SOCIAL SECURITY PROGRAM AND RETIREMENT BEHAVIOR IN KOREA: A MICRO ESTIMATION

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Abstract

We estimate the impact of social security program on the retirement behavior in Korea. We use the micro data from the Korea Labor and Income Panel Study to calculate the social security wealth (SSW) and three incentive measures: accrual, option and peak values. We apply probit regression models to quantify the effect of the National Pension Scheme in Korea on retirement decisions of Korean workers. Empirical estimation shows that in Korea the estimated effects of the incentive measures on retirement are negative and significant in most of our models. The SSW plays an important role indirectly, and its signs are different in different models. We conduct a plus-five-year policy simulation to show the magnitude of the impact and how individual workers would respond to policy changes.

Keywords: Social security; Retirement; Incentive measure.

INTRODUCTION

With rapidly aging population, the social responsibility to support the elderly for a comfortable retirement life has become more demanding. The Social Security (SS) system – the central component of social insurance programs – has contributed enormously to relieving poverty among the elderly. The Social Security system has faced unfavorable changes in the demographics and the labor market, however. Many countries face a serious question of how to reform their SS programs to continue to provide protection for the elderly and to maintain the SS system financially sustainable. Although much work has been done in this area for countries in the Organization for Economic Co-operation and Development (OECD) (Gruber

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and Wise, 2004), there are not many quantitative analyses performed for Asian countries despite the urgent issues there.

Korea is among the top countries with more than 2 million people aged 65 and over in 2000 (OECD, 2007a), and has been experiencing accelerating population aging and declining labor force participation rates (LFPR)[3] of the elderly. The vital statistics and the aged dependence ratios[4] are shown in Figure 1. With declining birth rates and low death rates, the natural increase rates have been dropping in recent years, which results in a larger proportion of the elderly in the total population. The baby-boom generation from the 1950s and 1960s are now near retirement. In the bottom panel of the figure, we plot the aged dependence ratios. The ratios are over 12 percent now, and will continue to rise at a fast pace into the next half century. The labor force participation rates from 1995 to 2002 are shown in Table 1. The LFPR decreases from 64.9 percent in 1995 to 63.9 percent in 1999, then increases to 65.4 percent in 2002 (International Labor Organization, 2007). The recent rise in LFPR is mainly caused by two trends: (1) A growing share of women switch out of the traditional role and become economically active. (2) Urban migration of the youth leaves rural residents no choice but to continue working at the old ages, due to the loss of young labor (Lee, 2004; OECD, 2007b). But Lee also points out that the LFPR of the elderly will go down eventually. First, the current LFPR of the older men in rural areas is twice as high as that in cities, so the average rate will decline when the rural population become smaller in the course of urbanization. Second, the coverage expansion and the maturity of the pension system will provide more income to more people over age 65, therefore we would expect a lower retirement age. Phang (2003) clearly shows that the LFPR of the elderly in Korea has dropped remarkably by age groups: for the age group of 55 to 59, the LFPR decreases from 84.9 percent in 1992 to 77.7 percent in 2001; for the age group of 60 to 64, from 73.9 percent in 1995 to 64.7 percent in 2001; for the age group of 65 and over, from 41.4 percent in 1996 to 40.4 percent in 2001. Figure 2 plots the Korean LFPR for the first two age groups from 1989 to 2001.

There are many factors that affect retirement decisions, such as savings and wealth, health condition, individual preference of work over leisure, financial support from the children and living arrangements, and labor market demand and supply (including secondary labor market opportunities). In this paper, we focus on the retirement incentives from an institutional side, SS program provisions. Studies (Gruber and Wise, 2004) have shown that in 12 OECD countries, the underlying SS structures play an important role in workers'

[3]The labor force participation rate refers to the number of persons in the labor force as a percentage of population aged between 15 and 64.

[4]The aged dependence ratio is the ratio of the number of the elderly aged 65 and over to the number of working people aged between 15 and 64.

retirement decisions. This holds true for countries with diverse cultural backgrounds, demographic distributions, labor market institutions, SS regulations and other social and political characteristics.

The question that we address is how SS program provisions in Korea affect retirement decisions of the elderly. We estimate the impact of the National Pension Scheme (NPS) on the retirement behavior in Korea, using the micro level data from the Korea Labor and Income Panel Study (KLIPS). We apply the methodology of the social security wealth (SSW) and the incentive measures: accrual, option value and peak value. We first project the entire wage earnings profile for each individual. Heckman's two-step procedure is performed to correct the sample selection bias. Then according to the Korea's NPS detailed provisions, we calculate the SS benefits that a worker expects if he or she retires at any given age. The SSW is then derived as the present discounted value of the SS benefits. The three incentive measures are computed thereafter. Age distributions of these constructed variables are discussed. Their evolution paths over individual workers' entire career illustrate different shapes that the SSW and the incentive variables may take. To capture retirement incentives, we run probit regression models separately for Korean male and female samples, assuming different forms of age effects. Semiparametric logistic regressions with nonlinear age effect is also explored. The estimates quantify the important effects that the NPS has on Korean workers' retirement behavior. Empirical estimates show that in Korea the SSW plays an important role but its signs are different in different models. The estimated effects of the incentive variables on retirement are negative and significant for the male sample and in most models for the female sample. As stated by the National Pension Service in Korea, the eligibility age for the full old-age pension shall be raised by 5 years gradually to age 65 in 2033. To show the magnitude of this impact, we conduct a plus-five-year policy simulation to see how individual workers would respond to this policy change.

LITERATURE REVIEW

Overview

The demographic changes have called attention to the aging society. Issues of the elderly include their economic status, social profile, and mental and physical health. (Refer to the U.S. Census Bureau (2005) for a comprehensive report). Financial security of the elderly is the key problem, and its support has transitioned from the traditional family to social responsibility and private savings. In U.S., child support is no longer an important means of old-age income since the end of 19th century (Lee, 2004a). Venti and Wise (2000b, 2001) find that in general, old people are unwilling to sell or downsize the houses that they have lived for many years, and that housing equity is not liquidated to support their post-retirement consumption. Fortunately, social security provides the largest share of the total income for the population aged 65 and above: according to the current population report (U.S. Census Bureau, 2005), in 2001, social security accounts for 39 percent of total personal money income, followed by 24 percent from earnings, 18 percent from pensions other than social security, and 16 percent from asset income. For 20 percent of the SS recipients[5], SS payments are their only source of income, and for another 13 percent of recipients, SS benefits account for more than 90 percent of their total income. Overall 65 percent of recipients rely on SS as at least a half of their total income.

With popularity of voluntary insurance programs in recent years, the retirement savings in Personal Retirement Account (PRA), or 401(K) have become important supplements to social security. There is a large literature discussing how to manage defined contribution[6] accounts and therefore to maximize financial resources at retirement. Education, especially financial knowledge, contributes to better asset allocation decisions (Poterba and Wise, 1997; Lusardi and Mitchell, 2006). Feldstein (2005a, 2005b) argues that the investment-based PRA together with a Pay-As-You-Go (PAYG)[7] plan is practical and is better than dramatic tax increases or sharp benefit cuts. He also proposes using a diversified portfolio with equities and Treasury Inflation Protection Securities (TIPS) to reduce the investment risk. Poterba, Venti and Wise (2001) show that defined contribution plans can lead to larger asset accumulations than defined benefit[8] plans with micro and macro evidences. Poterba, Rauh, Venti and Wise (2003, 2006, 2007a, 2007b, 2007c) offer more detailed discussions and new empirical work on this topic.

Observing that the labor force participation rate of the elderly has declined, researchers have been trying to identify and quantify the retirement incentives from social insurance programs. French and Jones (2004) use “the first estimable dynamic programming model” that simultaneously evaluates medical expenses reduction and volatility. They show that the eligibility and choice between employer-sponsored health insurance and Medicare are important in the retirement decisions, yet the effect is not as strong as that of social security. Chen and van der Klaauw (2005) explain that the Disability Insurance (DI) program reduces

[5]The SS recipient refers to an “aged unit,” which is a married couple either of whom is aged 65 and above, or an individual aged 65 and above.

[6]In a defined contribution pension system, contributions are accumulated in individual accounts and invested in portfolios, and annuitized benefits are determined by the performance of the investment.

[7]A pay-as-you-go pension system is one in which pension benefits are paid to the current retirees as contributions are collected from the current workers under the social security program.

