The Impact of Retirement on Health: Evidence from China

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Abstract: Using the 2005 one percent population survey and the 2002 Chinese Household Income Project Survey and exploring mandatory retirement policies in China with a regression discontinuity design, we identify the causal effect of retirement on health by focusing on sharp contrasts in retirement between men whose ages are just under and those just above the mandatory retirement age. We find that although it does not affect the probability of functional limitation, retirement does negatively affect both self-reported health status and psychological health represented by the feeling of happiness. We further explore the channel through which retirement affects health and find that this effect can only be partly explained by the sharp income decline after retirement and that education and skills play a significant role in smoothing the transition.

Key Words: Regression Discontinuity Design, Retirement, Health
JEL Classification: C14, C21, I10

1. Introduction

Urban Chinese workers retire at astonishingly young ages. According to the China Health and Retirement Longitudinal Study conducted in 2008, the retirement age for urban men is not only lower than that of their rural counterparts in China and other developing countries, but also that of developed countries such as the United States, South Korea, and Japan, and is similar to the retirement age seen in Western Europe (Zhao, 2008). Urban Chinese women retire even earlier than Western European women. This situation is unsustainable since China is quickly aging. However, proposals to raise the retirement age have been met with strong opposition. Critics argue that extending the retirement age would be harmful to the elderly, but this argument has not been substantiated. As a matter of fact, evidence from the medical literature indicates the opposite. For example, Tsai et al. (2005) find that retiring at a younger age is related to higher mortality. Zhan et al. (2009) show that engaging in bridge employment after retirement is associated with fewer major diseases and functional limitations. In this paper, we contribute to the debate by examining the impact of retirement on the health status of Chinese workers. More specifically, we will estimate the impact of retirement on self-reported health, functional limitations, psychological health as measured by feeling of happiness and other health outcomes in urban men.

The relationship between retirement and health has drawn the attention of many social scientists, but consensus has yet to be reached. Theoretically, retirement is accompanied by changes to many aspects of life, which are likely to affect a retiree's health in contradicting ways: On the one hand, retirement may liberate people from the stress of work and allow them to fully enjoy life, resulting in improved physical and psychological health. On the other hand, retirement may give people a sense of uselessness and nearing the end of their life, resulting in worsened health.

The main difficulty of empirical studies is the existence of the endogeneity problem. As has been shown in the literature, retirement is likely to be caused by declining health (e.g. Robin et al. 1986; McGarry 2004; Disney et al., 2006), and this poor pre-retirement health may continue well into retirement, leading to the reverse causality problem. In addition, there may be unobserved factors such as individual preference and health endowment that may simultaneously affect health status and retirement decisions, resulting in omitted variable bias.

Recent economics literature has exploited the exogenous changes in the retirement incentives around the retirement age set by the government to identify the causal effect of retirement. Typically, ages for normal and early retirement are used as instrumental variables. One problem with these studies, however, is that despite changes in incentives, the change in actual retirement is usually gradual, thus first stage results are sometimes weak after controlling for the direct age effect on health. In this paper, we propose to utilize the mandatory feature of the Chinese urban retirement system to achieve a sharper identification. Unlike retirement systems in Western countries, as soon as an urban Chinese worker who is subject to the retirement policy reaches the retirement age, he/she has no choice but to leave the job. If a retiree wishes to continue to work, he/she must find alternate employment, which is likely to be difficult. This creates a sharp discontinuity in retirement status around the mandatory retirement age.

The dramatic effect of the mandatory retirement policy is illustrated in Figure 1, which shows retirement rates for urban men from the 2005 one percent China population survey. A clear discontinuity point appears at age 60: retirement jumps from 60 percent at age 59 to 83 percent at age 61. This sharp discontinuity allows us to apply the regression discontinuity (RD) design to achieve a better identification of the impact of retirement on health outcomes.

Aside from the one percent population survey, which is a very large sample most ideal for the application of RD design, we also make use of the 2002 China Household Income Project (CHIP) urban data. The former only allows us to examine the effect on self-reported general health, while the latter has additional health measures, including a measure of happiness. In this paper, we focus on the impact of retirement on men, because the retirement age for women varies by occupation and the 2005 one percent population survey dataset does not contain information on pre-retirement occupation for those who have retired at the time of the survey..

The rest of the paper is organized as follows: we begin with a literature review in Section 2, followed by a description of institutional background in Section 3. We describe our empirical strategy in Section 4 and the data and related variables in Section 5. Validity tests of RD assumptions are provided in Section 6 and estimation results are presented in Section 7, followed with robustness tests in Section 8. Section 9 explores the channels and Section 10 concludes.

2. Literature Review

The relationship between health and retirement has long attracted the attention of sociologists, gerontologists and economists. Minkler (1981) summarizes the efforts of investigating the health effects of retirement before 1980, but describes it as "an uncertain legacy." Since the 1980s, a large amount of studies have focused on this issue, but the results remain conflicting. Some researchers have claimed a significant positive association between retirement and health (e.g., Bosse et al.1991; Midanik et al., 1995; Mein et al., 1998), others have reported negative effects (e.g., Ross and Mirowsky, 1995; Butterwolth et al., 2006), and a group of studies even argues that retirement has no effect on health (e.g., Palmore et al., 1984).

The inconsistency is due in part to the different data sets used, but the main reason lies in the difficulty of dealing with the endogeneity problem mentioned above. Studies since the late 1980s have tried to use panel data to control for endogeneity (e.g. Kerkhofs et al., 1997). The typical way is to use fixed-effects models to control for unobserved time-invariant heterogeneity across individuals (Dave et. al., 2006). The problem with this approach is that unobserved time-varying heterogeneity can not be controlled for, which is likely to be important for retirement decisions and health outcomes.

In recent years, studies have increasingly employed instrumental variable (IV) estimation to achieve identification. For example, taking advantage of age specific retirement incentives in the United States, Charles (2004) uses a set of binary variables (whether the person is at least 62, 65, 70 or 72 years old) as instrumental variables to identify the impact of retirement on mental health in men. With two-stage least squares (2SLS) estimate, Charles finds that retirement improves psychological wellbeing. Using a similar dataset and methodology as Charles', Neuman (2008) also finds that the health impact of retirement is, at the very least, not negative. Coe and Lindeboom (2008) use the unexpected early retirement window offered by employers as an instrument for retirement behavior and find a small positive health effect from retirement. These studies all include observations across a wide band of age. Considering that health itself is a function of age, polynomials of age are often employed to control for the age effect (Bound and Waidmann, 2007; Coe and Zamarro 2008), but this control is likely to be crude because the extent to which health conditions may be a function of the normal aging process is difficult to determine.

Ideally if there is a distinct jump at the retirement age then a regression discontinuity (RD) design is preferable. The RD design is very similar to the IV estimation except in that it restricts the comparison to a narrow band of age immediately above and below the retirement age, guaranteeing similarity except for retirement status. In other words, by narrowing the gap between the people in control and treatment groups, and specifying the function of age, an RD design alleviates the confounding effects of age and age-related (unobserved) factors on health. The RD design based on the discontinuity in program eligibility induced by age has been used to study the effect of pension (Edmonds, 2004, Edmonds et al., 2004), Medicare (Card et al., 2004) and disability (Chen and Van der Klaauw 2008), among others. In the study of retirement, however, this strategy is usually inapplicable because there is very little discontinuity at the retirement age in Western countries. By restricting the sample to people without a university degree, Johnston and Lee (2008) are able to detect a jump in retirement in England, and find that retirement lowers the probability of being in bad or very bad health for this group of people.

The Chinese institution provides us with a unique opportunity to apply the RD strategy to study the effect of retirement on health. Unlike many other countries, China still maintains a mandatory retirement policy, As of now, most employees eligible for retirement pensions are forced to give up their jobs at retirement age. This is different from many developed countries which have abolished mandatory retirement policies, and people are induced to retire by incentives only. As a result, the mandatory nature of the retirement policy in China arguably provides a more exogenous variation in retirement, which we will utilize to study the effect on health.

3. The Institutional Background

In this section we first discuss coverage of the Chinese retirement system, then program characteristics, including the management, retirement age, replacement rate, and medical insurance post retirement.

The Chinese retirement system was established in the 1950s to cover government employees and urban workers in government-run enterprises. Farmers are never included in any substantial government-run retirement system. For a short period of time in the 1990s, the government experimented with a defined contribution and fully-funded rural pension program but both the scale and coverage were tiny and highly insignificant. The government is currently piloting a rural pension system aiming at covering all of the rural population in the future. Even after such a scheme becomes fully implemented, it will only affect retirement through a lifetime income effect but not do so at the margin. In this paper we exclude farmers from our analysis.

In the urban sector, because the government nationalized nearly all private businesses in the 1950s and self-employment was nearly eliminated, the retirement system effectively covered all workers before the economic reform. Thus any urban worker who started to work 10 years (the minimum years of work to qualify for retirement) ahead of the retirement age expected to receive a pension. Because this was a young system, in the early years, most elderly people did not qualify to receive any retirement pension.

On program specifics, although the management of retirement and pension has gone through dramatic changes over time, program rules governing retirement age and benefits have remained relatively stable. The management of the pay-as-you-go system was initially by the national government. Because hardly anyone became eligible for retirement in the initial years, the management was merely personnel record keeping. During the chaotic period of the Cultural Revolution (1966-1976) and with the near collapse of central authority, the management of enterprise pension was delegated to individual firms, while the employees of government remained the responsibility of the central government. This system did not cause problems because very few people qualified to retire. However, a large number of workers began to retire in the 1980s and at the same time, financial difficulties surfaced as a result of market competition introduced by the economic reform, making it difficult for many firms to keep the pension promises to retired workers. Starting in the late 1980s and into the 1990s, the government gradually elevated the pooling of enterprise pensions from individual firms to some upper level management. Currently, the pension pools are mostly run at the county or city level and a small part of the pension contributions are in individual accounts.

The retirement age has not been changed since the inception of the retirement system in the 1950s. Men retire at age 60. Women face different retirement ages according to their occupations, presumably for the purpose of protecting their health. Women engaged in manual work retire at age 50 while those in office work (cadres) retire at age 55. Some exceptions are given to highly skilled women, such as full professors of universities, who can retire at age 60.

