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Abstract: This study examines the causal impact of retirement on migration decisions. Using a regression discontinuity (RD) design approach, combined with a nationally representative sample of 228,855 Chinese older adults, we find that retirement increases the probability of migration by 12.9 p.p. (an 80% increase in migration). Approximately 38% of the total migration effects can be attributed to inter-temporal substitution. Retirement-induced migrants are lower-educated, have restricted access to social security, and come from origins with high living costs. Relying on old age support from adult children in migration is a likely mechanism. These findings are consistent with a simple theoretical model of migration for older adults.

Keywords: Retirement; Internal Migration; Old age support; China; Regression discontinuity design.

JEL codes: J14; J26; J61.

Declarations of interest: None

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1 Introduction

Due to strong reductions in fertility in the past, the economic challenges posed by population aging are particularly high in China. Approximately one-third of its population will be aged 60 and above in 2050 (UN Population Division, 2017 Revision), leading to more retirees and a shrinking workforce. While the low coverage and inadequate benefits of social security imply that old age support from adult children remains essential for retirees in China, massive labor migration of adult children creates difficulties in guaranteeing such support for older adults left behind. One potential way of coping with these difficulties is for older adults to move to their children upon retirement. In this article we aim to analyze whether and how older adults' migration decisions change in response to their own retirement.

A long-standing theory considers migration as investment in human capital, which is costly but improves job opportunities (Schultz 1961; Sjaastad 1962; Bowles 1970). According to this line of argument we should witness a falling propensity to migrate when people exit the labor market upon retirement.[5] Another strand of literature shows that people may resort to migration as risk-sharing or shock coping strategies (Rosenzweig and Stark 1989; Gröger and Zylberberg 2016; Munshi and Rosenzweig 2016; Morten 2019). For example, while the increasing economic opportunities for the young may have contributed to the declining intergenerational co-residence from 1850 to 1980 (Ruggles 2007), recent evidence shows that young adults are increasingly more likely to move back home in the United States (Kaplan 2012; Bleemer et al. 2017; Dettling and Hsu 2018). This is consistent with young adults' increasing needs to save housing costs, pay back debts, and cope with adverse labor market outcomes.

Yet to some extent, migration after retirement is the flip phenomenon that has not received much attention in the literature. The massive labor migration of adult children makes it more likely that older adults and their adult children live separately (Antman 2010; Böhme, Persian, and Stöhr 2015; Scheffel and Zhang 2019). When older adults rely on their adult children for old age support, in the absence of sufficient social security upon retirement, they may choose to move (closer) to their adult children. Throughout history, it was common for older parents to receive support from their adult

[5] This is consistent with the old Chinese saying that falling leaves return to their roots.

children. Although government-financed social security benefits increase the income of retirees and thereby reduce their need to rely on children for support, these social security benefits are mainly present in rich countries.[6] In countries with mature social security systems such as the United States and many European countries, less than 30% of children help out their older parents either through monetary transfers or by helping to care for them. By contrast, more than 60% of children help out older parents in many developing countries such as China and India (Becker, Murphy, and Spenkuch 2016). Recent studies in China show that a large fraction of older adults live with their adult children, particularly when these older adults have limited access to pension (Chen 2015; Lei et al. 2015; Chen, Eggleston, and Sun 2018).

Understanding whether retirement will cause a higher geographic mobility of older adults is important for the following reasons. First, internal migration of older adults may lead to considerable demographic, social, cultural, and economic changes as the number of older adults increases over decades (Bean et al. 1994; Deller 1995). For example, it may have a negative impact on the financial stability of local social security systems through lower tax revenues and higher dependency ratios (Razin, Sadka, and Swagel 2002a; 2002b). It may also cause labor supply shocks in destinations through reallocating more labor supply of younger adults from market production to home production (Stancanelli and Van Soest 2012; Li, Shi, and Wu 2015). Second, high migration may lead to provincial-level heterogeneity in rates of population aging (Frey 1995; Rogerson 1996), which can have consequences for regional economic growth and income convergence between provinces (Barro and Sala-i-Martin 1992). Third, knowing the pattern of later-life migration provides the scientific foundation for designing aging-related policies in the domains of retirement, regional infrastructure, healthcare, and long-term care. Fourth, a better understanding of the migration decisions upon retirement sheds light on the rebounding intergenerational co-residence in both developed and developing countries (Ruggles and Heggeness 2008a; Kaplan 2012; Bleemer et al. 2017; Dettling and Hsu 2018). Finally, it is plausible that the migration behavior of older adults may be heterogeneous among subgroups defined by gender and educational attainment. Taking account of this variation may help policymakers in designing suitable targeted policies for subgroups and thereby improve

[6] According to the International Labor Office (2010), about 60% of the world's older population received no old-age pension. This fraction is about 70% in Asia and the Pacific, and over 80% in Africa.

the health and well-being of the older population altogether.

While late-life migration has been addressed in earlier frameworks such as the lifecourse model (Rossi 1955; Walters 2002), most of them have methodological constraints and suffer from endogeneity issues (Bradley et al. 2008; Longino Jr et al. 2008; Sander and Bell 2014). Previous studies focus on the association between retirement and migration rather than on causality. However, workers who want to migrate for various other reasons – e.g., because they experience declining health or the death of a spouse – are also more likely to retire. This raises problems related to reverse causality and implies the need for an accurate identification strategy. Furthermore, most of the previous studies use comparatively small datasets, a drawback that we address by using a unique large-scale representative dataset for China. Identifying the causal impact of retirement on migration is also important to assess the impact of a retirement reform when China might change the statutory retirement age.

To address endogeneity issues, we use a regression discontinuity (RD) design to estimate the causal effect of retirement on migration in China. The focus on China implies three crucial advantages: i) it allows us to utilize a unique large-scale nationally representative population-based dataset of a 20% random sample of the China Population Census survey in 2005. The resulting sample accounts for 0.2% of the total population in China, which corresponds to 2.6 million people in all 31 provinces. Among other variables, the dataset includes information on age, gender, education level, marital status, self-reported health, retirement status, social security participation such as medical insurance and pension, migration status, and income. We keep those individuals aged between 40 and 75 years who never exited the labor force before retirement, which amounts to a sample of 228,855 adults; ii) our RD framework exploits that the probability of retiring increases discontinuously at the statutory retirement age in China (i.e., 60 for males, 50 for female workers, and 55 for female civil servants). These thresholds are induced by mandatory retirement rules, which were officially established in 1978 and have not changed since then. The mandatory retirement rules are strictly enforced for nonagricultural *Hukou* holders (especially employed in public sectors) but less so for agricultural *Hukou* holders such as farmers or those who are self-employed.[7] This is ideal for conducting a placebo test on the sample of agricultural *Hukou* holders; iii) the Chinese institutional setting offers an important advantage over studies focusing on other countries such as the United States, where individuals become eligible for the Medicare insurance program once they pass the age threshold of 65. It is therefore hard to disentangle the effects of retirement from those of Medicare insurance such that studies using the threshold of age 65 as an instrument for retirement (Insler 2014; Neuman 2008) run the risk of confounding their results with the effects of Medicare eligibility. This problem is avoided when focusing on China because it has a universal healthcare system, in which more than 95% of its population are insured via the Urban Employee Medical Insurance (UEMI) or the Urban Residence Medical Insurance (URMI) for nonagricultural *Hukou* holders, and via the New Cooperative Medical Scheme (NCMS) for agricultural *Hukou* holders. Retirees continue to enroll in their healthcare plans. Thus, the estimated effect of retirement will not be confounded by changes in health insurance.

Our main findings are as follows. First, we find that retirement increases the probability of migration by 12.9 percentage points (p.p.), meaning an 80% increase in migration. Approximately 38% of the total migration effects can be attributed to inter-temporal substitution (delayed migration). Second, we find that the migration impact of retirement is more pronounced for the male (27.7 p.p.), lower-educated (15 p.p.), those who have restricted access to pension (39.5 p.p.) and medical insurance (24.8 p.p.), and those who come from areas with high living costs (15 p.p.). Third, we show that relying on old age support from adult children in migration is a likely mechanism. All of these empirical findings are in line with a theoretical model of migration for older adults as detailed in Section 3.

To our best knowledge, this is the first study that investigates migration decisions upon retirement, theoretically and empirically, complementing existing studies that largely focus on migration decisions of the working age population (Schultz 1961; Sjaastad

[7] More specifically, thanks to the *Hukou* system in China, everybody is born with either a nonagricultural *Hukou* or an agricultural *Hukou*. The main difference is that nonagricultural *Hukou* holders have better access to social benefits, e.g., pension and healthcare, compared with their counterparts with an agricultural *Hukou*, while agricultural *Hukou* holders have access to farmland. Moreover, converting from an agricultural *Hukou* to a nonagricultural *Hukou* was strictly controlled at the time for which we have the data. Unsurprisingly, it was rare to convert from a nonagricultural *Hukou* to an agricultural *Hukou*. More details on the *Hukou* System in China will be discussed in the next section.

1962; Bowles 1970), as well as studies that consider migration as risk-sharing or shock coping strategies (Rosenzweig and Stark 1989; Gröger and Zylberberg 2016; Munshi and Rosenzweig 2016; Morten 2019). To some extent, this study contributes to our understanding of migration behavior for older adults who are becoming an increasingly larger proportion as the population ageing continues. This study also sheds light on the (negative) spill-over effects of older adults' retirement (Börsch-Supan 2013). In particular, we find that parental retirement significantly reduces market production of their adult children, suggesting the importance of taking into account the accessibility of social security upon retirement when changing retirement policies. Finally, this study sheds light on rebounding co-residence in both developed and developing countries (Ruggles and Heggeness 2008b; Kaplan 2012; Bleemer et al. 2017; Dettling and Hsu 2018). In contrast to developed countries (e.g., United States) in which young adults are increasingly more likely to move back home to save housing costs and cope with adverse labor market outcomes, our findings show that older adults in China are more likely to move away for old age support from their adult children in migration, in the absence of sufficient social security.

The paper is organized as follows. In Section 2 we illustrate the institutional backgrounds of retirement policy and migration settings in China. In Section 3 we propose a simple theoretical framework for migration of older adults. In Section 4 we present the data and summary statistics. Section 5 contains our main results and various robustness and sensitivity analyses. In Section 6 we explore the heterogeneity in the effect of retirement across different sub-groups of the population. In Section 7 we discuss the potential causal mechanisms from retirement to migration related to older adults. In Section 8 we provide additional evidence on retirement-induced migration. Finally, in Section 9 we summarize and draw our conclusions.

2 Institutional details

2.1 Migration policy in China

To regulate internal migration, China established the *Hukou* System in 1958. According to the *Hukou* System, everyone is born with either a nonagricultural *Hukou* (NAH) or an agricultural *Hukou* (AH) registered at his or her birthplace. Having a NAH allows one to access local social welfare (e.g., housing subsidies, children's education, and social security), whereas AH holders have access to farmland but have little access to social protection.[8] Converting from AH to NAH was strictly controlled by the Chinese authorities in the 2000s (Chan and Buckingham 2008). More importantly, migrants, defined as individuals who move away from their registered places to unregistered places without obtaining a local *Hukou*, do not have access to local social security in their migrating destinations. For example, migrants' children cannot attend local public schools. In addition, migrants do not have access to local medical insurance and have to pay more for local public health care.[9] For retirees, it is also more costly to claim pension benefits from their registered place (the place they retired) if they migrate to a different place after retirement.[10] In order to access the same level of local social security, migrants have to obtain a local *Hukou*, which was strictly controlled and difficult to obtain in the 2000s.

Nevertheless, China witnessed unprecedented internal migration regardless of the restrictive migration policy.[11] Additionally, due to the restrictive migration policy, migrant workers used to be allowed to stay only temporarily in their migrating destinations (Meng 2012; Meng, Xue, and Xue 2016). Figure A1 in the appendix shows the relationship between age and the percentage of migrants in the population. We find that the percentage of migrants in the population decreases gradually with increasing age. However, the percentage of migrants among NAH holders decreases more slowly and even somewhat rebounds after reaching statutory retirement ages. So far, the majority of the economic studies on migration behavior are concerned with the working age population (Rosenzweig and Stark 1989; Gröger and Zylberberg 2016; Munshi and Rosenzweig 2016; Morten 2019), and little is known on the migration behavior of older

[8] More details on the *Hukou* System can be found in Chan and Zhang (1999) and Chan and Buckingham (2008).

[9] According to the State Council on Establishing the Urban Employees' Basic Medical Insurance System, released by the Chinese authority in December 1998, the social pooling unit of basic medical insurance shall be administered either at the prefecture level (or above) or at the county level (there are five de facto levels of local government: the provincial, prefecture, county, township, and village in China). However, according to official reports, it was common that the de facto social pooling unit of basic medical insurance was administered at the county level in 2007 (http://www.gov.cn/jrzg/2007-08/02/content_703781.htm). In other words, in general, older migrants received medical treatment in an unregistered county were not covered by medical insurance in their registered counties in early 2000s (medical insurance was largely non-portable across cities or provinces except for a few cites, for example, see http://d.wanfangdata.com.cn/claw/D320012497). However, this situation improved substantially recently in 2017. Patients can now access the medical insurance normally when they live in a different province after registering and meeting certain criteria regardless of the place of *Hukou* registration.

[10] To claim pension benefits from their registered places (the place they retired), they have to apply for certification of pension eligibility from their registered places at least once each year, which could be very time-consuming. In addition, banks will charge an withdrawal fee of pension benefits in unregistered places for about 0.5% to 1% of pension benefits.

