RETIREMENT SPILLOVER EFFECTS ON SPOUSAL HEALTH IN URBAN CHINA*

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ABSTRACT. This paper empirically studies the causal effect of retirement on spouses' subjective health for the elderly in urban China. We find that women's retirement positively affects their husbands, while husbands' retirement tends to affect wives negatively. The difference in post-retirement healthy (and unhealthy) behaviours and emotions between men and women can explain gender asymmetry. Men tend to have a negative state of mind and unhealthy habits and behaviours more than women, which results in the negative spillover effect. We also estimate the marginal threshold treatment effect (MTTE), showing that a small delay of statutory retirement age is beneficial for improving overall subjective health, yet the conclusion would actually be the opposite if the spillover effect were to be ignored. These results provide useful references for the current discussion on retirement policy reform in China.

Keywords: Retirement, Spillover Effect, Marginal Threshold Treatment Effect, Subjective Health, Regression Discontinuity

JEL: J26, I12, C21

We study the spillover effect of retirement on spouse's subjective health for the Chinese elderly and how the spillover effect would change if the Chinese *statutory retirement age* (SRA) were to be adjusted at a small scale. China has entered a stage of accelerated population aging. "*Aging before getting rich*" and "*rapid population aging*" have become

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serious challenges to China's policymakers. According to the World Bank Open Data,[1] China's old-age dependency ratio (the ratio of older dependents–people older than 64– to the working-age population–those ages 15-64) exceeded the world average in 2014 and maintained a rapid upward trend. In 2019, the ratio in China reached 16.22%—1.38 times that in middle-income countries. In 2020, the population over 65 years old reached 190 million, which is about 13.5% of the entire China population. Based on a forecast made by the United Nations, in 2050, this ratio will increase to 26%.[2]

Aging brings significant pressures to China's welfare system, including pension payments and medical expenses for the elderly. For example, Wang et al. (2014) concluded that under the current pension regime, China's pension gap will exceed 7 trillion by 2050 under the current trend. Unsurprisingly, the reform of the retirement system has become one of the focal points of policy discussions in China (see Liu & Sun, 2016). For example, China is considering delaying the SRA for both genders to alleviate the pressure on the pension system, starting with gradually increasing the SRA based on the principles of small-step adjustments (see discussions in Ren et al., 2019). In this background, it is useful to study the effect of retirement comprehensively, not just on retirees themselves but also on their spouses; it is also policy-relevant to examine how these outcomes could change under small-step adjustments.

With the motivation mentioned above, our paper has a few notable features. First, adding to much existing research on retirement's effect on one's own health, we specifically focus on the spillover effect of retirement on spousal health. As pointed out by Manski (1993), Kulik (1999), and Duflo & Saez (2003), and among many others, there are strong social interactions within households with respect to retirement decisions. Therefore, the intra-household externality of retirement ought not to be overlooked. Second, we document the gender asymmetry of the spillover effect and reflect on the possible mechanisms. This result

[1]World Bank Open Data: https://data.worldbank.org/indicator/SP.POP.DPND.OL?end=2019&locations=1W-CN-XP&start=1981&view=chart

[2]United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019, Online Edition. https://population.un.org/wpp/Download/Standard/Population.

connects to China's recent policy discussion of shortening the current gap between both genders' SRA (currently ten years and much longer than the OECD and major developing countries). Understanding the asymmetric effect and its mechanism is rather useful. These results are also novel in the empirical context of China. Third, we estimate the policy impact of small adjustments of SAR on both own and spillover health effects. To the best of our knowledge, our paper is the first to study the threshold effect of SRA empirically. Finally, we focus on the subjective health (or self-reported health) of the elderly as the main outcome variable of interest. Unlike many "objective" measures of health that are often disease-specific, subjective health provides a more comprehensive assessment of an individual's health status, not just from a physical standpoint but also on a mental standpoint. It is one of the popular variables for measuring overall health status, and hence our study complements those using objective health measures.

Identification and estimation of the causal effect of retirement on spousal health are challenging with observational data. There are likely unobserved factors that correlate with retirement decisions and spousal health. Reverse causality of ambiguous directions can also be possible. For instance, when the spouse has an adverse health shock, one may decide to retire so he or she can have more time to take care of the spouse, but he or she may also decide to delay retirement to cover unexpected medical expenses. Moreover, the sign of the spillover effect can be either positive or negative: the answer depends on the social background of the study and can be different across households. On the one hand, a retiree has more time at home and can potentially take on more family responsibility, thereby positively affecting his or her spouse's health. On the other, retirement may negatively affect the retiree's psychological emotions or physical condition,[3] which in turn harms both the mental and physical health of the spouse.

[3]The empirical research on the own effect of China's retirement indeed consists of mixed findings. For example, Lei & Liu (2018) estimated the impacts of retirement and found that retirement has a significantly positive effect on the cognitive competence of the male but an adverse effect on the female. Che & Li (2018) concluded a positive impact of retirement on health and behaviour, but Lei, Smith, et al. (2014), and Feng et al. (2020) found a negative impact of retirement on the health of the male.

In this work, we take advantage of the SRA policy in urban China to handle the difficulties. The SRA policy provides guidelines for the retirement of urban residents (50 for women and 60 for men) and thus creates discontinuities in men's and women's retirement rates at their respective SRAs. Such discontinuities provide the source to identify the local average treatment effect retirement near the cutoff in the fuzzy regression discontinuity (FRD) design framework. Using the survey data of 1% Chinese population in 2005 (also known as "the mini census"), we find an asymmetric spillover effect between the retirement of husbands and wives. The retirement of women increases the probability of husbands "self–reporting healthy" by about 8.8% in the baseline model (numbers slightly different under different model specifications) for compliers near the cutoff.[4] The results are statistically significant across different robustness checks. The retirement of men, on the contrary, decreases the "self-reporting healthy" probability of their wives by about 9.9% for compliers near the cutoff, though the effect is significant for some of the specifications and not for others.

We also find that the spillover effect is heterogeneous for households with different characteristics. First, women's retirement has a significant positive impact on the subjective health of their husbands who are still working. However, we note that the impact is mild and not statistically significant if the husbands have already retired. Men's retirement has a significant negative impact on the health of retired wives, while the impact is not significant if the wives have not yet retired. Second, there is also heterogeneity regarding educational background. The retirement of women with a lower education level (middle school or below) has a significantly positive impact on the health of their husbands. However, there is no significant effect for women with a higher education level (high school or above). On the contrary, the retirement of men with a lower level of education has a significantly negative impact on the health of their wives. However, such an effect is insignificant when retired men have a higher level of education.

[4] If the treatment effect is homogeneous near the cutoff, then this also represents an estimate of the average treatment effect at the cutoff.

Using an additional data source from the China Health and Retirement Longitudinal Study, we investigate the mechanism of the spillover effect, which provides explanations for the gender-asymmetry. Specifically, we considered two possible channels: (un) healthy behaviours (including drinking, smoking, socializing, and sports) and emotions (including whether satisfied with life, feelings of loneliness and depression). We learn men's retirement increases their unhealthy behaviours. For example, while there is no significant effect on the tendency to smoke (extensive margin), retirement increases cigarette consumption by 14 per day for men who have already smoked (intensive margin). Retirement also increases drinking tendency by 27% for men. Drinking and smoking have a negative externality to the health of wives. We do not discover any significant changes in women's smoking and drinking habits. Retirement increases women's frequency of attending social events by about 28% (significant at the 10% level), whereas there are no significant changes for men. The retirement effect for sports participation probability is positive for women and negative for men, despite not being statistically significant at a 10% level. These findings suggest retired men increase their unhealthy behaviours and reduce healthy behaviours, which can cause negative externalities to wives' subjective health.

Our results also show that retirement intensifies husbands' negative psychological emotions. For example, retirement makes men 17.7% less likely to be satisfied with their lives, whereas women are significantly less likely to feel depressed (by 47%). Retirement disrupts one's routine life, and it often makes the individual experience greater stress; thus, the psychological emotions are very likely to change (Pearlin et al., 1981; Burke, 1991). These emotions have strong externalities, especially to people who live together. Overall, husbands have more difficulties in the retirement transition, leading to emotions that are detrimental to their overall well-being with negative spillover effects. The wives, however, tend to enjoy more about their retirement lives (28.2% more likely to participate in social events), creating a positive spillover to their husbands. These findings are consistent with the cultural background of China, where men play dominant roles in households and take primary economic responsibility. Hence, retired husbands often face greater pressures on decreasing

income and loss of social status, which in turn leads to more devastating consequences like a negative state of mind and unhealthy habits and behaviours.

We discuss how a slight change in SRA would affect the magnitude of both own and spillover health effects. Using the framework of Dong & Lewbel (2015), we estimate the marginal threshold treatment effect (MTTE) under the local policy invariance assumption. This assumption allows the treatment effect to be a flexible function of the running variable (relative age) and only requires the functional form to be invariant to a cutoff perturbation within the small neighbourhood of the original cutoff. In the own health category, we find that the MTTE for men's retirement is insignificant but negative for women: delaying women's SRA by one quarter would decrease women's own health effect from 5.17% to 3.65% in the baseline model. In the spousal health category, we note the MTTE for men's retirement is positive and significant. For example, delaying husbands' retirement for one quarter would reduce the negative impact of their retirement on wives' health by 2.05 percentage points. The MTTE for women's spillover effect is not significant, and the magnitude is close to zero; these findings are consistent with our discussions on the mechanism. Delaying the retirement age for men provides extra time to prepare for their retirement lives mentally, thereby reducing their negative spillover effect. Because women can transition into retirement lives better, marginally changing their SRA creates no effect on women's spillover effect.

Our research contributes to the bulk of literature which studies the effects of retirement on health (and other outcomes). Many previous studies focus on how retirement affects retirees themselves.[5] Recently, Müller & Shaikh (2018, MS2018 hereafter) estimate the causal effect of retirement on a variety of spousal health behaviours and health status for 19 European

[5]An incomplete list includes papers which focus on the impacts of retirement on personal health (Coe & Zamarro, 2011; Behncke, 2012; Insler, 2014; Eibich, 2015; Che & Li, 2018; Hagen, 2018; Fitzpatrick & Moore, 2018; Feng et al., 2020), on psychological health (Heller-Sahlgren, 2017; Kolodziej & García-Gómez, 2019), on cognitive competence Mazzonna & Peracchi (2012); Lei & Liu (2018), and family income or consumption (Battistin et al., 2009; Li et al., 2015; Dong & Yang, 2017), and on the utilization of health equipment (Zhang et al., 2018). These researches conclude positive, negative, or insignificant effects on various health-related outcomes. See also the survey paper of Cawley & Ruhm (2011).

countries. Our paper adds to the research by analyzing the intra-family spillover effects in a similar direction to MS2018. Our paper, however, has notable differences and complements their results. First, MS2018 primarily focuses on the spousal effect, whereas we are more concerned with the asymmetry between husbands and wives.[6] Such a difference in the research goal is motivated by the difference in the empirical contexts. Unlike the European countries covered in MS2018, in China, the current gap between men's and women's SRA is quite large: the SRA for female workers is 50, and that for male workers is 60. One of the policy discussions is on shortening this gap; hence, it is useful to study the retirement effect by gender separately. We find that the mix-gender spillover effect is insignificant—so ignoring the gender asymmetry can be misleading in our empirical context (please see results in Table A.4). Second, given the average age gap between husbands and wives is about two years and the SRA gap is ten years, it is not common for a couple to make their retirement decision jointly at any given point in time or within a relatively short period. This enables us to separately estimate husbands' and wives' retirement effects without much concern about the couple making a collective decision.[7] Third, we provide further discussions on the possible channels' of the spillover effect under the cultural context of China, which is new in the literature.