In the state sector (government and state-owned enterprises), the ceiling of the retirement age is strictly enforced. Anyone reaching retirement age has no choice but to process retirement and leave their job. Theoretically a worker can be rehired after processing retirement by the employer from whom he/she retires, but this is rare — normally the work unit has little incentive to keep a retiring worker because senior workers are most likely already overpaid. The state sector traditionally has little wage flexibility and returns to seniority are usually high. Even within the non-state sector, the employer may also enforce the mandatory retirement age if delayed compensation is used to motivate the work force. Although leaving the career job does not prevent someone from taking another job or self-employing, it usually involves a significant decline in earnings and tremendous psychological barriers.

There are a few factors that may diminish the discontinuity of retirement at the mandatory retirement age. The first is early retirement. Government policy allows workers to retire 5 years before the normal retirement age if they are in jobs that are dangerous, harmful to health, or extremely onerous. Completely disabled workers qualify for early retirement if they satisfy a minimum work duration requirement and are medically certified. Civil servants also qualify for early retirement if they have worked for 30 years and within 5 years of retirement age. Early retirement must be approved first by the employer, then by the government social insurance administration. The early retirement rule was applied a lot more liberally for a short period of time in the 1990s when the Chinese state-owned enterprises experienced massive financial difficulties and many went through painful restructuring and bankruptcies. In order to smooth out the workforce downsizing or bankruptcy, the government granted early retirement to workers in these firms who were within five years to normal retirement age. In circumstances where early retirement could not be granted by the government, many firms let redundant workers retire before the normal retirement age at the firms' expenses and let the workers turn to social insurance administration for retirement pension after reaching the normal retirement age, a practice called "internal retirement." According to data from the China Health and Retirement Longitudinal Study, a random sample of around 1600 households with members aged 45 and older collected in Gansu and Zhejiang provinces in 2008, 29 percent of all processed retirement occurred before the normal retirement age.

We considered the possibility to study discontinuity at the early retirement age, but decided against it. Because there is less self-selection at the normal retirement age, i.e., nearly everyone has to leave their career job regardless of his/her income, social status, and health, we only consider the discontinuity caused by the normal retirement age

Another source of leakage that weakens the discontinuity of retirement at mandatory age is reduced coverage of the retirement system. Although the original retirement system covered all urban workers, coverage dwindled following the emergence of non-state sector employment and the subsequent demise of the government-run enterprises in the 1990s. A small number of state sector workers (usually skilled workers) “jumped into the sea” to work for higher-paying non-state enterprises. Many were forced to leave the state sector and find new employment in non-state enterprises or self-employ. Although some of the workers in the non-state enterprises who worked in the state-sectors before have managed to continue their pension eligibility, others have lost their pension claims. Starting in 1997, the government has stipulated that all urban employers including privately-owned enterprises must provide pension coverage to employees including migrant workers from rural areas, but the implementation was slow. It was not until recently that the coverage seems to have spread to the majority of urban workers. Aside from possible incentives from delayed compensation, there is little incentive for the non-state sector to enforce the mandatory retirement age because the wage more closely reflects productivity in the non-state enterprises. In fact the non-state enterprises have aggressively hired skilled workers retiring from the state sector. The self-employed can also contribute to the pension program if they like, but they are unlikely to enforce retirement on themselves. For reasons listed above, although the state sector maintained the mandatory retirement policy, the expansion of the non-state sectors is likely to weaken the jump in the rate of retirement around the retirement age.

Despite these factors that have weakened the discontinuity deriving from early retirement provisions from the state sector and continued retirement resulting from the growth of the non-state sector, it is fortunate that the discontinuity remains.

Medical insurance for workers past retirement age has gone through many changes. The regulation most relevant to our analysis is the one around 2005. A worker qualifies for health insurance if he/she has continuously participated in the social insurance program for a minimum number of years (women 20-25 years, men 25-30 years with variations across localities). It appears that qualification for health insurance is stricter than for retirement pension. This is possibly because although replacement rate can vary greatly according to number of years of work, health insurance is equally generous for everyone. Unlike pre-retirement health insurance, a qualifying retiree does not need to pay premium out of pocket. It is mostly paid by the work unit.

4. Empirical Strategy

To see how discontinuity in retirement status can be exploited to estimate health effect of retirement, consider the problem of estimating a causal effect of treatment D (e.g., retirement status) on outcome Y (e.g., health). Their relationship can be formally shown as

$$Y = Y_0 \cdot (1 - D) + Y_1 \cdot D = Y_0 + (Y_1 - Y_0)D \quad (1)$$

where Y_0 indicates potential outcome when D=0, and Y_1 potential outcome when D=1. Let z be the cutoff point, i.e. age 60, and X the "forcing variable", i.e., age. Under local continuity assumption, that is, $E[Y_0 \mid X]$ and $E[Y_1 \mid X]$ are continuous at z, if treatment effect is homogenous ($Y_1 - Y_0 = a$), then at the cutoff point z, we have:

$$\lim_{x \downarrow Z_1} E[Y \mid X] - \lim_{x \uparrow Z_1} E[Y \mid X] = a \cdot [\lim_{x \downarrow Z_1} E[D \mid X] - \lim_{x \uparrow Z_1} E[D \mid X]] + \lim_{x \downarrow Z_1} E[Y_0 \mid X] - \lim_{x \uparrow Z_1} E[Y_0 \mid X]$$

As long as there is a jump at z in probability, in which case the denominator is non-zero, i.e. $\lim_{x \downarrow Z_1} E[D \mid X] - \lim_{x \uparrow Z_1} E[D \mid X] \neq 0$, under the continuity assumption, $\lim_{x \downarrow Z_1} E[Y_0 \mid X] - \lim_{x \uparrow Z_1} E[Y_0 \mid X] = 0$, the treatment effect can be expressed as:

$$a = \frac{\lim_{x \downarrow Z} E[Y \mid X] - \lim_{x \uparrow Z} E[Y \mid X]}{\lim_{x \downarrow Z} E[D \mid X] - \lim_{x \uparrow Z} E[D \mid X]} \quad (2)$$

As shown by Hahn et al. (2002), in the case of the heterogonous treatment effect ($Y_{i1} - Y_{i0} = a_i$), adding a local monotonicity assumption similar to the one leading to the identification of a local average treatment effect (LATE, Imbens and Angrist 1994), equation (3) identifies the local average treatment effect at $X=z$:

$$a = \frac{\lim_{x \downarrow Z} E[Y \mid X] - \lim_{x \uparrow Z} E[Y \mid X]}{\lim_{x \downarrow Z} E[D \mid X] - \lim_{x \uparrow Z} E[D \mid X]} = \lim_{e \to 0} E[Y_1 - Y_0 \mid D(z + e) - D(z - e) = 1] \quad (3)$$

where e is a small constant. In other words, this treatment effect represents the average treatment effect of the 'compliers' which is the subgroup of individuals whose treatment status changes discontinuously at the cutoff age. In our case this represents the population of individuals around retirement age whose retirement status is dependent only on whether their age is just below or above the cutoff point.

Figure 1 provides evidence on the existence of the discontinuity. The retirement rate goes up smoothly with age, but it has a sharp jump at age 60. After 60, it returns to its normal trend, with a slightly lower gradient. From our discussions of the institutional background, we argue that the sudden jump in retirement status is attributed to the retirement policy and that the retirement rate would have gone up smoothly without it. When we restrict the comparison between people just above and those just below the retirement age, we ensure that these people are similar in all other ways except retirement status, and thus making sure the effects we identify are solely a cause of retirement.

To estimate the treatment effect of retirement on health mentioned above, we employ an econometric model:

$$Y_i = a_0 + \theta \cdot D_i + a_1(P)X_i + a_2(P)(X_i - z)S_i + u_i \quad \text{(4a)}$$

$$D_i = \beta_0 + \pi \cdot S_i + \beta_1(P)X_i + \beta_2(P)(X_i - z)S_i + \varepsilon_i \quad \text{(4b)}$$

where $z - h \le X_i < z + h$, h is the bandwidth and $a_1(P), a_2(P), \beta_1(P), \beta_2(P)$ are polynomials of X in P. S is an indicator variable, which equals 1 if $X \ge z$. Following Angrist and Imbens (1995), θ is the weighted effect of local average treatment effects across ages.

Equations (4a) and (4b) contain two identification strategies. First, we restrict the sample to a small age bandwidths. When using the 2005 one percent population survey, the bandwidths chosen are ± 1 through ± 5. Because the sample size is smaller in the 2002 CHIP data, we apply a larger bandwidth, ± 5 through ± 9. The small interval around the cutoff point guarantees that the samples selected are similar and the exogenous shock from the retirement policy can be utilized to identify treatment effects. This identification strategy is emphasized by Lee and Lemieux (2009) as local experiment design.

Secondly, because people above the retirement age are older than those below the retirement age and there are direct age effects on health, we use a smooth function of age to control for the effect of age on health (as reflected in the polynomials of age $X(P)$). When choosing the best possible order of polynomial functions, we adopt a formal specification test to assess the validity of the restrictions (see Lee and Card 2008). The basic idea is to compare the fitted model (polynomial function) with the raw dispersion in the mean outcome at each value of the forcing variable. Formally, let this statistic be:

$$G = \frac{[(ESS_R - ESS_{UR})/J - K]}{[ESS_{UR}/N - J]} \quad (5)$$

where ESS_R is the (restricted) error sum of squares from reduced form of estimating (4) with some polynomial function, and ESS_{UR} is the (unrestricted) sum of squares from regressing outcome Y on a full set of dummy variables for the J values of X. Under normality (and homoskedasticity) of the error term, this statistic is distributed as $F(J-K, N-J)$, where K is the number of parameters estimated in the reduced form of equation (1), and N is the number of observations. If the statistic exceeds the critical value, it suggests that the polynomial function is too restrictive. Results of the tests suggest that square control functions are good for regressions using the 2005 one percent population survey and cubic functions are good with the 2002 CHIP data (see Appendix Table 1). We also tried different specifications of the age profile. For example, in some specifications using the 2005 data we include a cubic function of age, but this specification does not have a large effect.