[11] According to the Population census in 2010, the total number of internal migrants was 261 million, which is about 81% higher than the number in 2000.

adults. This analysis intends to fill this gap.

2.2 Statutory retirement ages in China

The current statutory retirement ages in China have been formally established on May 24th, 1978 when the retirement policy was approved at the Second Meeting of the Standing Committee of the Fifth National People's Congress. Policy-relevant documents include "The State Councils' Provisional Measures for Taking Care of the Aged, Physically Weak, Sick and Disabled Cadres" and "The State Council's Provisional Measures Concerning the Retirement and Resignation of Workers". According to the retirement policy, the general statutory retirement ages for men and women are 60 and 50, respectively. For female civil servants, the statutory retirement age is 55. The statutory retirement policy is more strictly enforced among NAH holders, particularly for workers in the public sector. By contrast, AH holders (e.g., farmers, workers who are self-employed, etc.) are more flexible to choose the timing of retirement. The mandatory retirement policy among NAH holders allows us to better cope with the causal impact of retirement in our empirical analysis.

3 A simple model of migration

In the following we sketch the most important tradeoffs for retiring individuals in deciding whether or not to become migrants, i.e., whether or not to move from their registered Hukou to a place in which they are not registered. In doing so, we broadly follow the literature on the rational choice between alternatives (Borjas 1989; Akerlof and Kranton 2000; Dustmann and Kirchkamp 2002) and assume that retirees compare their prospects in terms of remaining lifetime utility under the two scenarios of i) migrating or ii) staying put. Rational individuals will choose the option that leads to the higher indirect utility.

Consider a situation in which retirees have the potential to live for two additional time periods $t = 1,2$. The probability of surviving from the first into the second period is $1 - \mu(b, z)$, where $\mu(b, z)$ is the mortality rate that depends negatively on care by family members b and on public health care z such that

$$\frac{\partial \mu(b,z)}{\partial z} < 0, \qquad \frac{\partial \mu(b,z)}{\partial b} < 0.$$

Utility in retirement is additively separable over time with $u(c_t)$ being the utility function for period $t = 1,2$, which increases with consumption c_t. We assume that the household has already solved the standard dynamic optimization problem for optimal consumption in periods $t = 1,2$ (Diamond 1965; Chakraborty 2004; Baldanzi, Prettner, and Tscheuschner 2019). Optimal consumption c_t^* then depends i) positively on pension payments $w_t(e)$, which rise with the individual education level e because better-educated workers tend to earn higher wages during their working age; and ii) negatively on living costs h_t comprising housing costs and the general price level of a certain location. Overall, we therefore have

$$\frac{dc_t^*(w_t(e),h_t)}{de} > 0, \qquad \frac{\partial c_t^*(w_t(e),h_t)}{\partial w_t} > 0, \qquad \frac{\partial c_t^*(w_t(e),h_t)}{\partial h_t} < 0.$$

Individuals discount the future with the discount factor $\beta < 1$ such that indirect utility in case of staying put as a non-migrant is given by

$$U^p = u(c_1^{*p}) + \beta[1 - \mu(b^p, z^p)]u(c_2^{*p}) + \tilde{u}(b^p),$$

where the superscript p refers to the scenario of staying put and $\tilde{u}(b)$ denotes the utility derived from interacting with and living close to family members. By contrast, indirect utility of those who choose to move and become migrants is given by

$$U^m = u(c_1^{*m}) + \beta[1 - \mu^m(b^m, z^m)]u(c_2^{*m}) + \tilde{u}(b^m),$$

where the superscript m refers to moving. Upon retirement, individuals calculate

$$U^p - U^m \gtreqless 0.$$

If $U^p - U^m > 0$, individuals stay put and if $U^p - U^m < 0$, they move. In case of $U^p - U^m = 0$, people are indifferent and we assume that they simply stay put in this case.

From these considerations, the following testable hypotheses emerge for those who live in their registered Hukou and, thus, having a non-migrant status.

1. For some individuals, for whom it was optimal to stay put during the period of labor force participation (e.g., because otherwise they would have had to give up their jobs or they would have faced long commutes), $U^p - U^m < 0$ holds after retirement, which induces them to move. Thus, upon retirement, migration should increase.

2. Living with the family is a strong motive in favor of moving out of the registered place and, thus, to become a migrant. This is because, for individuals living away from their family, $b^m > b^p$ holds at the outset such that moving *ceteris paribus* reduces mortality $\mu(b, z)$ and increases utility from living close to family members $\tilde{u}(b)$.

3. Since public health insurance is only provided in the registered Hukou, staying put is *ceteris paribus* associated with reductions in mortality via this channel. This increases expected lifetime utility by having a higher probability to survive into the second period.

4. Individuals facing high living expenses, e.g., in terms of housing, are more likely to move and become migrants. This is because for them, $h_t^m < h_t^p$, which *ceteris paribus* implies $w_t^m > w_t^p$ such that moving *ceteris paribus* increases consumption possibilities for individuals with high living expenses.

5. Individuals with higher education are less likely to move and become migrants. This is because it is more costly for them to claim pension payments when moving and therefore they lose more consumption possibilities in retirement when moving than individuals with a lower education level.

In the following sections, we analyze these implications from an empirical point of view.

4 Data and summary statistics

4.1 Data source

Our data comprises a 20% random sample of the China Population Census survey in 2005, which accounts for 0.2% of the total population in China. The sample covers about 2.6 million people in all 31 provinces and equivalent administrative units of mainland China. The survey includes individual-level variables such as relationship with the household head, age (in terms of years and months), gender, education level, *Hukou* type, marital status, self-reported health, work status, monthly income, weekly working hours, retirement status, migration status, and social security participation such as medical insurance and pension, as well as household-level variables such as size of the current accommodation (in meter squares), ownership of the current accommodation, and costs of purchasing or renting the current accommodation. Unique information on health and income imply that the census survey in 2005 is particularly valuable in our context as compared with census surveys in alternative years. See Xie and Zhou (2014) for more details of this dataset. Although there are alternative survey datasets such as RUMiC that can identify migrants, migrants included in these surveys are mostly AH holders and are therefore not as strongly affected by the mandatory retirement policy. By contrast, the census survey allows us to identify migrants with either AH or NAH.

4.2 NAH and AH holders

According to the National Bureaus of Statistics of China, NAH holders account for about 25.8% of total population in China in 2005.[12] Using our census data, we also find that, compared with AH holders, NAH holders are relatively older, more educated, more likely to be covered by social security (including pension and medical insurance), have higher migration propensity, have shorter working hours per week, and have higher monthly income on average. Table A1 reports summary statistics for AH and NAH holders in details.

4.3 Retirement definition and eligible sample

We keep those NAH holders aged between 40 and 75 years who never exited the labor force before retirement. Given our previous definition of AH/NAH holders, as well as the assumption that converting from AH to NAH was strictly controlled at that time,

[12] The percentage of NAH holders in the population further increased to 36.6% in 2015. The National Bureau of Statistics of China did not report the number of NAH holders after 2014 given the fact that the legal distinction between AH and NAH holders was abolished in 2014.

focusing only on NAH holders in this paper is not likely to imply serious sample selection problems. Specifically, we use the following two questions in the questionnaire to determine retirement: First, did you engage in paid work in the past week? Second, why did you have no paid work? We define people as retired if they: 1) did not engage in paid work in the past week; and 2) self-reported retired. Non-retirees are defined as individuals who engaged in paid work in the past week. We drop observations for the following alternative reasons of having no paid work: i) being a student, ii) seeking no paid work voluntarily, and iii) being unemployed to allow for a precise comparison between non-retirees and retirees.[13] Given that some retirees continue working after formal retirement, we resort to a third question in the questionnaire for an alternative way of defining retirement: what is your main source of living expenditures? According to this question, we define people as retired if they resort to pension payments as their main source for financing their living expenses, and define non-retirees as people who resort to other sources of living expenses (e.g., wage, unemployment benefits, property income, family support et al.). We use this alternative definition of retirement to perform a robustness check. The final sample consists of 228,855 individuals, of whom 133,422 are men and 95,433 are women.

According to the data, the average retirement rate of the whole sample is 42%, with 11% for the sample below the statutory retirement age and 87% for the remaining sample. Figure 1 shows the retirement rate by age and gender for nonagricultural *Hukou* holders. We observe that the retirement rate jumps significantly at ages 50 and 60 for women and men, respectively. For women, the retirement rate also increases slightly at age 55 but much less so than at age 50, which is consistent with the fact that civil servants account only for a small proportion of the female workforce (Zhang, Salm, and van Soest 2018). Since our data do not contain detailed information about civil servants and other public sector employees, we proxy the statutory retirement age by age 50 for all women.

[13] We also conduct robustness checks by including these observations as non-retirees and our main results are still robust.

Figure 1 Retirement rate by age and gender

Notes: The general statutory retirement ages for men and women are 60 and 50, respectively. For female civil servants, the statutory retirement age is 55. Note that we only keep NAH holders in the sample because the statutory retirement policy is more strictly enforced among them, while AH holders have more flexibility to choose the timing of retirement.

To merge the different statutory retirement ages for men and women into one single variable, we construct the normalized age, which is equal to the actual age (in terms of years and months) minus the retirement age. Thus, the normalized age variable equals zero for men and women at the respective statutory retirement age. Figure 2 shows that at the normalized age (i.e., the statutory retirement age for both men and women), the average retirement rate jumps from 44% to 68%, suggesting that there is a significant increase in the retirement rate immediately after reaching the statutory retirement age.

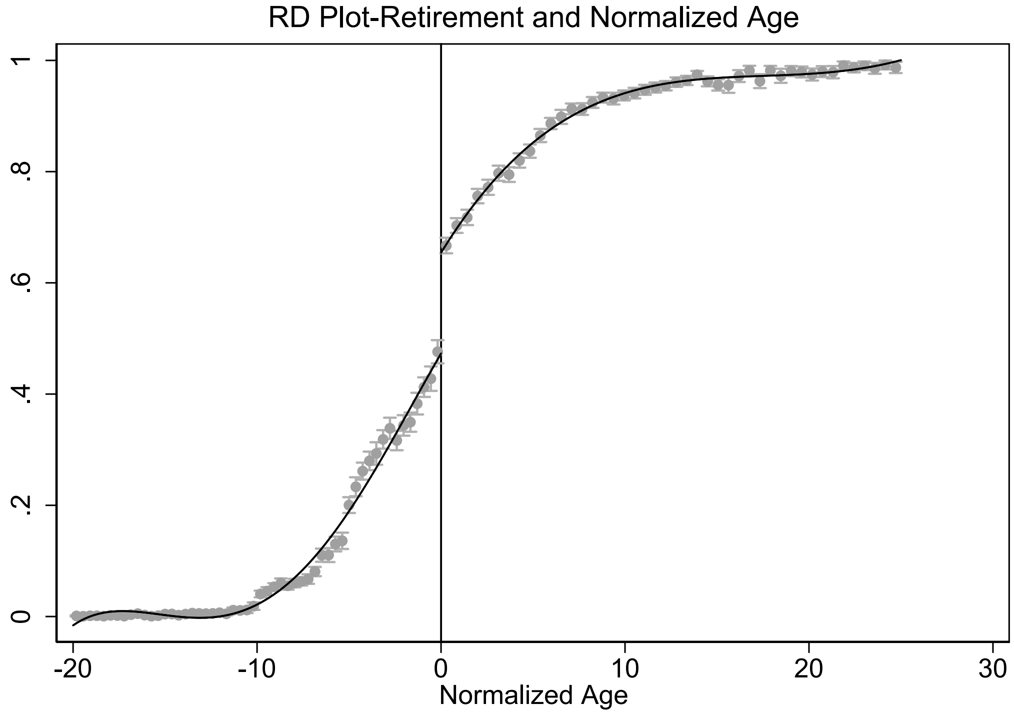

Figure 2 Retirement ratio and normalized age

Notes: The normalized age equals to the actual age (in terms of years and months) minus the statutory retirement age. We define people as retired if they: 1) did not engage in paid work in the past week; 2) self-reported as retired. Note that we drop observations for alternative reasons of having no paid work such as being a student, seeking no paid work voluntarily, and being unemployed to allow for a precise comparison between workers and retirees. The bin is selected based on the IMSE-optimal evenly-spaced method of Calonico, Cattaneo, and Titiunik (2014b).

4.4 Migration definition

We define a migrant as an individual who has lived away from his or her registered place to an unregistered place.[14] Specifically, we use the following question in the questionnaire to determine migration: what is your current *Hukou* registration status? We define people as migrants if they currently live away from their *Hukou* registered place. We also use an alternative definition of migration by excluding individuals who have lived away from their registered place but for less than 6 months for conducting a robustness check.[15] In doing so, we rely on an additional question in the questionnaire to determine migration duration: how long have you lived away from your *Hukou* registered place? Based on the answers, we define people as migrants if they (1)

[14] Due to data limitations, we cannot identify migrants who obtained a local *Hukou* and changed their registered place, which may underestimate the actual migration occurred to some extent. Since *Hukou* conversion was still strictly controlled in 2005, particularly for older adults, the registered place is typically the same as the place of birth. Also, we cannot identify individuals who return back from an unregistered place to his or her registered place (i.e. return migration). As a result, what we are really observing in the data is net migration.

[15] In the robustness check, individuals who migrated for less than six months are taken out of the estimation sample.

currently live away from their *Hukou* registered place; 2) have lived away from their *Hukou* registered place for more than 6 months. While the second definition of migration is consistent with the official definition of internal migration in China, it ignores the recent migrants who have just lived away from their registered place.

