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Option Value of Work, Health Status, and Retirement Decisions: New evidence from the Japanese Study on Aging and Retirement (JSTAR)*

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Abstract

This study examines retirement decisions in Japan, using the option value (OV) model proposed by Stock and Wise (1990) and examined by subsequent studies. This model assumes that individuals maximize a weighted average of utility from their labor income until retirement as well as that from their pension income afterward and determine the timing of retirement based on the OV of postponing it. Using micro-level data collected from the Japanese Study on Aging and Retirement (JSTAR), we computed the OV for each individual working in 2007 and examined its association with the retirement decisions made in 2009. We found that the probability of retirement correlates negatively with the OV and that healthier individuals are somewhat more sensitive to the OV. Furthermore, our simulations show that more generous parameters vis-à-vis eligibility for disability pension benefits slightly increase the probability of retirement, while reduced pension benefits have no significant impact.

Keywords: Retirement; Option value model; Social security wealth; JSTAR

JEL classification: H55, J26

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1. Introduction

This study examines retirement decisions in Japan, using the option value (OV) model proposed by Stock and Wise (1990) and empirically examined in many subsequent studies. For example, two works of Gruber and Wise (2004, 2010) derived from a series of NBER ISS (International Social Security) projects explore the relationship between the OV and retirement decisions, based on the common specification for 12 countries; those two works reveal that the OV indeed correlates negatively with the probability of retirement, regardless of the presence of various labor market institutions and other social characteristics across countries.

The OV model explicitly deals with dynamic decision-making on retirement in a relatively simple setting (Stock and Wise 1990a, 1990b). The thinking inherent in this model is that retirement decisions are determined by the present value of the flow of future social security benefits—rather than by income at the time of retirement—and that a rational individual is expected to determine one's own retirement age by considering the potential gains that derive from a postponement of retirement. This model assumes that an individual maximizes a weighted average of the utility from labor income until retirement, and that from pension income afterwards. The OV is defined as the gap between the maximum utility at a specific, future age and the utility at the current age. The timing of retirement is determined by comparing the utility gain associated with delaying retirement, which is summarized in a single variable of the OV model.

Despite the considerable attention recently paid to "late" retirement in Japan, there has been a limited body of literature that addresses retirement decisions in Japan. To our knowledge, only a few studies in Japan empirically use the OV model to examine retirement decisions. Oshio and Oishi (2004), the first empirical study of this sort, uses micro-level data from the Survey on Employment of the Elderly (*Konenreisha Shugyo Jittai Chosa*), a nationally representative and large-scale survey compiled by the Japanese government. While this study is a pioneering work in Japan, there are limitations owing to data availability: it uses cross-sectional data with insufficient control variables with respect to health status. On the other hand, Oshio, Shimizutani, and Oishi (2010) employ macro-level data to explore the effect of the OV—as well as other incentive measures to retire—on the labor force participation rate; it assumes a "typical person" and shows that the OV significantly correlates with labor force participation among the elderly, but not with unemployment among the young. These results imply that the exit of the elderly from the labor force has no bearing on job creation for the young.

Moreover, the study of Oshio, Oishi, and Shimizutani (2011)—which is closely related study to that of Oshio, Shimizutani, and Oishi (2010)—uses macro-level data to construct several incentive measures vis-à-vis retirement, including the OV; it also examines how social security programs have affected the labor force of the elderly over extended periods. That study also shows that the labor force participation of the elderly has been significantly sensitive to the OV and to social security reforms since 1985, the latter of which feature reduced benefits generosity and thus significantly encourage the elderly to remain in the labor force longer.

The current study presents further evidence vis-à-vis retirement in Japan, through the use of the OV model; it is driven by micro-level data collected through the Japanese Study on Aging and Retirement (JSTAR), a Japanese version of the Health and Retirement Study (HRS), the English Longitudinal Survey on Ageing (ELSA), and the SHARE (Survey on Health, Aging and Retirement in Europe). JSTAR has a longitudinal design and features a rich variety of variables touching on health status. We computed the OV for each individual working in 2007 and examined its effect on retirement decisions in 2009, while controlling for health status.[1] We found that the probability of retirement correlates negatively with the OV, and that this correlation is stronger for healthier individuals. Furthermore, our simulations based on the OV models show that greater generosity vis-à-vis eligibility for disability pension benefits slightly increases the probability of retirement, but that a reduced pension benefit has no significant impact.

This study is organized as follows. Section 2 describes Japan's social security program and retirement pathways. Section 3 describes JSTAR, from which the data used in this study are drawn. Section 4 presents the OV model and describes data construction for the OV and the health index. Section 5, the main part of this paper, presents the regression results and discusses them while highlighting some policy simulations. Section 6 provides concluding remarks.

2. Social security programs and retirement pathways in Japan

2.1 Social security programs in Japan

Japan's public old age pension program consists of three types of subprograms: National Pension Insurance (NPI; *Kokumin Nenkin*), Employees' Pension Insurance (EPI; *Kosei Nenkin*), and Mutual Aid Insurance (MAI; *Kyosai Nenkin*). It has been mandatory since 1961 for all Japanese nationals to participate in one of these types of public pension programs, and all citizens in Japan are eligible for one of them.[2]

[1] Ichimura and Shimizutani (2012) also employ similar JSTAR data (i.e., from the first and second waves) to explore retirement behavior in Japan. They group a variety of variables into health, family, and socio-economic factors and explore the effect of each factor in the first wave (2007) on the probability of retirement and hours worked in the second wave (2009).

[2] Oshio, Shimizutani, and Oishi (2010) and Oshio, Oishi, and Shimizutani (2011) each describe the old age

NPI covers self-employed workers or forestry and fishery cooperative employees; those covered by NPI constitute slightly less than half of all pensioners in Japan. The NPI benefits are disbursed on a flat rate, depending on the number of years of contribution (minimum of 25 years and maximum of 40 years). The normal eligibility age for NPI was set at age 60 for both genders in 2000; every three years, this age has been scheduled to increase by one year to 65, and this reform has been in effect since 2001 for males, and since 2006 for females.[3] As a result of this reform, in 2007—the benchmark year of JSTAR—the normal eligibility age was 63 for males and 61 for females.

EPI covers employees in the private sector, and the individuals whom it covers constitute slightly less than half of all pensioners. Unlike the NPI, the EPI benefit structure consists of two tiers: a flat-rate component and a wage-proportional component. The calculation of the flat-rate benefit (i.e., the "basic pension benefit") is identical to that in the NPI. The wage-proportional benefit is computed by considering the career average monthly wage (CAMW; *Hyojyun Hoshu Getsugaku*) and the number of months of premium contributions, as well as a gender- and birthday-dependent benefit multiplier. The normal eligibility age for the wage-proportional component is now set at age 60, but as of 2013 (2018), every three years that age is scheduled to increase by one year, reaching age 65 in 2025 (2030) for males (females).

MAI covers employees of the public sector and private schools; those covered by MAI constitute the small portion of pensioners covered by neither NPI nor EPI. The contribution–benefit structure and the normal retirement age for MAI benefits resemble those for EPI benefits, in most respects; thus, we combine EPI and MAI pensioners in the

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pension program in Japan in detail.

3 The social security program in Japan has undergone several large reforms over the last 40 years. Oshio, Shimizutani, and Oishi (2010) and Oshio, Oishi, and Shimizutani (2011) provide detailed descriptions of past reforms.

analysis below.