Our paper is also related to the literature on "Retired Husband Syndrome" in social science. For example, Bertoni & Brunello (2017) finds a rather negative effect of husband retirement on wives' mental health in Japan.[8] In China's context, Lei et al. (2011) found a mild impact

[6]MS2018 briefly mentioned the effect by gender, but no formal results were presented in the paper. Please see Müller & Shaikh (2018, Section 5.4).

[7]Our results are therefore specific to males and females, respectively. As we demonstrate in Table 1, in our sample for studying the retirement effect of husbands on wives, both men and women tend to belong to an older cohort and have lower education than those in the sample for studying the wife's retirement effect. This can partly contribute to the asymmetry of the husband's and wives' retirement spillover effect. Unfortunately, with only one-year cross-sectional data, it is difficult to identify the magnitude of it. Examining the dynamics of the spillover effect would be an exciting research topic when richer data is available.

[8]There are other researches which study the effect of retirement on varies of spousal outcomes (e.g. Szinovacz & Davey (2004), and Smith & Moen (2004)), where ordinary least square (OLS) estimation is used to estimate the spillover effect. As we discussed earlier, the OLS estimator is likely to be biased. Table A.3 shows that OLS estimators produce qualitatively and quantitatively different results from the FRD estimates in our case.

of husbands' retirements on wives' self-reported health. Our paper complements Lei et al. (2011) by studying both directions (and documenting that the positive spillover effect of retired wives is predominant in China) and doing so by examining possible mechanisms of gender asymmetry in detail.[9]

Our paper also contributes to the policy discussions in China regarding retirement system reform. It is among very few empirical research projects on the intra-household externalities of retirement for Chinese households, to the best of our knowledge. It is the first of its kind to study the threshold effect of small adjustments on SRA empirically. Our results show if we solely consider the own-health effect of retirement, delaying the SRA for both men and women would harm subjective health. However, if we take the spillover effect into account, then it becomes beneficial. Delaying the SRA of men provides them extra time to transit into a new lifestyle, thereby reducing a potential negative spillover effect on wives. The negative spillover effect of husbands' retirement and lack of post-retirement socialization also implies that programs which provide retirees social opportunities or infrastructural investment in community-based exercise facilities can be beneficial for the direct effect on men's health as well as for reducing the negative spillover effect on their wives.

Institutional Background and Data

Historical Development of Retirement Policies

Since the People's Republic of China was founded, the retirement system in China has undergone three stages: establishment (1950-1958), adjustment (1958-1977), and reform (1978-). The "*Labor Insurance Regulations of the People's Republic of China*" ("*Regulations*" hereafter) promulgated in 1951 marked the starting point of the retirement system. The "*Regulations*" stipulated that the retirement age for male employees was 60 and that for female employees was 50. In 1953, the scope of the "*Regulations*" was extended to employees in private enterprises. In 1955, the State Council promulgated the "*Interim*

[9]Another difference is that we use the birth quarter to construct the running variable, whereas Lei et al. (2011) use birth year.

Measures for Retirement of State Functionaries," which changed the lump-sum payment to monthly retirement pensions with benefits calculated based on individual working years. At the same time, while keeping the original rules, it also raised the retirement age for female cadres to 55, which has been in use ever since. During the adjustment stage, China set up a unified retirement procedure for government institutions and other enterprise employees and subsequently supplemented the retirement system for military officers and organizations with collective ownership. Consequently, more people were included in the retirement system. During the reform period, China introduced the pension insurance system in 1986. In 1997, the State Council promulgated the "*Decision of Establishing Consolidated Corporation Employee Pension System*," which transformed the pension of employees in enterprises from the pension under the labour insurance system to the one under the social insurance system. The following policy *"Decision of State Council on the Reform of the Pension Insurance System for Workers of Government Institutions and Institutions"* in 2015 transformed the pension of public sector staff from the pension under the labour insurance system to the one under the social insurance system.

To date, the retirement system has covered the majority of urban residents. The current retirement age is 60 for males and 50 for female workers (55 for female cadres). In recent years, there have taken place weighty talks to delay the retirement age. One argument is that for over more than 70 years, the average life expectancy in China has increased from about 40 years around the founding of the People's Republic of China to 77.3 years in 2019, and that of urban residents has exceeded 80 years. With a substantial increase in average life expectancy and a significant improvement in the physical fitness of the elderly, still using the retirement policy, which was devised more than 70 years ago, would waste human resources and bring pressures of a profound deficit in pensions. Second, delaying the retirement age can also alleviate the labour shortage due to the gradually decreasing benefits of a larger population in China. Third, China's current SRA is significantly behind that of developed countries. For example, the SRA in the United States is 67 (for those born after 1960), the SRA in Germany is 66.5, and the SRA in Japan is 65. These countries are

considering policies on delayed retirement. Particularly Japan, currently confronted with a growing elderly population, its government announced the "*Rectification of Employment Safety for the Senior*" on April 1, 2021. It stipulated the maximum retirement age to be 70. Although the law is not compulsory currently, Japan is expected to delay the retirement age to 70 over time. With technological, educational, and economic development, China is expecting to catch up with the pace of developed countries. Indeed, according to the "*Outline of 14th Five-Year Plan of People's Republic of China and the Long-Term Goals in 2035*", China will gradually increase the SRA in the future based on the principles of small-step adjustment, flexible implementation, classified promotion, and overall planning. The small-step adjustment refers to gradual reforms that increase the SRA by a few months every year. The flexible implementation intends that one can still choose to retire early. The classified promotion indicates people with different group identities and genders will have different SRAs.

Lastly, we summarize a few main take-away from the above introduction of China's retirement policy. First, the statutory retirement policy is only implemented in urban areas. Second, the current SRA is relatively low, and early retirement exists. Third, China is aiming to increase the SRA in the near future, and the adjustment is in small steps and is possibly gender asymmetric. Again, these policy perspectives motivate our study on the retirement effect by genders and MTTE, which identifies the effect of small changes in the threshold.

Data

Data Source and Processing

This paper considers an individual-level data set from the 1% population survey in 2005 (also known as the mini census). This survey is part of another large-scale social survey conducted by the National Bureau of Statistics after the fifth national census in 2000. The survey takes approximately 1.3 billion people in the country as the overall population, with provinces, autonomous regions, and municipality sub-populations. It adopts a stratified, multi-stage, and cluster probability proportionate sampling method and collects data for

about 1% of the population. The 2005 census provides essential demographic information, including details on education, health, employment status, income, immigration status, and family characteristics. We can also identify the spousal relationship and the parent-child relationship to match the information about the husband, the wife, and their children.

The main data used in this research is a 20% random sample from the 2005 mini census. The advantage is that the large sample size facilitates the local estimation in the RD design. To study the spillover effects of retirement within the family, we match the information of couples and children in all families based on the family information in the mini census. We also make some restrictions on the sample; first, the sample is limited to urban families, which is defined by the registration status. This is because the mandated retirement policy does not apply to rural areas in China. Please see Giles et al. (2021) for a thorough discussion on differences in retirement between urban and rural residents. Workers in informal sectors are also excluded because most of them are migrated workers from rural areas. Second, because we wish to study the spillover effect of retirement on the spouse, we exclude the observations for which family information is not available (for example, singles). Third, for our main result, we focus on families in which wives are within five years of their SRA (50). Likewise, to study the effect of husbands' retirement on wives, we focus on families whose husbands are within five years of their SRA (60). For greater details of the data processing, please see the section "Details on Data Processing" in the Appendix.

In practice, there are other retirement peaks. For instance, men have a retirement peak at 55, and women have retirement peaks at 45 and 55 (see studies in Lei & Liu, 2018). In our paper, we do not perform analysis on the early retired population for the following reasons. The first is data limitation. The early retirement policy has strict requirements on the industry in which the individual is engaged. The industry category information in the 2005 census data is not rich enough for us to infer whether the individual is affected by the early retirement policy. Second, workers engaged in underground, high-altitude, high-temperature and other special industries have different physical health conditions when they retire than normal workers, and their spillover effects on spouses may be quite different

from those of individuals engaged in normal industries. It is not the main object of analysis in this paper. Third, we have removed the individuals who are temporarily unable to work due to loss of labor capacity, essentially removing part of the sample who are eligible for early retirement.

In China, female cadres retire at the age of 55. We are able to use the personal occupation information in the mini-census data to identify a female subsample of "heads of state organizations, party organizations, enterprises and institutions" and "professional and technical personnel", which we use to approximate cadres sample. The total number of observations is 2730, accounting for only 8.57% of the total female sample (31,858). Using this information, we conduct a couple of robustness checks by (1) estimating the model by excluding the female cadres and (2) including all the female cadres and using the pooling& normalizing strategy of Cattaneo, Titiunik, et al. (2016) to estimate the model. The results are qualitatively similar to our main results. Please see Tables A.1 and A.2, respectively, for more details.

Variables and Their Descriptive Statistics

We define the retiree as any person who has gone through the retirement formalities and does not search for new jobs. Those who have gone through the retirement formalities but are still engaged in other paid jobs are not considered retirees. To reduce measurement errors, we exclude individuals incapacitated for work during their lifetime. Table 1 presents summary statistics of characteristics variables of wives and husbands. Columns (1) and (2) report the statistics of the sample for studying husbands' retirement effect on wives. The sample contains households in which the husbands are within 20 quarters before and after their retirement cutoff age (i.e., husbands are between the ages of 55-64 years). The mean age of husbands in this sample is 58.54 years, and the mean age of wives is 55.41 years. Similarly, columns (3)-(4) report the descriptive statistics of the sample for studying wives' retirement effect on husbands. For these observations, wives are within 20 quarters from

their retirement cutoff age (i.e., between the ages of 45-54 years). In this sample, the mean age of husbands is 50.92 years, and the mean age of wives is 48.91 years.

Since the SRA for men is higher than for women, the retirement rates for men and women in the husband retirement sample (56.9% and 49.2%, respectively) are higher than those in the wife retirement sample (12.9% and 31.0%, respectively). This indicates observations in the husband retirement sample tend to belong to older cohorts. In the wife retirement sample, the retirement rate for women (31.0%) is much higher than for men (12.9%). This is because the average age of men in this sample is about 51 years old, which is still far from the SRA for men.