[8]A defined benefit pension system is one in which annuitized benefits are determined by the earnings history and the coverage under the social security program in a prescribed formula.

LFPR. They estimate up to 20 percentage points increase in the LFPR of the DI beneficiaries, if the beneficiaries were not approved for DI benefits.

Stock and Wise (1990a, b) propose an option value model to simulate the effect of a firm's pension plan on retirement choices. The predictive performance of this model is compared with that of a dynamic programming model and a probit model by Lumsdaine, Stock and Wise (1990). They find that the option value model is a relatively simple and accurate method in approximating individual choices. This result is confirmed by using data from a second large Fortune 500 company (Lumstaine, Stock and Wise, 1992). The option value model is later widely used in studying the effects of SS programs on retirement decisions.

Gruber and Wise (1998) document the population aging trends in 11 OECD countries, and show that there is a strong correspondence between the benefits eligibility ages and the retirement choices. After calculating the implicit social security tax, they sum the SS tax rates on continued work from the early retirement age through age 69, and call it the "tax force to retire." In each country in their studies, the tax force to retire is closely correlated with the unused labor capacity[9]. They conclude that it is the SS program provisions that induce workers to exit early from the labor force.

The magnitude of these effects is shown in their later work (Gruber and Wise, 2004). Institutional backgrounds and micro data are collected from 12 OECD countries. They estimate the effects of several factors on retirement probabilities, and simulate policy changes. Their comparative study shows that SS programs play a significant role in workers' choices of retirement, regardless of the country's economic and social background. Coile and Gruber (2007) confirm their early result (Coile and Gruber, 2004) with more recent data, and more detailed calculations of the retirement incentives.

For more studies on pension programs from international perspectives, see the International Labor Office (2001), Diamond (2005), and OECD (2007a).

Korea's Experience

The demographic aging process in Korea has been dramatic. Korea became an aging society (with 7 percent of the population aged 65 and over) in 1999, and it is projected to become an aged society (with 15 percent of the population aged 65 and over) in 2020. For the same transition, it took France 115 years, Sweden 85 years, U.S. 75 years, U.K. and West Germany 45 years, and Japan 26 years (Phang, 2003). See Table 2 for a projection of proportion of the population aged 65 and above from World Population Prospects (2006).

The current public pension schemes in Korea include the NPS and special occupational

[9]The unused labor capacity refers to the proportion of persons not working at a given age.

programs. The NPS has dual features: public and private (Yang, 2001). It is public in that the coverage and benefits are available to all the residents. It is private because the National Pension Service manages the program with limited government interaction. Takayama evaluates the Korea's NPS and compares it with Japan's public pension program. There are many similarities in the two programs, such as coverage expansion, type of plan, contribution rate growth, benefits structure, Consumer Price Indexed (CPI) payments, normal replacement rate[10], sectoral differences in pension benefits, and reserve fund investment. The two programs also differ in many ways. First, the minimum coverage requirement is significantly higher in Japan – 25 years, compared to 10 years in Korea. Second, the self-employed enjoy the same program with the private sector employees in Korea, while they do not qualify for the earnings-related benefits in Japan. Third, divorcees in Korea get half of the pension payment. Fourth, different public pension programs cannot share revenues in Korea, therefore deficits are seen in the programs such as the military personnel program where payments are typically earlier.

Financial insolvency is a potential problem in the NPS. Many factors have contributed to this. First, the pension benefits are relatively generous. The reform in 1999 lowered the replacement rate from 70 percent to 60 percent for an average income worker with 40 years of contribution (OECD, 2007a). Further amendments have been made effective January 2008. Second, contributions are not properly enforced, especially for the non-employed and the self-employed. Reported income of the self-employed tends to be low, so that they pay lower contributions and take advantage of the flat-rate benefits that are not related to individual earnings. Takayama therefore proposes switching to a consumption-based tax to provide funds for the flat-rate pension benefits. Third, the pension coverage has been expanded "too fast too soon." (Yang, 2001) Last, the disadvantageous demographic changes aggravate the fund shortage. In the long run, with the rapid population aging, the contribution rates would have to increase to about 30 percent to keep the current benefits level when the system dependence ratio[11] is over 50 percent (Takayama). This would cause instability of the pension system and the national economy.

METHODOLOGY OF INCENTIVE MEASURES

There are several ways to measure retirement incentives. In this paper, we compute three incentive measures: accrual, option value and peak value. All these evaluate the financial

[10]The replacement rate is the percentage of a worker's wage earnings in a base period that pension benefits replace.

[11]System dependence ratio is the ratio of the number of pensioners to the number of contributors in the social security system.

gain or loss from continued work. The key variable used to derive them is the SSW, the present discounted value of all future SS benefits for each possible retirement year. The SSW and incentive measures for each year are then converted to a fixed base year[12] value with a real discount rate and mortality rates for comparison purposes.

The tradeoff facing a person is: by working one additional year, the worker has one fewer year to enjoy the benefits although the accumulated SS benefits may increase. The SSW drops when the possible increase in the annuitized SS benefits cannot outweigh the decrease in the overall SS benefits due to one fewer year of receiving payments. This results largely from the fact that SS benefits are not "actuarially fair." In the retirement decision making process, one should take into consideration both the level of SS benefits and the number of years of entitlement to achieve the maximum possible benefits.

The SS provisions enter the retirement decision in at least two ways: wealth effect and accrual effect (Coile and Gruber, 2004). First, the SSW has a wealth effect: workers with more SSW tend to consume more of all goods, including leisure. All else being equal, the greater the SSW, the earlier the worker would choose to retire. Second, the SSW development over time generates tradeoffs and uncertainties. There could be disincentives to work when staying employed would not bring more SSW. There might be incentives that keep workers stay in the labor force, such as the actuarial reduction of benefits for early withdrawal, the minimum age and coverage for the entitlement to pension benefits, and the general rule about the benefits level being conditioned on contributions. How these two effects work together can be determined by empirical estimates. It turns out that the net effect varies in different regression models. The sign of the estimated SSW coefficient can be positive or negative.

Accrual

One key consideration for the retirement decision is how the SSW changes over time. Social security accrual is defined as the change in the SSW from the current year to the next,

$$ACC_t = SSW_{t+1} - SSW_t. \tag{1}$$

The difference gives the benefits gain by continuing to work until time $t+1$ rather than retiring at time t. Lower SS accrual conttributes towards a worker's incentive to retire.

However, accruals may vary substantially from year to year. The SSW exhibits different trend patterns, most of which are not monotonic (Figure 5). This leads to the fundamental weakness of the accrual measure. Workers would behave myopically if their retirement decsions are based on only one-year comparison since there may be a large potential jump

[12]The base year we choose for Korea is 2000.

in the SSW in the future, especially in the early years.

Another useful calculation with a similar idea is the implicit SS tax (or subsidy) on earnings. This measure is the ratio of the SSW accrual to the wage earnings. When the ratio is negative (positive), it is called the implicit Social Security Tax (Subsidy) on earnings.

$$\text{SS Tax(Subsidy)} = \frac{SSW_{t+1} - SSW_t}{Wage_{t+1}}. \tag{2}$$

With this normalization, the incentive effects on retirement of the SSW and wage earnings are mixed (Coile and Gruber, 2001). Separating one effect from the other poses difficulties. In order to determine the impact of SS provisions, it is imperative to identify the source of retirement incentives.

Option Value

Stock and Wise (1990a, b) introduce utility into retirement decisions through the option value rule. According to the option value rule, one continues to work if the expected utility of retirement in some future date is higher than the utility from retiring today. That is, the worker compares the expected value of retirement, including weighted wage earnings and retirement benefits, at different ages, and chooses to retire at an age that yields the highest utility. Thus, the option value is a measure of the opportunity cost of retiring now versus in the future.

We adopt the additive utility function from Stock and Wise (1990a). If a worker retires at a future age r, the discounted utility value at the current age t is given by

$$U_t(r) = \sum_{s=t}^{r-1} \beta^{s-t} p_{s|t} Y_s^{\gamma} + \sum_{s=r}^{T} \beta^{s-t} p_{s|t} [kB_s(r)]^{\gamma}, \tag{3}$$

where Y_s is the wage earnings at age s, $B_s(r)$ is the SS benefit at age s if one retires at age r, k is the relative weight that the worker assigns to the retirement income, β is the real discount factor, $p_{s|t}$ is the probability of being alive at age s conditional on being alive at age t, γ is the parameter of risk aversion, and T is the maximum life length. We expect k to be greater than 1 since SS payments are received without sacrifice of labor.