In addition to the core programs, there are three additional features relevant to setting up Japan's retirement pathways and computing the OV: the social security earnings test, early/late claiming, and the disability pension program. Most of the previous studies implicitly assume that the age at which one starts to claim pension benefits corresponds to the retirement age (i.e., marked by one's departure from the labor force). However, this is not the case in Japan, and such an assumption ignores some important aspects of the association between pension benefits and labor force participation among the elderly.

First, the social security earnings test (*Zaishoku Rorei Nenkin*) can result in a suspension of payment of part or all of one's pension benefits, if one's labor income exceeds a certain threshold; the discouraging effect of this test on labor supply has been studied intensively in Japan and in other countries. Among recent studies in Japan, Shimizutani (2012) reveals the discouraging effect of the earnings test on the labor supply decisions of workers aged 60–64 years. Shimizutani and Oshio (2008) show that the repeal in 1985 of the earnings test for workers aged 65–69 did not affect the earnings distribution of the elderly, but that its reinstatement in 2002 partially altered earnings distribution.

Under the current program, the earnings test focuses on the average wage and bonus income per month.[4] For workers aged 60–64, pension benefit payments are not suspended if the average wage and bonus income per month is less than 280,000 yen; however, benefits are suspended by 0.5 per one-yen increase in labor income (i.e., a marginal tax rate of 50%) between 280,000 yen and 460,000 yen, and suspended by one yen per one-yen increase in labor income (i.e., a marginal tax rate of 100%) in excess of 460,000 yen. For

[4] The earnings test has been revised many times. Shimizutani (2012) and Shimizutani and Oshio (2008) each review previous reforms vis-à-vis the earnings test, over long-term periods.

workers aged 65 and over, the pension benefit payment is not suspended if the average wage and bonus income per month is less than 460,000 yen, but it is suspended by 0.5 yen per one-yen increase in labor income (i.e., a marginal tax rate of 50%) in excess of 460,000 yen. Note that the earnings test is applicable only to the second-tier (i.e., wage-proportional) benefit for EPI beneficiaries, and not to NPI or MAI beneficiaries.

Second, all three social security subprograms allow their beneficiaries to claim within a "window" period; indeed, a nontrivial proportion claim at ages other than the normal eligibility ages. First, NPI allows a 10-year window in claiming benefits, and an individual undergoes benefit reductions if he or she claims early at ages 60–64 (*Kuriage Jyukyu*) and a benefit reward if he or she claims late at ages 66–70 (*Kurisage Jyukyu*). The actuarial adjustment rate differs across birth cohorts; for example, the actuarial reduction rate before age 65 is 0.5% per month, and the actuarial credit rate after age 65 is 0.7% per month, for those born after April 2, 1941 (Shimizutani and Oshio, 2012). Second, EPI also allows some flexibility in terms of claim-timing, and it differs between the flat-rate and wage-proportional benefits. As of 2011, one cannot claim the special benefit (i.e., corresponding to the wage-proportional benefit prior to age 65) earlier or later than the normal eligibility age of 60 years, regardless of gender; however, one could claim the flat-rate component earlier, at ages 60–62 for males and 60 for female in 2007, when the normal eligibility ages were 63 and 61, respectively.[5] Moreover, an EPI beneficiary can claim either the flat-rate or wage-proportional component later than age 65, to enjoy an

[5] There are two types in early claiming in the EPI program: total early claiming (*Zenbu Kuriage*) and partial early claiming (*Ichibu Kuriage*). In the former, one can receive a flat-rate benefit at a reduced rate that is identical to that for an NPI beneficiary, but is no longer eligible for the special benefit. In the latter, one can receive both a part of the flat-rate component of the special benefit and a part of the flat-rate component of the formal benefit (as well as the wage-proportional component). See Shimizutani and Oshio (2012) for the detailed formula. If the duration of EPI participation is long, the flat-rate benefit of the special benefit and the formal component are almost the same, and partial early claim is in general more advantageous than total early claim. In this study, we assume that an EPI beneficiary chooses a partial early claim if he or she claims benefits earlier than the normal eligibility age.

incremental benefit. Note that once one claims his or her benefits—either before or after the normal eligibility age—one cannot change his or her take-up decision.

Third, the disability pension program—which is not specific to the old age pensions described above—covers some of the elderly in Japan. While the participation rate with regard to the disability pension program remains low in Japan, many European countries have expanded their respective disability insurance programs since the 1970s; in some countries, receiving disability insurance benefits is a typical feature of early retirement (Wise, 2012). Oshio and Shimizutani (2012) argue that this is not the case in Japan, and that the low participation in Japan's disability pension program can be attributed to its stringency of eligibility. Under the current program, if one consults with a doctor about the cause of disability for the first time before the age of 20, or if one is an NPI pensioner, one is entitled to receive the Disability Basic Pension benefit, which is disbursed on the basis of disability severity (grade 1 or 2) and the number of dependent children. In addition, if one consulted a doctor to identify the cause of the disability when one was an EPI (MAI) pensioner, one is entitled to receive a wage-proportional Disability Employees' Pension benefit or Disability Mutual Aid Pension benefit (for MAI recipients), the amount of which depends on the disability severity (grades 1–3) and whether or not one has a spouse (Oshio and Shimizutani, 2012).

2.2 Pathways to retirement

Based on the old age pension program and the three related subprograms, we need to describe and set up so-called pathways to retirement and allocate weights to them, to facilitate the computation of the OV for each individual. We set up the following pathways to retirement.

For EPI/MAI pensioners, there are five pathways:

(A) Normal claiming: “Employed” to “Normal claiming”—that is, claiming at the normal retirement age; more specifically, in this pathway, one claims wage-proportional benefits at ages 60–65 (depending on cohort) and a flat-rate benefit at age 65. This pathway is “standard” and it compares each year the benefit of stopping work now with the maximum benefit that could be obtained by continuing to work for additional years.

(B) Early claiming (*Kuriage*): “Employed” to “Early claiming”—that is, claiming the flat-rate benefit at an age prior to 65.

(C) Late claiming (*Kurisage*): “Employed” to “Late claiming”—that is, claiming wage-proportional/flat-rate benefits at ages 66–70.

(D) Employed under the earnings test (*Zaishoku*): “Employed” to “Employed,” with benefits discounted as per the results of the earnings test.

(E) Disability: “Employed” to “Claiming disability pension benefit”—that is, claiming EPI/MAI wage-proportional/flat-rate benefits at ages 60–64.

For NPI pensioners, there are four pathways:

(A) Normal claiming: “Self-employed” to “Normal claiming”—that is, claiming NPI benefits at age 65.

(B) Early claiming (*Kuriage*): “Self-employed” to “Early claiming”—that is, claiming NPI benefits at ages 60–64.

(C) Late claiming (*Kurisage*): “Self-employed” to “Late claiming”—that is, claiming NPI benefits at ages 66–70.

(D) Disability: “Self-employed” to “Claiming NPI disability pension benefit”—that is, claiming disability benefits initially at ages 60–64.

Note that no earnings test is applied to NPI beneficiaries. To simplify things, another way of setting up retirement pathways is to summarize (A)–(C) above as one option for EPI/MAI and NPI pensioners, resulting in three and two pathways for these groups, respectively. The differences among "Normal," "Early claiming," and "Late claiming" derive mainly from actuarial adjustments; all three are regarded as essentially the same pathway, in that all three options capture the period "from (self-) employed to old age pension." However, the actuarial adjustment is not complete, and thus we will deal these three pathways separately.

Next, we need to "weight" the proportion of each pathway; this step is essential to computing OVs and to determining ways in which we can average values across those pathways. Instead of considering the probabilities for each pathway under each individual's circumstances, we "impute" the probabilities for the "nonstandard" options and allocate 1 minus the sum of the other probabilities for the standard option; the result is used as the "weight." Since the assigned "weights" are exogenous characteristics of the individuals, we use the weights as an instrument by which we avoid endogeneity. Thus, we need to calculate the weights based on the cells, to allocate a probability to each feasible set of characteristics and match these probabilities to the individuals by cell.