TABLE 1. Summary Statistics

	husbands retire		wives retire	
	(1)	(2)	(3)	(4)
Variable	Mean	Std	Mean	Std
Retired_h	0.569	0.495	0.129	0.335
Retire_w	0.492	0.500	0.310	0.463
Schooling years_h	10.047	3.372	10.659	3.048
Schooling years_w	8.108	3.706	9.756	3.258
Age_h	58.537	2.819	50.920	4.197
Age_w	55.405	4.267	48.913	2.704
Han Chinese_h	0.945	0.228	0.950	0.218
Han Chinese_w	0.946	0.226	0.950	0.218
Employment Insurance_h	0.215	0.411	0.407	0.491
Employment Insurance_w	0.079	0.270	0.245	0.430
Pension Insurance_h	0.719	0.449	0.682	0.467
Pension Insurance_w	0.506	0.500	0.617	0.486
Medical Insurance_h	0.727	0.440	0.672	0.470
Medical Insurance_w	0.541	0.498	0.596	0.491
Number of Children	2.186	1.114	1.484	0.776
In Good Health_h	0.901	0.299	0.945	0.228
In Good Health_w	0.897	0.303	0.950	0.218
Sample Size	21116		31858	

Note: (a) Columns (1) and (2) report the statistics of the sample for studying husbands' retirement effect on wives. (b) Columns (3) and (4) report the statistics of the sample for studying wives' retirement effect on husbands. (c) The h suffix indicates a husband characteristic variable in the household, and the w suffix indicates a wife characteristic variable

The key outcome variable is "In Good Health". It is a binary variable constructed from subjective health or self-reported health. The mini census in 2005 has a survey on health conditions, where respondents rate their health conditions by choosing one of four options based on their work and living status in the last month. The four options are denoted by integers from 1 to 4, with a smaller integer representing better health conditions.[10] We set "In Good Health" to 1 if the respondent reports that he or she is in good health; otherwise, it is 0. In the wife retirement sample, the physical conditions of both spouses are generally good: about 95% reported in good health, as shown in column (3) of Table 1. This is not entirely surprising because the average age of men in the sample is about 51 years old. On the contrary, only about 90% of men and women reported in good health in the husband retirement sample (column 1) because they are about eight years older.

We also have some additional control variables, such as spousal years of schooling, a binary indicator of belonging to the Han ethnic group, a binary indicator of having employment insurance, pension insurance, medical insurance, and finally, the number of children. The number of children has a notable difference between the two panels. The reason is that the sample in the first panel is much younger, and many of them have been affected by the one-child policy.

Finally, we conduct balance tests for predetermined variables at the cutoff point. According to the test results in Tables 2 and 3, all the characteristic variables of men and women appear to be continuous at the cutoff point of spouses' retirement, and the results are robust under different bandwidths.

[10] More specifically, "1" means that the respondent is in good health and is qualified for daily work and can take care of himself or herself, "2" means that the respondent is in average health but can take care of his/her daily life, "3" means that the respondent is in poor health and cannot take care of his or her daily life, and "4" means that it is difficult for the respondent to tell which of the above three choices is most suitable. Therefore, the question measures self-reported or self-assessed health status.

TABLE 2. Balance Test on Spousal Characteristics

	Wife Retirement Sample			
	Women's own characteristics		Husbands' Characteristics	
Bandwidth	10 quarters	20 quarters	10 quarters	20 quarters
Schooling years	-0.053	-0.042	-0.085	-0.049
	(0.242)	(0.222)	(0.165)	(0.130)
Age	0.004	0.001	0.307	0.175
	(0.003)	(0.002)	(0.252)	(0.238)
Han Chinese	0.005	0.003	-0.001	0.002
	(0.021)	(0.019)	(0.020)	(0.018)
Employment Insurance	-0.084*	-0.107***	-0.011	-0.015
	(0.030)	(0.032)	(0.053)	(0.016)
Pension Insurance	0.004	0.006	0.005	-0.004
	(0.057)	(0.058)	(0.045)	(0.043)
Medical Insurance	0.021	0.026	-0.008	-0.001
	(0.065)	(0.066)	(0.050)	(0.050)
Number of Kids	0.041	0.032	0.041	0.032
	(0.106)	(0.104)	(0.106)	(0.104)
Number of Observations	16,854	31,858	16,854	31,858

Note: (a) There is no significant "jump" in the characteristics of husbands before and after the retirement of their spouse and no significant "jump" in the characteristics of wives before and after the retirement of their spouse either. (b) The unemployment insurance participation rate exhibits a significant "jump" before and after one's own retirement. This is natural because, in China, one automatically disqualifies for unemployment insurance as soon as applying for retirement.
†p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

Empirical Analysis

Parameters and Identification

Our goal is to estimate the causal effect of retirement on spouses' health. The difficulty is that the causal effect can be both heterogeneous in an unobserved way and that the retirement decision is endogenous. The unobserved heterogeneity means that even by controlling observed covariates, the spillover effect can still differ from household to household. In the context of our research, endogeneity can arise from many sources, e.g. missing variables. There could be a third unobserved factor affecting both retirement decisions and health-related behaviours. For instance, in China, it is common for grandparents to share the

TABLE 3. Balance Test on Spousal Characteristics

	Husband Retirement Sample			
	Men's own characteristics		Wive' characteristics	
Bandwidth	10 quarters	20 quarters	10 quarters	20 quarters
Schooling years	-0.008	-0.061	-0.019	-0.079
	(0.272)	(0.235)	(0.370)	(0.338)
Age	0.003	0.001	0.322	0.085
	(0.004)	(0.002)	(0.336)	(0.314)
Han Chinese	0.019	0.010	0.018	0.006
	(0.018)	(0.018)	(0.019)	(0.018)
Employment Insurance	-0.078*	-0.084*	0.017	0.016
	(0.035)	(0.029)	(0.013)	(0.011)
Pension Insurance	0.011	0.002	0.020	0.011
	(0.039)	(0.039)	(0.068)	(0.070)
Medical Insurance	0.025	0.015	0.010	0.012
	(0.040)	(0.041)	(0.067)	(0.067)
Number of Kids	-0.004	0.021	-0.004	-0.021
	(0.135)	(0.131)	(0.136)	(0.131)
Number of Observations	9,889	21,116	9,889	21,116

Note: same as Table 2.
†p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

responsibility of babysitting. One of the grandparents may choose to retire early, and in the meantime, either of them may choose to reduce unhealthy behaviours such as smoking and excessive drinking. Ignoring the factor of babysitting grandchildren may overestimate the spillover effects on health. Another source is the reverse causality between retirement decisions and the spouse's health. For instance, one may decide to retire early because the spouse is in poor health. In this case, a naive comparison can result in an estimate biased downward.

Before formally defining our parameter of interest and laying out our empirical strategy, we introduce some notation. Here, we consider the generic framework of Hahn et al. (2001). Let $R \in \mathcal{R}$ denote the age of an individual normalized with respect to his or her SRA (the actual age minus the SRA), and let C be the cutoff (hence $C = 0$ in the observed data). $D \in \{0,1\}$ be the observed retirement status ($D = 1$ is retired), Y be the observed spousal

health status, and X be the set of control variables. For generic values of $d \in \{0,1\}$, $r \in \mathcal{R}$, and $c \in \mathcal{R}$, let Y_d be the potential (or counterfactual) health status of an individual had his or her spouse retirement status been externally set to $d = 1$ or $d = 0$, respectively, giving everything else equal. Here, the individual causal effect of retirement on spousal health status is measured by $\Delta = Y_1 - Y_0$. Likewise, we define $D(r)$ as the potential treatment when the normalized age is set to be r. Again, the difficulties of identifying any causal parameters lie in the fact that (Y_1, Y_0) can be correlated with D, even conditioning on observed covariates X, and that Δ is a random variable instead of a constant.

In a fuzzy regression discontinuity design, not every individual retires once they reach the cutoff. To formally define the parameter of interest, we define the compliance status T of an individual whose R in a small neighbourhood $B_\epsilon = \{r : |r| \leq \epsilon\}$ near the normalized cutoff point $C = 0$ as follows:

$$T = \begin{cases} \textbf{A}, & \text{if } D(r) = 1, \text{ for } r \in B_\epsilon, \\ \textbf{N}, & \text{if } D(r) = 0, \text{ for } r \in B_\epsilon, \\ \textbf{Comp}, & \text{if } D(r) = 1\{r \geq 0\}, \text{ for } r \in B_\epsilon, \\ \textbf{DF}, & \text{otherwise} \end{cases} \tag{1}$$

where **A, Comp, N** and **DF** represent "always takers", "compliers", "never takers", and "defiers", respectively. This is analogous to the types of individuals used in Imbens & Angrist (1994) for binary treatment and binary instrument setup. For example, the "always takers" are the type of people who would choose to retire as long as their ages become close to the SRA ($r \in B_\epsilon$), and the "never takers" are those who would choose not to retire regardless of the age. The "compliers" are those who would strictly follow the government retirement guideline. As shown later in Table 4, the estimated portion of compliers is about 17% for women and 16% for men (based on 12 quarters bandwidth).[11]

[11] Although without additional information, it is not possible to exactly identify who are compliers in the LATE framework, some studies suggest that retirement compliers are more likely to have higher education and lower health condition than the averages of their peers (see discussions in Section 4.1 of Müller & Shaikh, 2018). We conjecture it is also the case for our data: higher-educated individuals tend to be more obedient, and people

Following Dong & Lewbel (2015), we define $\delta(r,c)$ as the average spillover effect (to spouses) for compliers whose normalized age is r and the policy cutoff is c:

$$\delta(r,c) = E[\Delta | R = r, C = c, T = \textbf{Comp}].$$

Note that this definition allows the treatment effect to be dependent on the values of running variable r and cutoff. Let δ_{FRD} be the $\delta(r,c)$ evaluated at $r = 0$ and $c = 0$, that is, $\delta_{FRD} = \delta(0,0)$.[12] δ_{FRD} thus measures the treatment effect of compliers at the cutoff and when the cutoff is zero. We make the following two assumptions:

Assumption 1 (Local monotonicity)**.** $\lim_{r\downarrow 0} P(T = \textbf{DF} | R = r) = 0$ *and* $\lim_{r\downarrow 0} P(T = \textbf{DF} | R = -r) = 0$.

Assumption 2 (Local continuity)**.** *For* $d = 0,1$, $t \in \{\textbf{A}, \textbf{C}, \textbf{N}\}$ *and* $y \in \{0,1\}$, *we have*

$$\lim_{r\downarrow 0} P(Y_d = y, T = t | R = r) = \lim_{r\downarrow 0} P(Y_d = y, T = t | R = -r).$$

Assumption 1 assumes there are no defiers in the population. It excludes individuals who would choose to retire if their ages were below the SRA but work if their ages were above the SRA (everything else remains the same). We are not aware of any policy or market incentives to induce such behaviours in our empirical context. Assumption 2 assumes the joint distribution of subjective health status and complying status is the same for individuals whose spouses locate near the spouses' SRA age. This assumption appears to be reasonable. We would expect the potential health (the counterfactual health status without intervention) to change continuously with age.[13]

with relatively weaker health conditions (but not bad enough for early retirement) have less incentive to work beyond their retirement age.

[12] Here we implicitly assume $\delta(r,c)$ is well defined for any value of r and c.

[13] In general, the distributional local continuity assumption is stronger than what one needs to identify the mean effect, but given Y is binary, it is not over-restrictive.