Let r^* denotes the optimal retirement age in the future when the discounted utility is maximized, so that $r^* = \arg\max_{r>t} U_t(r)$.

The Option Value is the difference between the utility from retiring at the optimal age r^* and the utility from retiring today,

$$OV_t(r^*) = U_t(r^*) - U_t(t). \tag{4}$$

If $OV_t(r^*) > 0$, it is in the worker's interest to delay retirement to the future optimal age r^*. Staying in the labor force gives the worker an option of receiving the highest discounted utility when he or she retires later. The worker may choose to retire now if $OV_t(r^*) \leq 0$.

The structural parameter estimation is beyond the scope of this paper; we assume that k is equal to 1.5, β is equal to 0.97, and γ is equal to 0.75.[13]

Peak Value

The option value incorporates not only retirement incentives from SS benefits, but incentives from wage earnings as well; identification for these two effects is again a potential problem. As discussed earlier, the accrual measure is myopic. Coile and Gruber (2001) propose a new incentive measure, which compares the expected SSW now to its highest value beyond today. The difference between the SSW at its peak in the future and the current SSW is called the Peak Value:

$$PV_t = \max_{t'>t} SSW_{t'} - SSW_t. \tag{5}$$

With the same rationale of the implicit SS tax (subsidy), the peak value can be normalized by dividing the change in the SSW by the wage earnings over the same period. If one can get more from wage earnings while receiving the same amount of increase in the SSW, the incentive to retire is lower. However the normalized peak value suffers the similar identification problem as the implicit SS tax (subsidy) when the effects from the SSW and wage earnings are mixed.

Comparison of the Incentive Measures

All the above methods measure the retirement incentives, from the perspective of financial gain or loss in the SS benefits from continued work. Now we compare some features of these incentive measures.

The accrual measure only looks one year ahead, while the peak value and the option value take into account the entire future path of the SSW.

As can be seen in Equation 3, the option value incorporates both the incentive effects of wage earnings and SS provisions. To separately identify the effect from each source, we add some wage earnings variables to the retirement models as predictors, such as projected earnings in the next year, and average lifetime wages. Their quadratic and interactive forms are also included, in an attempt to control for the potential nonlinear relationship between

[13]These parameter values follow those in Gruber and Wise (2004).

the option value and decisions for retirement. The peak value measure tries to address this issue by considering only the SS effects.

Unlike option value, the accrual and the peak value do not need to assume the functional form of one's utility, and thus have relative computational simplicity; they are easily derived from the SSW. The option value rule requires specific modeling of the retirement behavior. One needs to consider whether the utility function is linear in income, and how one weighs retirement income against wage earnings. The exact modeling may vary significantly from researcher to researcher, and the inferred role of SS incentives will also be different.

Besides the computational issue, the accuracy in measuring the retirement incentives differs among the three. First, the single year accrual measure suffers from the weakness that the SSW may possibly have a large increase in the future. The failure to take into consideration the entire path of the SSW makes some choices in the earlier years short-sighted. Second, the option value is equal to the sum of the discounted future wages through the optimal year and the difference in the expected future SS benefits between now and that year.[14] This may overstate the effect of the SS provisions themselves, because wage earnings may reflect individual heterogeneity in preference for work or leisure. Third, considering only the change in the SSW without accounting for wage earnings, as in the peak value measure, may understate the effect of the financial incentives on retirement, since wages obviously play an important role in one's choice of work or retirement. Also, none of the above measures explicitly allow for savings or a labor-leisure trade-off.

The utility function we use in the option value is a simplification from a more flexible specification

$$\begin{aligned} U_t(r) &= \sum_{s=t}^{r-1} \beta^{s-t} p_{s|t}(H_t, PI_t, G_t) u(c_t(I_t, S_t), l_t, \gamma) \\ &+ \sum_{s=r}^{T} \delta^{s-t} p_{s|t}(H_t, PI_t, G_t) v(c_t(k, B_s(t), I_t, S_t, \gamma)) \end{aligned} \quad (6)$$

where the pre- and post- retirement discount factors, β and δ, can be different; the survival probability $p_{s|t}(H_t, PI_t, G_t)$ is a function of health H_t, permanent income PI_t, gender G_t, and ages at time s and t;[15] intratemporal utility functions take different forms, u and v, when one is working or retired; the pre-retirement utility u allows for a labor-leisure (l_t)

[14] As defined in Equations 3 and 4, we can substitute $U_t(r^*)$ and $U_t(t)$ into $OV_t(r^*)$ and get $OV_t(r^*) = U_t(r^*) - U_t(t) = \sum_{s=t}^{r^*-1} \beta^{s-t} p_{s|t} Y_s^{\gamma} + \{\sum_{s=r^*}^{T} \beta^{s-t} p_{s|t} [kB_s(r^*)]^{\gamma} - \sum_{s=t}^{T} \beta^{s-t} p_{s|t} [kB_s(t)]^{\gamma}\}$.

[15] Survival probabilities could differ a lot by many observable and unobservable factors. De Nardi, French and Jones (2006) estimate survival probabilities as a function of age, gender, health and permanent income, using data from Assets and Health Dynamics of the Oldest Old (AHEAD) in U.S. Our approach in Equation 3 takes survival probabilities as exogenously given by age and gender.

trade-off and the consumption c_t depends on income I_t and savings S_t; the post-retirement utility v is a function of consumption which is determined by social security benefits $B_s(t)$, income I_t, relative weight on retirement income k, savings S_t, and risk aversion γ.

Each measure has its own merits. In our empirical work, we incorporate all of them, in order to provide a more comprehensive perspective of retirement incentives driven by SS provisions, and to better understand how and how much policy makers can affect individual retirement choices by changing the SS benefits rules.

NATIONAL PENSION SCHEME IN KOREA

The most important component in Korea's public pension system, National Pension Scheme, started on January 1st, 1988. The coverage has been extended several times since then. At the beginning, it only covered those in the workplaces with more than 10 full-time workers. In 1992, the coverage became compulsory in smaller workplaces with 5 to 9 full-time workers. In 1995, the National Pension Act was applied to farmers, fishermen, and all residents in Kun areas, and foreigners were also insured in the compulsorily covered workplaces. Since 1999, the program was further improved, covering all urban workers, the self-employed, non-income earners and foreigners. So at present, the National Pension Scheme covers all residents between ages 18 and 59, except for government employees, military personnel, private-school teachers and specially designated post office employees, who participate in their special pension schemes.

Disabled retirees can receive benefits which are determined by the degree of disability. Retirees with the 1st degree disability will receive an annuity of the basic pension amount, as defined in Equation 7. The amounts of annuities are reduced by 20 percent and 40 percent to retirees with the 2nd and the 3rd degree disability, respectively. Those under the 4th degree category are only eligible for a lump sum payment of 225 percent of the basic pension amount.

Another retirement option is through the Retirement Allowance Scheme, or severance payments, financed by the companies with 5 or more employees. Upon leaving the company, Korean workers with more than one continuous year of service at the company can receive lump-sum retirement allowances. For each year of service, workers are entitled to one month average base salary which is determined by the average salary during the last three months of employment. This lump-sum payment is relatively low and not enough for the majority of workers, unless they work for one company for many years. So it is typically used by laid-off workers just before they find the next job. The allowance is unfunded because the reserve is only recorded on the book. The Unemployment Insurance Scheme was introduced in 1995 to employers with 16 or more employees. The unemployed will receive 50 percent of the base salary for up to 6 months. From 1997, employers with 5 or more employees have an option to switch their retirement allowance schemes into Corporate Pension Scheme, in which the benefits can be a lump-sum or annuities, but the progress has been slow.

Private pension plans are also available from financial institutions and grow rapidly. However, it is considered by many Koreans as an investment tool rather than a retirement income source.