To compute the cells, we employ a "stock estimator" that uses the share of each pathway within the population for a combined-age group (say, ages 50–70) at a given point in time.[6] The estimator aggregates the decisions of workers from different cohorts, up to a

[6] There are two alternatives to the "stock estimator." One is the "age-specific flow" (i.e., the share of workers at each age who enter a pathway at that age). Another is the "aggregated flow" (i.e., the share of workers starting at an initial age who eventually enter a pathway at any point). This approach reflects the actual ultimate experience of the cohort, but it does need to assume perfect foresight vis-à-vis future changes to stringency.

point in time; thus, it does not assume any future knowledge, although the "stock" may include any cohorts outside the focal age range (say, younger than 50 or older than 70).

The data source is the *Annual Report on Social Security Administration*, which comprises administrative data compiled by Japan's Ministry of Health, Labor, and Welfare. The data contains the "stock" number by the types of pension recipients: normal pension claimers, early or late claimers, EPI beneficiaries under the earnings test, and disability pension recipients. Those data are available each year by gender but, unfortunately, not by age group, except in the case of the disability pensioners.

We need to define the cells using individual-level characteristics. The first cell is gender, a characteristic available in the data. The second cell should be the "age range" on which we focus, but the data provide only a total number of pensioners, with no mention of the ages therein. Due to the limited information available in the administrative data, to compute the number of stock in each pathway in each year, we implicitly assume that the "flow" into each pathway is identical across birth cohorts. We obtained the weights for each pathway as follows:

(a) EPI/MAI "Early claiming": Share of EPI/MAI enrollees who claimed earlier than the normal eligibility age, among all EPI/MAI enrollees in each year, by gender.

(b) EPI/MAI "Late claiming": Share of EPI/MAI enrollees who claimed later than the normal eligibility age, among all EPI/MAI enrollees in each year, by gender.

(c) EPI/MAI "Earnings test": Share of EPI enrollees whose pension benefits were reduced under the earnings test, among all EPI/MAI enrollees in each year, by gender.

(d) EPI/MAI "Disability": Share of EPI/MAI disability pension enrollees aged 60–64, among all EPI/MAI enrollees in each year, by gender.

(e) EPI/MAI "Normal claiming": Others (1 minus (a), (b), (c), and (d)).

(f) NPI “Early claiming”: Share of NPI enrollees who claimed earlier than the normal eligibility age, among all NPI enrollees in each year, by gender.

(g) NPI “Late claiming”: Share of NPI enrollees who claimed later than the normal eligibility age, among all NPI enrollees in each year, by gender.

(h) NPI “Disability”: Share of NPI disability pension enrollees aged 60–64, among all NPI enrollees in each year, by gender.

(i) NPI “Normal claiming”: Others (1 minus (f), (g), and (h)).

Figure 1 illustrates the weights of each pathway for the EPI/MAI group, since 2000. The upper panel shows that the most dominant pathway to retirement for males is “Normal claiming,” the proportion of which has seen a slightly declining trend to 60% in recent years. The second-most dominant pathway is “Earnings test,” the proportion of which has seen an increase exceeding 30%—an increase that may reflect 2002 reforms to the earnings test, intended to revive the test for workers aged 65–69 and those newly aged 70 or over. The proportions of “Early claiming,” “Late claiming,” and “Disability” remain small or negligible. The lower panel shows that the most dominant pathway to retirement for females is “Normal claiming,” which is also the case for males; its proportion among females has seen a slightly declining trend, but it remains larger than that among males, approaching 70% in recent years. The second-most dominant pathway for females is “Earnings test,” but the proportion there is much smaller than for males (i.e., just above 10%). The proportion of females under “Early claiming” is larger than that for males, but it still constitutes a small portion of the sample; the same is true of “Late claiming” and “Disability.”

Figure 2 depicts the weights of each pathway for the NPI group since 2000. The upper panel shows that until the mid-2000s, the most dominant pathway to retirement for males was “Early claiming”; however, that pathway’s proportion is now comparable to that of “Normal claiming.” The proportion of “Early claiming” has been in decline, while that of “Normal claiming” has been increasing. The proportion of “Disability” has been <10% in recent years, but is nonetheless larger than the male EPI/MAI group. The lower panel shows that the most dominant pathways to retirement for females are “Normal claiming” and “Early claiming,” each of which constitutes about 40% of the sample. As with males, the proportion of “Early claiming” females has been in decline, while that of “Normal claiming” has been increasing. The proportion of “Disability” exceeds 10%—a number larger than that for males—and it is experiencing a slightly increasing trend. For both genders, the proportion of “Late claiming” is negligible for the NPI group.

While the administrative data do not contain information on educational attainment, we impute the education gradient of the aforementioned pathways to generate year–age–education cells, the data for which are available from JSTAR (described in the next section). In the case of the EPI/MAI group, a more highly educated beneficiary is more likely to claim at the normal eligibility age than less-educated ones; this is the case for males and females alike. In contrast, a less-educated beneficiary is less likely to claim early, and this is particularly the case for female high school dropouts. The same pattern is observed for the NPI groups, but the gradient there appears to be much steeper. For females claiming at the normal eligibility age, about 75% of beneficiaries are university/graduate school graduates, and about 25% of them are high school dropouts; for males, those figures are roughly 60% and 25%, respectively. As expected, the proportions of the “Early claiming” group, by gender, are close to 70% and 60% for females and males, respectively.

In what follows, we will use year–age–education cells to weight the pathways for each individual in the JSTAR sample, to compute the OV.

3. Data description

The main data source for this study is the JSTAR, the Japanese counterpart of HRS, ELSA, and SHARE; it is a world-standard longitudinal survey of middle-aged and older persons (Ichimura, Hashimoto and Shimizutani, 2009). The JSTAR project started in 2005; its first wave was completed in five municipalities in 2007, and its second wave in seven municipalities (two new municipalities were added) in 2009 and in 10 municipalities (three new municipalities were added) in 2011–12. The baseline sample consists of individuals aged 50–75 years. The JSTAR uses random sampling within a municipality, rather than probabilistic national sampling; it places emphasis on securing a larger sample size within the same socio-economic environment.

The sample size in the first wave was about 4,200 at the baseline; its response rate in that wave was 60%. The respondents in the first wave were interviewed again in 2009, and the response rate in the second wave among the respondents from the first wave was about 80% (i.e., an attrition rate of about 20%), with some variations across municipalities. This study computes the OV for each individual working in 2007 (first wave) and examines the effect of the OV on retirement decisions made in 2009 (second wave). The sample size in this study is 1,585 individuals who were working in 2007 and re-interviewed in 2009, and for whom work status data in 2009 are available.

4. Option value and health status

The OV model assumes that an individual maximizes a weighted average of utility from labor income until retirement, and that from pension income afterwards. The OV is defined as the gap between the maximum utility at a specific point and the utility at the current point. The OV at age t is defined as

$$OV_t = \sum_{k=1}^{K} P_k OV_{kt} , \tag{1}$$

where k refers to the k^{th} pathway to retirement; P_k, the probability weight on the k^{th} pathway; and OV_{kt}, the OV of the k^{th} pathway at age t. K takes a value of 1–5 for the EPI/MAI beneficiaries and a value of 1–4 for the NPI beneficiaries. Moreover, we define the OV corresponding to each pathway as:

$$OV_{kt} = E_t V_{kt}(r^*) - E_t V_{kt}(t), \tag{2}$$

$$E_t V_{kt}(r) = \sum_{s=t}^{r-1} p_{s|t} \beta^{s-t} (y(s))^{\gamma} + \sum_{s=r}^{D} p_{s|t} \beta^{s-t} [\kappa B_{rk}(S)]^{\gamma} , \tag{3}$$

where $p_{s|t}$ is the probability of survival at age s, given survival at age t; y (s) refers to wage income at age s while working; B_{rk} (s) refers to pension benefits at age s when retired at age r through the k^{th} pathway; β is the discount rate; γ is the parameter of risk aversion; and κ is the parameter of labor disutility.