5. Data Description

Two datasets are used in this study, one fifth of the 2005 one percent population survey and the 2002 Chinese Household Income Project (CHIP). The advantage of the population survey is its large sample, facilitating the use of the local estimation in an RD design. The 2002 CHIP dataset is a smaller sample but has richer health measures so that we can examine more dimensions of health effects.

As mentioned earlier, we focus on men because we can not identify the exact cutoff points for women. We also restrict our sample to the urban sample as defined by registration status because the mandatory retirement policy is not applicable to rural Chinese.

In the population survey, we construct the age variable up to quarters using birth year and month, which enable more precise separation of people on both sides of the cutoff point. However, in the CHIP data we can not do so because we only have the reported age (in years).

In both datasets, we define retirement as being not-working and not looking for a job. We make an important distinction between processed retirement and stoping work. A man who has processed retirement and started to collect pension is not defined as retired if he continues to work. There may be measurement errors with the retirement variable. For example, there may be people who never worked their whole life due to a functional limitation. But this does not affect our analysis because the rate of functional limitation is unlikely to be a breaking point that coincides with our cutoff point.

Health status in the population survey comes from one question called the "status of physical health." Respondents choose from four options according to their health status in the past month and interviewer instructions gave specific meanings of each choice:

1, "Health is good," meaning that they have no problem taking care of daily living and work;

2. "Can basically maintain normal living and work," meaning that health is not good but can still manage to take care of themselves;

3. "Can not carry out normal work or can not take care of own daily living," meaning that health was bad in the past month, is where either the respondent is unable to work, or is limited in daily living such as eating, dressing, and moving around, or limited in both working and living.

4. "Hard to say," meaning that health fluctuates over the course of a month that can not be described by any of the choices above.

As can be seen, this question is not asked to conform to standard measures of health commonly seen in international surveys. It contains elements of the self-reported general health question as well as activities of daily living (ADL). While the ADL questions usually measure physical functional limitations, the general health variable can have variations in the absence of functional limitations. Thus we define two different dichotomous health variables from this question: one is called "good health," which equals 1 if the respondent chooses "health is good" and 0 otherwise; the other is "functional limitation," which equals 1 if the respondent chooses "Can not carry out normal work or can not take care of own daily living" and 0 otherwise. The variable "good health" measures health problems at a less advanced stage than the variable "functional limitation" and is more subjective too. As we will see below, we find effects of retirement on "good health" but not on "functional limitation."

The CHIP dataset contains a happiness variable "In general, do you feel happy?" Respondents are given choices of 1. "very happy", 2. "fairly happy", 3. "not good and not bad", 4. "fairly unhappy", 5. "very unhappy", 6. "hard to say"[1]. We define happiness variable equals 1 if the respondent chooses answer 1 or 2. Because happiness is a general measure of psychological health, we use this to supplement our analysis of general health status. In addition, CHIP has self-reported questions on specific health problems such as "do you have problems with your body", "do you have problems with your eye sight", "do you have problems with your hearing", "do you have any chronic diseases", "are you physically weak with many illnesses", "do you have any severe diseases," etc. These are used to supplement results on functional limitations from the population survey.

Basic descriptive statistics of the main variables from the one percent population survey and the 2002 CHIP data are shown in Tables 1 and 2 respectively. Table 1 gives the statistical summary of the population survey and Table 2 that of the CHIP survey. In both tables, we use different bandwidth to report the results in order to give detailed information for our estimations.

[1] The happiness variable in the CHIP dataset is thoroughly investigated by Knight (2007)

6. Validity Test of RD Assumptions

A concern of using the mandatory retirement policy to infer the causal effect of retirement is factors other than a retirement event, such as family structure changing discretely at age 60. The potential for a variable like family structure to confound the comparison of people on either side of age 60 can be assessed by fitting a model such as (4b) for that variable, and hence testing jumps at age 60. If it turns out to evolve smoothly, then this is less of a concern. We will employ such a test for suspicious variables in this paper.

In assessing the validity of our RD estimation, we first demonstrate that the forcing variable (age) is not precisely controlled by individuals. Although the actual age cannot be manipulated, the recorded age might be misreported and the measurement error may be related to retirement. For example, if people are able to change their recorded age in order to qualify for pension, our identification strategy would be threatened. To inspect the potential problems in self-reported age, one method is to see the population density of age (McCrary, 2008; Imbens and Lemieux, 2008). If individual density function of age is smooth at the cutoff, which means there is no selection of age, the population density function of age should also be smooth at the cutoff. Appendix Figure 1 gives the density function of age in the two surveys. Two facts are worth mentioning: First, the trend and the shape of the density functions from the two surveys are similar, showing a decline in population across ages; secondly, there is little evidence that density of age has a jump at 60, which supports our method as valid.

Another test implied by valid RD estimation involves testing the null hypothesis of a zero average effect on pseudo outcomes known not to be affected by the treatment. Such variables include covariates or pre-determined characteristics, such as marital status and family structure that are, by definition, not affected by the mandatory retirement policy. More specifically, we estimate equation (4b) with dependent variables being these pseudo outcome variables. If we do not see any significant results, it supports the conclusion that our method might be valid.

Appendix Table 2 gives the test results for such covariates we can find in the population survey, which contains covariates including marital status (married, never married, divorced and widowed), education level (have a college diploma or above, have a high school diploma, or have a primary diploma or below) and family structure. The results are encouraging: no significant results are found in this table, which suggests that there is no discontinuity on these characteristics that may confound our analysis of the impact of retirement.

7. Estimation Results

Estimation results are presented in the following order. We first examine the impact of mandatory retirement policies on retirement using both data sets. These effects are large. We then present the reduced-form effect of mandatory retirement policy on health, with health being measured by a relatively subjective measure of "good health" and a relatively objective measure of "functional limitation" from the 2005 one percent population survey, and a measure of "psychological health (happiness)" and various other measures of health coming from the 2002 CHIP data. We find noticeable effects on "good health" and "psychological health (happiness)" but not other measures of physical impairment. Finally, we estimate the main equation and investigate the effect of retirement on health.

7.1 The effect of mandatory retirement policy on retirement (First stage results)

We begin with a graphical presentation of the effect of mandatory retirement policy on retirement behavior. Figures 1 and 2 illustrate the relationship between retirement and age, with the 2005 one percent population survey and the 2002 CHIP data respectively. In both Figures, the solid line is a parametric estimate of the conditional expectation of retirement given age. The parametric estimate corresponds to least squares fitted values corresponding to equation (4b). The control variables are education level, marriage status and other demographic variables[2].

[2] In Section 6 we have demonstrated that these controls are smooth functions of age.

Several aspects of the figure are worth noting. First, for observations in both data sets, there is a clear discontinuity of retirement at age 60. This fact is confirmed by the local estimates given in the first rows in Table 3 (the one percent population survey) and Table 4 (CHIP). Each table presents results with five different interval widths (+/-1, +/-2, +/-3, +/-4, +/-5 years in the one percent population survey and +/-5, +/-6, +/-7, +/-8, +/-9 years in CHIP), with "+e/-e" meaning that the sample age is restricted to [60-e, 60+e]. Robust standard errors are presented in parentheses. Additional control variables in the equation for the one percent population survey include education level , marital status and province dummies. In the 2002 CHIP data, the control variables include an additional set of variables, the occupation dummies. Quadratic or cubic control functions of age are used in all estimations (quadratic function used in the one percent population survey and cubic function used in the CHIP data, as mentioned above). From the first rows of Tables 3 and 4, we see that upon reaching the mandatory retirement age of 60, the rate of retirement increases by 5-9 percentage points in the 2005 one percent population survey and about 19-29 percentage points in the 2002 CHIP data. With the mean rate of pre-60 retirement presented in Tables 1 and 2, we calculate and present the percent effects in the square brackets below the marginal effects. Using the 2005 1% population survey we find that the retirement policy increases retirement by 10-17 percent and the 2002 CHIP data shows a larger effect of 86-97 percent. These are large and significant effects. The reason why the effect is larger with the 2002 CHIP data is that this data set over-samples large cities and may have under-sampled the self-employed. This fact can be shown in the last rows of Tables 1 and 2: self-employment rate in 2005 Population Survey is significantly higher than that in the 2002 CHIP.

A second noteworthy aspect of the figure is that there is no evidence of a discontinuity at ages other than the mandatory retirement age. This supports the interpretation of the retirement discontinuity as directly attributable to the mandatory retirement policy.

Additionally, it is worth noting that a significant number of men retire before reaching the mandatory retirement age. As mentioned in the institutional background section, early retirement is granted quite liberally at times of economic transition. The existence of a significant number of early retirements does not affect our results. The important fact is, despite early retirement, there is still a large discontinuity in retirement induced by the mandatory retirement policy, and thus we have a strong first stage in the estimation of the effect of retirement on health.

7.2 The effect of mandatory retirement policy on health (Reduced form)

If retirement has large effects on health, which is to be shown in 7.3, then the mandatory retirement policy should have a reduced form effect on health as well. Following our previous analysis, we begin with a graphical illustration of the relationship between health indicators and age in Figure 3 in the population survey. Similar to retirement, we observe a discontinuity point in "good health" at age 60 although the size of the discontinuity is smaller than that for retirement. The discontinuity of "functional limitation" is less obvious. Figure 4 gives the graphic illustration of health indicators in CHIP, in which the rate of being happy has a big drop at age 60. Other health outcomes seem to have no obvious discontinuity points.

To achieve an estimation of the magnitude, we estimate a reduced form of equation (4a) and (4b) and report the results in Tables 3 and 4. We can see that mandatory retirement policy causes a decline in the probability of good health by 3 percentage points (3 percent effect), and reduced the probability of reporting happy by 29-37 percentage points (50-61 percent). However, we do not see significant change in the probability of being disabled and other objective health outcomes.

The other significant point is that the slopes of both "good health" and "functional limitation" become steeper past age 60. This is an interesting phenomenon; it seems that retirement not only damages health, but also speeds up the deterioration of health. This fact indicates the importance of including age function and cutoff as additional controls to avoid the potential bias from the changes of health status at the time of retiring. In this paper, these changes in trend are treated as controls while identifying the effects of retirement on health, but how to specifically identify these changes and what are the underlying meanings of these changes still need to be explored.