According to the data, the percentage of migrants in the population is 17%. In contrast to previous studies that focus on migrants from rural China, more than 92% of migrants in our study come from urban China. This is consistent with the fact that the statutory retirement policy mainly applies to the NAH holders, and most of them are registered in urban China. We also find that the percentage of migrants in the population is 17% in the sample below the statutory retirement age and 16% in the remaining sample, which is consistent with previous studies showing that the migration propensity is negatively related to age (Zhao 1999). Figure 3 shows that at the statutory retirement age, the percentage of migrants in the population increases from 16% to 18%, suggesting that there is a significant increase in the migration propensity immediately after reaching the statutory retirement age.

To explore geographical aspects of migration, we further distinguish between inter-city migrants, defined as people who migrate to a different city, and intra-city migrants, defined as people who migrate within the same city (e.g., across-county migration).[16] According to the data, intra-city migrants account for about 80% of total migrants. We also distinguish between migration to urban areas and migration to rural areas. According to the data, about 90% of migrants lived in urban areas.[17] Finally, we distinguish between migrants who have recently lived away from their registered places and migrants who have lived away from their registered places for a long time (e.g., more than five years). According to the data, 46% of migrants have lived away from their places for more than five years. More details on the data description can be found in Tables A2-A3 in the appendix.

[16] Note that there are rural areas in a city. China's constitution provides for three de jure levels of government. Currently, however, there are five practical (de facto) levels of local government: the provincial (including province, autonomous region, municipality, and special administrative region), prefecture, county, township, and village. In this article, for the sake of simplicity, we treat "prefecture-level city" and "city" as interchangeable. Each city used to contain a number of counties (or county-level cities).

[17] By contrast, when using the sample of AH holders, we find that inter-city migrants account for about 64% of total migrants, and about 80% of migrants lived in urban areas.

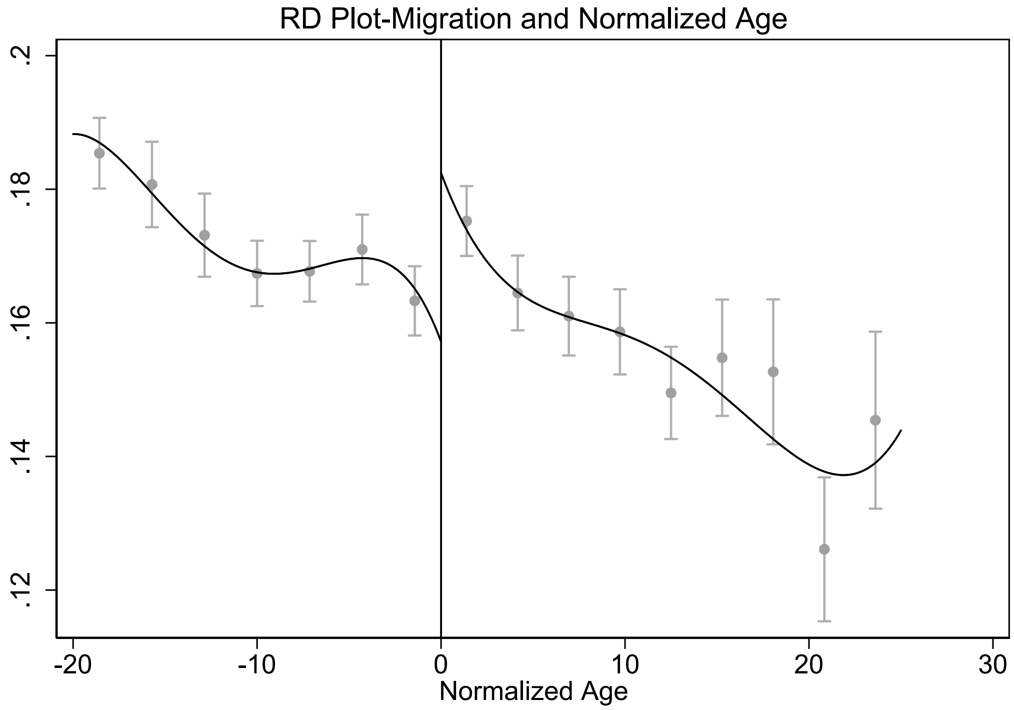

Figure 3 Ratio of migrants in the population with NAH and normalized age

Notes: we define people as migrants if they currently live away from their *Hukou* registered place. Note that this definition of migrants is slightly different from the official definition of migrants in China, the latter of which excludes people who have lived away from their *Hukou* registered place for less than 6 months. The bin is selected based on the IMSE-optimal evenly-spaced method of Calonico, Cattaneo, and Titiunik (2014b).

4.5 Match older adults to their relatives

In addition to the main dataset above, we take advantage of available information (e.g., household ID, relationship with the household head) to construct two separate datasets by matching older adults to their relatives within the same household. The first dataset matches older adults to their partners. We start by restricting to individuals who were NAH holders and were aged between 40 and 75 years old. To increase the sample size, we also include individuals who did not engage in paid work for reasons such as being students, being unemployed, and other reasons. Then we match all couples who lived in the same household or who did not live in the same household but were registered in the same household at the time of the survey. Our final sample size is 152,004.

The second dataset matches older adults to their children (-in-law). There are three different scenarios in the data. The first one is to match household head (and spouse) with their children (-in-law). The second one is to match household head (and spouse) with their parents (-in-law). The third one is to match children (-in-law) of household head and grandchildren (-in-law). We restrict older parents to individuals who were NAH holders and were aged between 40 and 75 years old. As a result, the final sample size is 133,922. It is noteworthy that our dataset only allows us to link parents and children who live together or those who do not live together currently but are registered in the same household.[18]

5 Assessing the causal effects of retirement on migration

5.1 Simple regression model

Our aim is to estimate the causal effect of retirement on migration decisions, or the probability of moving away from one's registered place. To this end, we start with a Linear Probability Model:

$$M_i = \tau R_i + X_i' \mathrm{B} + \varepsilon_i, \quad (1)$$

where M_i is the migration status of individual i, which is equal to one for a migrant and zero otherwise, R_i is the dummy variable for the retirement decision, and τ is the causal effect of retirement on the outcome variable. The vector X_i' contains predetermined variables such as gender, age polynomials[19], education, marital status and ethnicity. Since retirement decisions might be endogenous to the propensity to migrate, the OLS estimates are biased which is the reason for following an RD design.

5.2 Regression discontinuity design

To address the potential endogeneity of retirement decisions, we use a nonparametric fuzzy RD design, which exploits the statutory retirement age as a source of exogenous variation in retirement decisions (Battistin et al. 2009; Li, Shi, and Wu 2015; Heller-Sahlgren 2017; Fitzpatrick and Moore 2018).

The treatment effect can be estimated as the ratio of the jump in the probability of migration M and the jump in the probability of retirement at the statutory retirement age, as shown in Eq. (2)

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[18] Specifically, if parents and children are registered in the same household, when either parents or children are temporarily migrating to another place, we could still link parents and children in our dataset.

[19] We use quadratic and cubic polynomials because there is still an ongoing debate on the correct polynomial order to be included (Lee and Lemieux 2010; Gelman and Imbens 2018).

$$\tau_{FRD} = \frac{\lim_{\varepsilon \downarrow 0} E[M|a=0+\varepsilon] - \lim_{\varepsilon \uparrow 0} E[M|a=0+\varepsilon]}{\lim_{\varepsilon \downarrow 0} E[R|a=0+\varepsilon] - \lim_{\varepsilon \uparrow 0} E[R|a=0+\varepsilon]}. \quad (2)$$

Here a is the normalized age, i.e., the actual age (in years and months) minus the retirement age and τ_{FRD} is the local average treatment effect on compliers at the threshold point. In our context, it is the average change in the probability of migration for those who are induced to retire as a result of the statutory retirement age.

To estimate the parameter τ_{FRD}, we choose nonparametric estimation to avoid assuming a particular functional form of the assignment variable. We use the triangular kernel function to construct the local-polynomial estimators and a data driven method to choose the bandwidth of the kernel function based on one common MSE-optimal bandwidth selector method (Calonico, Cattaneo, and Titiunik 2014b).

With age as the running variable, assignment to treatment is inevitable as all individuals would eventually reach retirement age (age 60 for men and age 50 for women in this case). This gives rise to an "anticipation effect" which means that individuals who anticipate the change may behave in a certain way before treatment is provided (Lee and Lemieux 2010). In particular, older adults may delay migration until after retirement, which may accentuate the size of the discontinuity. A common practice to alleviate this concern is to conduct a donut-hole RD (Barreca et al. 2011; Shigeoka 2014).

5.3 Validity tests

A valid fuzzy RD design relies on two main assumptions in our context. The first assumption requires a discontinuity in the probability of retirement at the threshold point. Figure 2 shows that the retirement rate increases significantly (by about 20 percentage points) at the statutory retirement ages for NAH holders. As expected, there is no jump of the retirement rate at the threshold for AH holders (Figure A2). These results are consistent with the fact that the statutory retirement ages mainly apply to NAH holders.

The second assumption requires continuity in potential outcomes as a function of the assignment variable around the threshold. This implies that in the absence of retirement, the probability of migration should not change at the threshold. In other words, "all other factors" driving migration must be continuous at the threshold point. Following Imbens and Lemieux (2008), we conduct several tests to check this assumption. First, we test the hypothesis that all covariates are continuous at the statutory retirement ages. Second, we test whether there is a discontinuity in the density of the assignment variable using the manipulation test proposed by Cattaneo, Jansson, and Ma (2018). All the test results justify the validity of the RD design. Details on these test results can be found in the appendix.

5.4 Main results

We start with OLS estimation using different model specifications. However, since OLS estimates are likely to be biased, we only report the results in the appendix. We find that the coefficient of retirement is close to zero, i.e., the OLS estimates do not reveal a significant relationship between retirement and migration. To address endogeneity concerns and isolate the causal effect of retirement, we next apply the described fuzzy RD design and report the results in Table 1. We report both conventional RD estimates with conventional variance estimator and bias-corrected RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). Columns 1 and 2 show the RD estimates using the optimal bandwidth. We find that the migration probability increases significantly after retirement. According to the bias-corrected RD estimates, retirement increases the probability of migration by 12.9 percentage points, meaning an 80% increase in migration (percentage of migrants is 16%). Column 2 presents additional results by including covariates such as education and ethnicity. Including covariates is not necessary for unbiased inference under the assumptions of an RD design. However, adding covariates to the estimation is useful for: 1) eliminating small sample imbalances in observed variables that are correlated with the threshold; and 2) improving the precision of the causal RD estimates. Our main results are still robust when including covariates.

Columns 3-5 use alternative bandwidths to address concerns that data-driven criteria for an optimal choice of the bandwidth might be suboptimal or cannot be applied for categorical outcomes (Xu 2017). Taking 50%, 75%, 125%, and 150% of the bandwidth used in the benchmark model, we still find consistent evidence that retirement encourages migration. In addition, we find that the standard errors become larger when using smaller bandwidths, suggesting a bias-variance trade-off when selecting bandwidths. Reassuringly, the results of an alternative instrumental variable approach (see below) are consistent with the results based on the RD design.

Table 1 Causal impact of retirement on migration decisions

	(1)	(2)	(3)	(4)	(5)	(6)
Conventional	0.116	0.115	0.140	0.117	0.104	0.089
	(0.032)	(0.032)	(0.055)	(0.041)	(0.028)	(0.026)
Robust	0.129	0.129	0.165	0.143	0.132	0.134
	(0.036)	(0.036)	(0.080)	(0.060)	(0.042)	(0.038)
Bandwidth	4.6	4.6	2.3	3.4	5.7	6.9
Covariates	NO	YES	YES	YES	YES	YES
Observations	228,855	228,855	228,855	228,855	228,855	228,855

Notes: This table shows the impact of retirement on migration decisions using the RD design. We report both conventional and robust estimates. Conventional estimates refer to conventional RD estimates with conventional variance estimator. Robust estimates refer to bias-corrected RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). Column 1 reports the baseline model results. Column 2 reports the RD estimates by controlling for covariates such as education, ethnicity and marriage status. Columns 1-2 select the bandwidth based on the MSE-optimal bandwidth selector (Calonico, Cattaneo, and Titiunik 2014b). Columns 3-6 take 50%, 75%, 125% and 150% of the optimal bandwidth, respectively. Standard errors are in parentheses.

As we discussed earlier, there is a potential bias in estimating the impact of retirement on migration decisions, largely due to the "anticipation effect". To partially account for this effect, we run a donut-hole RD by excluding a few months of observations around the threshold (Barreca, Lindo, and Waddell 2016). There is no guideline for choosing the size of the "donut-hole" statistically or economically because it is often not clear what magnitude of delay is reasonable to expect. Thus, we first experiment with small "donut-hole" sizes ranging from zero to six months. As is shown in Table 2, the RD estimates are qualitatively unchanged though larger standard errors are observed as the donut-hole expands. When further increasing the size of the "donut-hole", shown in Figure 4, we find evidence that the point estimates are relatively stable up to 23 months. However, when the size of the "donut-hole" reaches 24 months and above, we find a reduction of the point estimates towards zero, likely due to the fact that too many observations (about 40% of the bandwidth) are excluded which will "undermine the virtue of the RD design" (Shigeoka 2014). Nonetheless, the "donut-hole" results show that the RD estimates are not sensitive to the "anticipation effect", which makes it unlikely that the increased migration after retirement can be attributed solely to the "anticipation effect".