The main components of the OV computation are y (s), the labor income until retirement, and $B_{rk}(s)$, the pension income between retirement and death. y (s) is computed by earnings projections made in terms of gender and pension group, which are imputed via a very simple method. First, we obtain observed median earnings at each age (50–75) by gender and pension group (NPI or EPI/MAI); these are available from the first-wave data of the JSTAR. Second, we project wage profiles forward and backward by multiplying the actual earnings observed in 2007 by the growth rate of median earnings by gender and pension group. Third, we compute the earnings projection for individuals aged under 50 or over 75, since wages are not observed in the JSTAR data. For simplicity, we assume that the wage among those aged below 50 is the same as that at age 50, thus implying a flat earnings profile. Moreover, we assume that all individuals have stopped working by age 75, and so we need not impute an earnings profile beyond age 75.

On the other hand, $B_{rk}(s)$, the pension benefit between retirement and death, is computed based on the estimated benefits at all future ages, based on information available from the data. First, pension membership—i.e., whether an individual belongs to the EPI/MAI group or to the NPI group—is available in the JSTAR data. Second, the years of premium contributions are also available in the JSTAR data, and it is required for computing both the flat-rate and wage-proportional benefits. Third, the career average monthly wage (CAMW)—the average preretirement labor income, which serves as the base of the wage-proportional benefit—is estimated via the earnings projection, as explained above. Fourth, the benefit multiplier is provided exogenously, by gender and birthday.

In addition, we assume several parameter values in the computation of OVs. We set the value of γ, the parameter of risk aversion, and κ, the parameter of labor disutility, to equal 1; we also set β, the discount rate, to 0.97. The mortality rates are taken from the 2007 "Life Table," which was published by the Japanese government.

Figure 3 illustrates the average computed OVs for the NPI/MAI group across age levels, by gender. The OV unit is millions of yen. We commonly observe that the OVs for all subgroups tend to decline with age. Upon taking a closer look, however, we see some differences across pathways. For males, the OV is the largest for the "Normal" group, followed by the "Earnings test" group—both of which are almost identical for individuals beyond the mid-60s. On the other hand, the "Early claiming" and "Disability" groups have lower OVs. For females, we see a pattern similar to that for males, but the gap between the subgroups is much smaller than for males.

Figure 4 shows the estimated OVs for the NPI group across age levels, by gender. Again, we observe that the estimated OVs tend to decline with age, a result similar to the observation in Figure 3. The differences between the EPI/MAI and the NPI groups are (1) the levels of OVs are generally higher for the former, (2) the gaps across the subgroups are smaller for the latter, and (3) the "Disability" group enjoys higher OVs beyond the mid-60s, but only in the case of the latter.

In addition to OV computation, we constructed a health index that is used as an explanatory variable. To do so, we followed the methodology of Poterba, Venti, and Wise (2010). The idea of this approach is to construct a simple index that hinges on the first principal component of many health indicators. We use the first principal component of the 22 health indicators included in the JSTAR, and the data comprise that pooled from the first and second waves.[7] The upper panel of Appendix Table 1 reports the loadings on each health indicator; we use the variable as a continuous variable. The lower panel of Appendix Table 1 shows the percentile cutoffs for each quintile, by gender, in the first and second waves. What is interesting is that the threshold value for the transition from the first to the second quintile increased in 2009, while those for the other transitions are lower in 2009;

[7] The 22 items are as follows: (1) difficulty in walking 100 m, (2) difficulty in lifting/carrying, (3) difficulty in pushing/pulling, (4) difficulty with an activity of daily living (ADL), (5) difficulty in climbing a few steps, (6) difficulty in stooping/kneeling/crouching, (7) difficulty in getting up from a chair, (8) self-reported health fair/poor, (9) difficulty in reaching/extending an arm up, (10) BMI, (11) difficulty in sitting two hours, (12) difficulty in picking up a dime, (13) ever experienced heart problems, (14) hospital stay, (15) doctor visit, (16) ever experienced psychological problems, (17) ever experienced a stroke, (18) ever experienced high blood pressure, (19) ever experienced lung disease, (20) ever experienced diabetes, (21) ever experienced arthritis, and (22) ever experienced cancer.

this implies that the number of individuals in the poorest health condition (i.e., the first quintile) increased between 2007 and 2009. Deterioration in health on account of aging is also evident in Appendix Figure 1, showing that the proportion of the fifth quintile (the best health status) declines with age, thus reinforcing the rationale for health-index and quintile use.

5. Regression results and policy simulations

5.1 Regression results

Table 1 provides the summary statistics of the variables used in the current study. The mean OV of the full sample is 36.5 million yen, but it is much higher for males (43.5 million yen) than for females (24.4 million yen). The higher OVs among males are consistent with their higher wage incomes, more years of contributions, and correspondingly higher levels of pension benefits, relative to females. Meanwhile, females have a lower average level of health, with wider variations across individuals, than males. The bottom panel of Table 1 summarizes the dummy variables used as control variables in the regressions. Educational attainment is higher for men, and the proportion of married individuals is higher for males than for females.

We perform some regressions to associate the computed OV with the retirement decision, along with a variety of control variables. We estimate two types of model:

$$Y_{i,2009} = F_1\left(OV_{i,2007},\ Health_{i,2007},\ \boldsymbol{X}_{i,2007}\right) + \varepsilon_1, \tag{4}$$

$$Y_{i,2009} = F_2\left(OV_{i,2007},\ Health_{i,2007},\ OV_{i,2007} \times Health_{i,2007},\ \boldsymbol{X}_{i,2007}\right) + \varepsilon_2. \tag{5}$$

The dependent variable is an indicator that takes a value of 1 if individual *i* retired in 2009, and 0 otherwise. We define an individual as "retired" if he or she was not working in 2009, and "not retired" if working in 2009. $OV_{\mathrm{i},\,2007}$, the main variable, is the OV for individual *i*, computed as per the method described in the previous section. $Health_{\mathrm{i},\,2007}$ is another key variable; it indicates the health index of individual *i*. The coefficients of both *OV* and *Health* are expected to be negative. The second model (eq. (5)) includes the interaction between *OV* and *Health*. If healthier individuals are more sensitive to the OV, then we should derive a negative coefficient for the term *OV***Health*.

Finally, $X_{i,2007}$ refers to the set of remaining control variables, including the dummy variables for age (those aged 55–59, 60–64, 65–69, and 70–75 in 2007), gender, educational attainment, marital status (married), incidence of working spouse, total assets, occupation, and firm size in 2007.[8] We cumulatively add control variables, to facilitate an assessment of the robustness of the estimation results vis-à-vis the choice of control variables.