7.3 The effect of retirement on health

We now turn to estimating effects of retirement on health with the RD framework. The procedure is the same as two-stage least squares estimation with the retirement policy serving as an instrument variable for retirement. The only difference from the IV estimation is that we use observations close to the cutoff point of mandatory retirement age and polynomial functions to control for age effect..

The first stage of our estimation is shown in Tables 3 and 4, and the second stage results in Tables 5 and 6. From Table 5, we can see that retirement reduces the probability of being in good health by about 29-40 percentage point. Because the mean rate of good health is 89-90 percent for people right before reaching retirement age, this represents a 32-44 percent reduction of being in good health. These are fairly large effects considering that we are looking at a short time span.

Looking at the effects on functional limitations, however, none of the models produced significant effect. One reason is that the RD design only allows us to look at the outcome immediately before and after retirement. Although health problems start to appear right after retirement, as indicated by the effect of good health, they are unlikely to manifest as functional limitations because disabilities are more serious and take time to develop. Our identification strategy does not allow us to examine the long-term effect on functional limitations.

Results from the CHIP data are consistent with the findings above. Because the number of observations is relatively small, we use a longer bandwidth of age. As Table 6 shows, retirement has a large and statistically significant negative effect on psychological health (happiness). Being retired reduces the probability of being happy by 40-54 percentage points (66-86 percent). Looking at other physical health problems (bodies, eyesight, hearing, chronic illnesses, lack of strengths and prone to diseases and severe diseases), however, we do not find any significant effect.

Our conclusion is that retirement has immediate and large effect on subjective self-evaluation of health, which is more related to psychological health than physical health. Because poor mental health can cause physical health to deteriorate, it will eventually lead to functionally limitations, an effect we are unable to capture with our data.

Some may claim that in anticipating retirement, those near the retirement age may start to feel anxious before actual retirement. This effect would bias our estimation down. Thus, our estimation effects are a lower bound.

Our results are quite different from what the literature has found. Recent literature using IV estimation tends to find that retirement has a positive but small or insignificant effect on mental and subjective health, with little impact on objective health. For example, Charles (2004) finds a positive effect on mental health. Neuman (2008) reports at least no negative impact from retirement. Johnston and Lee (2008), using RD design on non-college educated workers, find a positive impact on self-reported health. Charles (2004) explains these findings as "perfectly consistent with the description of a voluntary retirement decision."

There can be two possible explanations as to why our findings differ from these existing studies. First, the true effects might be different. There are two further possible reasons for this: First, retirement age is different. The retirement age is 60 for Chinese men whereas in the U.S. and U.K. it is 65. It is possible that the negative effect of retirement is stronger for younger workers. Secondly, opportunities and supports for the retired are different. It is true that American and British elderly have more resources at retirement and can afford to take vacations to fill the void created by leaving a beloved job whereas Chinese elderly do not have that luxury. On the other hand, Chinese elderly have more social interactions with their children, grandchildren and neighbors which can offset the loneliness and the feeling of valueless caused by retirement.

Alternatively, methodological differences can also explain the differences in our results. The voluntary nature of retirement in the U.S. and U.K. implies that retirement decision is endogenous – if a worker dislikes life in retirement, he will find a way to continue to work, and the IV method can not eradicate the endogeneity problem. In addition, the IV estimation here just identifies the local average treatment effects (LATE). As Behncke (2009) has criticized, the LATE estimator only identifies the effects on compliers, not on the whole population (the average treatment effect, ATE), nor on all the retirees of interest (the average treatment effect on the treated, ATET). The more the compliers, the more likely that the LATE estimator approaches the effects on the population. Under a flexible retirement policy, the sample of always-takers might be large, while the sample of compliers might be smaller. But with a mandatory retirement policy in China, people have fewer choices, indicating that the proportion of compliers are likely to be larger than that in other countries without such a policy. Combined with the RD design, we are better able to capture the causal effect of retirement on health outcomes.

8. Robustness Tests

In this section, we run two robustness tests to dispel possible doubts that our estimation results come from randomness deriving from either the large sample size or pure luck, not actual causal effects.

First, we choose other ages as our psedo cutoff points, and run estimations of retirement against these cutoff points using the same method as in Table 3. Specifically, we choose 59, 61, 58 and 62 as the possible cutoffs.[3] As shown in Appendix Table 3, none of the coefficients is significant and the magnitudes are all close to zero[4].

The second test uses rural workers to run the same regressions. We had excluded rural workers because they are not covered by the mandatory retirement policy therefore the identification strategy should not work on them. To do this, we first choose the analytic sample to be rural-registered residents from the one percent population survey, then exclude individuals who reported to have never worked[5].

Appendix Figure 2 describes the relationships between retirement, health and age

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[3] Note that when we estimate using the cutoff of age 61, we can no longer use the sample +/-2, because age 60 is a true jump point, so we only use +/-1 as our base sample. The same is true when using age 59 as the cutoff.

[4] We do not test the jumps in CHIP, because in such a small bandwidth, there is not enough samples to estimate.

[5] We cannot do this placebo test for the CHIP data because questions of happiness and health outcomes are not asked in the rural questionnaire.

for rural workers. We first note that the rate of retirement is much smaller compared to urban workers. At age 59, only 4% ceased to work. This is consistent with what has been found in the literature that rural elderly have much higher rate of labor force participation than their urban counterparts (Benjamin, etc. 2003). Most importantly, we cannot detect any discontinuity in retirement at age 60 both in retirement and health. To confirm the result, we report local estimates in Appendix Table 4. The first row tells that the effect of mandatory retirement policy has no effect on the retirement behavior of the rural people at all. If we look at reduced form results of the mandatory retirement policy on having "good health" there is no effect either. Recall that we find large and significant effect of mandatory retirement policy on having good health for urban workers while at the same time we find large and significant effects on retirement. Not finding any reduced form effect on rural workers when there is no first stage gives us additional confidence that the reduced form effect is indeed through retirement. Similar to the results for urban workers, the effect of mandatory retirement policy on having functionally limitations is non-existent.

9. Mechanisms/Channels

Given the negative impacts we have found of retirement on self-reported health and psychological health (happiness), the next question to ask is "Why?" In this section, we try to explore several potential channels through which retirement plays a role. The three candidates we consider are income, education and position.

Although retirees continue to receive an income following retirement, the amount of pension is very low compared to pre-retirement salaries. For this reason, we observe a dramatic decline in income after retirement as seen in Figure 5. The linear trend is quite smooth except at the turning point at age 60. Table 7 reports the first and the second stage estimates of the effect of income on health outcomes. The first panel shows that the mandatory retirement policy has a large and statistically significant negative effect on income; the second panel shows that income in turn has a large and statistically significant positive effect on reporting good health. To investigate whether the decline in income can explain away the effect of retirement on health, in the third panel we include income as a control variable in the two-stage estimation of the effect of retirement on health. It turns out that the effects of retirement on health still remain, but the coefficients have become less significant and smaller in magnitude (as compared to the results obtained in Table 5) under different specifications[6]. This indicates that income can partly explain the health effect of retirement, but it is not the whole story.

According to what we described in the section of institutional background, retirement is also likely to affect the cost of medical care. We first examine whether coverage changes with retirement. The 2005 one percent population survey asks one question: "Are you covered by medical insurance?" We explore whether the coverage of medical insurance is affected by the mandatory retirement policy in Appendix Table 2 and find that the rate of coverage of medical insurance does not jump at the cutoff; thus participation in medical insurance is not the channel of the negative effect of retirement on health. Alternatively, even though the coverage remains constant after retirement, the costs of health care could change. For example, compared to a pre-retirement worker, retirees have lower deductables and co-payments. In addition, their time cost of seeking medical treatment is also lower. However, these factors reduce the cost of medical care, not increasing it, thus they cannot help to explain the negative effect of retirement on health.

Education has been shown to be an important factor influencing health status (e.g., Smith 2007). Education may also affect people's ability to adjust to changes in environment. Retirees with higher education, for example, may be better able to adjust their feelings and behaviors to better adapt to the shock of retirement. If this is true, we would see a smaller negative health effect of retirement for this group of people. The RD estimation, which divides people into two education groups, one with a college degree diploma or above (high education) and the other with high school degree diploma or below (low education), using the one percent population survey in

[6] Of course, this method would face "bad control" problems, because retirement is the cause of change in income. As a result, we do not treat the estimations here as consistent; we only want to use the method as a possible exploration of how and in what extent change in income affects people's health.

Table 8 gives supporting evidence. For the low education group, most of the health effects are significant, but none of the coefficients for the high education group is significant[7]. This supports the theory that low education might be one of the reasons that retirement has a negative impact on self-reported health.

One important feature of position in China related to retirement is whether an employee is a cadre or an ordinary worker. Being a cadre often means that one is in a position of management or scientific and technological personnel in an organization, while the opposite usually means engaging in physical work[8]. We use the 2002 CHIP for this analysis because respondents are asked for their pre-retirement occupations. The subgroup regression results are presented in Table 9, where we can see the effects of retirement on psychological health (happiness) are very negative among ordinary workers, but the effects among cadres are barely significant. This indicates that cadres are better able to manage post-retirement life.

Putting things together, we conclude that the negative shock caused by retirement is partly driven by income decline and partly by the inability of retirees to manage the transition due to lower education and skills.

10. Conclusions

Taking advantage of the mandatory retirement policy in China, this paper uses a regression discontinuity design to identify the impact of retirement on health. Two large datasets, the 2005 one percent population survey and the 2002 Chinese Household Income Project, allow us to focus on sharp contrasts in retirement between individuals whose age is just under and those just above the mandatory retirement age, avoiding potential confounding effects driven by differences in other factors. Our estimates pass various validity tests and placebo tests, thus lending credibility to the robustness of the results.

[7] We also tried to divide people into three groups, people with college degree diploma or above, with high school diploma and junior high school or blow diploma to estimate, the results are similar to the estimations here: the high education people seem to be unaffected by retirement, the other two group both show negative effects.
[8] The distinctions between cadres and ordinary workers may be confounded with the distinction by education as cadres in China often have higher education, but the difference in work type may dominates the difference in education.