Table 2 Estimates from the donut-hole RD

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Conventional	0.099	0.108	0.108	0.100	0.088	0.088	0.105
	(0.031)	(0.034)	(0.034)	(0.035)	(0.063)	(0.063)	(0.082)
Robust	0.110	0.120	0.120	0.112	0.086	0.086	0.100
	(0.035)	(0.037)	(0.037)	(0.039)	(0.077)	(0.077)	(0.100)
Size of Donut-hole	zero month	one month	two months	three months	four months	five months	six months
Observations	228,073	226,853	226,853	224,536	223,399	223,399	221,296

Notes: This table shows the estimates from the donut-hole RD design by excluding observations around the threshold. We report both conventional and robust estimates. Conventional estimates refer to conventional RD estimates with conventional variance estimator. Robust estimates refer to bias-corrected RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). Column 1 shows estimates by removing observations at the threshold, or the statutory retirement age. Column 2 shows estimates by removing observations of one month around the threshold from either side of the statutory retirement age. Columns 3-7 each show the estimates by removing one more month around the threshold from either side of the statutory retirement age. Standard errors in parentheses.

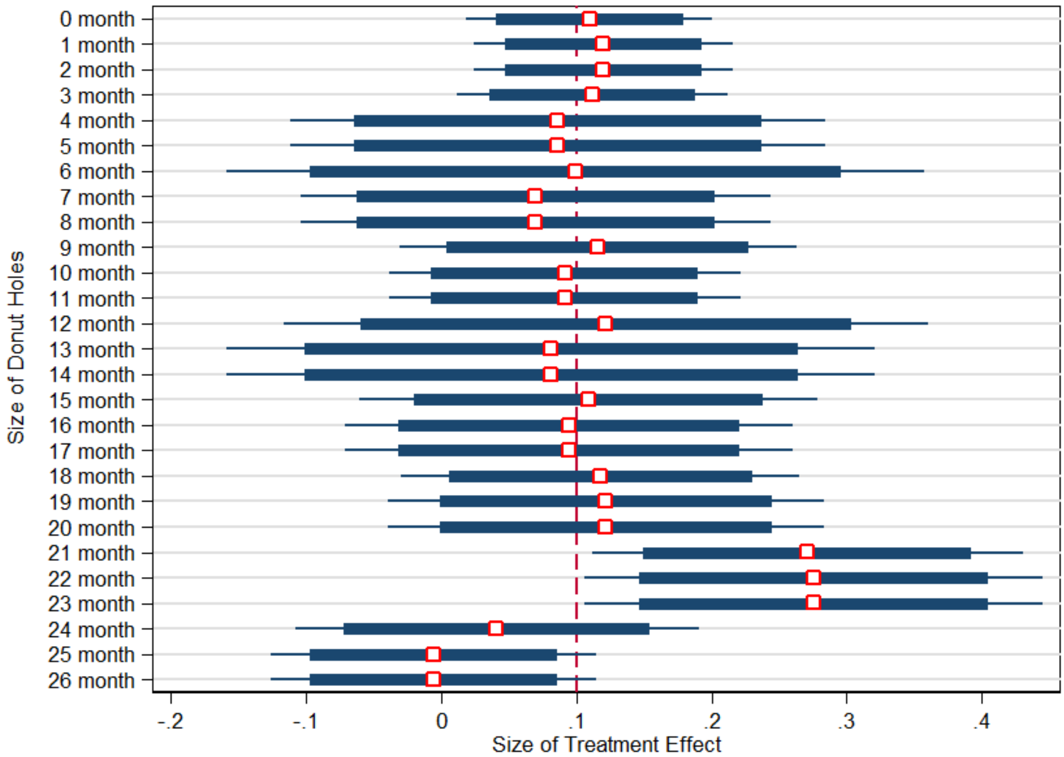

Figure 4 Donut-holes approach

Notes: The “donut-hole” sizes range from 0 to 26 months. The markers show the point estimates using different “donut-hole” sizes. Confidence spikes are reported for 99% and 95% confidence intervals. The vertical dash line refers to an average treatment effect of 10 percentage points.

Given that the donut-hole RD approach does not rule out the possibility that there is some degree of inter-temporal substitution of migration, or “delayed migration” in our context, the extent to which we can interpret the local average treatment effect as the net effect of retirement is a priori uncertain. While the donut-hole RD estimate strengthens the causal interpretation of the average treatment effect, it cannot be used to decompose the overall treatment effect into the part of migration that is caused by inter-temporal substitution and the net effect of retirement on migration.

To decompose the overall effect by assessing the importance of inter-temporal substitution of migration, we resort to a bunching approach. In so doing, we follow Ehrlich and Seidel (2018) and compare the observed percentage of migrants in the population over the normalized age to a counterfactual distribution calculated as if there was no statutory retirement. This allows us to infer the extent to which people delay migration when approaching retirement.

We follow the conventional method, compute the percentage of migrants in the population over normalized age, assign observations to evenly spaced bins (Calonico, Cattaneo, and Titiunik 2015), and depict the local averages by bin against the distance from the treatment threshold. Figure 5 illustrates the idea, where the dots represent the observed percentage of migrants in the population in each bin. The dashed curve depicts the counterfactual distribution of the percentage of migrants in the population obtained by fitting a flexible polynomial to the observed distribution, excluding observations within a range of 24 months around the statutory retirement age, and extrapolating the fitted distribution.[20] We also fit the distribution of the observed percentage of migrants in the population on both sides of the statutory retirement age separately as represented by the solid curves.

Two insights can be derived from this analysis. First, the intersections of the solid and dashed curves provide an estimate of the overall time horizon for migration reallocation. From Figure 5, we can see that reallocation starts approximately 2 years prior to the statutory retirement age and reaches to approximately 4 years after the statutory retirement age, implying reallocation happens over a period of approximately 6 years. Second, the difference between the observed and the counterfactual distributions (areas between the dashed and solid lines) provides us with an estimate of the associated mass of reallocated migration (Ehrlich and Seidel, 2018). We find that the missing mass on

[20] Results with an even larger range (e.g., 4 years) are very similar and are presented as robustness checks in the appendix.

the left side of the statutory retirement age accounts for approximately 38% (with 90% confidence interval between 36% and 42%) of the additional mass on the right side of the statutory retirement age. We interpret these results as evidence for substantial inter-temporal substitution of migration. That being said, the net migration effect of retirement is still dominant and accounts for 62% of the migration effects. Overall, our results support the first prediction of the simple model proposed in Section 3.

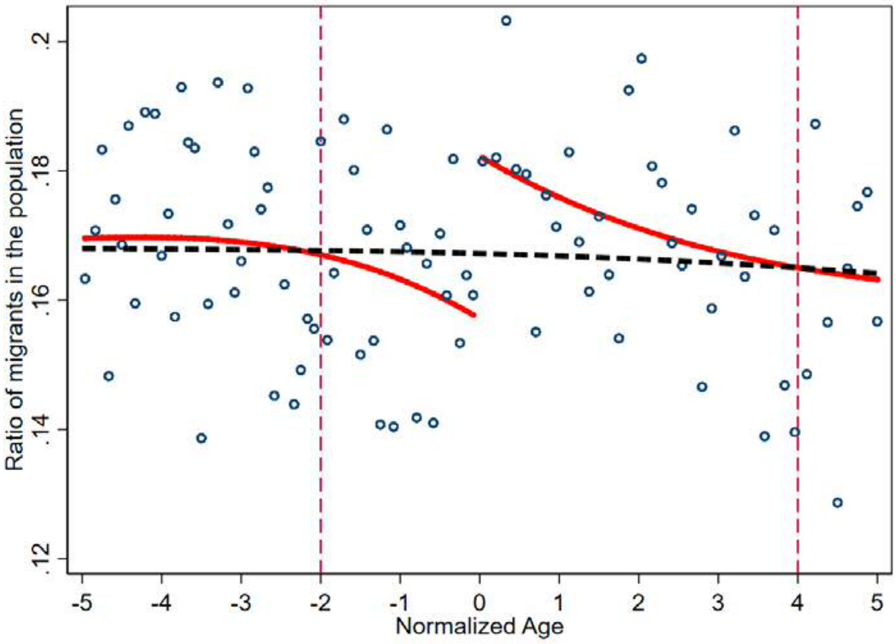

Figure 5 Bunching approach: Ratio of migrants in the population with NAH over normalized age
Notes: Observations are assigned to equally sized bins, where the dots illustrate the percentage of migrant in the population with NAH within bins. The bin is selected based on the IMSE-optimal evenly-spaced method of Calonico, Cattaneo, and Titiunik (2014b). The dashed line illustrates the estimated counterfactual distribution. The solid lines represent flexible polynomials fitted separately on both sides of the treatment threshold. Note that we drop observations in a range of 2 years around the treatment threshold to draw the counterfactual distribution of the ratio of migrants in the population with NAH.

5.5 Robustness checks

To further assess the robustness of our results, we considered the following changes. First, following Lee and Card (2008), we use standard errors clustered by the running variable to check whether our results are robust when allowing for a discrete running variable (age in terms of years and months). We report the estimation results in Table 3. We do not find substantial changes, suggesting that our main results are robust. Second, we use an instrumental variable approach to estimate the impact of retirement on migration decisions. We restrict the final sample based on the benchmark bandwidth and construct the instrumental variable based on whether an individual is eligible for retirement. The IV estimation results are shown in Table 4. We find that retirement increases the probability of migration by 11 percentage points, which is consistent using different model specifications. Therefore, our main results are robust with respect to the estimation approach adopted. Finally, we conduct two different placebo regressions. The first uses different placebo age thresholds, before and after the statutory retirement ages (shown in Table 5a). The second uses the sample of AH holders that is not affected by the statutory retirement ages (shown in Table 6a). Unsurprisingly, we do not find significant effects of retirement on migration decisions using both placebo analyses, further strengthening our main results that retirement is indeed an important causal driver of migration decisions. Given the fact that the denominator of the discontinuity estimand is nearly zero, making the point estimates largely imprecise, we also check the potential discontinuity at the artificial cut-offs without dividing by the change in the probability of retirement (the reduced form), and our results are generally robust (Results are shown in Tables 5b and 6b).

Table 3 Impact of retirement on migration decisions by considering discrete running variable

	(1)	(2)	(3)	(4)	(5)	(6)
Conventional	0.115	0.115	0.140	0.117	0.104	0.089
	(0.033)	(0.034)	(0.060)	(0.044)	(0.031)	(0.028)
Robust	0.129	0.129	0.165	0.143	0.132	0.134
	(0.038)	(0.039)	(0.079)	(0.061)	(0.044)	(0.040)
Bandwidth	4.6	4.6	2.3	3.4	5.7	6.9
Covariates	NO	YES	YES	YES	YES	YES
Observations	228,855	228,855	228,855	228,855	228,855	228,855

Notes: This table shows the impact of retirement on migration decisions using the RD design by considering the risks caused by a discrete running variable (Lee and Card 2008). We report both conventional and robust estimates. Conventional estimates refer to conventional RD estimates with conventional variance estimator. Robust estimates refer to bias-corrected RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). Column 1 reports the baseline model results. Column 2 reports the RD estimates by controlling for covariates such as education and ethnicity. Columns 1-2 select the bandwidth based on the MSE-optimal bandwidth selector (Calonico, Cattaneo, and Titiunik 2014b). Columns 3-6 take 50%, 75%, 125% and 150% of optimal bandwidth, respectively. Standard errors are clustered by the age variable and are reported in parentheses.

Table 4 Impact of Retirement on migration decisions using the IV approach

	(1) IV	(2) IV	(3) IV
Retirement	0.114	0.116	0.113
	(0.026)	(0.026)	(0.027)
Observations	63823	63823	63823

Notes: This table shows the impact of retirement on migration decisions using the IV approach. The instrumental variable takes the value 1 when the normalized age is equal to zero and above, and takes the value 0 otherwise. Column 1 controls for variables such as age, gender, education, ethnicity, and marriage status. Column 2 further controls for Age^2 and Column 3 further controls for Age^3. Samples are restricted based on the benchmark bandwidth (-4.6 to 4.6). Standard errors are in parentheses.

Table 5a Impact of retirement on migration decisions using alternative age cut-offs

	(1)	(2)	(3)	(4)	(5)	(6)
Conventional	-2.896	-0.039	0.249	-0.279	-0.369	-0.049
	(5.915)	(0.087)	(0.437)	(0.443)	(0.257)	(0.158)
Robust	3.525	-0.055	0.195	-0.082	-0.302	-0.037
	(6.368)	(0.096)	(0.506)	(0.472)	(0.273)	(0.171)
Age cut-offs	-0.5	0.5	-1	1	-2	2
Observations	228,855	228,855	228,855	228,855	228,855	228,855

Notes: This table conducts placebo analyses using alternative age cut-offs to estimate the impact of retirement on migration decisions. We report both conventional and robust estimates. Conventional estimates refer to conventional RD estimates with conventional variance estimator. Robust estimates refer to bias-corrected RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). The age cut-off for the benchmark model is 0. Columns 1 and 2 use -0.5 and 0.5 to conduct placebo analyses, Columns 3 and 4 use -1 and 1 to conduct placebo analyses, and Columns 5 and 6 use -2 and 2 to conduct placebo analyses. We select the bandwidth based on one common MSE-optimal bandwidth selector. Covariates are excluded. Standard errors are in parentheses.