Table 2 (1) reports the regression results of the first model (eq. (4))—which does not include the interaction term—in terms of marginal effects. For all models with different sets of control variables, we see a similar pattern in the coefficients of *OV* and *Health*. An individual with a larger OV or better health status in 2007 is less likely to retire in 2009, after controlling for a variety of household characteristics. The coefficients of *OV* are modestly significant ($p < 0.1$) and negative; they also lie within a small range of around –0.00068 and –0.00075, across six specifications. The coefficients of *Health* are more significant ($p < 0.05$) and lie between –0.00991 and –0.01160. These results are in line with

[8] There are some missing data for each variable; this is especially true for the total assets. We impute the variable by allocating its average value for those who have attributes similar to those of the respondent.

expectations and are intuitively sound.

Table 2 (2) presents the results obtained from the models containing the interaction term (eq. (5)). The coefficients of *OV* decline slightly compared to the levels in the top panel, but remain significant at the 10% level. The coefficients of *Health* remain negative but insignificant. Meanwhile, the coefficients of the interaction term between *OV* and *Health* are all negative and significant at the 10% level for models (5) and (6), each of which includes a rich set of control variables. These results suggest that healthier individuals are more sensitive to the OV when deciding whether to retire or stay in the labor force.

5.2 Policy simulation

Based on the estimation results—using a full set of control variables and no interaction term—we perform two types of policy simulation with regard to the retirement decision. First, we consider the case where the eligibility for disability pension becomes more generous; more specifically, we assume that the share of the "Disability" group rises to 20% from the current, 2007 levels of <1% for the EPI/MAI group and 10% for the NPI group. This policy change is expected to reduce the weighted average OV, thereby discouraging individuals from staying in labor force. Second, we consider the case where pension benefits are cut by 10%. This policy change will reduce lifetime pension benefits, but any impact on the OV is likely limited, as maximum utility will also be reduced. Correspondingly, its impact on the retirement decision may not be substantial.

Figure 5 presents simulation results in terms of the estimated kernel distribution of the probability of retirement in 2009; the black, blue, and red curves indicate cases at the baseline, cases with a 20% weight on the disability path, and cases with a 10% cut in pension benefits, respectively. As can be seen in this figure, the two types of policy change have no significant impact. Upon closer examination, we find that the distribution of retirement shifts rightward when the weight on the disability pathway is raised to 20%, suggesting that a more generous disability pension will discourage individuals from staying in the labor force. Meanwhile, we see that a 10% cut in pension benefits would have only a negligible impact on the distribution of the probability of retirement. This result is not consistent with that of Oshio, Oishi, and Shimizutani (2011), likely due to a difference in the types of data used in the regression analysis: while the current study uses a large-scale micro-level dataset representing just two different years, the study of Oshio, Oishi, and Shimizutani (2011) uses data aggregated over a 40-year period.

6. Conclusion

This study examines retirement decisions in Japan, using the option value (OV) model proposed by Stock and Wise (1990) and examined by in subsequent studies. The assumption of this model is that an individual maximizes a weighted average of utility from labor income until retirement, and that from pension income afterwards; it also assumes that the timing of retirement coincides with the point at which the OV is maximized. Using micro-level data captured via the Japanese Study on Aging and Retirement (JSTAR), we computed the OV for each individual working in 2007 and examined its association with retirement decisions in 2009. We found that the probability of retirement negatively and significantly correlates with the OV, and that healthier individuals are somewhat more sensitive to the OV. Furthermore, our simulations based on the OV models show that a more generous eligibility of disability pension benefits slightly increases the probability of retirement, while a reduced pension benefit has no significant impact.

We recognize that there remains much to be addressed in future research. First, we should further elaborate the specifications of the OV models. The value of an OV depends on the parameters of the utility function, such as the parameters for converting income to utility and the discount rate, all of which are tentatively assumed in the current study. Second, we should more precisely project wage profiles and capture different pathways to retirement, on the basis of further information obtained from official statistical sources. Third, we should also model couples, rather than individuals, as retirement decisions are likely to be made jointly by elderly couples: we should therefore incorporate information about spouses and survivors' pension benefits, which are ignored in this study.

Acknowledgements

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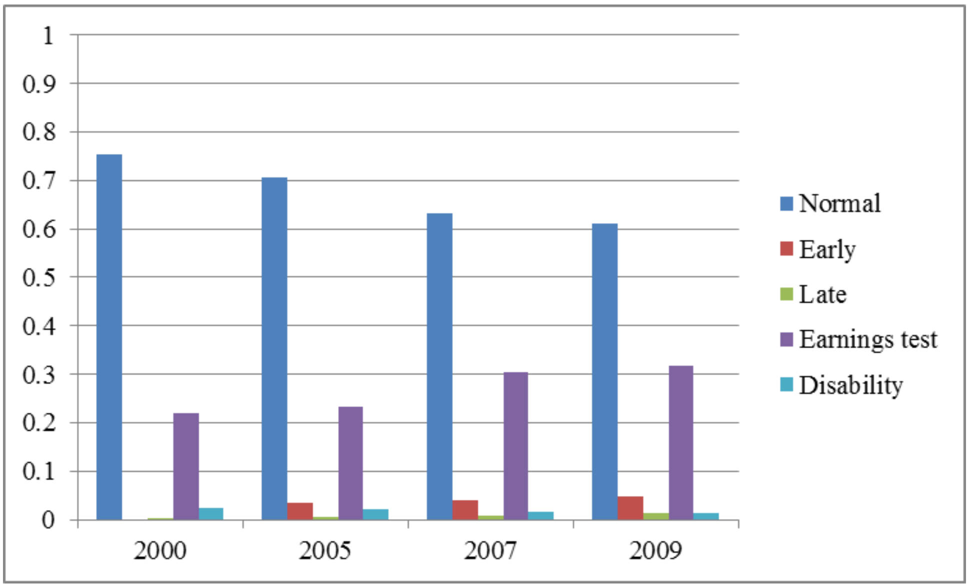
Figure 1 Pathways to retirement for the EPI/MAI group

(1) Males



(2) Females

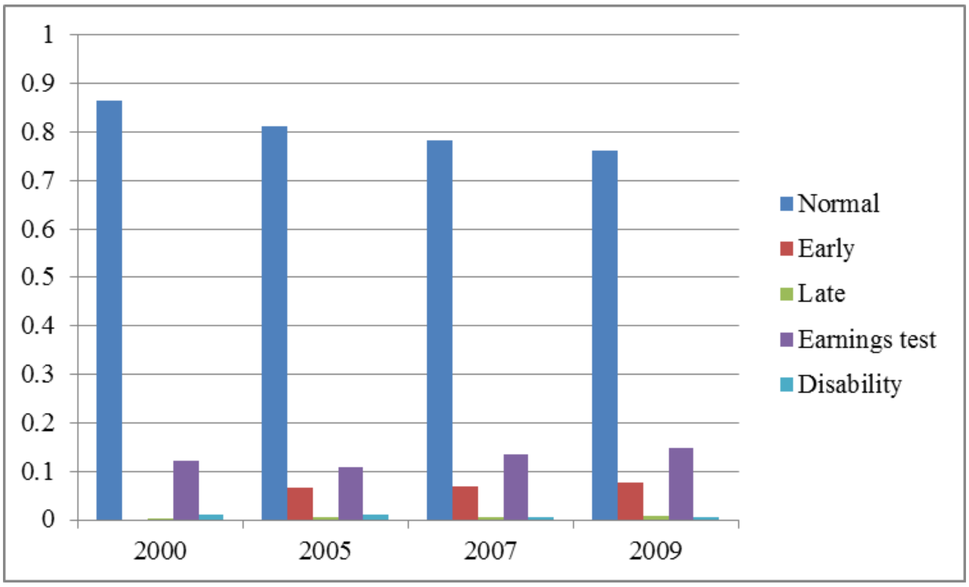
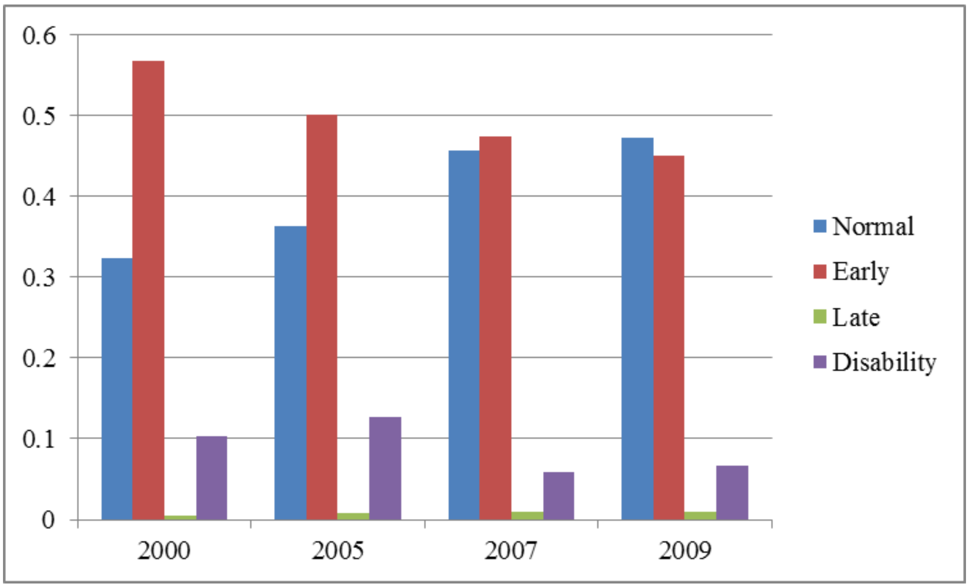