The NPS is the most important path to retirement, however it is not completely phased-in. Only until 2008 can someone be eligible for the full old-age pension. During this transition period, the National Pension Service has collected tremendous amount of contributions since 1988. As of 2006, the National Pension Fund have been accumulated to 189 trillion won, diversely invested in stocks, fixed income and alternative investment. There are 1.8 millions of pension beneficiaries, 82 percent of whom are old-age pensioners, 3 percent are disability pensioners, and another 15 percent are survivor pensioners. Due to the immaturity of the NPS, 85 percent of the old-age pensioners receive the special old-age pension. The total pension benefits payment is 351 billion won, and the percentages for the above three groups are 80 percent, 6 percent and 14 percent, respectively.

Categories

There are two main categories of the insured: mandatory and voluntary.

The mandatorily insured persons are further divided into two types:

(1) Workplace-based insured persons, who are mainly regular and full-time workers aged from 18 to 59, in workplaces with more than 5 full-time employees;

(2) Individually insured persons, which consist of the self-employed, irregular and part-time workers, and non-income earners.

The voluntarily insured persons can choose to participate or withdraw at their own will. They are divided into two types:

(1) Voluntarily insured persons;

(2) Voluntarily and Continuously insured persons.

The voluntarily and continuously coverage plan allows those insured persons who are reaching 60 years old but have less than 20 years of coverage to maintain their insured status. It serves to protect pension benefits rights. Ten years of contributions is required for the entitlement to pension annuities, and 20 years for full old-age pensions. For example, if a 60-year-old man has less than 10 years of coverage, he will receive only a lump-sum refund of the contributions made by him and his employer. By opting for this plan, he improves his opportunity of receiving pension annuities when his total insured period exceeds 10 years. In another scenario, suppose that his initial coverage is between 10 and 20 years so that he is entitled to a reduced old-age pension. If he applies for this plan and accumulates 20 years of contribution, he can increase his pension amount to a full old-age pension.

Contributions

The National Pension Scheme is a defined benefit, pay-as-you-go plan. The payments to the current retirees are financed by the contributions from the current insured and their employers.

Due to the ever increasing aged dependence ratio, the contribution rate has been raised from 3 percent to 9 percent since 1999. The contributions of the workplace-based insured persons are shared equally between workers and employers, and all the others have to pay contributions entirely by themselves.

The calculation of contribution is based on the insured person's Standard Monthly Income (SMI), which ranges in 45 grades from 220,000 won to 3,600,000 won. The base of contribution for the voluntarily insured persons is determined by the median value of the standard monthly income of all the mandatorily insured persons as of the last day of the previous year.

Benefits

Old-age pension benefits include life annuities and lump-sum refunds. They are determined by age, the insured period, the earnings history of the insured and the average income of all the mandatorily insured persons. Pension annuities are adjusted by the CPI every year to maintain real values.

The basis for calculating all types of pension annuities is the Basic Pension Amount (BPA), defined as

$$BPA = 1.8 \times (A + B) \times [1 + 0.05 \times \max(0, N - 20)], \tag{7}$$

where A is the average of the price-indexed SMI of all the mandatorily insured persons in the 3 years preceding the first benefit year, B is the average of the price-indexed SMI history of the insured, and N is insured years.

In the above BPA formula, A and B have different functions. The variable A, the average SMI across all the mandatorily insured, aims to equate income across different wage earnings classes and help the poor to earn basic life security through the income redistribution. The variable B, which is closely related to one's entire earnings history, encourages hardworking during employment and helps maintain the pre-retirement standard of living. The constant 1.8 intends to make the replacement rate equal to 60 percent for an average income worker with 40 years of contribution. As an incentive for being insured for a longer period, the BPA is raised by 5 percent for each year of coverage over 20 years.

According to the first age of the benefits payment, the insured period, and the retirement test[16], the pension annuity can be one of the five types: full, reduced, active, early and special old-age pension.

(1) Full Old-Age Pension (FOAP)

When a worker reaches 60 years old and has been covered for at least 20 years, he or she is entitled to receive the full old-age pension, provided that he or she is not economically active. The full old-age pension amount is the same as the BPA.

$$FOAP = BPA. \tag{8}$$

The eligibility age will be raised gradually to age 65 in 2033. The workers in special occupations, like miners, fishermen, or those with physically demanding jobs, can enjoy the full pension benefits from age 55. The retirement test does not apply to the insured aged 65 and above.

(2) Reduced Old-Age Pension (ROAP)

When a worker reaches 60 years old but has only 10 to 19 years of coverage, his or her pension benefits are reduced from the BPA by some certain payment rates, as in the following equation,

$$ROAP = [0.475 + 0.05 \times (N - 10)] \times BPA. \tag{9}$$

If we substitute $N = 20$ into the above equation, we can only get 97.5 percent of the BPA, instead of a full old-age pension amount. This shows that from the 19th to the 20th insured year, the reduced pension payment rate jumps by 7.5 percentage points, rather than 5 percentage points specified in Equation 9. So when one is close to 20 years of contribution, this jump gives an extra incentive for the worker to stay in the labor force a few years longer.

[16]The retirement test refers to the test for active economic participation, either by being employed, or as a business owner. According to the National Pension Service, one is considered as being economically active, if his or her wage earnings are over the exemption amount for the income taxation "under the Income Tax Act (5 millions won as of 2001) or runs a business registered under the Added Value Tax Act or Income Tax Act."

(3) Active Old-Age Pension (AOAP)

Both the full old-age pension and the reduced old-age pension require that the pensioners younger than 65 years old pass the retirement test. If a pensioner is economically active, he or she will receive the active old-age pension, and the pension amount is multiplied by a reduced payment rate ranging from 0.5 to 0.9 depending on the age.

$$AOAP = \begin{cases} [0.5 + 0.1 \times (Age - 60)] \times BPA & if \quad N \geq 20 \\ [0.5 + 0.1 \times (Age - 60)] \times ROAP & if \quad N < 20 \end{cases} \tag{10}$$

(4) Early Old-Age Pension (EOAP)

The early old-age pension applies to the insured aged between 55 and 59 with at least 10 years of coverage, and it requires the retirement test. Depending on whether the insured years are over 20 or not, the pension amount is determined by multiplying the full or reduced old-age pension by 0.75 for age 55 with a 0.05 increase for each additional age.

$$EOAP = \begin{cases} [0.75 + 0.05 \times (Age - 55)] \times BPA & if \quad N \geq 20 \\ [0.75 + 0.05 \times (Age - 55)] \times ROAP & if \quad N < 20 \end{cases} \tag{11}$$

(5) Special Old-Age Pension (SOAP)

The special old-age pension was introduced in 1995 and 1999, in order to help those who cannot meet the above criteria in the transition period before the pension scheme is fully phased in.[17] It covers those who are aged between 50 and 60 and with 5 to 9 years of coverage. A special old-age pensioner can receive pension benefits starting from age 60.

$$SOAP = [0.25 + 0.05 \times (N - 5)] \times BPA. \tag{12}$$

(6) Lump-Sum Refund

When the insured cannot meet the requirements of any of the above types of annuities, either aged less than 50 or with less than 5 years of coverage, he or she receives a lump-sum refund of the total contributions made by him or her and his or her employer, plus a 3-year-deposit interest rate. As in many other defined benefit plans, this provides an incentive for employees to stay in the labor force for at least a certain time period. In other words, this restriction helps prevent early retirement.

[17] Since the NPS started in 1988, the earliest possible year for some kind of pension annuities (reduced old-age pension with 10 years of coverage) was 1998. The full old-age pension is not available to anyone until 2008.

Amendment to the National Pension Act

Effective January 1st, 2008, the National Pension Act in Korea is subject to change, in order to keep the financial solvency and intergenerational balance of the system. The main changes are highlighted here.

(1) The definition of income is clarified. For wages earners, tax-free income is deducted from total earnings. For business owners, necessary expenses can be deducted from total income.

(2) The 45 Standard Monthly Income classes used to have the appeal of computational and administrative simplicity, but it is no longer the case with technology development. The actual income will be used to calculate contributions and benefits.

(3) Benefits are cut to keep the system financially sound. The constant term in Equation 7 is lowered from 1.8 to 1.5 in 2008, and will be further decreased by 0.015 every year, until it reaches 1.2 by 2028. The corresponding target replacement rate for an average income worker with 40 years of contribution will be 50 percent in 2008, and is lowered by 0.5 percent each year, until 40 percent in 2028.

(4) The reduction rate in Equation 11 of the early old-age pension increases from 5 percent to 6 percent.

(5) A new credit system is introduced. Extra coverage is given to a person who finishes military service, or parents with more than 1 child born after January 1st, 2008.