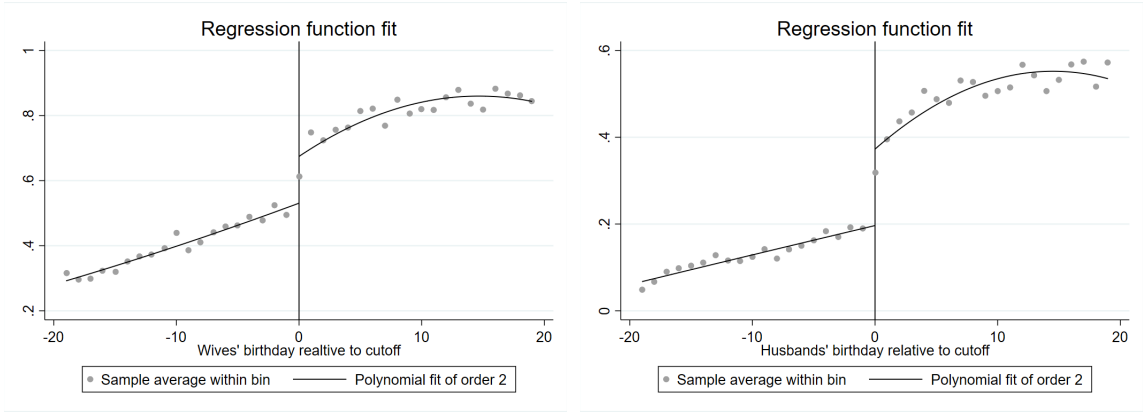
Under the Assumptions 1 and 2, δ_{FRD} is identified by the FRD estimand (see Imbens & Lemieux, 2008):

$$\delta_{FRD} = \frac{g_Y^+ - g_Y^-}{g_D^+ - g_D^-}, \tag{2}$$

where $g_Y(r) = \mathbb{E}[Y|R = r]$, $g_Y^+ = \lim_{r \downarrow 0} g_Y(r)$, $g_Y^- = \lim_{r \uparrow 0} g_Y(r)$, and the two terms in the denominator g_D^+ and g_D^- are defined analogously with Y being replaced by D.

First Stage Regression

In this subsection, we provide preliminary results of the first stage FRD regression. Figures 1a and 1b plot the propensity of husbands' and wives' retirement as a function of their normalized age (relative to 60 and 50 years old, respectively). Since the mini census in 2005 includes the year and month of the individual's birth, we use this information to construct the quarterly age variable. For example, an individual with a horizontal axis value 20 is five years old than his or her SRA. Measuring the age by quarter can mitigate the issue of discrete running variables better than measuring it by year. In Figures 4a and 4b, we plot This figure plots the differences in retirement status ratio between two consecutive age groups for males and females, respectively, from where we also observe a peak for males around 60 and females around 50.



(A) Husband Retirement Rate (B) Wife Retirement Rate

FIGURE 1. First Stage

In these two figures, the curves are second-order polynomial fits. As we can see from both figures, the retirement rate increases as age increases and has clear jumps at the normalized cutoff for both husbands and wives. In addition, we find that a considerable number of people choose to retire before reaching the SRAs, while many other people choose not to retire even though they are above the SRAs. Table 4 presents estimates of the jumps in Figures 1a and 1b. It is evident that the jump size differs from zero, and this result is robust under various bandwidth choices.

TABLE 4. First Stage Estimates

Dependent Variable: Wife's Retirement				
Bandwidth	4 quarters	8 quarters	12 quarters	20 quarters
Estimates	0.137***	0.152***	0.172***	0.205***
Std	(0.021)	(0.016)	(0.016)	(0.018)
Sample Size	5921	13277	20079	31858

Dependent Variable: Husband's Retirement				
Bandwidth	4 quarters	8 quarters	12 quarters	20 quarters
Estimates	0.141***	0.146***	0.158***	0.178***
Std	(0.039)	(0.025)	(0.021)	(0.016)
Sample Size	3589	7724	11818	21116

Notes:†p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

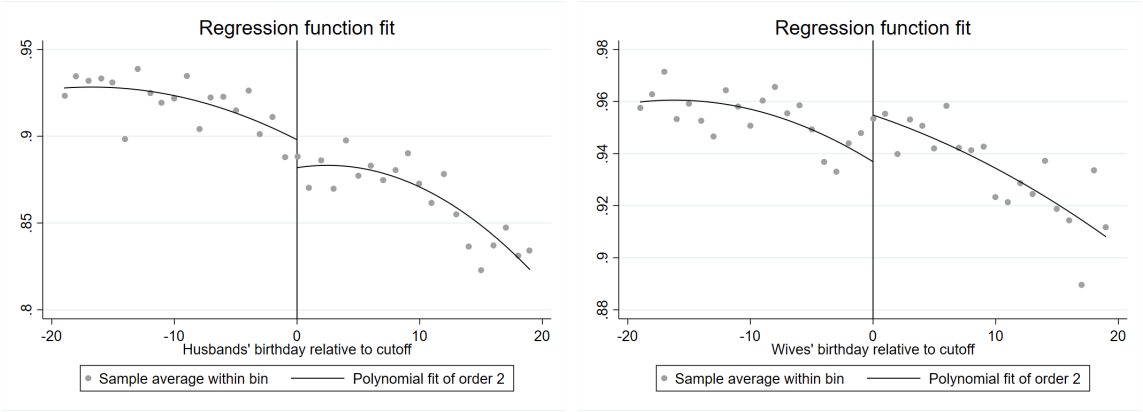
Main Results

In this section, we present our main results on estimating the parameter δ_{FRD}. For our baseline setup, we employ the local linear regressions to non-parametrically estimate each of the conditional expectations in Equation (2). Specifically, δ_{FRD} is estimated by the following formula:

$$\hat{\delta}_{FRD} = \frac{\hat{g}_Y^+(b) - \hat{g}_Y^-(b)}{\hat{g}_D^+(b) - \hat{g}_D^-(b)}, \tag{3}$$

where $\hat{g}_Y^+(b)$ is the local linear estimator of g_Y^+ with a triangular kernel and bandwidth b. Throughout the paper, unless specifically mentioned, the bandwidth is chosen by the data-driven method suggested by Calonico et al. (2014, CCT hereafter). The other three terms

in Equation (3) are local linear estimators for the corresponding population counterparts. Figures 2a and 2b provide an illustration of the numerator.



(A) Wives Self-Reported Health (B) Husbands Self-Reported Health

FIGURE 2. Age and Spousal Self-reported Health

For the main regression, the CCT bandwidth is 11 quarters for both wives and husbands. Table 5 reports the impact of wives or husbands on the health of spouses under this optimal bandwidth. The standard error is clustered at the provincial level (same for all subsequent empirical results). Column (1) shows the effect of wives' retirement on the husbands' health without any control variables. We discover that wives' retirement has a significantly positive impact on the husband's health. Wives' retirement, given everything else equal, will increase the probability of husbands being in good health by 8.8 percentage points, which is significant at the 5% significance level. In column (2), we list the FRD estimate with all control variables listed from Table 1.[14] It can be seen the FRD estimate varies only slightly after the control variables are added. Wives' retirement increases the probability of her husband's good health by 9.8 percentage points, which is significant at a 5% significance level.

Columns (3) and (4) present the effect of husbands' retirement on their wives' health conditions. As shown in column (3), the impact of husbands' retirement on their wives'

[14]For incorporating the covariates, please see Calonico et al. (2017) for details.

TABLE 5. Effect of Retirement on Spousal Health

	Wives' Retirement Effect		Husbands' Retirement Effect	
	(1)	(2)	(3)	(4)
Bandwidth	11	11	11	11
Estimates	0.088*	0.098**	-0.099†	-0.093
Std	(0.035)	(0.035)	(0.058)	(0.058)
Provincial Dummy	Yes	Yes	Yes	Yes
Characteristics	No	Yes	No	Yes
Sample Size	18423	18423	10803	10803

Notes: †p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

health is opposite in sign to the impact of wives' retirement on the husbands' health. Husbands' retirement reduces the probability of the wives being in good health by 9.9 percentage points, which is significant at a 10% significance level. However, column (4) shows that the husbands' retirement effect on the wives' health is no longer significant after the control variables are added. In addition, since the legal retirement age for the group of women with cadre status is 55, this paper conducts further robustness checks for this group in Table A.1 and Table A.2.

As a comparison, Table A.3 in the appendix presents OLS estimates. We can see clearly that OLS estimates contrast the FRD estimates significantly. Wives' retirement spillover effect becomes either negative (without control) or insignificant (without control). Husbands' spillover effect, while it remains negative (without control), its magnitude shrinks by more than two times. Overall, the OLS estimates bias the two effects toward zero. Table A.4 reports the pooled OLS and FRD estimate, where we do not separately estimate husbands' and wives' retirement effects. The pooled FRD estimate suggests an overall positive effect. We can still see the bias caused by ignoring the endogeneity of retirement for pooled OLS regression: the OLS estimates are all negative.

Robustness

We perform various robustness checks. First, in addition to the CCT bandwidth, we consider other choices of bandwidths. Table 6 reports the estimates under bandwidth selection of 8 quarters, 12 quarters, and 20 quarters, respectively. We find that under all bandwidth choices, the wives' retirement significantly improves the husbands' health. Under most settings, the male's retirement reduces the health status of their wife. The results are consistent with the main regression results in Table 5 and reinforce the gender heterogeneity of the retirement spillover effects in families.

TABLE 6. Effect of Retirement on Spousal Health: Robustness

	Wives' Retirement Effect					
	(1)	(2)	(3)	(4)	(5)	(6)
Bandwidth	8 quarters	8 quarters	12 quarters	12 quarters	20 quarters	20 quarters
Estimates	0.065†	0.081*	0.088**	0.097**	0.069***	0.074***
Std	(0.039)	(0.040)	(0.034)	(0.034)	(0.022)	(0.022)
Provincial Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Hus'ds Characteristics	No	Yes	No	Yes	No	Yes
Sample Size	13277	13277	20079	20079	31858	31858
	Husbands' Retirement Effect					
	(1)	(2)	(3)	(4)	(5)	(6)
Bandwidth	8 quarters	8 quarters	12 quarters	12 quarters	20 quarters	20 quarters
Estimates	-0.045	-0.032	-0.103*	-0.098†	-0.087**	-0.089**
Std	(0.073)	(0.073)	(0.052)	(0.052)	(0.033)	(0.032)
Provincial Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Wives' Characteristics	No	Yes	No	Yes	No	Yes
Sample Size	7724	7724	11818	11818	21116	21116

†p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

Second, we change the triangular kernel density function to a uniform kernel density function for RD estimation, and the results are listed in Table 7. Again, we find that the female's retirement positively impacts the husbands' health, while the male's retirement

negatively affects the wife's health. This result is still consistent in direction with the result based on the triangular kernel function.