Figure 2 Pathways to retirement for the NPI group

(1) Males



(2) Females

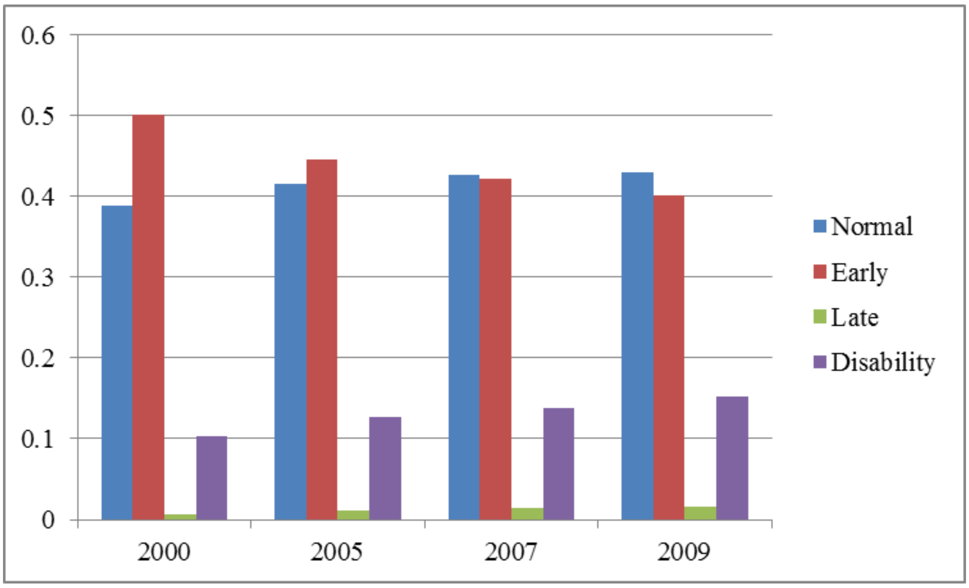
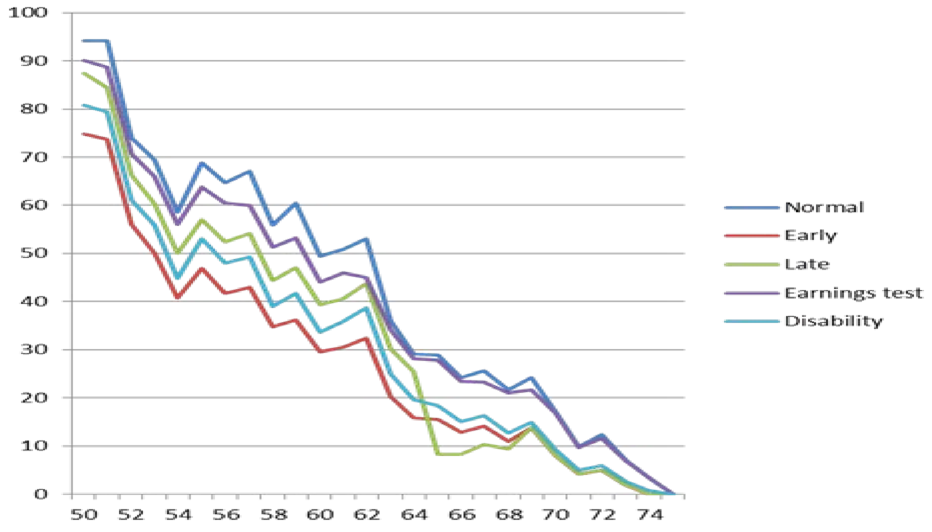


Figure 3 Option values across age levels for the EPI/MAI group

(1)Males



(2)Females

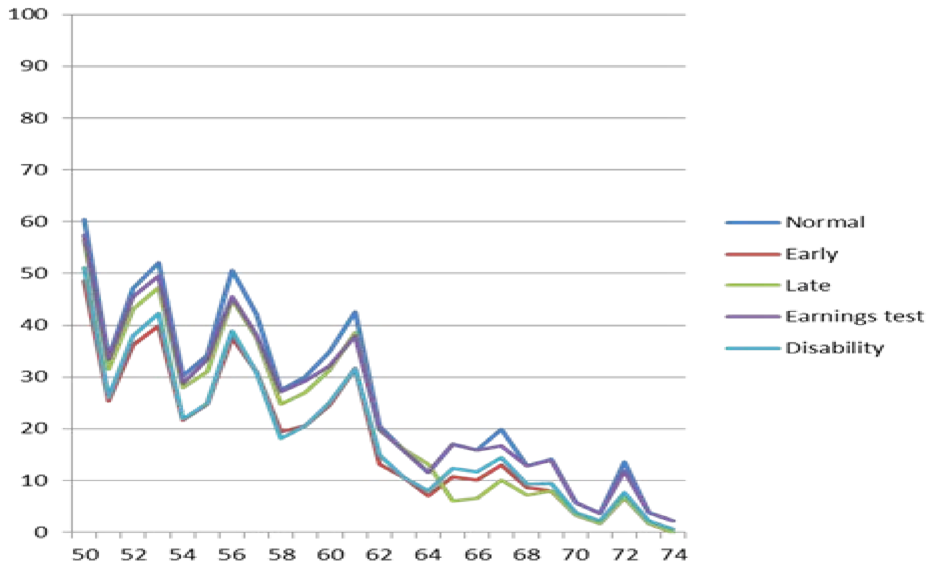
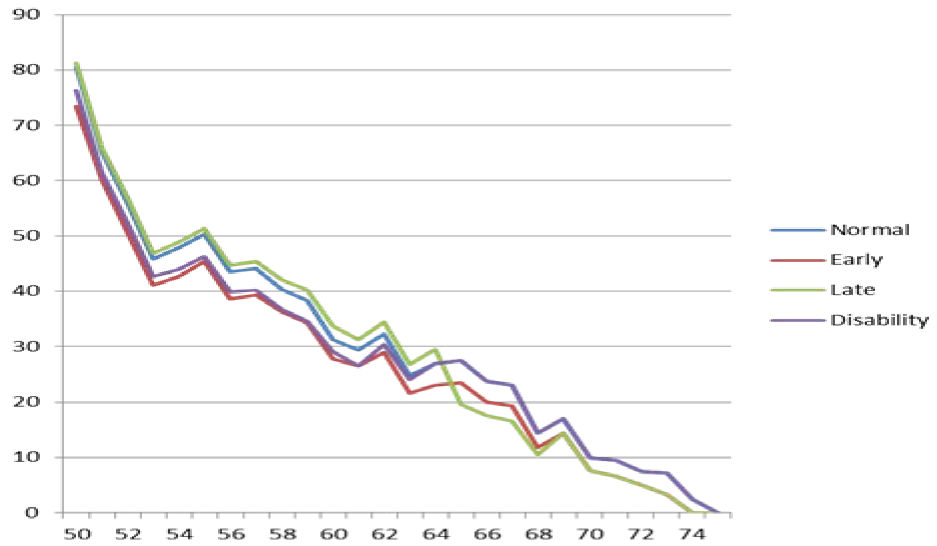