Table 5b Reduced form results using alternative age cut-offs (reduced form results)

	(1)	(2)	(3)	(4)	(5)	(6)
Conventional	0.019	0.002	0.002	0.007	0.001	-0.001
	(0.007)	(0.005)	(0.007)	(0.005)	(0.007)	(0.006)
Robust	0.021	0.001	0.001	0.008	0.001	-0.000
	(0.008)	(0.006)	(0.008)	(0.006)	(0.008)	(0.007)
Age cut-offs	-0.5	0.5	-1	1	-2	2
Observations	228,855	228,855	228,855	228,855	228,855	228,855

Notes: This table conducts placebo analyses on reduced form results using alternative age cut-offs. We report both conventional and robust estimates. Conventional estimates refer to conventional RD estimates with conventional variance estimator. Robust estimates refer to bias-corrected RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). The age cut-off for the benchmark model is 0. Columns 1 and 2 use -0.5 and 0.5 to conduct placebo analyses, Columns 3 and 4 use -1 and 1 to conduct placebo analyses, and Columns 5 and 6 use -2 and 2 to conduct placebo analyses. We select the bandwidth based on one common MSE-optimal bandwidth selector. Covariates are excluded. Standard errors are in parentheses.

Table 6a Impact of retirement on migration decisions using the sample of agricultural *Hukou* holders

	(1)	(2)	(3)	(4)	(5)	(6)
Conventional	1.178	1.025	-9.944	3.409	0.392	0.112
	(3.694)	(2.651)	(76.294)	(12.075)	(1.385)	(0.583)
Robust	2.270	1.870	20.520	17.626	1.891	0.293
	(4.145)	(3.019)	(116.338)	(17.902)	(2.023)	(0.855)
Bandwidth	2.4	2.4	1.2	1.8	3.1	5
Covariates	NO	YES	YES	YES	YES	YES
Observations	493,640	493,640	493,640	493,640	493,640	493,640

Notes: This table conducts the placebo analyses in the sample of agricultural *Hukou* holders to estimate the impact of retirement on migration decisions using the RD design. We report both conventional and robust estimates. Conventional estimates refer to conventional RD estimates with conventional variance estimator. Robust estimates refer to bias-corrected RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). Columns 1-2 select the bandwidth based on one common MSE-optimal bandwidth selector. Column 1 reports the benchmark model results. Column 2 reports the RD estimates by controlling for covariates such as education and ethnicity. Columns 3-6 take 50%, 75%, 125% and 150% of benchmark bandwidth, respectively. Standard errors are in parentheses.

Table 6b Reduced reform results using the sample of agricultural *Hukou* holders

	(1)	(2)	(3)	(4)	(5)	(6)
Conventional	0.000	0.000	0.003	0.002	0.001	0.000
	(0.002)	(0.002)	(0.004)	(0.003)	(0.002)	(0.002)
Robust	0.000	0.001	0.007	0.004	0.002	0.001
	(0.003)	(0.003)	(0.006)	(0.005)	(0.003)	(0.003)
Bandwidth	2.4	2.4	1.2	1.8	3.1	5
Covariates	NO	YES	YES	YES	YES	YES
Observations	493,640	493,640	493,640	493,640	493,640	493,640

Notes: This table conducts the placebo analyses on the reduced form results using the sample of agricultural *Hukou* holders. We report both conventional and robust estimates. Conventional estimates refer to conventional RD estimates with conventional variance estimator. Robust estimates refer to bias-corrected RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). Columns 1-2 select the bandwidth based on one common MSE-optimal bandwidth selector. Column 1 reports the benchmark model results. Column 2 reports the RD estimates by controlling for covariates such as education and ethnicity. Columns 3-6 take 50%, 75%, 125% and 150% of benchmark bandwidth, respectively. Standard errors are in parentheses.

6 Who is more likely to migrate after retirement?

6.1 Subgroups

We have shown that retirement increases migration propensity significantly, which is consistent with our simple model of migration. This section explores further who is more likely to migrate after retirement. Specifically, we investigate the impact of retirement on migration decisions by gender, education groups, whether the individual has access to social security, average housing costs in the registered place, and the type of registered place. The education level is categorized as low (highest degree achieved includes primary school, junior high school, and senior high school), or high (highest degree achieved includes vocational school, "two-/three-year college/associate degree", “four-year undergraduate/bachelor degree”, master degree, or doctoral degree). In addition, we use the following questions to determine access to social security: “do you have medical insurance?” and “do you have pension?” If an individual answers with “yes” to either one of these questions, s/he will be categorized as having access to social security. Moreover, we use the following questions to determine the costs of purchasing/renting the current accommodation and the size of current accommodation (per square meter): “what’s the nature of your current accommodation?” If an individual answers with owning/renting the accommodation, s/he will further answer the total costs of owning/renting the current accommodation as well as size of the accommodation (in meter squares) accordingly. We then calculate the average costs of owning and renting an accommodation (per square meter) in each (registered) city, respectively. We define individuals exposed to relatively higher housing costs as individuals registered in a city with average housing costs above the median value of the average housing costs distribution, and define individuals exposed to relatively lower housing costs as individuals registered in a city with average housing costs below the median value of the average housing costs distribution). Finally, we use the following question to determine the type of registered place: “what is your type of registered place?” If an individual answers with urban (rural), s/he will be a migrant registered in urban (rural) areas.

6.2 Main Results

Table 7 shows the results by subgroups. We find that the causal effects of retirement on migration vary significantly across gender. First, while retirement increases the probability of migration for men by 27 percentage points (Column 1), the increase is much smaller for women (Column 2). Second, retirement has a large and significant effect for the low-educated group, yet only a moderate and insignificant effect for the high-educated group (Columns 3 and 4), suggesting that migration after retirement mainly occurs among lower-educated people. Third, retirement has a larger effect on migration for people who do not have access to social security than for those who do (Columns 5-8). Specifically, retirement leads to an increase of 39 percentage points in the probability of migration for individuals with no access to pension. By contrast, we find a much smaller impact of retirement on the migration probability when retirees have access to pension. Fourth, retirement has a larger effect on migration for people who are registered in cities with relatively higher costs of owning (or renting) an accommodation. Specifically, retirement leads to an increase of 15 percentage points in the probability of migration for individuals registered in cities with relatively higher costs of owning an accommodation (Column 9). By contrast, we find a much smaller impact of retirement on the migration propensity when retirees are registered in cities with relatively lower costs of owning an accommodation (Column 10). We find similar results when using the costs of renting an accommodation to capture housing costs (Columns 11-12). Finally, we find retirement results in a significant increase in the migration probability for individuals who are registered in urban areas (Column 13). We do not find significant evidence that retirement results in more migration from rural areas (Column 14). To summarize, retirement-induced migrants are mainly from urban areas, they are typically less well educated, they are more likely to suffer from restricted access to social security, and they are more likely to migrate from places with higher housing (living) costs.[21] These results are again all consistent with the model proposed in Section 3.

[21] An alternative explanation is that there are more migrants among those without a pension because those people do not have to give up a pension when they migrate. In this paper, we focus on temporary migrants who do not change their *Hukou* registration after migration. This means that the social security status, which is tied to the *Hukou* system, does not change after migration, reducing this concern to some extent.

Table 7 Heterogeneous effects of retirement on migration

VARIABLES	(1) Male	(2) Female	(3) College	(4) No College	(5) Pension	(6) No Pension	(7) Medical Insurance	(8) No Medical Insurance
Conventional	0.242	0.075	0.050	0.134	0.079	0.346	0.086	0.218
	(0.110)	(0.041)	(0.101)	(0.036)	(0.033)	(0.136)	(0.033)	(0.077)
Robust	0.277	0.073	0.050	0.150	0.093	0.395	0.098	0.248
	(0.127)	(0.049)	(0.123)	(0.040)	(0.039)	(0.156)	(0.038)	(0.085)
Observations	133,422	95,433	43,470	185,385	166,779	62,076	166,990	61,865

VARIABLES	(9) High own cost	(10) Low own cost	(11) High rents	(12) Low rents	(13) Urban	(14) Rural	(15) Labor migration	(16) Family
Conventional	0.136	0.059	0.137	0.069	0.108	0.008	0.003	0.101
	(0.037)	(0.089)	(0.039)	(0.049)	(0.030)	(0.009)	(0.015)	(0.025)
Robust	0.149	0.061	0.151	0.080	0.119	0.011	0.007	0.110
	(0.041)	(0.107)	(0.042)	(0.055)	(0.034)	(0.010)	(0.016)	(0.029)
Observations	154,344	74,510	129,339	99,515	228,855	228,855	228,855	228,855

VARIABLES	(17) Other	(18) Household	(19) Individual
Conventional	0.002	0.160	0.015
	(0.013)	(0.072)	(0.038)
Robust	0.001	0.190	0.004
	(0.016)	(0.080)	(0.046)
Observations	228,855	152,004	152,004

Notes: This table shows the causal effects of retirement on migration by subgroups using the RD design. We report both conventional and robust estimates. Conventional estimates refer to conventional RD estimates with conventional variance estimator. Robust estimates refer to bias-corrected RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). Columns 1 and 2 report the effects of retirement on migration for men and women, respectively. Columns 3 and 4 report the effects of retirement on migration for individuals with and without college degree (and above). Columns 5 and 6 report the effects of retirement on migration for individuals with and without pension. Columns 7 and 8 report the effects of retirement on migration for individuals with and without medical insurance. Columns 9-10 report the effects of retirement on migration for individuals exposed to higher and lower costs of owning an accommodation in registered cities, respectively. Columns 11-12 report the effects of retirement on migration for individuals exposed to higher and lower costs of renting an accommodation in registered cities, respectively. Columns 13-14 report the effects of retirement on migration from urban areas and migration from rural areas, respectively. Columns 15-17 report the effects of retirement on work relevant migration, family relevant migration and other migration, respectively. Columns 18-19 report the effects of retirement on migration with partner and migration without partner, respectively. We select the bandwidth based on MSE-optimal bandwidth selector. Covariates are excluded. Standard errors are in parentheses.

7 Why does migration rebound after retirement?

As we have discussed above, urban vulnerable people (e.g., the less well educated with restricted access to social security and high living costs) are more likely to choose migration after retirement. In this section, we further explore the most likely mechanisms behind.

7.1 General motives for retirement-induced migration

To shed more light on the reasons why people migrate after retirement, we resort to the following question in the questionnaire to define migration motives: why did you live away from your registered place? In general, there are three types of migrants categorized by migration motives: labor migrants, family migrants, and other migrants. We define labor migrants as individuals who migrate for work-related reasons (e.g., people migrate to another place to find a job). We define family migrants as individuals who migrate for family-related reasons (e.g., people migrate to another place to live with their children, relatives etc.). When an individual migrates for neither work-related reasons nor family-related reasons, s/he is categorized as other migrant. We investigate which type of migration is actually induced by retirement. Table 7 shows the corresponding RD results. We find that retirement encourages migration for family-related reasons significantly (Column 16). By contrast, we do not find significant evidence that retirement affects migration for work-related reasons (Column 15) and for other reasons (Column 17). Therefore, retirement-induced migration is largely driven by family-related motivations.

[Table 7]

7.2 Do retirees migrate to support their families (children)?

There are at least two different types of family-oriented migration. The first one is to support family members in the receiving households (e.g., looking after grandchildren). The second one is to receive support from family members in the receiving households to insure against adverse income shocks. The policy implications of these two types of migration would be quite different. Our previous findings that vulnerable people are more likely to migrate after retirement suggest that the latter channel is more important.

We move a bit further by testing the alternative mechanism that retirees migrate to the receiving households to support their adult children (-in-law). The null hypothesis is that market production of their adult children would increase if retirees migrate to support their adult children (in-law) such as looking after grandchildren, due to re-allocation of adult children's working time from home production to market production. Otherwise, we should witness decreasing market production of their adult children in the receiving households if retirees' migration decisions are driven by relying on their adult children for old age support.[22]

An ideal test would be to compare the children who have parents aged right before the retirement age and the children whose parents are aged right after the retirement age, regardless of whether children and parents live together. However, our dataset does not permit such an empirical exercise. Our dataset only allows us to link parents and children who live together or those who do not live together currently but are registered in the same household.[23] Therefore, we should interpret our results with more caution due to this sample selection problem.[24] We examine the impact of parental retirement on market production decisions of their children (-in-law) in the same household under an RD framework.

We restrict our sample to individuals who can be matched with their children or children-in-law. The final sample size is 133,922. We resort to three indicators for our main analyses: Children (-in-law)'s labor market participation decision, weekly working hours, and monthly income. The main results are reported in Table 8. Column (1) examines the impact of parental retirement on their children (-in-law)'s market production decisions. We find that parental retirement slightly decreases the market production probability of their children (-in-law) by 3.5% but this is not statistically significant at the conventional level.[25] Column (4) examines the impact of parental retirement on their children (-in-law)'s weekly working hours in the market production. We find that parental retirement decreases weekly working hours of their children (-in-

[22] An alternative story could be tied to income effects of labor supply. We will also discuss this channel later.

[23] Specifically, if parents and children are registered in the same household, when either parents or children are temporarily migrating to another place, we could still link parents and children in our dataset.

[24] The sample selection problem may not be a serious concern if parental retirement affects market production of their children (-in-law) only when they live in the same household. If children (-in-law) who live separately from their parents are spending more time in market production than their counterparts living with their parents prior to parental retirement, the sample selection problem suggests that our estimates are biased upward if retirees rely on more support from their children.

[25] One explanation for the (statistically insignificant but) negative impact of parental retirement on their children (-in-law)'s labor market participation rate is the sample selection problem, which makes the estimate biased upward.

law) by 7.1% on average.[26] Column (7) further shows that parental retirement decreases monthly income of their children (-in-law) by 23.8% on average.