Other changes include how to count insured period if contributions are in arrears, enforcement of accurately reporting income and paying contributions on time, elimination of gender discrimination, determination of degrees of disability and eligibility for disability pensions.

The empirical analysis in this paper is based on the current rules.

DATA OVERVIEW

Our micro-level data are from the Korea Labor and Income Panel Study (KLIPS) conducted by the Korea Labor Institute. The KLIPS is the first panel survey in Korea on labor-related issues. It is a longitudinal survey of nationally representative urban adults (except Jeju Island), and has been successfully conducted annually from 1998 to 2006, with a very high retention rate of about 78 percent. Our analyses are based on the latest released data, which include 7 waves from 1998 to 2004. The initial samples were drawn with equal probability from 7 metropolitan cities and the urban areas in 8 provinces. In 1998, 13,738 individuals aged 15 years old and over were selected from 5,000 households. In the following surveys, the same households and individuals were followed up, and as the original households were separated and expanded, new entrants were added who were biologically or economically tied to the original samples.

We choose our sample from those who were interviewed in the Health and Retirement Survey in 2003. These are 3,530 individuals aged 50 and over in that year. This special module asked specific information about the retirement years, reasons, workplace retirement age regulation, life after retirement, and for those who had not retired by then, it asked their expected retirement ages.

We delete 302 persons who had retired by 1988 when the National Pension Scheme went into effect, since their decisions were not subject to the NPS provisions. There are 764 individuals who never worked, but their demographic information is available. We include this group in Heckman's two-step procedure to correct the sample selection bias. Because wages or the self-employed income are essential in our empirical analysis, we drop those whose earnings are missing. It is difficult to define the retirement status for the self-employed, so for the current paper, we focus our attention on wage earners, which consists of 1,032 males and 581 females.

Combining the interview waves, we are able to construct 4,042 person-year observations for males and 2,272 person-year observations for females. Our objective is to study the motivations that drive workers' decisions on retirement, therefore the age range of 45 and 70 is more relevant. We delete 3 male observations and 67 female observations, who started to work after age 60. Further exclusions are: 77 male observations and 40 female observations because their corresponding ages are outside of the range of interest. To project wage earnings, we exclude 609 male observations and 173 female observations due to missing data on their employment or demographic information used in the second step of Heckman's procedure. Our final samples are 713 men and 493 women which yield 3,333 and 1,992 person-year observations, respectively.

KLIPS surveys asked interviewees about their NPS participation, and whether and how much they had received the social insurance payments. However, responses were not always consistent. For example, some did not report to have the NPS coverage, but actually received old-age pension benefits. Some were covered through their employers in the Work History Surveys, but reported no coverage in Individual Surveys. Some worked for the government and were supposed to be covered by the government employee pension plans; however, they claimed having coverage under the NPS. These inconsistencies may be due to insufficient knowledge about the pension system. For simplicity we assume that all individuals who work in or after 1988 are mandatorily covered as workplace-based insured persons.

Information about demographic background and work history is available from the KLIPS data, such as date of birth, gender, education, marital status, residence location, health status[18], industry, occupation, firm type, employment status and wage earnings. If a person changes his or her job within one year, the annual wage earnings are calculated as the mean of all wages at different workplaces in that year. Nominal wage earnings are turned into real wages indexed to year 2000. For those who do not have records for the year they started their first jobs, we assume that they started to work immediately after completing their formal education. The distributions of the actual ages at retirement from our samples are plotted in Figure 3. For the male sample, 177 out of 713 men were retired by 2003 when they were interviewed. Their focal retirement ages are 57, 58, 60, 61 and 62. For the female sample, 210 out of 493 women were already retired. The most frequently observed retirement ages are 50, 54, 58, 60. Summary statistics of the data are given in Table 3. The average age in our sample is approximately 55 for both men and women. About 96 percent of men and only 75 percent of women are married. The men in our sample have higher education background than women: 20 percent of the male samples have some college education, while only 5 percent of female samples ever go to college; 35 percent and 17 percent out of male and female samples complete high school education, respectively. More than a half of our male samples report that they are in good health; this ratio is 16 percentage points higher than that of women. The average annual real wages are 16,586,200 won in year 2000 won for men, and those for women are about a half of what men earn. The average job experience is 31 years and 22 years for men and women, respectively. There are 69 percent of men who work regularly, and 94 percent who work full-time; the ratios for women are 53 percent and 85 percent, respectively. Most of our samples, 65 percent of men and 72 percent of women work in private companies, 19 percent of men and 11 percent of women work in governments or government-related companies. The top three areas that the sample come from are City of Seoul, Kyonggi Province and City of Pusan.

PROJECTIONS ON THE EARNINGS PROFILE

The most important quantitative information available from the KLIPS is the wage earnings from 1998 to 2004 at the individual level. To calculate the SSW and the incentive variables, we first need to project entire earnings profile for everyone from their start years until age 70. We apply different methods for forward and backward projections.

[18]The self-reported health status is available only in three waves, from 1999 to 2001. We assume that the health status before 1999 is the same as that in 1999, and that the health status after 2001 is the same as that in 2001.

Forward Projection

Based on our available wage data, we apply Heckman's two-step procedure to predict future earnings between ages 45 and 70. This technique takes care of potential selection bias, by incorporating information on persons who choose not to work. In the first-step selection equation, the demographic information, such as age, marital status, education, health condition and residence address, are used. In the second-step wage estimation, we regress the log of nominal wages on a constant, a linear time trend and a series of dummy variables, indicating demographic information as in the first step, and employment information, such as firm type, industry, occupation, regular or irregular, and full-time or part-time employment status. The regressions are run separately for male and female samples. The results from the first step are not reported. Our wage estimation results from the second step are shown in Table 4. Columns 2 and 3 show the estimated coefficients and standard errors for men, and the last two columns are for women correspondingly.

Here are some interesting results from the wage estimation. The nominal wages are estimated to increase by 5.6 percent and by 4.6 percent each year for Korean male and female samples, respectively. After wage 45, wages start to decline, and the decreases are significant after age 58 for men and age 57 for women. Interestingly but also intuitively, the inverse Mill's ratio and marriage status have different effects on men and women. The inverse Mill's ratio is not significant for men's wage equation, implying that the selection bias does not appear to be a big problem; the ratio is significant for women's wage equation, hence it matters to the wage earnings potentials whether women choose to work or not. This could be explained by the tradition that men usually take more financial responsibilities within the family. Consistent with findings from many other researchers, married men earn a significantly higher premium compared to single men, but on the other hand, single women make significantly more than their married counterpart. Family obligation for men and economic independence of single women could be one reason to account for this result. Health conditions are positively correlated to earnings: workers with good health earn more than those under fair condition. It pays to get higher education. Those who work regularly or full-time naturally earn more than those who work irregularly or part-time. Other factors, like firm type, industry, occupation and residence areas also have effects on wage earnings.

Based on the regression estimates, we are able to predict the wages for each individual from age 45 to age 70. The years range from 1973 through 2023 for our sample.[19]

[19]Year 1973 corresponds to the year that the eldest one in our sample was at age 45; year 2023 corresponds to the year that the youngest one in our sample will be at age 70.

Backward Projection

Since our wage data are only available from 1998, we also need to estimate the wages for everyone before their age 45 in order to obtain entire earnings history. We take a simple approach for the backward projection. We assume that the nominal wages growth rate is 15 percent[20] each year, and apply this growth rate to every year backwardly until each worker's first working year. The earliest year in the working history is 1943.[21]

With the above two steps, we have complete profiles of wages at each age for all workers from 1943 to 2023. Before calculating the SSW and the incentive measures, we apply the Standard Monthly Income on these wages to get their income classes and income remunerations which are the basis to compute the contributions and pension benefits. We also apply the CPI to nominal wages and SMI to make them real values in year 2000 won. Earnings for men and women are combined when we infer the average SMI of all mandatorily insured persons.

ANALYSIS OF SSW AND INCENTIVE MEASURES

We calculate the SSW[22] and all the incentive measures discussed above for every sample from 1989 through age 70. The National Pension Scheme started in 1988, so 1989 is the first relevant year of retirement decisions under the SS system. All monetary figures are evaluated in real terms in year 2000 won. The first employment year is the year when one started his or her first job, or if that information is missing, is assumed to be the year that each sample finishes his or her highest education. We also apply survival probabilities from the gender-specific Korean life table, evaluated every year, from Korean National Statistical Office (KNSO) 2002. Thus the future SS benefits are adjusted by both mortality and time discounts. A real interest rate of 3 percent is applied for the lump-sum refund of contributions, if the worker is not qualified for pension annuities.