Our results suggest that although retirement does not immediately cause functional limitations or other aspects of physical health conditions, it has an immediate and large negative impact on self-reported health status and this may mainly come from a large deterioration of psychological health represented by the feeling of happiness. Further investigation finds that this effect can only be partly explained by the sharp income decline after retirement and that education and skills (being a cadre) play a significant role in smoothing the transition. The negative shock is only placed on people with lower education and manual (non-cadre) workers.

As an aging society, China has been facing the choice of whether to continue its mandatory retirement policy. This research shows that the cost of eliminating or at least relaxing this policy may be lower than expected.

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Figure 1: Retirement and Age, 2005 1% Population Survey

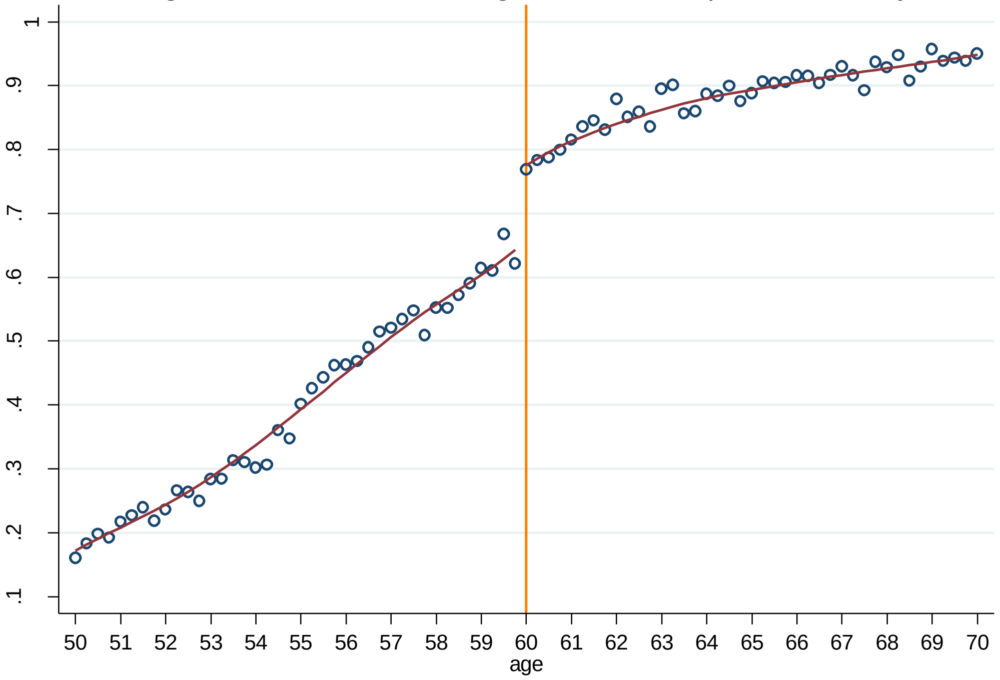


Figure 2: Retirement and Age, 2002 CHIP

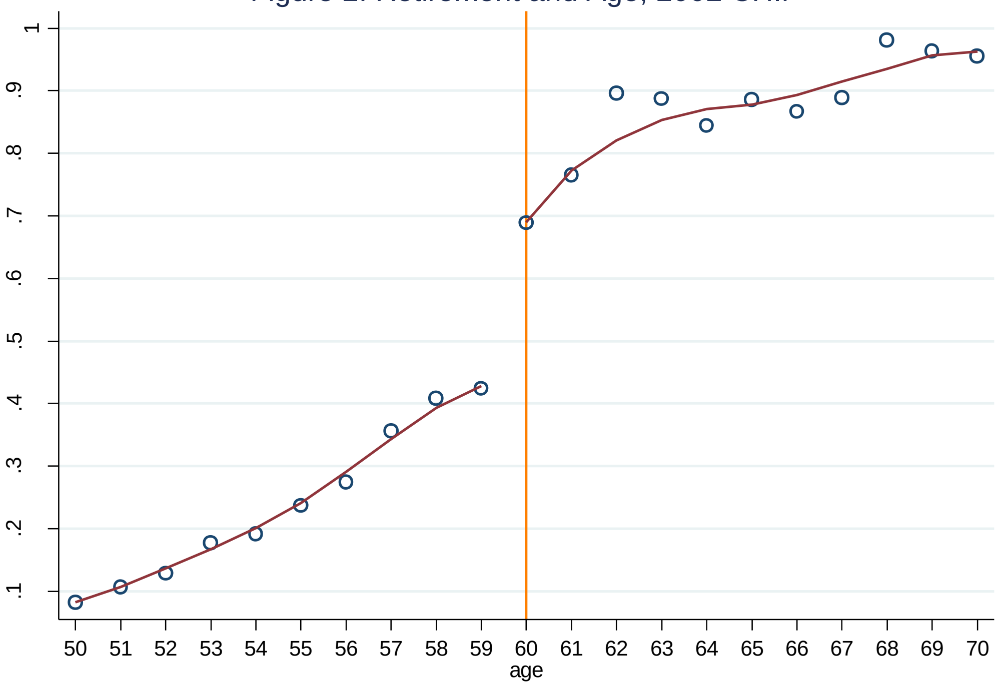


Figure 3: Health and Age, 2005 1% Population Survey

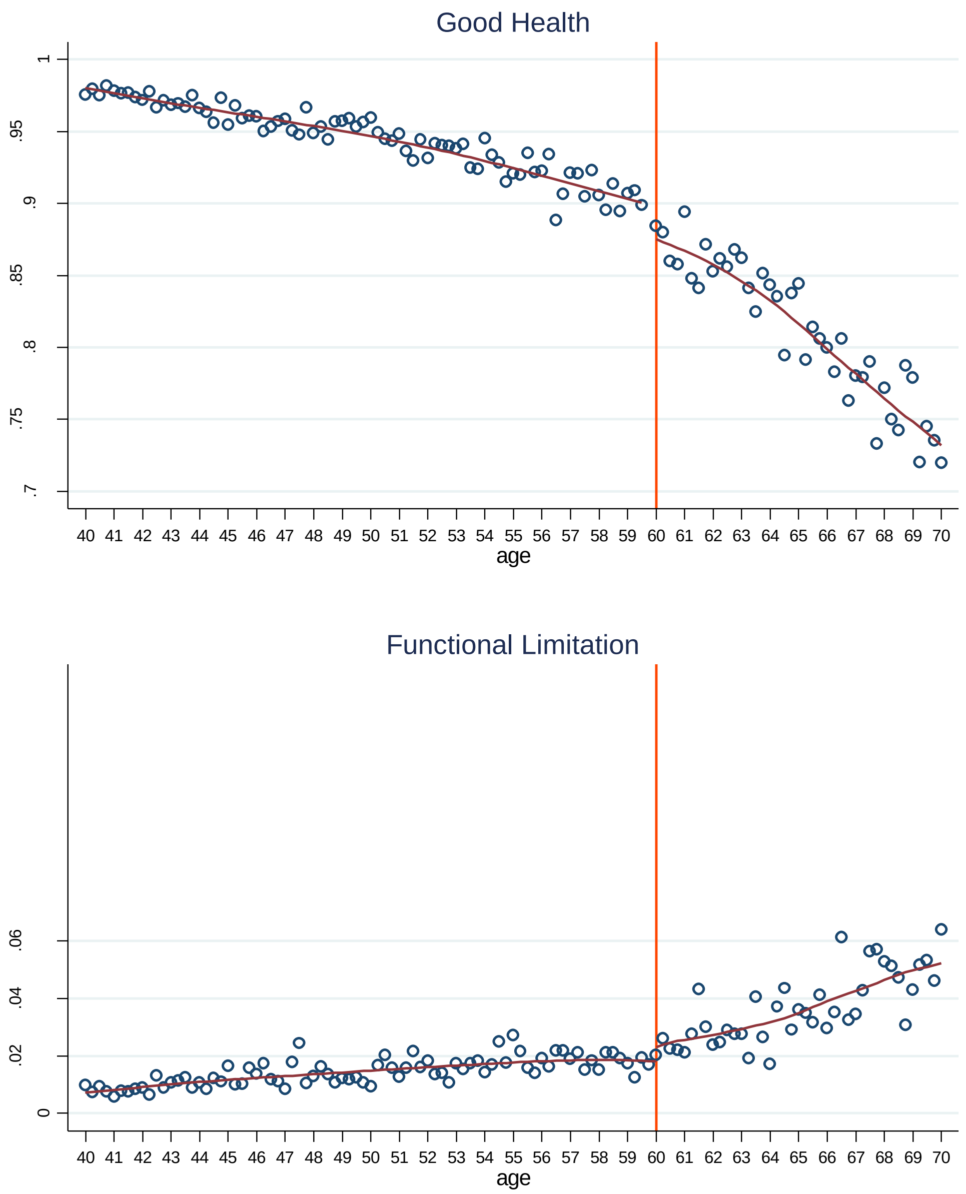
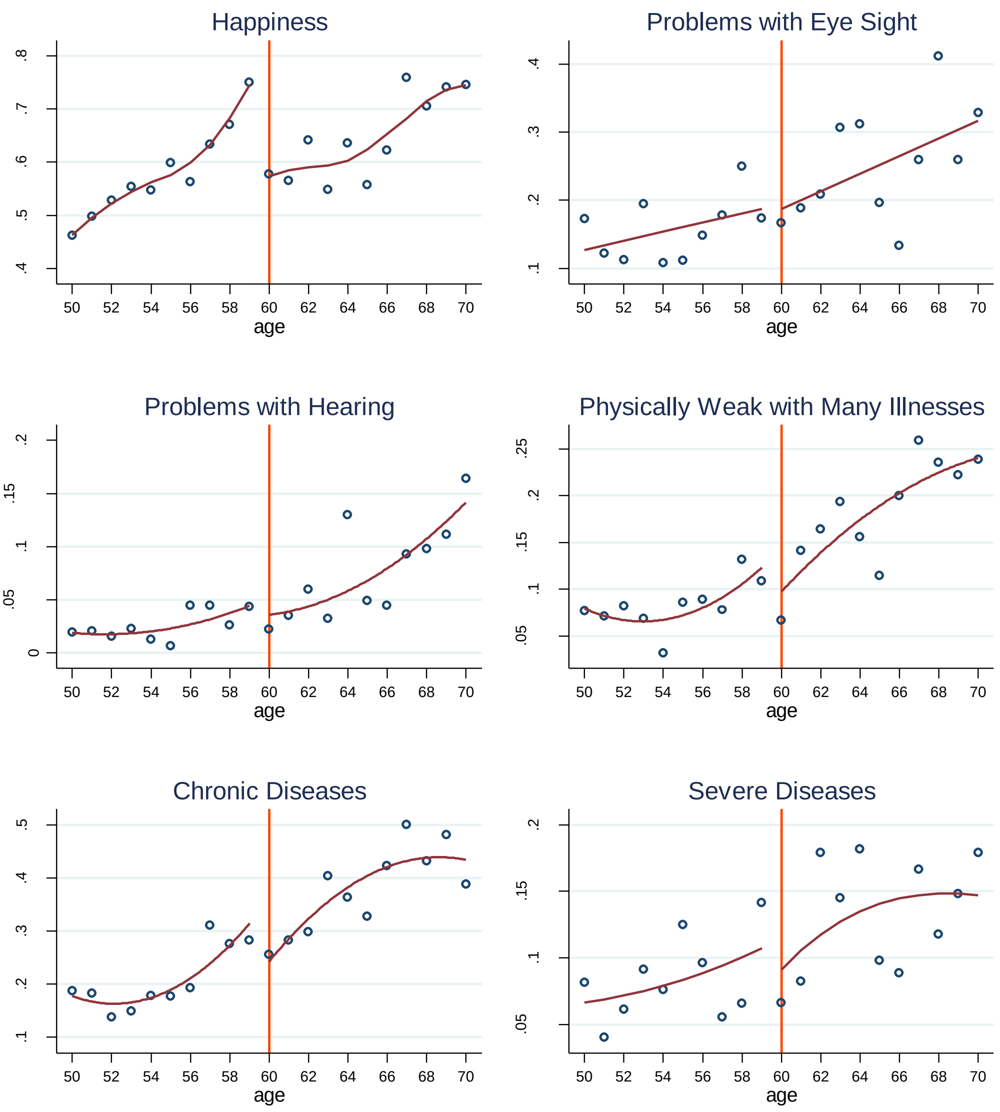