While these findings alleviate the concern that retirees migrate to support their adult children (in-law) in terms of looking after grandchildren, an alternative explanation for the decreasing market production of retirees' adult children in the receiving households could be tied to income effects. If retirees bring financial resources to the household, this might reduce incentives for children to work. However, our previous findings suggest that it is less likely to be true in our context as retirement-induced migrants are relatively disadvantaged older adults. To move forward a bit more, we compare labor market responses in (receiving) households with different ownership of current accommodation.[27] "Rich households" (with ownership of current accommodation) are much less likely to be affected by financial resources brought by older adults than "poor households" (without ownership of current accommodation). We find that the labor market responses above are more pronounced in "rich households" (Columns (2), (5), (8)). These findings further alleviate the concern that the labor market responses above are mainly driven by income effects of labor supply. In sum, we did not find significant evidence suggesting that parental retirement allows their children (-in-law) to participate more in market production. Quite the contrary, our findings indicate that parental retirement reduces the market production of their children (-in-law) at the intensive margin.

Column (10) uses the matched sample to estimate the impact of retirement on parental migration decisions. Unsurprisingly, we find that retirement increases the probability of parental migration by 16.2 percentage points, a bit larger than that of the benchmark model (12.9). Columns (11) and (12) contain estimates of the impact of retirement on the probability of parental migration by the migration status of their children (-in-law). We find evidence that the migration impact is much larger when the retirees' children (-in-law) are currently migrants (40.8 p.p.) compared to their counterparts whose children (-in-law) are not migrants (6.6 p.p.). All these results suggest that relying on

[26] Given the sample selection problem discussed above, this estimate is more likely to be biased upward. In other words, we estimate a *lower* bound of the negative impact of parental migration on their children (-in-law)'s market production at the intensive margin.

[27] An ideal test would be investigating how labor market responses vary across retirees with different wealth. Unfortunately, we do not have data on the wealth of retirees.

old age support from their children (-in-law) in migration is an important mechanism behind the retirement-induced migration in China.

[Table 8]

7.3 Does retirement cause negative income and health shocks?

We have shown that, rather than supporting families in the receiving households, retirees are more likely to rely on support from families in the receiving households, reducing the market production of adult children in the receiving households. So why do older adults migrate for old age support after retirement? One potential reason for migration comes from the consideration of future incomes. For example, reductions in income and rising income uncertainty after retirement may encourage older adults to migrate to get better financial support from other family members or to reduce living expenses. Table 9 shows the RD estimates regarding the impact of retirement on income-related outcomes. The results show that both income and working time decrease strongly after retirement (Columns 1-6). We also find that retirement leads to a higher dependence on pension as the main source of living expenses (Columns 7-9). Moreover, we have shown before that the retirement impact on migration is larger for individuals with no access to pension. Therefore, these findings suggest that retirees migrate to insure against reductions in income after retirement.

[Table 9]

Another possible explanation is that older adults migrate to insure against their rising health risks after retirement. Existing studies suggest that retirement increases healthcare utilization in China (Zhang, Salm, and van Soest 2018). In the presence of inadequate public healthcare, people may resort to their family members for informal healthcare, particularly when retirement increases their demand for healthcare. This is consistent with our previous findings that vulnerable people who have limited access to public healthcare services are more likely to migrate upon retirement. To make these arguments more convincing, we explore the impact of retirement on self-reported health further, as shown in Table 9.[28] We find that retirement deteriorates health significantly (Columns 10-12). Specifically, retirement leads to a 0.11 unit change in heath on a 1-3 scale. The results are robust against using an alternative health indicator (Columns 13-

[28] The indicator of self-reported health takes the value of one for people in good health, the value of two for people with fair health, and the value of three for people with bad health.

15)[29] and the large health impact of retirement for men is consistent with previous findings (Lei, Tan, and Zhao 2011; Fitzpatrick and Moore 2018). These findings suggest that increasing health risks after retirement induce retirees to migrate to live with their families.

7.4 Do retirees migrate to reduce living costs?

A competing explanation is that people move from areas with high living costs to areas with low living costs after retirement to reduce living costs by their own, rather than moving for old age support from their adult children in migration. When people make a location choice, they take into account labor market conditions, housing costs, amenity, etc. Retirement means that labor market conditions become a much less important factor, while the relative importance of the other factors rises. Thus, the migration probability increases because the optimal location could change. To test this channel, we resort to information on the ownership of the current accommodation as well as the costs of purchasing or renting the current accommodation and estimate the impact of retirement on these costs. The main results are reported in Table 10. We did not find significant evidence showing that retirement affects ownership of accommodation or costs of purchasing/renting the accommodation, suggesting that reducing housing (living) costs by their own is not the main reason for the rebounding migration after retirement.

[Table 10]

7.5 Household-level migration decisions after retirement

While both reductions in income and increased health risks can partly explain the rebounding migration propensity after retirement, it is still puzzling why migration triggered by retirement is stronger for men than for women. One possibility is that retirement results in larger reductions in income and higher health risks for men relative to women. While a larger negative health impact of retirement is indeed found for men relative to women, we failed to find significant differences in the impacts of retirement on income and the main sources of living expenses across gender. Therefore, the heterogeneous income and health impacts of retirement across gender cannot fully

[29] When using an alternative indicator of good health, which equals to one for good health and zero otherwise, we find retirement decreases the probability of good health by 20 and 4 percentage points for men and women, respectively.

explain the larger impact of retirement on migration for men.

An alternative explanation for the heterogeneous migration responses across gender is that migration decisions of older individuals are made at the household level. With the large gap between statutory retirement ages for men and women, even though a woman has reached her retirement age, her husband may not have reached his retirement age, and as a result, she may choose to wait to migrate until her husband can retire and migrate as well. To verify this argument, we restrict our sample to individuals who can be matched with their partners. To increase the sample size, we also include individuals who did not engage in paid work for reasons such as being students, being unemployed, and other reasons. Our final sample size is 152,004. To examine the impact of retirement on migration decisions at the household level, we also redefine the retirement age as the one of the spouse with the later retirement date. We define household-level migration as the situation in which both partners migrate and individual-level migration as the situation in which one partner is left behind. The main results are reported in Columns 18-19 of Table 7. We find that retirement results in a significant 19 percentage points increase in the migration probability at the household level. By contrast, we did not find a significant impact of retirement on the migration propensity at the individual level. Therefore, the different migration responses after retirement across gender can be reconciled by migration decisions being made at the household level rather than at the individual level.

Overall, retirees migrate for old age support from their adult children in migration to insure against reductions in future incomes and increased health risks upon retirement, at the expense of reducing market production of their adult children in the receiving households. We do not find evidence supporting alternative mechanisms that retirees migrate i) to support their children in the receiving households, or ii) to reduce living costs after retirement by their own. The heterogeneous retirement effects on migration across gender can be well reconciled with the household-level migration decisions after retirement.

Table 8 Impact of parental retirement on children (in-law)'s labor market outcomes

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Labor market participation decision	Ownership of current accommodation	No ownership	Weekly Working Hours (in log)	Ownership of current accommodation	No ownership
Conventional	0.003	-0.091	0.241	-0.069	-0.090	0.007
	(0.063)	(0.083)	(0.113)	(0.034)	(0.038)	(0.061)
Robust	-0.035	-0.144	0.246	-0.071	-0.094	0.004
	(0.076)	(0.098)	(0.138)	(0.037)	(0.043)	(0.074)
Observations	133,922	113,332	16,612	56,385	48,878	6,143
	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	Monthly wage (in log)	Ownership of current accommodation	No ownership	Parental migration decisions	Parental migration (children in migration)	Parental migration (children not in migration)
Conventional	-0.130	-0.221	0.135	0.144	0.354	0.061
	(0.114)	(0.141)	(0.188)	(0.045)	(0.122)	(0.032)
Robust	-0.238	-0.344	0.012	0.162	0.408	0.066
	(0.137)	(0.169)	(0.227)	(0.048)	(0.146)	(0.038)
Observations	56,772	49,233	6,159	133,922	20,254	113,429

Notes: This table shows the impact of parental retirement on children's labor market outcomes using the RD design. We report both conventional and robust estimates. Conventional estimates refer to conventional RD estimates with conventional variance estimator. Robust estimates refer to bias-corrected RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). We use the same Census Survey data to conduct this analysis by restricting our samples to individuals who can be matched with their children (-in-law). Columns 1-3 show the effects of retirement on children (in-law)'s labor market participation decision for all households, households with ownership of current accommodation, and households without ownership of current accommodation, respectively. Columns 4-6 show the effects of retirement on children (-in-law)'s weekly working hours for all households, households with ownership of current accommodation, and households without ownership of current accommodation, respectively. Columns 6-9 show the effects of retirement on children (-in-law)'s monthly income for all households, households with ownership of current accommodation, and households without ownership of current accommodation, respectively. Column 10 uses the restricted sample to estimate the impact of retirement on individuals' migration decisions. Column 11 uses the restricted sample to estimate the impact of retirement on individuals' migration decisions when retirees' children are currently migrants. Column 12 uses the restricted sample to estimate the impact of retirement on individuals' migration decisions when retirees' children are currently not migrants. We select the bandwidth based on MSE-optimal bandwidth selector. Covariates are excluded. Standard errors are in parentheses.

Table 9 Impact of retirement on other outcomes

VARIABLES	(1) Income	(2) Male	(3) Female	(4) Working Hours	(5) Male	(6) Female	(7) Pension as main sources of living	(8) Male	(9) Female
Conventional	-6.769	-7.149	-6.678	-3.631	-3.628	-3.656	1.061	1.121	1.016
	(0.056)	(0.181)	(0.092)	(0.030)	(0.132)	(0.064)	(0.015)	(0.049)	(0.021)
Robust	-6.800	-7.145	-6.725	-3.632	-3.634	-3.657	1.058	1.135	1.009
	(0.068)	(0.198)	(0.105)	(0.036)	(0.145)	(0.069)	(0.018)	(0.059)	(0.023)
Observations	228,855	133,422	95,433	228,855	133,422	95,433	228,855	133,422	95,433
VARIABLES	(10) Self-report Health	(11) Male	(12) Female	(13) Good Health	(14) Male	(15) Female			
Conventional	0.105	0.253	0.040	-0.079	-0.195	-0.036			
	(0.034)	(0.123)	(0.020)	(0.022)	(0.102)	(0.023)			
Robust	0.115	0.263	0.049	-0.092	-0.206	-0.041			
	(0.038)	(0.136)	(0.024)	(0.027)	(0.112)	(0.026)			
Observations	228,855	133,422	95,433	228,855	133,422	95,433			

Notes: This table shows the impact of retirement on other outcomes using the RD design. We report both conventional and robust estimates. Conventional estimates refer to conventional RD estimates with conventional variance estimator. Robust estimates refer to bias-corrected RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). Columns 1-3 report the impact of retirement on income in log using full, male only, and female only sample, respectively. Columns 4-6 report the impact of retirement on working hours in log using full, male only, and female only sample. Columns 7-9 report the impact of retirement on the probability of resorting to pension as main sources of living expenditures using full, male only, and female only sample. Columns 10-12 report the impact of retirement on self-reported health using full, male only, and female only sample. Columns 13-15 report the impact of retirement on the probability of having a good health using full, male only, and female only sample. We select the bandwidth based on MSE-optimal bandwidth selector. Covariates are excluded. Standard errors are in parentheses

Table 10 Retirement and housing arrangements

	(1)	(2)	(3)
Conventional	0.001	0.016	0.064
	(0.031)	(0.118)	(0.187)
Robust	0.004	-0.015	0.056
	(0.035)	(0.140)	(0.205)
Observations	228,855	136,585	31,350

Notes: This table shows the impact of retirement on housing arrangements. We report both conventional and robust estimates. Conventional estimates refer to conventional RD estimates with conventional variance estimator. Robust estimates refer to bias-corrected RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). We distinguish between people with house ownership and without house ownership (e.g. rent). Column 1 shows the impact of retirement on the probability of living in a house with ownership. Column 2 shows the impact of retirement on the costs of purchasing the house among people with house ownership. Column 3 shows the impact of retirement on the costs of renting the house among people without house ownership. Standard errors are in parentheses

8 Other evidence on retirement-induced migration

In the section, we further explore the destinations as well as duration of these retirement-induced migration.

8.1 Where do retirees migrate to?

We explore the geographical aspects of retirement-induced migration. Table 11 reports the main findings. We start by distinguishing between migration to urban areas and migration to rural areas. Using the same RD design, we find that retirement-induced migration is mainly driven by migration to urban areas (Columns 1-2). We then distinguish between intra-city migration and inter-city migration and find that retirement-induced migration is mainly driven by intra-city migration, or migration within the same city (Columns 3-4). These findings are consistent with the fact that most of younger adults who are NAH holders migrate to different urban locations within the same city. [30] In other words, the geographical aspects of retirement-induced migration is largely determined by migration destinations of their adult children. As more and more adult children migrate to other cities and provinces, caused by a more relaxed migration policy, the geographical aspects of retirement-induced migration are likely to change accordingly.

8.2 New arrivals or old migrants?

It is still unclear on whether the retirement-induced migration is driven by new arrivals who migrate recently or by old migrants who have lived away from their registered places for a long time (e.g., more than five years). Specifically, we distinguish between migrants who have lived away from their registered place for more than five years and migrants who have lived away from their registered place for less than five years. Using the same RD design, we find that the migration impact of retirement is significant for both types of migration (Columns 5-6 of Table 11), suggesting that retirement-induced migration is not only induced by older adults who are previously non-migrants and migrate to the destinations upon retirement but is also induced by older adults who are previously migrants but choose to stay longer in destinations upon retirement.

[30] According to our data, among migrants who are nonagricultural *Hukou* holders and between 16 and 40 years old, 34% migrated to other cities, and 66% of them migrated to unregistered places within the same city. By contrast, among migrants who are agricultural *Hukou* holders and between 16 and 40 years old, 74% migrate to other cities, and 26% of them migrated to unregistered places within the same city.