TABLE 7. Effect of Retirement on Spousal Health: Uniform Kernel

	Wives' Retirement Effect		Husbands' Retirement Effect	
	(1)	(2)	(3)	(4)
Bandwidth	11 quarters	11 quarters	11 quarters	11 quarters
Estimates	0.089*	0.095**	-0.107*	-0.105*
Std	(0.036)	(0.035)	(0.043)	(0.043)
Provincial Dummy	Yes	Yes	Yes	Yes
Spousal Characteristics	No	Yes	No	Yes
Sample Size	20079	20079	11818	11818

Notes: †p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

Third, we also perform robustness checks with parametric FRD estimation. Gelman & Imbens (2019) show that the order of polynomials should not be too large for parametric RD estimation. Following this recommendation, we conduct the parametric analysis based on linear and quadratic polynomials. Specifically, following the common practice of the RD regression (see Angrist & Lavy, 1999), we apply 2SLS of the following form:

$$D_i = \delta_0 + \delta_1 1\{R_i \geq 0\} + \delta_2 R_i^2 + h(X_i) + \xi_i, \tag{4}$$

$$Y_i = \beta_0 + \beta_1 D_i + \beta_2 D_i R_i + \beta_3 R_i^2 + \beta_4 D_i R_i^2 + f(X_i) + \varepsilon_i. \tag{5}$$

where the first stage Equation (4) reflects the impact of whether to reach the SRA on the probability of retirement. By replacing D_i by its predicted value, the structural Equation (5) estimation provides the estimates of the retirement's causal effects on the spouse's health Y_i, which is the parameter β_1. f and h contain control variables. Results under the CCT bandwidth are shown in Table 8. The parametric RD estimation results again show that the wives' retirement positively impacts the husbands' health. In contrast, the husbands' retirement has a significant negative impact on health: qualitatively consistent with the main regression results.

TABLE 8. Effect of Retirement on Spousal Health: Parametric

Wives' Retirement Effect

	(1)	(2)	(3)	(4)
Bandwidth	11 quarters	11 quarters	11 quarters	11 quarters
β_1 estimates	0.086*	0.092*	0.055*	0.059*
Std	(0.039)	(0.039)	(0.026)	(0.026)
$\delta_2 = \beta_3 = \beta_4 = 0$	Yes	Yes	No	No
Provincial Dummy	Yes	Yes	Yes	Yes
Hus'ds Characteristics	No	Yes	No	Yes
Sample Size	18423	18423	18423	18423

Husbands' Retirement Effect

	(1)	(2)	(3)	(4)
Bandwidth	11 quarters	11 quarters	11 quarters	11 quarters
β_1 estimates	-0.142*	-0.141*	-0.075*	-0.074*
Std	(0.068)	(0.069)	(0.035)	(0.035)
$\delta_2 = \beta_3 = \beta_4 = 0$	Yes	Yes	No	No
Provincial Dummy	Yes	Yes	Yes	Yes
Wives' Characteristics	No	Yes	No	Yes
Sample Size	10803	10803	10803	10803

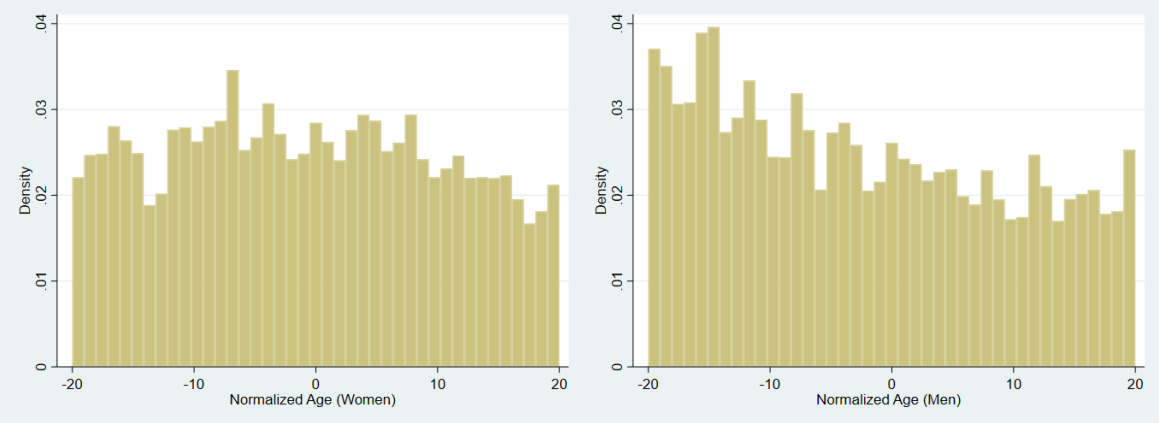
Notes: †p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

We also estimate the model by including the characteristics of both spouses. The results are reported in Table A.5. We can still observe a negative effect of husbands' retirement on wives, although the effect is not statistically significant. In the meantime, there is still a significant positive effect of the wives' retirement on their husbands. Finally, we estimate the model by clustering at the prefecture level and report the results in Table A.6. Again, all the conclusions are qualitatively similar to the main results in Table 5.

FRD Validity

In this paper, the running variable is the normalized age calculated based on the date of birth and SRA. Because China implements a strict household registration system (Hukou), it is challenging to lie about the date of birth. While the FRD validity for identifying the LATE parameters appears justifiable in our empirical context, it is desirable to test it formally.

In a seminal paper, Lee (2008) shows that under a set of assumptions, the FRD validity implies the continuity of the running variable density at the cutoff. Figures 3a and 3b plot the histogram of women and men's normalized age, where we do not observe a clear discontinuity at the cutoff. In this paper, we assess this implication using the methods of Cattaneo, Jansson, & Ma (2016); Cattaneo et al. (2018). The t-statistic of the manipulation test is 1.49 for the wife's normalized age, and the t-statistic for the husband's normalized age is 1.37. Neither is significant at the 10% level.



(A) Women's Normalized Age (B) Men's Normalized Age

FIGURE 3. Running Variable Histogram

Next, we test the sharp testable implication of the identifying Assumptions 1 and 2 for the LATE type parameter δ_{FRD} using the method of Arai et al. (2022). They show that the sharp testable implication for the joint assumptions (of local monotonicity and local continuity) is given by the following set of inequalities (6) and (7).[15] For $y \in \{0,1\}$,

$$\lim_{r\uparrow 0} \mathbb{E}[1\{Y=y\}D|R=r] - \lim_{r\downarrow 0} \mathbb{E}[1\{Y=y\}D|R=r] \leq 0, \tag{6}$$

$$\lim_{r\downarrow 0} \mathbb{E}[1\{Y=y\}(1-D)|R=r] - \lim_{r\uparrow 0} \mathbb{E}[1\{Y=y\}(1-D)|R=r] \leq 0. \tag{7}$$

[15]Please see Arai et al. (2022) for the relationship between the testable implication (6)-(7) and the running variable density test. Indeed, they recommend empirical researchers to implement both tests.

The testing results for inequalities (6) and (7) are summarized in the Table 9.[16] Under a wide range of bandwidths, the test returns large p-values across the board, showing no evidences against the null hypothesis of the joint assumption of local monotonicity and local continuity.

TABLE 9. P-Values for Testing the Joint Assumptions 1 and 2

Bandwidth	Wives' Retirement Effect	Husbands' Retirement Effect
8	0.968	0.988
11	0.971	0.990
12	0.976	0.994
16	0.995	0.998
20	0.976	1.000

To summarize, neither the density test nor the LATE-identifying assumption test provides any statistical evidence against the validity of using the FRD design in this empirical context.

Placebo Test

To further prove the reliability of our estimation results, we conduct different falsification tests. First, like Godard (2016), we generate fictitious retirement ages and then estimate the effect of retirement on the spouse's health based on these fictitious retirement ages. We find no significant effect of fictitious retirement on the spouse's health (see Table 10).

The second placebo test uses the data from rural households to estimate the effects of retirement on health. As mentioned earlier, there is no "official retirement" for rural residents in China, so we should expect no spillover effect of "retirement" on spousal health. In this case, "retirement" is defined as being older than 50 and 60 for women and men, respectively. Table 11 presents the results under CCT bandwidth. As expected, we did not find any significant retirement effect on spouses' health for both men and women.

Since there are many rural workers in the city (i.e., the migrant worker group) who are mainly engaged in informal employment and are largely unaffected by retirement policies,

[16] In the notation of Arai et al. (2022), we set $\xi = 0.01$ and the number of bootstrap sample 1000. We tried other tuning parameter values, and the results are consistent.

TABLE 10. Placebo Test: Fictitious SRA

	Wives' Retirement Effect		Husbands' Retirement Effect	
Fictitious SRA	49	51	59	61
Bandwidth	7 quarters	5 quarters	9 quarters	6 quarters
First Stage	-0.015	-0.018	-0.008	-0.025
	(0.013)	(0.020)	(0.021)	(0.022)
Second Stage	0.944	0.060	-0.483	-0.772
	(0.931)	(0.407)	(1.821)	(0.821)
Sample Size	11524	7951	9504	5356

Notes: †p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

we conduct Placebo tests separately for this group of informally employed workers. The estimation results in Table A.7 show that informal employment does not indeed have a jump in retirement at the retirement threshold, again confirming the robustness of the main regression results.

TABLE 11. Placebo Test: Rural Residents

	Wives' Retirement Effect in Rural Area		Husbands' Retirement Effect in Rural Area	
Bandwidth	8 quarters	8 quarters	11 quarters	11 quarters
First Stage	0.0011	0.0010	0.003	0.003
	(0.0007)	(0.0008)	(0.004)	(0.004)
Second Stage	0.378	3.946	-2.079	-1.778
	(4.814)	(6.367)	(3.556)	(3.385)
Controls	No	Yes	No	Yes
Sample Size	31488	31488	20809	20809

Notes: †p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

We also perform a third placebo test, which estimates the retirement effect on the first child's health who lives with the family. Because the parents and child do not live in the same room, and typically there is less interaction between parents and child than between husband and wife, we expect that the retirement would have less spillover effect on the child's health than the spouse's. Table 12 reports the retirement effect on kids' health. It shows that neither mothers' nor fathers' retirement effects on kids' health are significant.

TABLE 12. Effect of Retirement on First Child Health

Dep: Child in Good Health		
	Mothers' Retirement Effect	Fathers' Retirement Effect
Bandwidth	12 quarters	11 quarters
Estimates	0.043	0.061
	(0.070)	(0.127)
Provincial Dummy	Yes	Yes
Baseline Controls	No	No
Sample Size	20079	10803

Notes: †p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

Heterogeneous Spillover Effects

Our main regression does not take the spouse's retirement status into account when we estimate the retirement effect on the spouse's health. Table 13 shows the retirement effect varies with spousal retirement statuses. The results indicate that if the husband has already retired, the wife's retirement effect on his health is insignificant.[17] However, if the husband is still working, the wife's retirement effect on his health is significantly positive. So women's retirement is mainly good for the health of unretired husbands. The possible reason is that women can better take care of the family and still place great care on the husband's well-being after their retirement, which makes the husband more comfortable at work and improves his overall health.

The husband's retirement effects on the wives' health are also obviously different as the wives' retirement status varies. If a wife has retired, her husband's retirement has a significantly negative impact on her health; on the other hand, if she has not retired, her husband's retirement has no significant impact on her health. The possible reason is that some husbands increase unhealthy behaviours with negative spillover effects (such as smoking) after they retire. If the wives have already retired, their health is adversely affected by these behaviours. If the wives are still working, the couple spends less time together, and

[17]The large p-value can possibly be due to the small sample size since most of their husbands have not yet retired when women retire.