Figure 4: Health and Age, 2002 CHIP



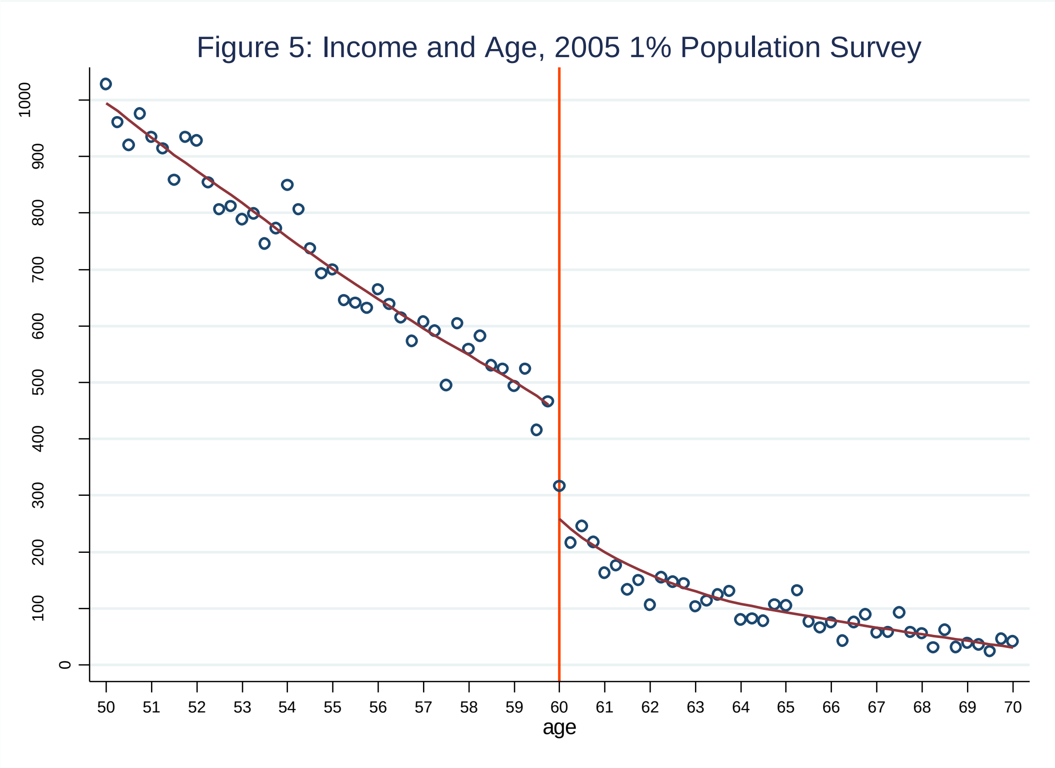


Figure 5: Income and Age, 2005 1% Population Survey
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Table 1: Descriptive Statistics, 2005 1% Population Survey

	+1	−1	+2	−2	+3	−3	+4	−4	+5	−5	[−5, +5)
% Retirement	0.77	0.63	0.80	0.59	0.82	0.57	0.83	0.55	0.84	0.52	0.66
	(0.01)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% Good Health	0.87	0.90	0.87	0.90	0.86	0.91	0.86	0.91	0.85	0.91	0.89
	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% Functional Limitation	0.02	0.02	0.03	0.02	0.03	0.02	0.03	0.02	0.03	0.02	0.02
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Income(Thousand)	0.25	0.48	0.21	0.52	0.18	0.54	0.17	0.56	0.15	0.58	0.40
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
% College Degree or above	0.18	0.18	0.17	0.18	0.17	0.17	0.17	0.17	0.17	0.17	0.17
	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% High School Degree	0.57	0.58	0.58	0.58	0.58	0.59	0.58	0.60	0.58	0.61	0.60
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% Primary School or below	0.25	0.24	0.25	0.24	0.25	0.24	0.25	0.23	0.25	0.22	0.22
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% Married	0.94	0.94	0.95	0.95	0.94	0.95	0.94	0.96	0.94	0.96	0.95
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% Unmarried	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% Divorce	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
% Window	0.04	0.03	0.03	0.03	0.04	0.02	0.04	0.02	0.04	0.02	0.03
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Household Size	3.31	3.30	3.34	3.32	3.35	3.32	3.33	3.30	3.32	3.30	3.30
	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Self-employment	0.07	0.07	0.06	0.07	0.06	0.07	0.06	0.08	0.06	0.08	0.07
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	7651		13618		20218		27728		35128		35128

Table 2: Descriptive Statistics, 2002 CHIP

	+5	−5	+6	−6	+7	−7	+8	−8	+9	−9	[−9, +9)
% Retirement	0.84	0.22	0.82	0.29	0.82	0.27	0.83	0.24	0.84	0.22	0.42
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
% Happiness	0.62	0.58	0.59	0.61	0.59	0.60	0.61	0.59	0.62	0.57	0.59
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)
% Problems in Bodies	0.05	0.03	0.05	0.03	0.05	0.03	0.05	0.03	0.05	0.03	0.04
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)
% Problems in Eyes	0.24	0.15	0.23	0.15	0.22	0.16	0.22	0.15	0.24	0.15	0.18
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
% Problems in Ears	0.06	0.02	0.05	0.03	0.05	0.03	0.06	0.02	0.06	0.03	0.04
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)
% Dysgnosia	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01
	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
% valetudinarianism	0.16	0.08	0.14	0.08	0.14	0.08	0.15	0.08	0.17	0.08	0.10
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.10)
% Chronic Disease	0.35	0.19	0.22	0.23	0.33	0.21	0.35	0.20	0.36	0.20	0.24
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
% Severe Disease	0.12	0.10	0.12	0.10	0.12	0.09	0.12	0.09	0.12	0.10	0.09
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
% College Degree or above	0.24	0.26	0.24	0.29	0.23	0.28	0.23	0.27	0.23	0.28	0.25
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
% High School Degree	0.33	0.29	0.36	0.31	0.36	0.30	0.34	0.29	0.33	0.29	0.30
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
% Middle School Degree	0.29	0.37	0.27	0.31	0.28	0.33	0.29	0.35	0.29	0.37	0.35
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
% Married	0.97	0.99	0.97	0.99	0.97	0.99	0.97	0.99	0.97	0.99	0.98
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)
% Cadres	0.54	0.40	0.53	0.46	0.53	0.44	0.53	0.42	0.54	0.40	0.45
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)
Self-employment	0.02	0.01	0.03	0.02	0.03	0.04	0.03	0.04	0.03	0.04	0.04
	(0.00)	(0.00)	(0.01)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)
Observations	1133		1351		1600		1848		2109		2109

Table 3: Impact of Policy on Retirement and Health, 2005 1% Population Survey

	+/- 1	+/- 2	+/- 3	+/- 4	+/- 5
Retirement	0.07**	0.08***	0.05***	0.07***	0.09***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
	[0.11]	[0.14]	[0.10]	[0.13]	[0.17]
Good Health	-0.03*	-0.03**	-0.03**	-0.03**	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
	[0.03]	[0.03]	[0.03]	[0.03]	[0.03]
Functional Limitation	0.01	0.00	0.00	0.01	0.01
	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)
	[0.5]	[0.32]	[0.5]	[0.5]	[0.4]
Observations	7651	13618	20218	27728	35128

Note: (1) For all functions, square control functions are applied. (2) All estimations add control variables including education, province dummy and marital status. (3) Standard errors are presented in parentheses and percent effect are shown in brackets (4)* p<0.1, ** p<0.05, *** p<0.01.