Figure 4 Option values across age levels for the NPI group

(1)Males



(2)Females

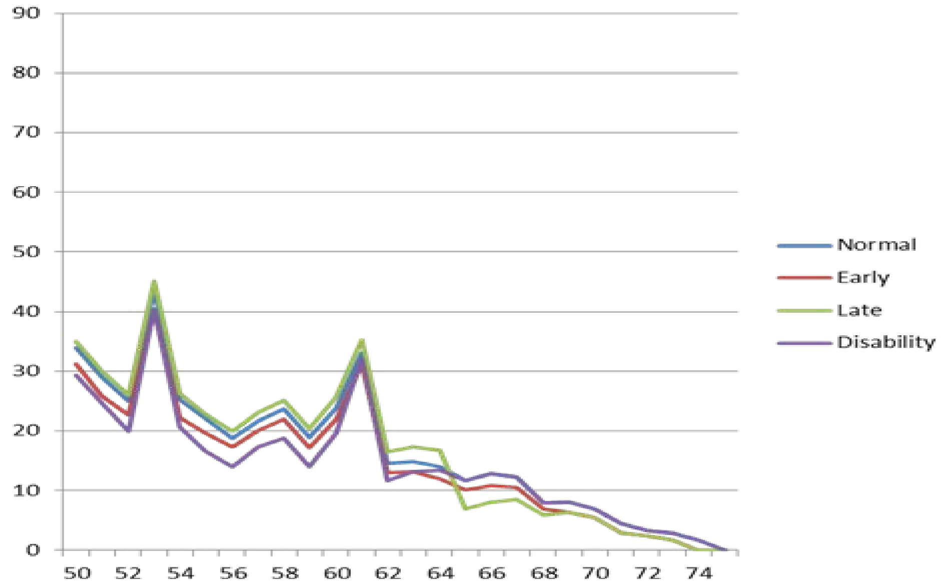
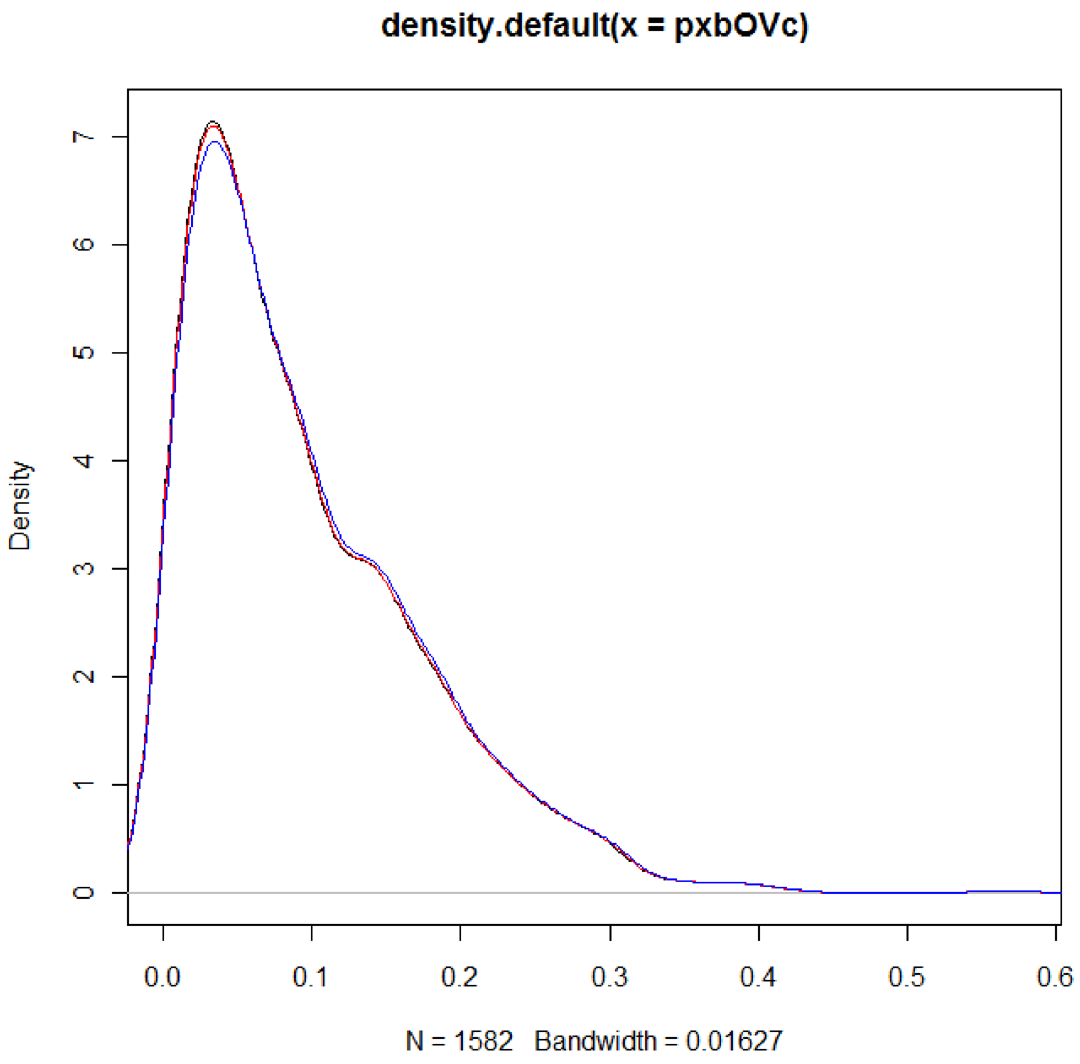


Figure 5. Simulation results: Estimated kernel density of the probability of retirement