TABLE 13. Heterogeneous Retirement Effect: Retired vs. Not Retried

Wives' Retirement Effect

Husbands' Status	Retired		Not Retired	
Bandwidth	13 quarters	13 quarters	11 quarters	11 quarters
Estimates	0.123	0.111	0.102**	0.108***
	(0.210)	(0.186)	(0.034)	(0.033)
Provincial Dummy	Yes	Yes	Yes	Yes
Hus'ds Characteristics	No	Yes	No	Yes
Sample Size	2532	2532	16365	16365

Husbands' Retirement Effect

Wives' Status	Retired		Not Retired	
Bandwidth	14 quarters	14 quarters	11 quarters	11 quarters
Estimates	-0.096*	-0.093*	-0.134	-0.106
	(0.039)	(0.037)	(0.175)	(0.178)
Provincial Dummy	Yes	Yes	Yes	Yes
Wives' Characteristics	No	Yes	No	Yes
Sample Size	7087	7087	5418	5418

Notes: †p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

thus it is possible to avoid this negative impact. In the subsequent section, we will examine how men's and women's health and health-related behaviours change after retiring. We indeed discover that women tend to possess a more positive outlook and attitude, whereas men react negatively.

It is known that there is a notable disparity in economic development between the eastern coastal and the inland regions of China, and also notable cultural and climate differences between southern and northern regions. Therefore, We estimate the model separately for the eastern coastal and inland regions and for southern and northern regions, respectively. The results are reported in Table 15. We can see that the positive spillover effect of wives' retirement on husbands' health is significant in the northern and inland regions, which are often considered more traditional parts of China. In contrast, the spillover effect of husbands' retirement on wives' health is not significant either by the north-south division or by the coastal-inland division.

TABLE 14. Heterogeneous Retirement Effect: Education Level

Wives' Retirement Effect

Wives' Edu. Level	Low		High	
Bandwidth	11 quarters	11 quarters	13 quarters	13 quarters
Estimates	0.155***	0.159***	-0.015	0.002
	(0.044)	(0.042)	(0.048)	(0.049)
Provincial Dummy	Yes	Yes	Yes	Yes
Hus'ds Characteristics	No	Yes	No	Yes
Sample Size	10899	10899	8796	8796

Husbands' Retirement Effect

Husbands' Edu. Level	Low		High	
Bandwidth	13 quarters	13 quarters	12 quarters	12 quarters
Estimates	-0.202*	-0.210*	-0.028	-0.028
	(0.094)	(0.101)	(0.061)	(0.060)
Provincial Dummy	Yes	Yes	Yes	Yes
Hus'ds Characteristics	No	Yes	No	Yes
Sample Size	7651	7651	4894	4894

Notes: "High": high school and above; "Low": middle school and below.
†p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

Many studies have documented the impact of education on healthy behaviours and have found a close relationship between education and health (see for example Lleras-Muney, 2005; Oreopoulos, 2006). We also examine the heterogeneous effects of individuals with different educational backgrounds on their spouses' health after retirement. Women with a lower education level (middle school and below) are more likely to affect their husbands' health after their retirement in a positive manner. In contrast, women with higher education levels (high school and above) have no significant impact. A possible reason is traditionally, men oftentimes take on the dominant role in the family. Wives, particularly those who stem from lower education levels, typically play the caregiver role. Hence, husbands benefit more from lower-educated wives when wives become retire. Conversely, the retirement of men with a lower level of education has a negative impact on wives' health. In comparison, the retirement of men with a higher level of education reveals no significant impact. One

TABLE 15. Heterogeneous Retirement Effect: Region Level

	Wives's retirement effect			
Bandwidth	11 quarters	11 quarters	11 quarters	11 quarters
	North	South	Costal area	Inland area
Estimates	0.123*	0.062	0.051	0.148*
Std	(0.054)	(0.041)	(0.033)	(0.067)
Provincial Dummy	Yes	Yes	Yes	Yes
Husbands' characters	Yes	Yes	Yes	Yes
Sample Size	11,840	6,583	7,314	11,109
	Husbands' retirement effect			
Bandwidth	11 quarters	11 quarters	11 quarters	11 quarters
	North	South	Costal area	Inland area
Estimates	-0.089	-0.099	-0.059	-0.153
Std	(0.078)	(0.088)	(0.048)	(0.113)
Provincial Dummy	Yes	Yes	Yes	Yes
Wives' characters	Yes	Yes	Yes	Yes
Sample Size	6,616	4,187	4,239	6,564

Notes: †p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

explanation is that retirement brings negative emotions. However, men with higher education can control such emotions and deal with the transition of retirement better, resulting in less negative impact on wives' health. Please see more detailed discussions in the next section.

Delaying SRA

In this section, we discuss how a slight change in SRA would affect the magnitude of the spillover effect. We consider the framework of Dong & Lewbel (2015). Let δ_{TED} and δ_{MTTE} denote the "treatment effect derivative" (TED) and "marginal threshold treatment effect" (MTTE) at $(r=0, c=0)$, respectively, as following:

$$\delta_{TED} = \frac{\partial \delta(r,c)}{\partial r}|_{r=0,c=0}, \quad \delta_{MTTE} = \frac{\partial \delta(c,c)}{\partial c}|_{c=0} = \frac{\partial \delta(r,c)}{\partial r}|_{r=0,c=0} + \frac{\partial \delta(r,c)}{\partial c}|_{r=0,c=0}$$

Here δ_{TED} measures how the local average treatment effect (LATE) $\delta(r,c)$ would change in responding to an infinitesimal change in the age, given everything else being equal. It informs the heterogeneity of the LATE with respect to age within the local neighbourhood

of the factual cutoff zero. On the other hand, δ_{MTTE} provides information on how the LATE (as a function of r) would change near the original cutoff zero if we change the cutoff marginally. Dong & Lewbel (2015) show that δ_{TED} is nonparametrically identified by

$$\delta_{TED} = \frac{g_Y^{'+} - g_Y^{'-} - (g_D^{'+} - g_D^{'-})\delta_{FRD}}{g_D^{+} - g_D^{-}}, \tag{8}$$

where

$$g_Y^{'+} = \lim_{e \downarrow 0} \frac{g_Y(e) - g_Y(0)}{e}, \quad g_Y^{'-} = \lim_{e \uparrow 0} \frac{g_Y(e) - g_Y(0)}{e}.$$

Furthermore, if the following "local policy invariance" Assumption 3 is satisfied, δ_{MTTE} is also nonparametrically identified and it equals to δ_{TED}.

Assumption 3 (Local Policy Invariance)**.** $\frac{\partial \delta(r,c)}{\partial c}|_{r=0,c=0}$.

Assumption 3 does not restrict the shape of LATE as a function of r: it still allows the LATE to depend on age r, but requires that the effect of an infinitesimal change in the cutoff does not change how LATE is dependent on r. In our context, this assumption holds true because a marginal change in SRA (e.g. one or two quarters) is not likely to induce a significant change in people's lifestyles. To estimate δ_{TED} (or δ_{MTTE} under local policy invariance), we follow Dong & Lewbel (2015) and consider local linear regression to estimate corresponding quantities in Equation (8).

The final results are reported below in Tables 16 and 17, for own effect and spillover effect, respectively. Let us consider our own effect first. Table 16 illustrates that the own retirement effects are positive for women and negative for men, which are consistent with existing research such as Lei, Smith, et al. (2014). The MTTE (TED) is not significant for men but significantly negative for women. Hence, if we only consider the own-health effect, we would not recommend the government delay the SRA because, overall, it decreases the effect of retirement on own health.

Next, we consider the spillover effect Table 17. MTTE (TED) estimates show if we delay the SRA slightly, the negative spillover effect of husbands' retirement on wives will be reduced significantly. For example, suppose we were to delay the SRA of husbands by

two quarters. In that case, the husbands' retirement would reduce the probability of wives feeling healthy from 10.7% to $10.7\% - 1.97\% \times 2 = 6.8\%$ (without controls) or 6.7% with controls, respectively. On the other hand, there is no significant change in wives' spillover effect on husbands if wives' SRA were to be modified slightly.

The discussion suggests that if we ignore the spillover effect, we may make a misleading policy recommendation. If we weigh men and women equally and weigh their own effect and spillover effect equally, it appears that the gain from the increasing spillover effect dominates the loss from their own-effect. For instance, if we delay SRA by one quarter, then an average wife's own retirement effect will be reduced by 0.0152, but the spillover effect from her husband would increase by 0.0197. Then delaying the SRA may not be a wrong choice (at least for this outcome variable), given everything else is unchanged.

TABLE 16. Effect of Delaying SRA on Own Health

	Wives' Own Effect		Husbands' Own Effect	
Bandwidth	11 quarters	11 quarters	13 quarters	13 quarters
Treatment Effect	0.0517**	0.0792***	-0.123***	-0.118**
	(0.0193)	(0.0262)	(0.033)	(0.043)
MTTE(TED)	-0.0152***	-0.0208***	0.0023	0.0007
	(0.0033)	(0.0045)	(0.0049)	(0.0057)
Controls	No	Yes	No	Yes
Province dummy	Yes	Yes	Yes	Yes
Sample Size	18423	18423	10803	10803

Notes: †p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

Mechanism

In this section, we present additional empirical results to discuss further possible channels through which retirement has spillover effects on spouses' subjective health, which is helpful for us to understand more about the asymmetry impact between wives and husbands. For this purpose, we use another data source: China Health and Retirement Longitudinal Study (CHARLS). The survey collected micro-data representing the families and individuals of

TABLE 17. Effect of Delaying SRA on Spousal Health

	Wives' Spillover Effect		Husbands' Spillover Effect	
Bandwidth	11 quarters	11 quarters	11 quarters	11 quarters
Treatment Effect	0.091***	0.096***	-0.107*	-0.106*
	(0.022)	(0.021)	(0.041)	(0.041)
MTTE(TED)	-0.0020	-0.0023	0.0197*	0.0194***
	(0.0035)	(0.0035)	(0.0071)	(0.0062)
Controls	No	Yes	No	Yes
Province dummy	Yes	Yes	Yes	Yes
Sample Size	18423	18423	10803	10803

Notes: †p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

middle-aged and elderly over 45 years old in China to facilitate researchers to analyze China's population aging problem. Unlike the 2005 Mini Census, we used in previous sections, the CHARLS data set contains variables on health-related behaviours, such as smoking, drinking, and emotions.

CHARLS selected two provinces in China to conduct a pre-survey in 2008. In 2011, 2013, 2015 and 2018, it conducted four rounds of surveys in 450 communities (villages) in 150 counties of 28 provinces. Four rounds of surveys were carried out, of which 2011 was the baseline sample. In the subsequent survey process, the baseline sample was continuously tracked to reflect the development and changes of the respondents. As of completing the national follow-up in 2018, the CHARLS sample covers 19,000 respondents in a total of 12,400 households. The data used in this paper comes from the four rounds of formal surveys. We retained a sample with urban Hukou for our study, containing 7982 individuals (3425 women and 4557 men).

Based on the questions in the CHARLS questionnaire, we measured the changes in the respondents' health behaviour, socializing activities, and emotional health before and after retirement. Among these categories, healthy behaviours mainly include smoking and drinking habits and exercise status, social activities are mainly reflected in the interaction with others, and emotional health status includes life satisfaction and the frequency of

negative emotions. This information is not available from the mini-census data we used in the main results.[18] The detailed definitions and descriptive statistics are summarized in Table A.8. Table A.9 reports first-stage results, which show a significant jump size in the retirement probability.