Table 11 Retirement and Migration (by location and duration)

VARIABLES	(1) Migrate to urban	(2) Migrate to rural	(3) Intra-city migration	(4) Inter-city migration	(5) long-term migration	(6) short-term migration
Conventional	0.097	0.025	0.112	0.014	0.068	0.066
	(0.029)	(0.013)	(0.030)	(0.015)	(0.025)	(0.023)
Robust	0.107	0.030	0.124	0.015	0.077	0.072
	(0.033)	(0.014)	(0.033)	(0.017)	(0.027)	(0.028)
Observations	225,063	194,334	221,224	198,173	208,188	211,209

Notes: This table shows the impact of retirement on migration decisions by migration location and duration. We report both conventional and robust estimates. Conventional estimates refer to conventional RD estimates with conventional variance estimator. Robust estimates refer to bias-corrected RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). Columns 1-2 report the impact of retirement for migration to urban areas and migration to rural areas, respectively. Columns 3-4 report the impact of migration for intra-city migration and inter-city migration, respectively. Columns 5-6 shows the impact of migration for long-term migration (defined as individuals who have lived away from their registered places for more than five years) and short-term migration, respectively. Standard errors in parentheses

9 Conclusion

To the best of our knowledge, this is the first study to examine the causal effects of retirement on migration behavior under an RD framework, using a large-scale nationally representative population-based dataset. Our findings show that retirement increases the migration probability by 12.9 percentage points, and approximately 38% of the total migration effects are caused by intertemporal substitution (delayed migration).

Our finding that migration rebounds after retirement contrasts with the conventional wisdom that the migration propensity decreases as people get older. Important lessons to be taken from our study are that i) older adults are likely to migrate because of increasing demand for old age support after retirement, particularly when government-financed social security benefits are inadequate and the massive adult children migration fails to guarantee the old age support from children for older parents left behind; and ii) difficulties in collecting pension and health insurance prevents people from migrating after retirement, and, if they migrate, increase the burden on the younger adults to which retirees migrate. Thus, reforming the *Hokou* system so as to make social security more flexible and portable, would likely result in efficiency gains.

Our study also sheds light on the changing patterns of intergenerational co-residence in both developed and developing countries. Previous studies in rich countries such as United States emphasize that young adults are increasingly more likely to move back home to live with their parents to cope with the adverse labor market outcomes. By contrast, our study shows that in developing countries like China, older people are moving away from their home to their adult children in migration to cope with the income and health risks after retirement, which is the flip phenomenon to some extent.

Finally, our study sheds light on the labor market consequences of retirement-induced migration on receiving households. According to our findings, parental retirement significantly reduces weekly working hours and monthly income of their children (-in-law) in the receiving households by 7% and 23% on average, respectively. These results suggest that retirement-induced migration acts as an important channel to impact labor supply decisions of the young population (Börsch-Supan 2013). Therefore, it is important for policy makers to consider the spill-over effects on the young adults when changing the statutory retirement age policies.

There are several limitations of this study. First, we cannot rule out the possibility that migration affects health, which may weaken the mechanisms discussed above. For example, when there is poor portability of social security such as medical insurance, migrants are subject to higher medical costs at the destination. These higher medical costs discourage healthcare utilization and in turn affect migrants' health negatively. These effects tend to be relatively large for migrants who have been previously covered by medical insurance in the origin region. However, we think that this issue is less problematic in our context because migration effects after retirement are more pronounced for those vulnerable people who have no access to social security to begin with. Second, we cannot simply extend our findings to agricultural *Hukou* holders, who are more likely to migrate but are hardly affected by the mandatory retirement policy. Third, we cannot identify return migrants as well as migrants who obtained a local *Hukou*, suggesting that our main results provide a lower bound of the migration impact of retirement to some extent.

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Appendix

A1. Additional figures

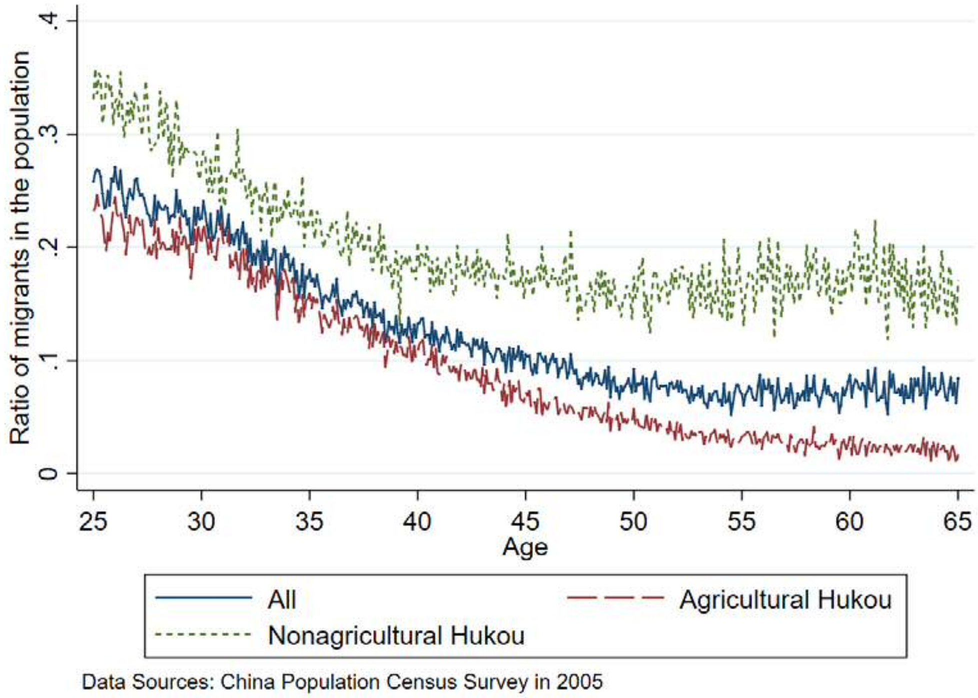

Figure A1 Age and percentage of migrants in the population by cohorts

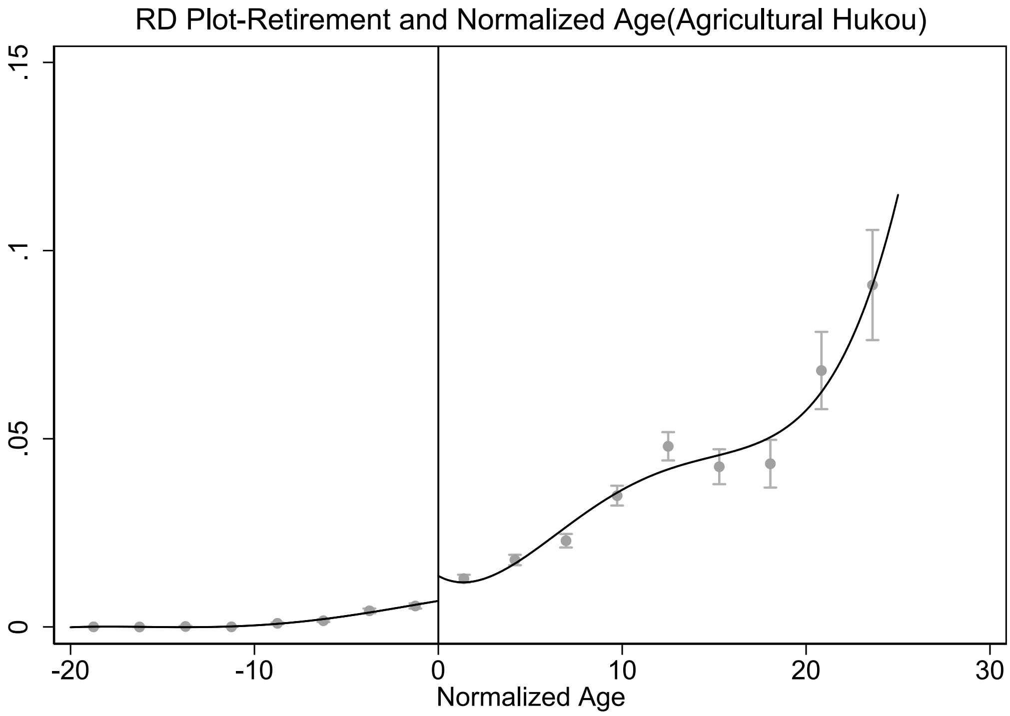

Figure A2 Retirement ratio and age for agricultural *Hukou* holders

Notes: The bin is selected based on IMSE-optimal evenly-spaced method based on (Calonico, Cattaneo, and Titiunik 2014b).

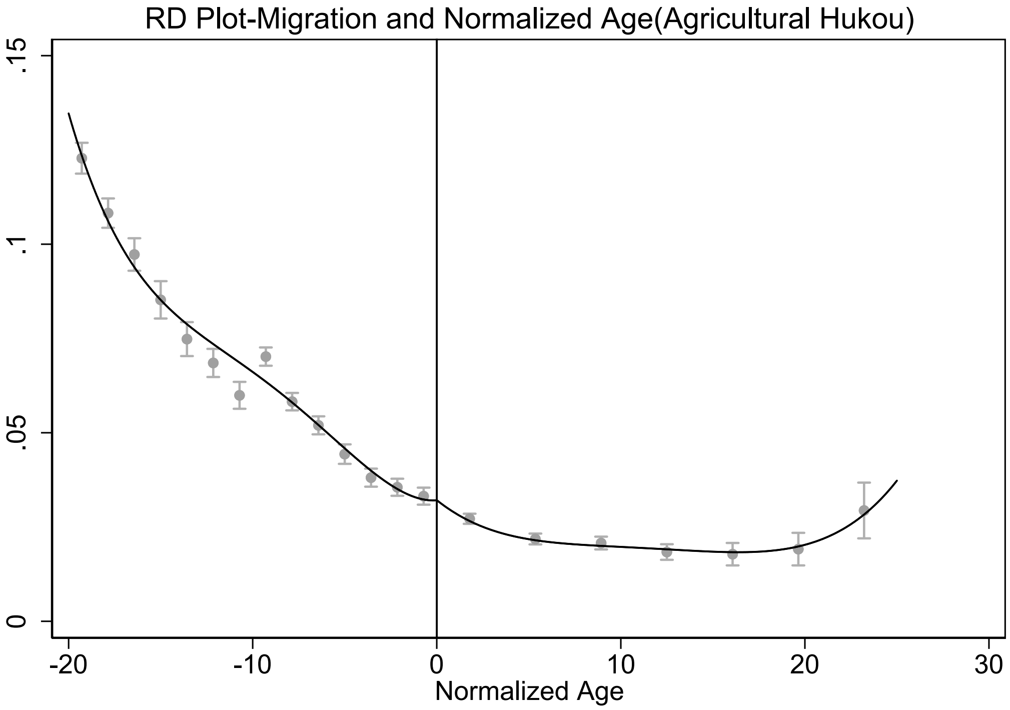

Figure A3 Retirement and migration for agricultural *Hukou* holders
Notes: The bin is selected based on IMSE-optimal evenly-spaced method based on (Calonico, Cattaneo, and Titiunik 2014b).

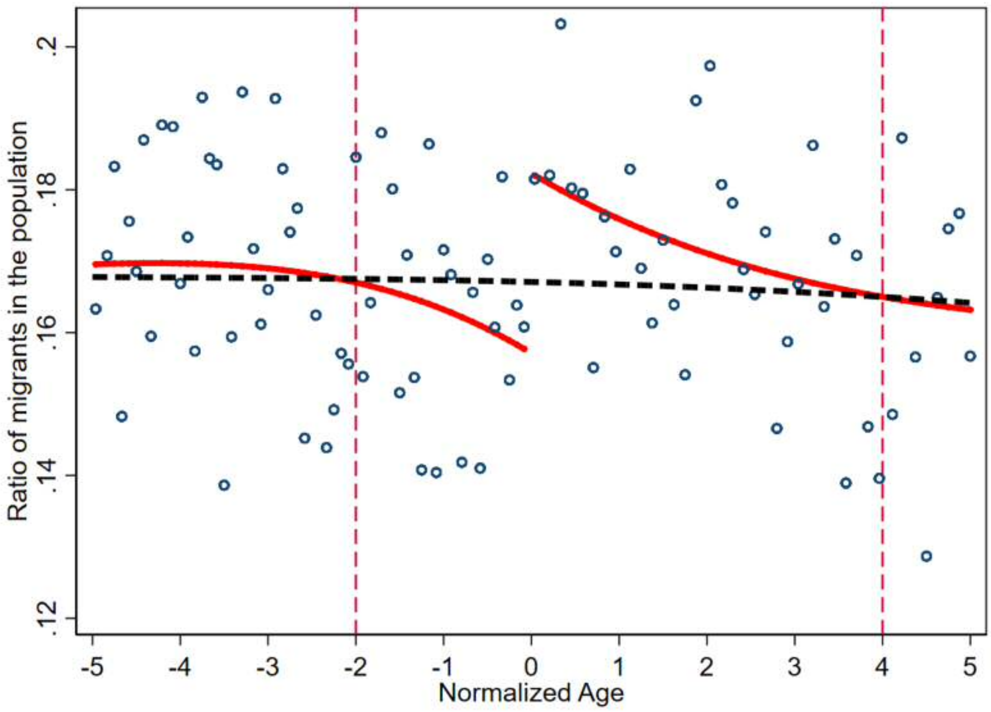

Figure A4 Bunching approach: Ratio of migrants in the population over normalized age
Notes: Observations are assigned to equally sized bins, where the dots illustrate local averages of the ratio of migrants in the population within bins. The bin is selected based on the IMSE-optimal evenly-spaced method of Calonico, Cattaneo, and Titiunik 2014b. The dashed line illustrates the estimated counterfactual distribution. The solid lines represent flexible polynomials fitted separately on both sides of the treatment threshold. Note that we drop observations in a range of 4 years around the treatment threshold to draw the counterfactual distribution of the ratio of migrants in the population.