Table 4: Impact of Policy on Retirement and Health, 2002 CHIP

	+/- 5	+/- 6	+/- 7	+/- 8	+/- 9
Retirement	0.20**	0.29*	0.29**	0.21*	0.19*
	(0.10)	(0.18)	(0.14)	(0.12)	(0.11)
	[0.91]	[0.97]	[1.00]	[0.88]	[0.86]
Happiness	-0.29***	-0.37**	-0.34**	-0.33***	-0.31***
	(0.10)	(0.18)	(0.14)	(0.12)	(0.11)
	[-0.50]	[-0.61]	[-0.57]	[-0.56]	[-0.54]
Problems with Bodies	0.04	0.01	0.10*	0.07	0.05
	(0.03)	(0.05)	(0.06)	(0.04)	(0.04)
	[1.00]	[0.33]	[3.00]	[1.75]	[1.67]
Problems with Eye Sight	-0.04	0.16	0.14	-0.05	-0.08
	(0.08)	(0.14)	(0.11)	(0.10)	(0.09)
	[-0.27]	[0.97]	[0.88]	[-0.33]	[0.53]
Problems with Hearing	-0.03	0.01	0.02	-0.01	-0.02
	(0.04)	(0.07)	(0.06)	(0.05)	(0.04)
	[-1.01]	[0.33]	[0.66]	[-0.50]	[-0.66]
Dysgnosia	0.03	0.02	0.02	0.03	0.03
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
	[2.02]	[2.00]	[1.50]	[2.50]	[2.00]
Physically Weak with	-0.05	-0.09	-0.02	-0.02	-0.05
Many Illnesses	(0.06)	(0.11)	(0.09)	(0.08)	(0.07)
	[-0.63]	[-0.97]	[-0.25]	[-0.25]	[-0.63]
Chronic Disease	-0.05	0.08	0.01	-0.04	-0.02
	(0.09)	(0.17)	(0.14)	(0.12)	(0.10)
	[-0.26]	[0.35]	[0.05]	[-0.20]	[-0.01]
Whether have severe	-0.07	-0.30*	-0.20	-0.17	-0.13
Disease	(0.07)	(0.12)	(0.15)	(0.10)	(0.09)
	[-0.07]	[-3.10]	[-2.50]	[-1.83]	[-1.30]
Observations	1133	1351	1600	1848	2109

Note: (1) All estimations use cubic control function used with control variables education, province dummy, marital status and whether cadre or work type. (2) Standard errors are presented in parentheses and percent effect are shown in brackets (3)* p<0.1, ** p<0.05, *** p<0.01.

Table 5: Impact of Retirement on Health, 2005 1% Population Survey

	+/- 1	+/- 2	+/- 3	+/- 4	+/- 5
Good Health	-0.35*	-0.32**	-0.40**	-0.36**	-0.29**
	(0.22)	(0.14)	(0.19)	(0.17)	(0.12)
	[-0.39]	[-0.36]	[-0.44]	[-0.40]	[-0.32]
Functional Limitation	0.08	0.05	0.08	0.08	0.07
	(0.09)	(0.06)	(0.11)	(0.07)	(0.05)
	[4.00]	[2.51]	[4.00]	[4.00]	[3.52]

Note: (1) For all functions, square control functions are applied. (2) All estimations add control variables including education, province dummy and marital status. (3) Standard errors are presented in parentheses and percent effect are shown in brackets (4)* p<0.1, ** p<0.05, *** p<0.01.

Table 6: Impact of Retirement on Health, 2002 CHIP

	+/- 5	+/- 6	+/- 7	+/- 8	+/- 9
Happiness	-0.54**	-0.40**	-0.46***	-0.45***	-0.49***
	(0.25)	(0.19)	(0.18)	(0.17)	(0.15)
	[-0.93]	[-0.66]	[-0.77]	[-0.76]	[-0.86]
Problems with Bodies	0.02	0.35	0.35	0.49	0.43
	(0.18)	(0.23)	(0.27)	(0.33)	(0.27)
	[0.67]	[11.3]	[10.9]	[16.3]	[14.3]
Problems with Eye Sight	0.56	0.50	-0.24	-0.41	-0.18
	(0.60)	(0.48)	(0.47)	(0.49)	(0.41)
	[3.73]	[3.33]	[-1.50]	[-2.73]	[-1.20]
Problems with Hearing	0.02	0.06	-0.05	-0.11	-0.14
	(0.24)	(0.21)	(0.24)	(0.24)	(0.21)
	[1.00]	[2.00]	[-1.67]	[-5.50]	[-4.67]
Dysgnosia	0.06	0.07	0.15	0.14	0.15
	(0.08)	(0.07)	(0.11)	(0.11)	(0.11)
	[6.00]	[0.07]	[16.1]	[14.0]	[15.1]
Physically Weak with	-0.30	-0.07	-0.11	-0.26	-0.27
Many Illnesses	(0.44)	(0.32)	(0.37)	(0.40)	(0.36)
	[-0.38]	[-0.88]	[-1.38]	[-3.25]	[-3.38]
Chronic Disease	0.27	0.03	-0.17	-0.10	-0.26
	(0.58)	(0.47)	(0.56)	(0.54)	(0.50)
	[1.42]	[0.13]	[-0.81]	[-0.50]	[-13.1]
Whether have severe	-1.04	-0.69	-0.80	-0.68	-0.33
Disease	(0.73)	(0.48)	(0.58)	(0.53)	(0.37)
	[-10.4]	[-6.94]	[-8.89]	[-7.56]	[-3.33]
Observations	1133	1351	1600	1848	2109

Note: (1) All estimations use cubic control function used with control variables education, province dummy, marital status and whether cadre or work type. (2) Standard errors are presented in parentheses and percent effect are shown in brackets (3)* p<0.1, ** p<0.05, *** p<0.01.

Table 7: Income Effect, 2005 1% population survey

	+/- 1	+/- 2	+/- 3	+/- 4	+/- 5
			Mandatory Policy on Income		
Cutoff of 60	-0.13***	-0.15***	-0.12***	-0.15***	-0.16***
	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
			Income on Good Health		
Income	0.21*	0.17**	0.23*	0.18**	0.16**
	(0.13)	(0.08)	(0.12)	(0.08)	(0.07)
			Retirement on Good Health Controlling on Income		
Retirement	-0.30	-0.55*	-0.26*	-0.20*	-0.14*
	(0.20)	(0.31)	(0.14)	(0.11)	(0.07)
Income	-0.07	-0.13	-0.05	-0.03	-0.01
	(0.13)	(0.09)	(0.04)	(0.03)	(0.03)

Note: (1) For all functions, square control functions are applied. (2) All estimations add control variables including education, province dummy and marital status. (3) Standard errors are presented in parentheses (4)* p<0.1, ** p<0.05, *** p<0.01.

Table 8: Effect of Retirement on Good Health by Education, 2005 1% population survey

	+/- 1	+/- 2	+/- 3	+/- 4	+/- 5
			College Diploma or above		
Cutoff 60	0.13***	0.18***	0.15***	0.18****	0.19****
	(0.05)	(0.04)	(0.05)	(0.04)	(0.04)
Retirement	-0.15	-0.06	-0.16	-0.13	-0.10
	(0.24)	(0.12)	(0.19)	(0.13)	(0.11)
			High School Diploma or below		
Cutoff 60	0.06***	0.06***	0.05**	0.05***	0.07***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Retirement	-0.47*	-0.50**	-0.31**	-0.53*	-0.40**
	(0.25)	(0.24)	(0.13)	(0.30)	(0.18)

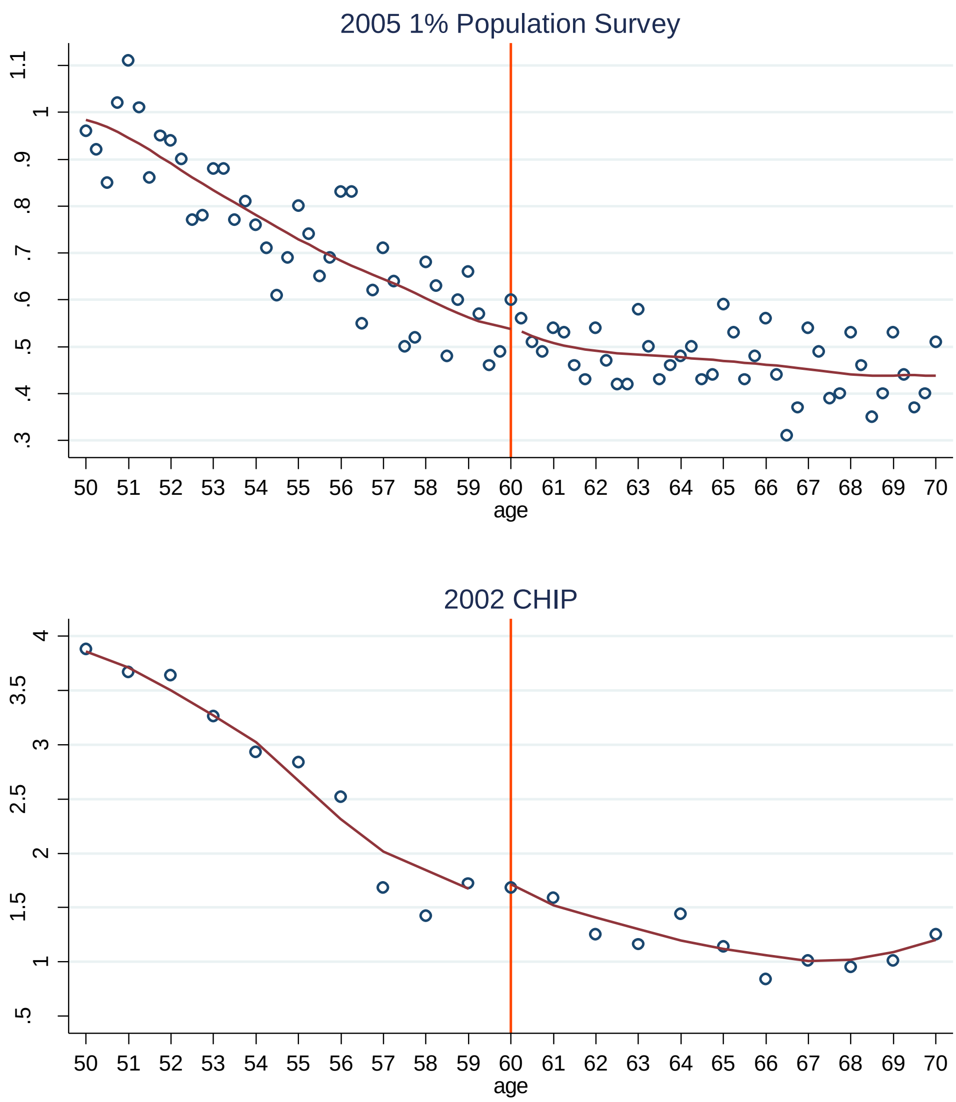
Note: (1) For all functions, square control functions are applied. (2) All estimations add control variables including education, province dummy and marital status. (3) Standard errors are presented in parentheses (4)* p<0.1, ** p<0.05, *** p<0.01.