For couples living together, their habits usually affect their spouses, and behaviours such as smoking can have a non-negligible negative impact on their spouses' health. Retirement may increase the frequency of these bad behaviours to a certain extent (see Fletcher & Marksteiner, 2017). At the same time, the couple tends to spend more time at home together after retirement, which amplifies negative externalities caused by unhealthy habits. For example, passive smoking increases people's probability of cardiovascular diseases, respiratory diseases, and cancer. While there are rules against smoking in public areas, there are no effective rules to prevent people from smoking indoors at home. If retired husbands smoke more often than before, it is possible for them to adversely affect the health of their wives through passive smoking at home. Table 18 presents such a result.[19] While there is neither evidence of quitting or starting smoking for the husbands, those who smoke already tend to smoke more after retirement. For instance, the estimate is about 14 more cigarettes per day after retirement under the optimal bandwidth. Compared with the summary statistics in Table A.8, this is about 70% of the sample average. Retirement also increases the probability of drinking for men by 27.4%, while the effect on women is not significant.

Studies have shown that negative emotions can seriously damage one's health, inhibit the ability to work, and increase the probability of sickness as well as healthcare utilization (see Clark, 2003; Lindo, 2011). Indeed, as documented by Lei, Sun, et al. (2014), there are high levels of depressive symptoms among the elderly in China. With emotional contagion, spouses' emotions often strongly affect people themselves. If one has difficulty adapting

[18]We also match husbands and wives in for the CHARLS data. The matched data set provides too few observations near the cutoff.

[19]Because the sample size of women who smoke is too small, we do not report results on how wives' retirement affects their smoking quantity (number of cigarettes).

TABLE 18. Effect of Retirement on Own Smoking and Drinking

Dept.Var.	Smoked or Not		# of Cigarettes	Drink Past Year		Spirit Past Year	
	Wives	Husbands	Husbands	Wives	Husbands	Wives	Husbands
Bandwidth	19	20	18	19	18	20	14
Estimates	0.007	-0.081	14.247**	0.198	0.229*	0.038	0.292
	(0.054)	(0.135)	(5.472)	(0.145)	(0.114)	(0.079)	(0.221)
Prov. Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year. Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample Size	1615	1985	1035	1612	1780	1472	1037

Notes: Bandwidths are the CCT optimal bandwidths. More results see Tables A.10 and A.11.
†p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

to the new lifestyle of retirement, he or she may have strong negative emotions, which adversely affect the health of the spouse and oneself. Table 19 demonstrates the FRD estimates of retirement effects on one's own negative emotions. The results show that retirement has no significant impact on whether women are satisfied with their lives but significantly decreases the life satisfaction rate of men by 17.7%. Meanwhile, women tend to be less depressed after retirement. The effect of retirement on whether an individual feels lonely or not is not significant, but the signs of the estimates again suggest women enjoy retirement more than men. These results are consistent with existing studies (see Marcus, 2013) that retirement negatively affects men's emotions more, and it can adversely impact the health of their spouses through the mechanism of emotional contagion between couples.

We also find that women are more open to social events and sports activities after retirement than men. For example, Table 20 shows that women increase the probability of attending social events significantly after retirement, but there are no significant changes for husbands. It appears that women are more open to socializing with friends than men after retirement. This is consistent with the results on emotions and explains why women are happier and more stable after retirement. The signs of the retirement effect on sports participation are also consistent with this conclusion, although both effects are not statistically significant.

TABLE 19. Effect of Retirement on Own Emotions

Dept.Var.	Satisfied with Life		Feel Lonely		Feel Depressed	
	Wives	Husbands	Wives	Husbands	Wives	Husbands
Bandwidth	18	18	15	12	21	16
Estimates	-0.045	-0.177*	-0.076	0.196	-0.470**	-0.057
	(0.088)	(0.084)	(0.352)	(0.368)	(0.189)	(0.343)
Prov. Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year. Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Sample Size	1411	1625	1198	1026	1667	1418

Notes: Bandwidths are the CCT optimal bandwidths. For more results, see Table A.13.
†p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

TABLE 20. Effect of Retirement on Own Social and Sports

Dept.Var.	Social Events		Sports	
	Wives	Husbands	Wives	Husbands
Bandwidth	21	14	25	21
Estimates	0.282†	0.060	0.210	-0.102
	(0.150)	(0.194)	(0.187)	(0.141)
Prov. Dummy	Yes	Yes	Yes	Yes
Year. Dummy	Yes	Yes	Yes	Yes
Sample Size	1777	1334	1171	1094

Notes: Bandwidths are the CCT optimal bandwidths. For more results, see Table A.12
†p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses. .

The above findings coincide with the traditional roles that husbands and wives (e.g., those born around 1940-1960) play in their families in China. Husbands often play patriarchal roles and take the primary economic responsibility, whereas the image of wives is more nurturing and supporting. Therefore, retired husbands often face more pressures on decreasing income and loss of social status, which not surprisingly leads to negative emotions and unhealthy behaviours (such as smoking). On the other hand, retired wives have a smoother transition because there is not much difference in their family roles before and after retirement. This is particularly true for women with lower education levels, who may tend to have less

reputable jobs. It is easier for them to finish the transition, resulting in a more positive spillover effect.[20]

Conclusion

The retirement effects are complex. Although much research analyzes the effects of retirement on retirees themselves, less focuses on the spillover effect on family members. This paper takes an extra step to provide empirical evidence about the gender-asymmetric spillover effect of retirement on spouses' subjective health. We realize that women's retirement has a positive effect on their husbands, while husbands' retirement tends to have a negative effect. The difference in how healthy (and unhealthy) behaviours and emotions respond to retirement between men, and women can provide explanations for the gender asymmetry of the spillover effect. We also show that a small delay of SRA for both men and women is beneficial if we consider the spillover effect. These results provide useful references for policy discussions in China.

Our paper has limitations, and it does not attempt to answer all the policy questions regarding retirement reform in China. Our research, like that of many other peers, provides partial equilibrium-type results. We need to interpret our results carefully under a specific policy environment together with existing research (e.g. those focus on cognitive skills or other measures of health). In our sample, the retirement time is about eight years apart for husbands and wives on average.[21] Therefore, for males and females who are facing retirement decisions at the same point of time, males tend to belong to a more senior age

[20]One way of analyzing the mediation effect is to consider an approach in the spirit of Baron & Kenny (1986), where a system of equations is built with the mediator (e.g. drinking) appears as the dependent variable of one regression and appears as an independent variable in another long regression together with the explanatory variable of interest (retirement). The existence of mediation effects boils down to testing the product of specific regression coefficients being zero or not. However, as Imai et al. (2011) points out, even in linear models, such an approach requires additional assumptions, which can be hard to justify with either experimental data or observational data. Therefore we do not pursue this direction. To the best of our knowledge, there is no coherent statistical framework for point identification of the mediation effect or testing its existence in the regression discontinuity setup yet.

[21]Recall that husbands are on average two years older than wives, but their retirement age cutoff is 60 whereas wives's is 50.

group. We shall take this factor into consideration when generalizing our result to other empirical settings with less gender gap in SRA.

There are interesting questions to be answered by future work, too. For example, we focus by in large on short-run health status, and it is undoubtedly helpful to examine the long-run or dynamic health effects if richer data sets are available. We estimated the average effect for the compliers. The causal effect for always-takers and never takes are not point-identified without additional assumptions. It is desirable to examine if the effect is heterogeneous across different types and, if so, how the result can be extrapolated to the entire population when additional information becomes available (e.g., a survey contains questions on individuals' retirement attitudes, from which one can infer the complying status).

Additional Empirical Results

We collect additional tables and empirical results in this section.

TABLE A.1. Effect of Retirement on Spousal Health: Female Workers

Bandwidth	11 quarters	11 quarters
Estimates	0.095**	0.102**
Std	(0.035)	(0.035)
Provincial Dummy	No	Yes
Husbands' characters	Yes	Yes
Sample Size	16,762	16,762

Notes: According to the personal occupation information in the mini-census data, we identified the female sample of "heads of state organs, party organizations, enterprises and institutions" and "professional and technical personnel", which can basically be considered as having cadre status and the legal retirement age is 55 years old. The total number of this sample is 2730, accounting for only 8.57% of the total female sample(31,858). After excluding female cadres from the sample, the core findings of Table 5 remain unchanged.
†p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

TABLE A.2. Effect of Retirement on Spousal Health: Normalized Results

Bandwidth	11 quarters	11 quarters
Estimates	0.102**	0.103**
Std	(0.036)	(0.036)
Provincial Dummy	No	Yes
Husbands' characters	Yes	Yes
Sample Size	18,766	18,766

Notes: We normalize the forcing variables based on the study of Cattaneo, Titiunik, et al. (2016), set the forcing variables for female cadres with 55 years old as the retirement threshold, and combine them with the sample of female workers into a unified regression discontinuity framework for analysis. It can be seen that the spillover effect of female retirement on the husband's health becomes more significant compared to the estimation results in Table 5, and also, the magnitude of the effect is relatively larger, once again indicating that the estimation results in this paper are robust.
†p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

TABLE A.3. Effect of Retirement on Spousal Health: OLS Estimation

	Wives' Retirement Effect		Husbands' Retirement Effect	
	(1)	(2)	(3)	(4)
Bandwidth	20 quarters	20 quarters	20 quarters	20 quarters
Estimates	-0.0101***	0.0021	-0.0378***	-0.0224***
Std	(0.0029)	(0.0031)	(0.0042)	(0.0043)
Schooling Years		0.0057***		0.0059***
		(0.0005)		(0.0007)
Age		-0.0051***		-0.0061***
		(0.0004)		(0.0006)
Han Chinese		0.0133†		0.0093
		(0.0068)		(0.0107)
Employment Insurance		0.0176***		0.0124†
		(0.0032)		(0.0066)
Pension Insurance		-0.0062		0.0070
		(0.0039)		(0.0062)
Medical Insurance		0.0171***		0.0055
		(0.0037)		(0.0060)
Number of Kid		0.0049*		0.0011
		(0.0020)		(0.0024)
Constant	0.940***	1.085***	0.909***	1.160***
	(0.0068)	(0.0225)	(0.0122)	(0.0334)
Sample Size	31858	31858	21116	21116
R-squared	0.011	0.031	0.018	0.032

Notes: †p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

TABLE A.4. Effect of Retirement on Spousal Health: Pooled Estimation

	OLS		FRD	
	(1)	(2)	(3)	(4)
Bandwidth			10	10
First Stage			0.161***	0.155***
			(0.016)	(0.015)
Retirement	-0.034***	-0.009***	0.015	0.033
	(0.003)	(0.002)	(0.030)	(0.029)
Controls	No	Yes	No	Yes
Province Dummy	Yes	Yes	Yes	Yes
Observations	52974	52974	26743	26743
R-square	0.015	0.037		

Notes: †p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

TABLE A.5. Effect of Retirement on Spousal Health: with more controls

Bandwidth	11 quarters	11 quarters
	Husbands' retirement effects	Wives' retirement effects
Estimates	-0.124	0.126*
Std	(0.081)	(0.050)
Provincial Dummy	Yes	Yes
Husbands' characters	Yes	Yes
Wives' characters	Yes	Yes
Sample Size	10803	18,423

Notes: †p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

TABLE A.6. Effect of Retirement on Spousal Health: with city-specific clusters

Bandwidth	11 quarters	11 quarters	11 quarters	11 quarters
	Husbands' retirement effect		Wives' retirement effect	
Estimates	-0.099	-0.093	0.088*	0.098*
Std	(0.077)	(0.077)	(0.044)	(0.043)
Provincial Dummy	Yes	Yes	Yes	Yes
Characteristics	No	Yes	No	Yes
Sample Size	10,803	10,803	18,423	18,423

Notes: The estimation results were clustered at the prefecture-level based on the information from the mini-census about the cities where individuals live.
†p<0.1, *p<0.05, **p<0.01,***p<0.001.