A2. Summary Statistics

Table A1 Summary statistics by *Hukou* type

	(1)	(2)	(3)	(4)
	AH		NAH	
VARIABLES	N	mean	N	mean
Age	1,856,084.00	33.83	715,756.00	37.40
Self-report health(=1,2,3,4)	1,856,084.00	1.10	715,756.00	1.09
[1]Good health	1,856,084.00	0.93	715,756.00	0.93
[2]Fair	1,856,084.00	0.04	715,756.00	0.05
[3]Bad	1,856,084.00	0.03	715,756.00	0.01
[4]Uncertain	1,856,084.00	0.00	715,756.00	0.00
Male(=0,1)	1,856,082.00	0.50	715,755.00	0.51
[0]Female	1,856,082.00	0.50	715,755.00	0.49
[1]Male	1,856,082.00	0.50	715,755.00	0.51
Education Degree(=1,2,3,4,5,6,7)	1,730,568.00	2.44	681,017.00	3.53
[1]No school	1,730,568.00	0.13	681,017.00	0.04
[2]Primary school	1,730,568.00	0.39	681,017.00	0.17
[3]Junior high school	1,730,568.00	0.40	681,017.00	0.31
[4]Senior high school	1,730,568.00	0.07	681,017.00	0.28
[5]College	1,730,568.00	0.01	681,017.00	0.13
[6]Undergraduate	1,730,568.00	0.00	681,017.00	0.07
[7]Master and above	1,730,568.00	0.00	681,017.00	0.01
Marriage Status(=1,2,3,4,5)	1,450,309.00	2.00	609,655.00	2.00
[1]Single	1,450,309.00	0.21	609,655.00	0.19
[2]Married	1,450,309.00	0.70	609,655.00	0.73
[3]Remarried	1,450,309.00	0.02	609,655.00	0.02
[4]Divorced	1,450,309.00	0.01	609,655.00	0.02
[5]Widowed	1,450,309.00	0.06	609,655.00	0.04
Medical Insurance(=0,1)	1,346,736.00	0.26	556,894.00	0.56
[0]No Medical Insurance	1,346,736.00	0.74	556,894.00	0.44
[1]With Medical Insurance	1,346,736.00	0.26	556,894.00	0.56
Pension(=0,1)	1,346,734.00	0.04	556,893.00	0.56
[0]No Pension	1,346,734.00	0.96	556,893.00	0.44
[1]With pension	1,346,734.00	0.04	556,893.00	0.56
Migrant(=0,1)	1,856,082.00	0.11	715,755.00	0.19
[0]Non-migrant	1,856,082.00	0.89	715,755.00	0.81
[1]Migrant	1,856,082.00	0.11	715,755.00	0.19

Table A2 Summary Statistics for the main sample

VARIABLES	(1) N	(2) mean	(3) min	(4) max
Age	228,855.00	53.46	40.00	75.00
Normalized Age	228,855.00	-2.37	-20.00	25.00
Retirement(=0,1)	228,855.00	0.42	0.00	1.00
[0]Not retired	228,855.00	0.58	0.00	1.00
[1]Retired	228,855.00	0.42	0.00	1.00
Self-report health(=1,2,3,4)	228,855.00	1.10	1.00	4.00
[1]Good health	228,855.00	0.91	0.00	1.00
[2]Fair	228,855.00	0.08	0.00	1.00
[3]Bad	228,855.00	0.01	0.00	1.00
[4]Uncertain	228,855.00	0.00	0.00	1.00
Male(=0,1)	228,855.00	0.58	0.00	1.00
[0]Female	228,855.00	0.42	0.00	1.00
[1]Male	228,855.00	0.58	0.00	1.00
Education Degree(=1,2,3,4,5,6,7)	228,855.00	3.54	1.00	7.00
[1]No school	228,855.00	0.03	0.00	1.00
[2]Primary school	228,855.00	0.15	0.00	1.00
[3]Junior high school	228,855.00	0.34	0.00	1.00
[4]Senior high school	228,855.00	0.29	0.00	1.00
[5]Two-/three-year college/associate degree	228,855.00	0.12	0.00	1.00
[6]Undergraduate	228,855.00	0.06	0.00	1.00
[7]Master and above	228,855.00	0.00	0.00	1.00
Marriage Status(=1,2,3,4,5)	228,855.00	2.20	1.00	5.00
[1]Single	228,855.00	0.01	0.00	1.00
[2]Married	228,855.00	0.89	0.00	1.00
[3]Remarried	228,855.00	0.03	0.00	1.00
[4]Divorced	228,855.00	0.02	0.00	1.00
[5]Widowed	228,855.00	0.04	0.00	1.00
Medical Insurance(=0,1)	228,855.00	0.73	0.00	1.00
[0]No Medical Insurance	228,855.00	0.27	0.00	1.00
[1]With Medical Insurance	228,855.00	0.73	0.00	1.00
Pension(=0,1)	228,855.00	0.73	0.00	1.00
[0]No Pension	228,855.00	0.27	0.00	1.00
[1]With pension	228,855.00	0.73	0.00	1.00
Migrant(=0,1)	228,855.00	0.17	0.00	1.00
[0]Non-migrant	228,855.00	0.83	0.00	1.00
[1]Migrant	228,855.00	0.17	0.00	1.00

Notes: Normalized age=age-60 for men and Normalized age=age-50 for women

Table A3 Summary statistics for the main sample around the cut-off

	(1)	(2)	(3)	(4)
	-1<=age<0		0<=age<1	
VARIABLES	N	mean	N	mean
Age	6,555.00	53.93	7,503.00	54.68
Normalized Age	6,555.00	-0.55	7,503.00	0.45
Retirement(=0,1)	6,555.00	0.44	7,503.00	0.68
[0]Not retired	6,555.00	0.56	7,503.00	0.32
[1]Retired	6,555.00	0.44	7,503.00	0.68
Self-report health(=1,2,3,4)	6,555.00	1.06	7,503.00	1.09
[1]Good health	6,555.00	0.94	7,503.00	0.92
[2]Fair	6,555.00	0.05	7,503.00	0.07
[3]Bad	6,555.00	0.00	7,503.00	0.01
[4]Uncertain	6,555.00	0.00	7,503.00	0.00
Male(=0,1)	6,555.00	0.45	7,503.00	0.42
[0]Female	6,555.00	0.55	7,503.00	0.58
[1]Male	6,555.00	0.45	7,503.00	0.42
Education Degree(=1,2,3,4,5,6,7)	6,555.00	3.51	7,503.00	3.43
[1]No school	6,555.00	0.02	7,503.00	0.02
[2]Primary school	6,555.00	0.16	7,503.00	0.16
[3]Junior high school	6,555.00	0.35	7,503.00	0.40
[4]Senior high school	6,555.00	0.31	7,503.00	0.27
[5]Two-/three-year college/associate degree	6,555.00	0.11	7,503.00	0.10
[6]Undergraduate	6,555.00	0.05	7,503.00	0.05
[7]Master and above	6,555.00	0.00	7,503.00	0.00
Marriage Status(=1,2,3,4,5)	6,555.00	2.16	7,503.00	2.17
[1]Single	6,555.00	0.01	7,503.00	0.01
[2]Married	6,555.00	0.91	7,503.00	0.90
[3]Remarried	6,555.00	0.03	7,503.00	0.04
[4]Divorced	6,555.00	0.02	7,503.00	0.02
[5]Widowed	6,555.00	0.03	7,503.00	0.03
Medical Insurance(=0,1)	6,555.00	0.73	7,503.00	0.76
[0]No Medical Insurance	6,555.00	0.27	7,503.00	0.24
[1]With Medical Insurance	6,555.00	0.73	7,503.00	0.76
Pension(=0,1)	6,555.00	0.73	7,503.00	0.76
[0]No Pension	6,555.00	0.27	7,503.00	0.24
[1]With pension	6,555.00	0.73	7,503.00	0.76
Migrant(=0,1)	6,555.00	0.16	7,503.00	0.18
[0]Non-migrant	6,555.00	0.84	7,503.00	0.82
[1]Migrant	6,555.00	0.16	7,503.00	0.18

Notes: Normalized age=age-60 for men and Normalized age=age-50 for women

A3. Alternative estimation results

Table A4 Impact of Retirement on migration decisions using the regression approach

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) Probit	(7) Logit
Retirement	-0.009	0.004	0.004	0.001	0.006	0.006	0.006
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Observations	228855	228855	228855	228855	228855	228855	228855

Notes: This table estimates the impact of retirement on migration using different regression models. Column 1 shows the OLS estimate without control variables. Column 2 controls for age variables. Column 3 controls for quadratic polynomials of age. Column 4 controls for cubic polynomials of age. Column 5 further controls for other individual characteristics such as gender, education, ethnicity, and marriage status. Column 5 uses a Probit model and Column 6 uses a Logit model, with all variables controlled for. Standard errors are in parentheses.

A4. Validity tests

A4.1 Continuity tests

Table A5 Continuity tests for covariates

	(1) Primary	(2) Non-primary	(3) Han	(4) Non-Han	(5) Married	(6) Unmarried
Conventional	0.004	0.005	-0.000	-0.009	-0.004	0.003
	(0.036)	(0.032)	(0.029)	(0.024)	(0.018)	(0.018)
Robust	0.016	-0.009	-0.002	-0.007	-0.004	0.003
	(0.038)	(0.035)	(0.031)	(0.028)	(0.022)	(0.022)
Bandwidth	Data driven	Data driven	Data driven	Data driven	Data driven	Data driven
Observations	228,855	228,855	228,855	228,855	228,855	228,855

Notes: This table shows continuity tests for covariates. Primary refers to people who did not attend junior high school and above. Non-primary refers to people who attended junior high school or above. Han refers to people with ethnicity of Han. Married refers to people in a marriage. Unmarried refers to people who are single, divorced or widowed. Standard errors are in parentheses.

A4.2 Manipulation tests

We conduct the manipulation tests using the STATA command *rddensity* proposed by Cattaneo et al. (2018). The p-value of the final manipulation test is 0.3755. Therefore, there is no statistical evidence of systematic manipulation of the running variable.

A5. Alternative definition of retirement

Table A6 Causal impact of retirement on migration decisions using an alternative definition of retirement

	(1)	(2)	(3)	(4)	(5)	(6)
Conventional	0.116	0.115	0.140	0.117	0.104	0.089
	(0.032)	(0.032)	(0.055)	(0.041)	(0.028)	(0.026)
Conventional	0.109	0.109	0.134	0.110	0.098	0.083
	(0.030)	(0.031)	(0.053)	(0.039)	(0.027)	(0.024)
Bandwidth	4.6	4.6	2.3	3.4	5.7	6.9
Covariates	NO	YES	YES	YES	YES	YES
Observations	228,855	228,855	228,855	228,855	228,855	228,855

Notes: This table shows the impact of retirement on migration decisions using an alternative definition of retirement. We redefine retirees as individuals who resort to pension as the main source of living expenditures. Conventional outcomes refer to RD estimates with conventional variance estimator. Robust outcomes refer to RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). Column 1 reports the baseline model results. Column 2 reports the RD estimates by controlling for covariates such as education, ethnicity and marriage status. Columns 1-2 select the bandwidth based on the MSE-optimal bandwidth selector (Calonico, Cattaneo, and Titiunik 2014b). Columns 3-6 take 50%, 75%, 125% and 150% of optimal bandwidth, respectively. Standard errors are in parentheses.

A6. Alternative definition of migration

Table A7 Causal impact of retirement on migration decisions using an alternative definition of migration

	(1)	(2)	(3)	(4)	(5)	(6)
Conventional	0.108	0.107	0.125	0.106	0.098	0.084
	(0.032)	(0.032)	(0.055)	(0.041)	(0.028)	(0.026)
Robust	0.119	0.119	0.148	0.127	0.119	0.123
	(0.035)	(0.035)	(0.081)	(0.060)	(0.042)	(0.038)
Bandwidth	4.6	4.6	2.3	3.4	5.7	6.9
Covariates	NO	YES	YES	YES	YES	YES
Observations	227,931	227,931	227,931	227,931	227,931	227,931

Notes: This table shows the impact of retirement on migration decisions using an alternative definition of migration. We redefine migrants as individuals who have lived away from their registered place for more than 6 months. Conventional outcomes refer to RD estimates with conventional variance estimator. Robust outcomes refer to RD estimates with robust variance estimator (Calonico, Cattaneo, and Titiunik 2014b; 2014a). Column 1 reports the baseline model results. Column 2 reports the RD estimates by controlling for covariates such as education, ethnicity and marriage status. Columns 1-2 select the bandwidth based on the MSE-optimal bandwidth selector (Calonico, Cattaneo, and Titiunik 2014b). Columns 3-6 take 50%, 75%, 125% and 150% of optimal bandwidth, respectively. Standard errors are in parentheses.

A7. Alternative range selection for bunching approach

In the main analysis, we fit a flexible polynomial to the observed distribution, excluding observations in a range of 2 years around the treatment threshold, and extrapolate the fitted distribution. We use an alternative range of 4 years around the treatment threshold to conduct robustness checks and find that approximately 36% of total migration effects are due to inter-temporal substitution (delayed migration), with the 90 percent confidence interval for the missing mass ranging between 34% and 42%.