The Korean pension system is so complicated that the SSW computation is difficult. For each worker, we need to know which year one starts to work, the entire wage earnings profile, and from which year he or she is covered under the NPS. For this worker at each age before

[20] We rely on two data sources to make the assumption of the nominal wage growth rate: first, the average monthly wage earnings between 1975 and 2003, published by the Korea National Statistical Office; second, the wage index between 1957 to 2004, available from EconStats.

[21] Year 1943 corresponds to the year that the eldest one in our sample started to work.

[22] We do not consider the active old-age pension, because we define the retirement as having no wage earnings. In addition, from the website of Korean National Pension Service, there are no active old-age pensioners as of December 2006.

age 70, those key factors that play a role in the pension eligibility and pension benefits payments must be calculated, including age, years of coverage, amount of contributions and employer match[23], the average wages of the worker from the work start year until this particular year, and the average wages level of all the workers in the 3 years before this year. Suppose that the worker chooses to retire in this year, then the BPA is derived, and the type of pension benefits and the pension amount are determined, so that the present discounted value of all the future benefits payments is computed, discounted for time preference and survival probabilities. Then we repeat this procedure for the same worker for the next year. When completing calculations for this individual, we move on to the next worker and repeat the above.

The option value calculation procedure is similar, but involves more iterations to achieve utility maximization over one's lifetime. For each worker at each age, we need to compute the discounted utility, if one decides to retire in every single year beyond that time point. Therefore the highest utility that one can expect, and thus the optimal age to retire are projected.

Distribution by Age

We summarize the distributions of the SSW and all the incentive variables from age 55 to age 69 in Tables 5 through 10. In each table, the top panel is for the male sample, and the bottom panel for the female sample.

Table 5 displays the age pattern and heterogeneity in the SSW. We can see that the SSW does not follow a monotonically increasing path. Alternatively, the median SSW for Korean men increases from 21.2 million won at age 55 to the maximum of 31.3 million won at age 60 when the full old-age pension is available. After this turning point, the SSW falls to 25.3 million won at age 69. The SSW for Korean women shows a similar trend, which also peaks at age 60. The heterogeneity among individuals is substantial; the average of standard deviations from age 55 to age 69 is 11.5 million won and 8.0 million won for men and women, respectively.

Table 6 reveals the age pattern of the accrual. Corresponding to the trend we see in Table 5, the median accruals are positive before age 60, with a declining tendency, which indicates the SSW goes up but in a decelerating mode. After age 60, the accruals turn to be negative. The accrual rule suggests that the median worker have a higher propensity to

[23] Different contribution and match rates are applied following the changes in pension policies. Before 1993, the contribution rates were 1.5 percent and 3 percent for employees and employers, respectively. The rates increased to 2 percent and 4 percent between 1993 and 1997, 3 percent and 6 percent in 1998, and 4.5 percent and 9 percent since 1999.

retire at age 60. This is consistent with the NPS provisions in that age 60 is the eligibility age for most pension benefits. After age 61, the accrual is more negative so that the disincentive to continue working becomes larger. For workers at the 90th percentile, they tend to retire at a later age.

We can understand the reason more directly from Table 7, the age distribution for the SS tax (subsidy). Continued work is subsidized for men at the median until age 59. After age 60, negative values imply that workers are punished for staying in the labor force with an implicit SS tax imposed on them. The median SS tax grows from 2.3 percent at age 61 to 15.4 percent at age 69. Another result is worth mentioning. The SS subsidy is much lower for workers at the 10th percentile than for those at the 90th percentile, and the SS tax penalty is a lot heavier. This results from the redistributive function of the defined benefit scheme. Lower wage earners are given more SS benefits relative to their wage earnings and SS contributions, so that they receive a higher replacement rate. For this group, they can probably get more from the SS system by leaving the labor force earlier and receiving the pension annuity payments for more years.

The next three tables are for forward-looking measures. Table 8 presents the age pattern of the option value. The option values decrease with age, indicating that as workers get older, the value of reserving an option of retiring in the future becomes less. When the option values turn negative, it is time for the worker to retire, according to the option value rule. For women workers at the median, their option values remain positive until age 65, so they are expected to retire at age 66, following the rule. The women workers at the 10th percentile are more likely to choose age 63 to retire. It is surprising to see that for men and for women at the 90th percentile, their option values are positive at each age. This may be due to three reasons. First, it could indicate misspecification of our parameter values. Second, the option value rule may tend to predict a higher expected retirement age. Last but not the least, it could be related to the NPS's short history.

To help understand how much parameter values affect the option values quantitatively, we run several sensitivity tests on Korean male sample, varying k or γ. Figure 4 demonstrates the distribution of the ages at which workers would choose to retire, if they rely exclusively on the option value rule. It is clear that if we increase the weight on the retirement income k, the distribution of the retirement age shifts to the left. Intuitively when one receives higher utility from pension benefits than from wage earnings, one is more likely to retire earlier. But as we increase the value of k, it takes a dramatic change from 1.5 to 5 to see the distribution shift towards younger ages, and it requires a structural model to estimate the parameter values after the full old-age pension is available to eligible Korean workers. So we would assume that NPS in the transition phase plays a bigger role in what we see in

Table 8.

In fact, the current retirees cannot receive full old-age pensions. Not until year 2008 can any worker be covered by the NPS for 20 years. So that the benefits are lower than what they would have been provided the NPS had fully phased-in. The option value is equal to the sum of the discounted future wages and the difference in the expected SS benefits. The changes in the SS benefits, no matter positive or negative, are of a relatively small size compared to the wage earnings which are not affected by the NPS's short history. By design, it is very likely that the option values remain positive even at late ages.

Table 9 shows the age distribution for the peak value. The median peak value is positive until age 60 and age 64, respectively for men and women. As workers age, they are closer to their largest potential SSW. On the downward path of the SSW, the peak value is the same as the accrual value. Table 10 for the normalized peak value reveals the magnitude of the change in the SSW compared to that of the wage earnings over the period.

Graphical Analysis

Note that in the above analysis, the median values of the SSW and the incentive measures at a certain age typically do not represent the same individual. To depict a clear picture of how these variables evolve over one's NPS coverage for a particular worker, different sampling schemes are used. Among the male samples, we choose 4 workers, the first 3 of whom are at the 10th, 50th, 90th percentile of the SSW at age 45, respectively, and the last one is chosen to demonstrate another possible shape of the SSW growth. We randomly choose 4 from the female sample. We then illustrate the shapes of the entire profiles for the SSW and each incentive variable in Figures 5 to 10 for Korean male sample. The time period shown is between each worker's age with the first eligible SS benefits payment and age 69. Since the NPS was implemented in 1988, the first possible eligibility year is either 1989 or the individual's first employment year, whichever is later.

Figure 5 demonstrates 4 different patterns how SSW develops over one's insured period. The first data point corresponds to the age when the worker first started to work, or the age in 1989, due to the aforementioned reason. The last data point is at age 69 for everyone. We can see a steady but very slow increase in the SSW in the earlier ages. This reflects the fact that the SS annuities are available only if the insured is at least 50 years old *and* has been covered for no less than 5 years. Otherwise, the pensioner can only receive a lump-sum refund of the total contributions made by himself or herself and his or her employer(s). Once one is eligible for the pension annuities, there is an immediate and substantial jump in the SSW. Thereafter, the SSW typically first goes up in the course of the accumulation of pension entitlement. As years pass on, the worker's earnings history is adjusted, and the redistributive function of the defined benefit is also re-evaluated, so each pension benefits payment increases with age. After several years, the SSW begins to drop. The downturn in the SSW implies that the loss from receiving one less pension payment over-balances the benefits from a larger pension amount. Thus the present discounted value of the SS pension annuities decreases. Our calculation shows that, there are 41.1 percent of the male sample and 27.0 percent of the female sample whose SSW peaks at their age 60.[24]

Another phenomenon in Figure 5 is the existence of multiple local maxima, which causes the potential problem in the accrual measure. The reason for multiple peaks in the path of the SSW is the availability of different types of pension annuities. When the worker receives the first pension annuity he or she is entitled to, the SSW exhibits an upturn and a downturn due to the tradeoff that is discussed above. As one meets certain age and coverage requirements, the entitled pension type is upgraded. This upgrade typically generates another cycle of initially increasing and then decreasing pattern of the SSW. Considering the amount of the annuities and the years that the worker expects to receive pension payments, the second peak could be higher or lower than the first one. It varies by individual at what age the global peak occurs.