Black line: Baseline

Blue line: Weight on disability pathway = 20%

Red line: 10% cut in pension benefits

Table 1. Summary statistics of key variables

		All	Male	Female
Continuous variables				
OV (million yen)		36.5	43.5	24.4
		29.0	29.8	23.1
Health index	*M*	0.528	0.568	0.459
	S.D.	1.248	1.189	1.342
Monthly wage (thousand yen)	*M*	260.3	320.8	156.1
	S.D.	177.2	179.4	113.5
Enrolled years	*M*	36.6	39.7	31.3
	S.D.	10.5	10.2	10.7
Assets (million yen)	*M*	59.7	46.1	66.3
	S.D.	13.4	12.1	14.0
Binary variables				(proportion)
Age:				
Less than 55		0.210	0.198	0.232
55 – 59		0.308	0.309	0.308
60 – 64		0.215	0.206	0.231
65 – 69		0.165	0.178	0.143
70 –		0.101	0.110	0.086
Female		0.367	-	-
Education:				
High school dropouts		0.268	0.285	0.239
High school graduates		0.443	0.409	0.503
Two-year college/Vocational school graduates		0.125	0.082	0.200
University/Graduate school graduates		0.164	0.225	0.059
Married		0.841	0.896	0.745
Incidence of working spouse		0.570	0.550	0.604
Occupation:				
Specialist		0.098	0.103	0.090
Managers		0.078	0.110	0.024
Clerk		0.160	0.116	0.236
Salesperson		0.131	0.132	0.129
Service		0.138	0.069	0.258
Guards		0.013	0.020	0.002
Farmers		0.051	0.052	0.048
Trans and com.		0.052	0.078	0.009
Construction		0.247	0.293	0.169
Unknown		0.031	0.028	0.036
Firm size:				
Less than 100		0.704	0.696	0.716
100-299		0.092	0.102	0.074
300-999		0.050	0.062	0.029
1000-		0.154	0.139	0.179
Unknown		0.075	0.040	0.136
Retired in 2009		0.096	0.089	0.108
Public pension enrollee				
EPI/MAI enrollee		0.655	0.734	0.518
NPI enrollee		0.345	0.266	0.482
N		1,582	1,001	581

Note: M = mean; S.D. = standard deviation

Table 2 Regression results (marginal effects)

(1) Without the interaction term

	(1)	(2)	(3)	(4)	(5)	(6)
OV	-0.00068 †	-0.00074 †	-0.00071 †	-0.00072 †	-0.00070 †	-0.00075 †
	(0.00038)	(0.00039)	(0.00039)	(0.00039)	(0.00039)	(0.00039)
Health	-0.00991 *	-0.00995 *	-0.01100 *	-0.01100 *	-0.01150 *	-0.01160 *
	(0.00469)	(0.00473)	(0.00466)	(0.00467)	(0.00466)	(0.00457)
Controlled for:						
Age	✓	✓	✓	✓	✓	✓
Gender	✓	✓	✓	✓	✓	✓
Education		✓	✓	✓	✓	✓
Married		✓	✓	✓	✓	✓
Working spouse			✓	✓	✓	✓
Total assets				✓	✓	✓
Occupation					✓	✓
Firm size						✓
N	1582	1582	1582	1582	1582	1582

(2) With the interaction term

	(1)	(2)	(3)	(4)	(5)	(6)
OV	-0.00061	-0.00067 †	-0.00065 †	-0.00066 †	-0.00063	-0.00068 †
	(0.00039)	(0.00040)	(0.00039)	(0.00039)	(0.00039)	(0.00039)
Health	-0.00236	-0.00212	-0.00315	-0.00317	-0.00339	-0.00318
	(0.00701)	(0.00701)	(0.00691)	(0.00691)	(0.00684)	(0.00664)
OV*Health	-0.00022	-0.00023	-0.00023	-0.00023	-0.00024 †	-0.00025 †
	(0.00015)	(0.00015)	(0.00015)	(0.00015)	(0.00014)	(0.00014)
Controlled for:						
Age	✓	✓	✓	✓	✓	✓
Gender	✓	✓	✓	✓	✓	✓
Education		✓	✓	✓	✓	✓
Married		✓	✓	✓	✓	✓
Working spouse			✓	✓	✓	✓
Total assets				✓	✓	✓
Occupation					✓	✓
Firm size						✓
N	1582	1582	1582	1582	1582	1582

Note: Standard errors in the parentheses. $^{*}p < 0.05$, $^{\dagger}p < 0.1$.

Appendix Table 1. Principal component analysis on health indicators

(1) Factor loadings of the 1st principle component health index

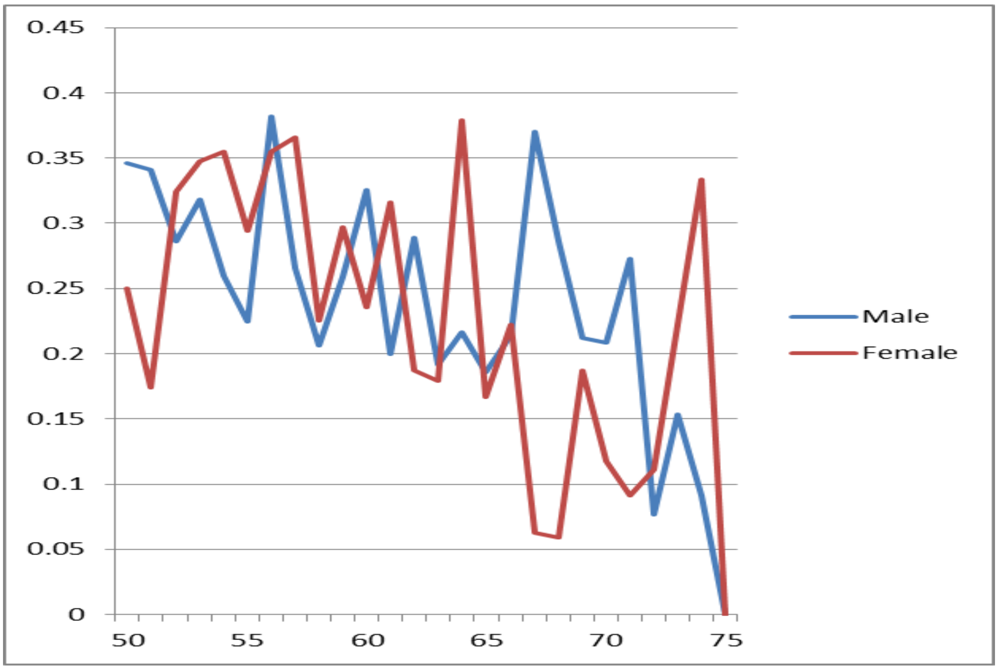
1. Difficulty walking 100 m	0.311	12. Difficulty pick up a dime	0.248
2. Difficulty lifting/carrying	0.337	13. Ever experienced heart problems	0.094
3. Difficulty pushing/pulling	0.340	14. Hospital stay	0.109
4. Difficulty with an activity of daily living (ADL)	0.242	15. Doctor visit	0.082
5. Difficulty climbing a few steps	0.315	16. Ever experienced psychological problems	0.017
6. Difficulty stooping/kneeling/crouching	0.309	17. Ever experienced a stroke	0.126
7. Difficulty getting up from a chair	0.304	18. Ever experienced high blood pressure	0.075
8. Self-reported health fair/poor	0.211	19. Ever experienced lung disease	0.040
9. Difficulty reaching/extending arm up	0.269	20. Ever experienced diabetes	0.071
10. Ever experienced arthritis	0.122	21. BMI	0.026
11. Difficulty sitting two hours	0.277	22. Ever experienced cancer	0.035

(2) Percentile cutoffs for each quintile, by gender and year

	2007		2009	
	Male	Female	Male	Female
1st to 2nd quintile	0.3890	0.3692	0.3958	0.4077
2nd to 3rd quintile	0.7714	0.8207	0.7605	0.7937
3rd to 4th quintile	0.9381	0.9515	0.9349	0.9437
4th to 5th quintile	1.1104	1.1099	1.1041	1.0863

Appendix Figure 1. Health index across age levels

(1) Proportion of individuals in the 5th health quintile, by age and gender (2007)



(2) Proportion of individuals in 5th health quintile, by age and gender (2009)