TABLE A.7. Placebo test for informal employment

Bandwidth	11 quarters	11 quarters	13 quarters	13 quarters
	Wives' retirement for immigrants		Husbands' retirement for immigrants	
First stage	0.002	0.002	0.003	0.003
	(0.001)	0.001	(0.005)	(0.005)
Second stage	-0.060	0.872	-6.011	-5.924
	(2.251)	(2.551)	(12.578)	(12.148)
Controls	No	Yes	No	Yes
Sample Size	17,306	17,306	9,314	9,314

Notes: Migrant workers are identified based on their responses to the survey on the nature of housing structure in mini-census. In this paper, the sample with rural household registration but with "reinforced concrete structure" or "mixed structure" housing is considered as the group of migrant workers living and working in the city.

†p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

TABLE A.8. Summary Statistics: CHARLS

	Women			Men		
	#Obser.	Mean	Std	#Obser.	Mean	Std
Retired	3,228	0.453	0.498	4,338	0.525	0.499
Smoke or Not	3,409	0.031	0.173	4,537	0.414	0.493
Cigarettes Per Day if Smokes	131	10.920	8.301	2,632	19.030	12.666
Drink Past Year[a]	3,400	0.191	0.394	4,529	0.602	0.490
Drink Spirit Past Year[b]	2,880	0.045	0.207	3,487	0.482	0.500
Social Activities[c]	3,409	0.658	0.474	4,537	0.652	0.476
Sports Activities[d]	1,915	0.592	0.492	2,490	0.485	0.500
Satisfied with Life[e]	3,147	0.890	0.313	4,140	0.927	0.260
Frequency of Feeling Lonely[f]	3,195	1.409	0.833	4,191	1.295	0.714
Frequency of Depression[g]	3,188	1.807	0.992	4,182	1.581	0.901

a : Binary variable. Takes value 1 if drinks anything contains alcohol in the past year.

b : Spirit contains Chinese Baijiu, Whisky, or equivalents.

c : Binary variable. Takes value 1 if participates in any of the 11 categories of social activities listed in CHARLS.

d : Binary variable. Takes value 1 if do moderate-intensity physical activity every week for no less than 10 minutes (includes carrying light things, riding a bicycle at regular speed, mopping the floor, Tai Chi, sprinting, etc.)

e : Binary variable. Takes value 1 if the respondent feels "Extremely satisfied", "Very satisfied", or "Relatively satisfied".

f : Frequency of feeling lonely in a week. 1- little or no (less than 1 day); 2- not too much (1-2); 3- sometimes or generally time (3-4 days); 4- large Most of the time (5-7 days).

g : Frequency of feeling depressed in a week. 1- little or no (less than 1 day); 2- not too much (1-2); 3- sometimes or generally time (3-4 days); 4- large Most of the time (5-7 days).

TABLE A.9. First Stage Estimation of the CHARLS Data

Dep: Women's Retirement			
Bandwidth	12 quarters	16 quarters	20 quarters
Estimates	0.312***	0.349***	0.362***
	(0.078)	(0.048)	(0.043)
Provincial Dummy	Yes	Yes	Yes
Yearly Dummy	Yes	Yes	Yes
Sample Size	965	1359	1698
Dep: Men' Retirement			
Bandwidth	12 quarters	16 quarters	20 quarters
Estimates	0.426***	0.417***	0.402***
	(0.106)	(0.074)	(0.058)
Provincial Dummy	Yes	Yes	Yes
Yearly Dummy	Yes	Yes	Yes
Sample Size	1105	1538	1985

Notes: †p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

TABLE A.10. Effect of Retirement on Own Smoking Behaviors

Dept.Var.	Smoked Last Month						# of Cigarettes		
	Wives' Retirement			Husbands' Retirement			Husbands' Retirement		
Bandwidth	19^{o}	15	23	20^{o}	16	24	18^{o}	14	22
Estimates	0.007	0.010	0.011	-0.081	-0.066	-0.098	14.247**	$14.030^{\dagger}$	10.447*
	(0.054)	(0.081)	(0.045)	(0.135)	(0.154)	(0.104)	(5.472)	(7.349)	(4.086)
Prov. Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year. Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample Size	1615	1277	1949	1985	1538	2454	1035	789	1288

Notes: ^{o} is the CCT optimal bandwidth.
†p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.

TABLE A.11. Effect of Retirement on Own Drinking Behaviors

Dept.Var.	Drink Past Year						Drink Spirit Past Year					
	Wives			Husbands			Wives			Husbands		
Bandwidth	19^o	15	23	18^o	14	22	20^o	16	24	14^o	10	18
Estimates	0.198	0.224	0.132	0.229*	$0.308^\dagger$	0.147	0.038	-0.001	0.026	0.292	0.307	0.190
	(0.145)	(0.200)	(0.121)	(0.114)	(0.171)	(0.100)	(0.079)	(0.111)	(0.062)	(0.221)	(0.506)	(0.149)
Prov. Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year. Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample Size	1612	1274	1946	1780	1331	2218	1472	1111	1676	1037	702	1375

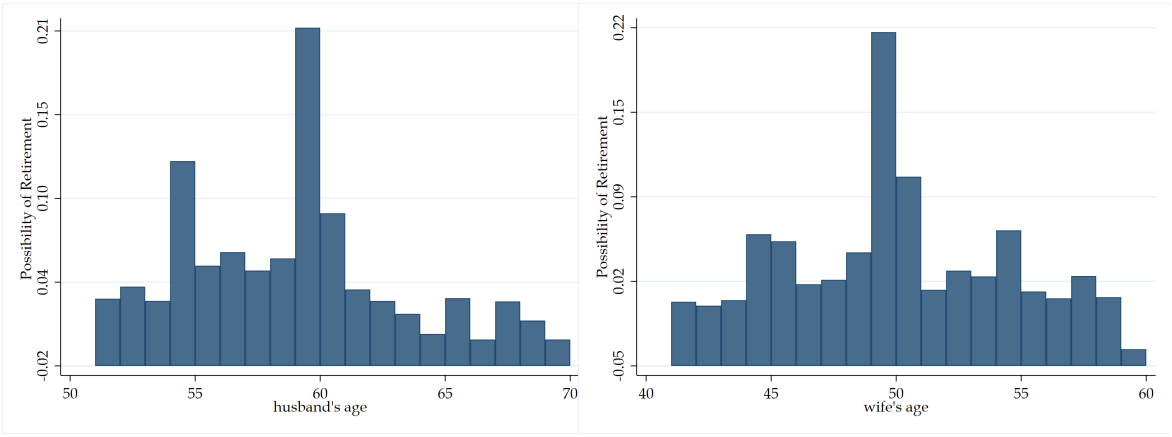
TABLE A.12. Effect of Retirement on Own Social and Sports

Dept.Var.	Attend Social Events						Sports					
	Wives			Husbands			Wives			Husbands		
Bandwidth	21^o	17	25	14^o	10	18	25^o	21	29	21^o	17	25
Estimates	$0.282^\dagger$	0.255	0.267*	0.060	0.104	-0.065	0.210	0.203	0.171	-0.102	-0.096	-0.084
	(0.150)	(0.185)	(0.121)	(0.194)	(0.316)	(0.136)	(0.187)	(0.207)	(0.166)	(0.141)	(0.188)	(0.133)
Prov. Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year. Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample Size	1777	1443	2074	1334	887	1784	1171	1004	1290	1094	851	1344

TABLE A.13. Effect of Retirement on Own Emotions

Dept.Var.	Satisfied with Life						Feel Lonely						Feel Depressed					
	Wives			Husbands			Wives			Husbands								
Bandwidth	18^o	14	22	18^o	14	22	15^o	11	19	12^o	16	20	21	17	25	16	12	20
Estimates	-0.045	-0.066	-0.026	-0.177*	-0.181	-0.190**	-0.076	-0.141	-0.026	0.196	0.212	0.192	-0.470**	$-0.381^\dagger$	-0.407*	-0.057	-0.034	-0.062
	(0.088)	(0.146)	(0.072)	(0.084)	(0.118)	(0.068)	(0.352)	(0.532)	(0.250)	(0.368)	(0.251)	(0.186)	(0.189)	(0.228)	(0.174)	(0.343)	(0.456)	(0.201)
Prov. Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year. Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample Size	1411	1094	1725	1625	1214	2017	1198	819	1513	1026	1422	1828	1667	1350	1945	1418	1024	1823

Notes: ^{o} is the CCT optimal bandwidth.
†p<0.1, *p<0.05, **p<0.01,***p<0.001. Robust standard errors clustered at the province level are given in parentheses.



(A) Husband Retirement Rate (B) Wife Retirement Rate

FIGURE 4. Retirement Rate by Age

Note: In the mini-census, we do not directly observe at which year an individual retires, but only the retirement status at the survey year. This figure plots the differences in retirement status ratio between two consecutive age groups for males and females, respectively.

Details on Data Processing

The mini-census data used in this paper contains a total of 2,585,481 observations. In this section, we summarize the process of obtaining our final data for empirical analysis. It includes the following four steps:

(1) First, we keep the sample with individuals who are either "household head" or "spouse of the household head", which contains 1,346,434 observations in total. This is the sample we use to match husbands and wives in later steps.

(2) Second, we divide the above samples by gender, resulting in a total of 676,044 observations in the wife sample and 670,390 observations in the husband sample. On this basis, the husband's characteristics regarding employment status, year of birth, and health level are matched with the wife's sample by household information to obtain the household sample, which has a total of 437,611 observations.

(3) In the third step, we construct a further subsample by (1) retaining males aged 50-70 years and females aged 40-60 years, (2) retaining observations with urban

household registration and (3) excluding individuals who are studying in school and incapacitated. After this step, we have 49,002 male and 64,822 female observations.

(4) Finally, the optimal bandwidths are estimated separately for the male and female samples, and the optimal bandwidths are found to be 11 quarters for both male and female samples. For the purpose of the subsequent robustness check, we limit the sample for the parameter and non-parametric estimation to observations who are within 20 quarters before and after their retirement, resulting in a total of 21,116 observations for males and 31,858 observations for females.

After the processing, our final sample retains only the urban household population so that both the rural population and the migrant worker group are excluded, thus also essentially excluding the urban informal employment, which is mostly taken by the migrant worker group.

Compliance with Ethical Standards

Conflict of Interest: Author Shenglong Liu declares that he/she has no conflict of interest. Author Yuanyuan Wan declares that he/she has no conflict of interest. Author Xiaoming Zhang declares that he/she has no conflict of interest.

This article does not contain any studies with human participants or animals performed by any of the authors.

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