Figure 6 exhibits the evolution of accruals. As defined in Equation 1, accruals are the increments in the SSW over the next year. Corresponding to the SSW upward and downward patterns, accruals are at first positive and then turn to be negative; it could be positive again in later years. For comparison's sake, we add a horizontal line where the accrual value is equal to zero. According to the accrual rule, a worker is more likely to retire once the accrual value is negative.

Figure 7 displays the trends in the SS tax (subsidy). The direction of change is the same as that in the accrual values. The points above the horizontal line are SS subsidies, and those below are SS taxes. The spike comes from the strong SS subsidy, when one's pension eligibility changes from the lump-sum refund to annuities.

Figure 8 shows the change in option values. The option values for most male workers are positive even at age 69. From the utility point of view, these workers receive a higher utility from continuing to work beyond age 70 than from retiring before that.

Figure 9 plots the path in peak values. Rather than a one-year comparison in the accrual measure, the peak value looks for the difference in the SSW at its maximum in the future and the SSW today. If the peak value is positive, that implies that there is a financial incentive for delaying departure.

Figure 10 illustrates the evolution of normalized peak values. They show a similar pattern

[24] If one has several peaks on the SSW curve that tie, we refer to the first occurrence.

of changes as in Figure 9, but with a much smaller magnitude. There is a possibility that multiple local maxima in the SSW all have the same value. In this case, intuitively we pick the first occurrence of the local maximum to be the age when the worker would take into comparison with his or her SSW at the decision point. This is important also because we need to determine the wage earnings over the period of interest.

ESTIMATION OF RETIREMENT MODELS

In order to find out how the SSW and the incentive measures work together with other factors to affect individual retirement decisions, we quantify the impacts with probit retirement models. We include many factors as predictors that could also have effects on retirement behavior, based on the information available in the KLIPS.

Probit Model

Our dependent variable is a retirement dummy. It equals to 1 if one retires within the year, given he or she works in the previous year, and it equals to 0 otherwise. Since it is dichotomous, we use a probit model as follows, and the parameters are estimated by maximum likelihood.

$$\begin{aligned}\Phi^{-1}(\Pr(R_{it}=1)) &= \beta_1 SSW_{it} + \beta_2 Incentive_{it} + \beta_3 Age_{it} + \beta_4 Wage_{i,t+1} + \beta_5 AVG_{it} \\ &\quad + \beta_6 Wage^2_{i,t+1} + \beta_7 AVG^2_{it} + \beta_8 Wage_{i,t+1} \times AVG_{it} + \beta_9 Health_{it} \\ &\quad + \beta_{10} Mar_{it} + \beta_{11} Edu_{it} + \beta_{12} Add_{it} + \beta_{13} Fix_{it} + \beta_{14} Ind_{it} + e_{it}, \quad (13)\end{aligned}$$

where $\Phi^{-1}()$ is the the inverse of the cumulative distribution function of the standard normal distribution; i denotes individual; t denotes age; R_{it} is the retirement status dummy, equal to 1 or 0 as defined above; SSW_{it} is the present discounted value of SS pension benefits if individual i retires at age t; $Incentive_{it}$ is one of our incentive measures introduced above; Age_{it} is either a linear age variable or a set of age dummies for each age from 45 to 69; $Wage_{i,t+1}$ is the wage prediction for the next year; AVG_{it} is the average wage throughout one's entire insured period until t; $Health_{it}$ are dummies for the health condition; Mar_{it} are dummies for marital status; Edu_{it} are dummies for education levels; Add_{it} are dummies for 15 urban locations; Fix_{it} are dummies for mandatory retirement age requirements; Ind_{it} is a set of dummies, one for each of the 20 Korean Standard Industry Classifications (KSIC).

Potential wage earnings are also important in the retirement decision. In order to control for this effect, we include projected wages in the next year and lifetime earnings, as well as their quadratic and interactive terms. It is unclear how the age effect works exactly, so we try both the age variable of a linear form and a set of age dummies. In addition, we also explore the possibility of the nonlinear age effect with semiparametric estimation models.

Monetary terms such as SSW, accruals, peak values and wage earnings are expressed in 10,000,000 won in real terms in year 2000, and the option values in 1,000,000 utility units. The estimation results are shown in Table 11 for the male sample and Table 13 for the female sample. Combining two possible age forms and three incentive measures, we run six models for each sample. The first equation form of each model includes a linear age variable, and the second consists of a set of age dummies. The numbers in the parentheses are standard errors. We mark the probit estimated coefficients which are significantly different from zero, at different levels. The marginal effects are in the square brackets, evaluated at the mean values. Consider the estimation results for the male sample.

Incentive Measures Our estimates show that the incentive measures inherent in the NPS provisions have significant impacts in individual retirement decisions. Consistent with our expectation, the estimated coefficients are all negative. Because every incentive measure implies a financial compensation for continuing to work, higher incentives lowers the odds of withdrawal. Out of six models, four estimates are significant at a 1 percent confidence level, and one at a 10 percent confidence level. The marginal effects on retirement of a 1,000,000 won increase from the mean are -0.003 and -0.002 on average, respectively for accrual and peak value models. The difference, although small, is intuitive. If the same amount of change in the incentives is realized in one year versus in n ($n > 1$) years, the impact would be stronger in the former case. The elasticities of retirement probabilities with respect to the incentives are -0.018 and -0.007 in the accrual models, -0.285 and -0.167 in the peak value models, and -0.357 and -0.213 in the option value models, respectively for the linear age and the age dummies versions. We can infer from the magnitude of the elasticity estimates that workers consider the forward-looking measures more important than single-year changes.

SSW Although SSW coefficient estimates appear insignificant in the peak value and option value models, the SSW plays an important role indirectly through these incentive measures, since incentives incorporate dynamic flows of the SSW. The impact of the SSW is significant in the two accrual models. The signs of the estimates are different in different models. The higher SSW increases the odds of retirement in the accrual models, and the option value model with a linear age. In the rest three models, SSW effects are slightly negative. The SSW has two forces that might work in opposite directions, accrual effect and wealth effect. In the two accrual models, most of the accrual effect is absorbed by the incentive measure, so that the SSW is left with a dominating wealth effect. In the other models, the two powers work together, showing a weakly negative net effect. The marginal effects of the SSW are shown in the brackets. An increase of 10,000,000 won from the mean of the SSW increases the likelihood of retirement by 0.046 and 0.021 in the accrual models. The elasticities are 1.705 and 0.393 in the accrual models, -0.134 and -0.007 in the peak value models, and -0.014 and -0.102 in the option value models, respectively for the linear age and the age dummies versions.

Significance test We perform two exercises to further understand the importance of the SSW and incentive measures. First, we do a likelihood ratio test against the null hypothesis that neither the level of the SSW nor the inherent incentives affect retirement decisions. The likelihood ratio statistics follows a χ^2 distribution with 2 degrees of freedom. It is not surprising that the null is rejected in all six models at a significance level of 1 percent, as shown in Table 12. We also run the probit regression models without the SSW or the incentive measures, and compare the new *c*-statistics[25] with what we get in Table 11. The *c*-statistics drops when we exclude the two variables. The decreases are more substantial in models with a linear age.

Age effects The coefficients for the linear age are negative and significant in all the three models. It seems contrary to common sense that higher ages lower the odds of retirement. However, those who are still working at an old age are probably the winners in the labor market with a decent job with a higher pay check, and it is not surprising if they stay employed longer. When we include a set of age dummies, we can see that in one's late 40s and early 50s, the age effects are negative. They turn positive after age 55 and thus increase the propensity of retirement. The positive age effects keep growing and become quite sizable at ages 60 through 66 and at 68. The trend is consistent with the pattern of hazard rates[26] observed in our data. We compare the empirical hazard rates and the hazards predicted by these age dummies in Figure 11. It can be seen that the age dummies track the trend and do a great job in accounting for the retirement choices at younger ages before 55. After that, although the hazard rate increases with age, the age effect appears relatively flat. Aging alone can not explain the jumps at ages 62 and 65 in the empirical hazard plot. The differences could be contributed by the incentive effects from the SS programs.

