, people may report a better health even though the actual health has not been improved or become even worse. Secondly, after retirement, some people improved their health. However, people who have already been in bad health, get even worse.

Then in chapter 3, I use the mandatory retirement policy in China's public sector. I find workers in public sector has a higher probability of retirement, than workers in the private sector. However, their self-reported health becomes worse after the retirement. The physical examination and blood test results also suggest the same effect. These findings complement chapter 3 in two ways. Firstly, self-reported health is a good approximation of actual health despite the change in labor force status. This suggests that the contradict findings on health and mortality are more plausible due to heterogeneous effects on different people than the retiree's misunderstanding of their own health. Secondly, the difference in the retirement policy may also lead to a different effect on health.

The effect I find on the mortality and health outcomes in the U.S. and China are larger than expected and associated with large standard errors. This means that the real effect can be really large or really small. Therefore, in this dissertation, I focus more on the direction of the effect on health than the size of the effect on certain health outcomes. Given the identification strategy that requires dividing the sample into multiple groups and the large variation in health outcomes, the large standard error is expected. With the large standard error, the estimations have to be large enough to be statistically significant. Previous literature finds contradict results on the effect. Finding out the correct direction of the effect is important for understanding the effect of retirement on health.

Overall, this dissertation provides a basic understanding of the effect of retirement on health. It shows that retirement can have a significant effect on health, and the effect is not homogeneous. Understanding this effect can help people understand the determinants of elderly's health. It will also provide policy guidance regarding the future modification in retirement policies.

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VITA

Name: Xu Yuanrong
University of Illinois at Chicago, Dept. of Economics
817 University Hall (MC 144), 601 Morgan Street
Chicago, IL 60607
Email: yxu49@uic.edu
Tel: (312) 319-4317

EDUCATION

University of Illinois at Chicago, *Ph.D., Economics* Exp. 2018
Iowa State University, *B.S., Triple Major in Statistics, Economics, and Mathematics* 2012

FIELD OF CONCENTRATION

Labor Economics, Health Economics, Public Expenditure, Economics of Education, Applied Econometrics

RESEARCH PAPERS AND WORK IN PROGRESS

"The Effect of Retirement on Health and Mortality in the United States" (Job Market Paper) Nov. 2017
"The Effect of Retirement on Health in China" (In progress)
"The Effect of Retirement on Time Use" (In progress)

RESEARCH EXPERIENCE

Research Assistant to Prof. Marcus Casey, University of Illinois at Chicago Fall 2014 – Spring 2016
Research Assistant to Prof. Mo-Yin Tam, University of Illinois at Chicago Spring 2013
Data Visualization Student Challenge, U.S. Department of Transportation Fall 2011

TEACHING EXPERIENCE

INSTRUCTOR

Principles of Macroeconomics, University of Illinois at Chicago Summer 2016

TEACHING ASSISTANT

University of Illinois at Chicago

Principles of Macroeconomics Fall 2017
Principles of Macroeconomics Summer 2017
Microeconomics: Theory and Applications Spring 2017
Microeconomics: Theory and Applications Fall 2016
International Corporate Financial Management Spring 2014
Principles of Macroeconomics Spring 2014
Managerial Finance Fall 2013
Economic Demography Fall 2013
Statistics for Economics Spring 2013
Microeconomics: Theory and Business Applications Fall 2012

Iowa State University

Statistics Help Room Assistant Fall 2010 - Spring 2012
Math Help Room Assistant and Class Grader Fall 2010 - Spring 2011

PROFESSIONAL PRESENTATIONS

Illinois Economics Association Conference 2017

UIC Economics Research Lunch 2017

SKILLS

Computer software

Stata, R, ArcGIS (Proficient). SAS, Python, Matlab (Experience)

Language

English (Fluent), Mandarin Chinese (Native)

Other

Teaching of Economics Certificate, University of Illinois at Chicago

Society of Actuaries Exam FM/Financial Mathematics

Society of Actuaries Exam P/Probability Theory

REFERENCES

Professor Darren Lubotsky (Advisor)
UIC Department of Economics
University Hall
601 South Morgan Street
Chicago, Illinois 60607
lubotsky@uic.edu
(312)996-6240

Professor Marcus Casey
UIC Department of Economics
University Hall
601 South Morgan Street
Chicago, Illinois 60607
mcasey@uic.edu
(312)413-2100

Professor Ben Ost
UIC Department of Economics
University Hall
601 South Morgan Street
Chicago, Illinois 60607
bost@uic.edu
(312)996-2683