Table 9: Impact of retirement on Happiness by Work Type, 2002 CHIP

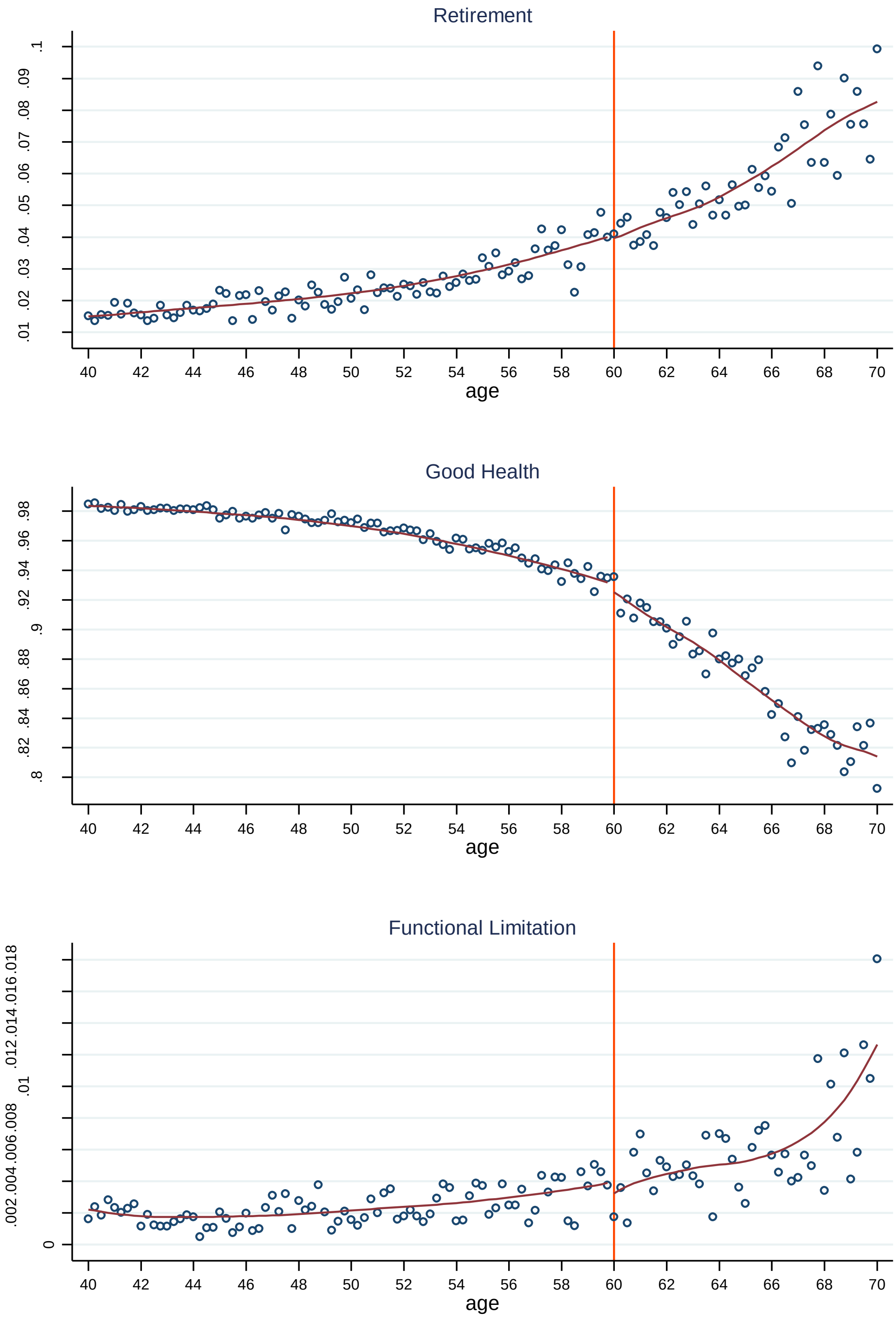
	+/- 6	+/- 7	+/- 8	+/- 9	+/- 10
			Cadre		
Cutoff 60	0.20	0.20*	0.27*	0.29**	0.28**
	(0.13)	(0.12)	(0.15)	(0.15)	(0.14)
Retirement	0.09	-0.08	-0.17	-0.31*	-0.30*
	(0.23)	(0.21)	(0.19)	(0.18)	(0.16)
			Normal worker		
Cutoff 60	0.51**	0.35*	0.37*	0.38**	0.22*
	(0.25)	(0.19)	(0.20)	(0.14)**	(0.13)
Retirement	-0.67**	-0.55*	-0.77**	-0.70**	-0.75***
	(0.26)	(0.31)	(0.31)	(0.30)	(0.28)

Note: (1) All estimations use cubic control function used with control variables education, province dummy, marital status and whether cadre or work type. (2) Standard errors are presented in parentheses (3)* $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Appendix Figure 1: Density Function of Age



Appendix Figure 2:Consequences being in Rural Areas



Appendix Table 1: Robustness of Polynomial Functions in Table 3 and 4

2005 1% Population Survey

	+/- 1	+/- 2	+/- 3	+/- 4	+/- 5
Retirement	1.18	1.38	0.96	1.33	1.27
	(0.15)	(0.17)	(0.50)	(0.12)	(0.14)
Income	1.57	1.27	1.27	1.25	1.14
	(0.16)	(0.23)	(0.20)	(0.18)	(0.26)
Good Health	1.09	1.26	1.00	1.37	1.18
	(0.37)	(0.23)	(0.45)	(0.10)	(0.21)
Functional Limitation	0.71	1.32	0.98	0.95	0.97
	(0.62)	(0.20)	(0.48)	(0.53)	(0.51)

2002 CHIP

	+/- 5	+/- 6	+/- 7	+/- 8	+/- 9
Retirement	0.66	0.71	0.72	0.73	0.94
	(0.62)	(0.64)	(0.68)	(0.70)	(0.51)
Happiness	0.72	0.75	0.63	0.71	0.72
	(0.58)	(0.61)	(0.75)	(0.72)	(0.76)
Problems with Bodies	0.14	0.91	0.86	0.77	0.75
	(0.97)	(0.49)	(0.55)	(0.66)	(0.70)
Problems with Eye Sight	0.54	1.28	1.53	1.93	2.11
	(0.71)	(0.26)	(0.14)	(0.04)	(0.01)
Problems with Hearing	1.26	1.99	1.79	1.65	1.28
	(0.28)	(0.06)	(0.07)	(0.09)	(0.21)
Dysgnosia	0.12	0.09	0.25	0.54	0.50
	(0.98)	(1.00)	(0.98)	(0.86)	(0.91)
Physically Weak with	0.43	0.42	0.92	1.15	0.83
Many Illnesses	(0.79)	(0.87)	(0.50)	(0.32)	(0.63)
Chronic Disease	0.86	0.74	0.73	0.72	0.65
	(0.49)	(0.62)	(0.66)	(0.70)	(0.82)
Whether have severe	0.52	1.36	1.08	1.41	1.36
Disease	(0.72)	(0.23)	(0.37)	(0.17)	(0.17)

Note: Variables on the left column are dependent variables. This table reports test of the robustness of the polynomial approximation introduced by Lee and Card (2008). Each entry in the table is an F-statistic that compares the fit of a completely saturated model in age to the more paraimonious model underlying the estimates of reduced form in Table 3 and 4. The numerator degree of freedom for the F-statistic is P-values are given in brackets.

Appendix Table 2: Smooth of Control Variables, 2005 1% population survey

	+/- 1	+/- 2	+/- 3
Have Pension	0.02	0.01	0.01
	(0.02)	(0.02)	(0.02)
Medical Care enrollment	0.03	0.02	0.02
	(0.02)	(0.02)	(0.02)
Married	-0.01	0.00	0.00
	(0.01)	(0.01)	(0.01)
Never Married	0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)
Divorced	-0.00	-0.01	-0.01
	(0.00)	(0.00)	(0.00)
Widowed	0.01	0.00	0.01
	(0.01)	(0.01)	(0.01)
College Diploma or above	0.02	0.01	0.01
	(0.02)	(0.01)	(0.02)
High School Diploma	-0.01	-0.00	-0.01
	(0.02)	(0.02)	(0.02)
Primary School Diploma	-0.01	-0.01	-0.01
	(0.02)	(0.01)	(0.02)
Family structure	0.06	0.06	0.08
	(0.08)	(0.06)	(0.07)

Note: (1)All estimations use the same method as Table 1 except the dependent variables (2)Standard errors are presented in parentheses

Appendix Table 3: Test of Other Possible Retirement Rate Jumps, 2005 1% Population Survey

	+/- 1	+/- 2
Cutoff of 58	-0.00	-0.02
	(0.02)	(0.02)
Cutoff of 59	0.02	
	(0.02)	
Cutoff of 61	0.00	
	(0.02)	
Cutoff of 62	0.01	-0.02
	(0.02)	(0.01)

Note: (1) For all functions, square control functions are applied. (2)All estimations add control variables including education, province dummy and marital status. (3)Standard errors are presented in parentheses (4)* $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Appendix Table 4: Smooth Assumption Test Using Males Who Are outside Mandatory Retirement,2005 1% population survey

	+/- 1	+/- 2	+/- 3
Retirement	0.00	0.00	0.00
	(0.61)	(0.06)	(0.06)
Good Health	-0.01	-0.01	-0.01
	(-0.88)	(-1.47)	(-1.62)
Functional Limitation	-0.00	-0.00	-0.00
	(-1.18)	(-1.08)	(-0.52)
Observations	14789	26926	40162

Note: (1)all estimations use the same method as Table 3,
(2)Standard errors are presented in parentheses