Other variables Next year wage earnings pose a negative effect on retirement: if one expects to receive high wages in the next year, one is less likely to retire in the current year.

[25] *c*-statistics shows the association between the predicted probability and the actual probability.

[26] The hazard rate is a conditional withdrawal rate from the labor force.

Marital status, education, and fixed retirement age regulation all impact the retirement choice significantly. Single workers tend to have a higher tendency of withdrawal than their married counterparts, maybe because they have no family burden and have more freedom to choose when to retire at their own will. The education level clearly has an effect in our samples; those who graduate from college or above have a higher chance to retire. People with higher education probably get a better career, so that they may have saved enough for retirement by the time they make the decision. People who do not go to high school may have to make a living by working at an old age. Whether the employers have rules regarding the fixed retirement ages directly impact when workers retire. Lower regulated retirement ages, like 45-59 or 60-64, substantially raise the likelihood of leaving the job, assuming it is lower than what the worker would have chosen if he or she were allowed to. Higher regulated ages (65-70) lowers the odds, but the effect is relatively small. Health status does not show enough evidence of impact, mainly because we have poor coverage on health data. However, health plays a role in the wage estimations, thus its effect is implicitly accounted for. There are different propensities to retire across industries. There are some industries in which experiences are more valuable, so that the probability of retirement is lower, such as transport (VIII), real estate and renting and leasing business (XI), business activities (XII), education (XIV), and other community, repair and personal services (XVII). Workers in some other industries are more likely to retire, for example, electricity, gas and water supply (V), and hotels and restaurants (VII). The dummies for residence areas show that workers in Kangwon and Kwangju provinces have higher tendency to retire.

The regression results of the female sample are similar to those of the male sample. The estimated incentive effects are negative and significant in the last four models. The accrual effects in the first two models have wrong signs, however they are small. The retirement ages concentrate substantially at ages 50, 54, 58 and 60, which exactly match the actual retirement age pattern we observe in Figure 3. Within the industry dummies, women tend to stay longer in the agriculture and forestry sector (I), since these activities are more flexible in working hours and have less restrictions on ages.

Semiparametric Model

To explore any potential nonlinear relationship of age with respect to retirement decisions, we use our data to fit the Generalized Additive Model (Hastie and Tibshirani,1990). It allows us to capture the age effect in a nonparametric way, to specify a logistic link function, and to preserve the additivity of other predictors.

$$\begin{aligned}\Phi^{-1}(\Pr(R_{it}=1)) &= \beta_1 SSW_{it} + \beta_2 Incentive_{it} + S(Age_{it}) + \beta_4 Wage_{i,t+1} + \beta_5 AVG_{it} \\ &+\beta_6 Wage^2_{i,t+1} + \beta_7 AVG^2_{it} + \beta_8 Wage_{i,t+1} \times AVG_{it} + \beta_9 Health_{it} \\ &+\beta_{10} Mar_{it} + \beta_{11} Edu_{it} + \beta_{12} Add_{it} + \beta_{13} Fix_{it} + \beta_{14} Ind_{it} + e_{it}, \quad (14)\end{aligned}$$

where $S(Age_{it})$ is the smooth function for the nonparametric age effect. The smoother is optimally selected by the Generalized Cross Validation (GSV) function to minimize the prediction error.

The smoothing component graph and the analysis of deviance are shown for each model in Figure 12. It turned out that for all 3 incentive measures, the nonlinear part of the age effect appears to be insignificant. Our approach in the previous section is sufficient to uncover the age effect from the data.

POLICY SIMULATION

According to the National Pension Service in Korea, the age to receive a full old-age pension shall be raised by one year every five years, starting from 2013. The eligibility age will be 65 in 2033. In this section, we perform a plus-five-year policy simulation to show the effects of changes in the social security provisions on retirement behavior.

The new experiment policy is as follows. The eligibility ages for the full, reduced, active, early and special old-age pensions are all raised by 5 years. Correspondingly, the minimum coverage requirements need to be 5 years longer. All other factors remain the same.

Based on these changes, we can recalculate: for each worker in each year, we need to determine all the factors in the formula of pension eligibility, type of benefits, and pension benefits amounts. Then we recalculate the SSW and incentive measures, and plug them into the retirement models and estimate the hazard rates. We consider three possible scenarios.

- Simulation 1 (S1): we use the coefficients obtained from the linear age models.
- Simulation 2 (S2): we use the coefficients obtained from the age-dummy models, assuming that the age dummies do not shift with changes in the pension eligibility ages.
- Simulation 3 (S3): we use the coefficients obtained from the age-dummy models, but allow all the age dummies to shift forward by 5 years. For example, the dummy at age 60 before is now used as the dummy for age 65. The dummies for age 45 to 49 are assumed to be the average of the age-45 through age-49 dummies.

With three simulation models and three incentive measures, we run the simulations nine times for each sample. With stricter regulations on the minimum coverage requirements, one has to work longer in order to receive the same amount of pension benefits. However, less generous pension rules and the delayed timing of receiving benefits yield a lower present value of pension benefits. Depending on how much the SSW changes over time, the effect on the incentive measures are uncertain. The results are presented in Figures 13 to 15, and Table 14.

In Figure 13, the simulated hazards from plus-five-year reform are lower than base hazards in the accrual model, higher in the peak value model, and almost identical in the option value model.

In Figure 14, the retirement pattern does not change much. Again the accrual model generates lower hazard rates in the experiment than in the benchmark case, the peak value model produces higher hazard rates, and the hazard rates are the least affected by the option value model.

In the third scenario, we can decompose the effect on hazard rates into two parts. One is entirely from shifting the estimates age dummies by 5 years, without changing the benefits rules. The second part includes the effect from less generous pension benefits. It is clear from Figure 15, the first part produces a shift to the right by 5 years as well, represented by the blue line marked by asterisks. The changes in benefits cause the upward or downward movements in hazard rates at each age. Therefore, policy revisions are transferred to retirement behavioral responses.

Table 14 shows the average retirement ages predicted by the baseline models, and by 3 simulation scenarios. In simulation 1 where linear age models are used, the average shifts in retirement age are 11 months. In the age dummies models, the effects of raising the eligibility ages are stronger. The average retirement ages are about 2.3 years higher than those in the baseline cases under simulation 2, and about 3.6 years higher under simulation 3. Simulations 2 and 3 differ in our assumptions on how much motivation from the pension programs are reflected in the age patterns we observe.

There can be quite a few policy changes, such as changing benefits formulae, proposing new type of pension annuities, and we are able to predict the workers' responsiveness by applying the above methods.

CONCLUSION AND FUTURE RESEARCH

This paper introduces the Korea's pension system, and studies how its NPS provisions affect individual worker's retirement decisions. We quantify the impact of the National Pension

Scheme in Korea on Korean workers by probit regression models, and show the magnitude by a plus-five-year policy simulation.

Our methodology is to calculate the SSW and several incentive measures for each individual at each age, using the micro level data from the KLIPS. Then we estimate how our constructed variables provide incentives to the retirement decisions of the workers. Our incentive measures include accrual, option value and peak value. We also calculate the social security tax (subsidy) and the normalized peak value.

Our regression results for Korea's case show that both the stock and the dynamic flow of the SSW play significant roles in individual retirement decisions. The SSW can have either a positive or negative effect on the probability of retirement. The net effect depends on whether the wealth effect dominates or the accrual effect does. Larger financial incentives from the SS system delay the timing of departure from the labor force. With a higher value of an incentive variable, the workers expect to receive a larger amount of the present discounted value of (or utility from) the SS benefits by staying employed and retiring sometime in the future. The age effect is treated in two forms, a linear age variable, and dummies at each age. The possibility of nonlinear age effect is also tested by a semi-parametric model; however, it appears insignificant. Our policy simulation results depend on which model we use, especially how much we believe the changes in the retirement age patterns are due to pension benefits.

There are still many unanswered questions, such as pension expenditures projections and financial viability of various reform proposals. Heterogeneity and uncertainty are not explicitly modeled in this paper. Other pathways to retirement can also be considered. A joint retirement decision model can be built with spouse information. Cross-country comparisons of similar researches will further our understanding of the impact of social security systems on retirement behaviors.

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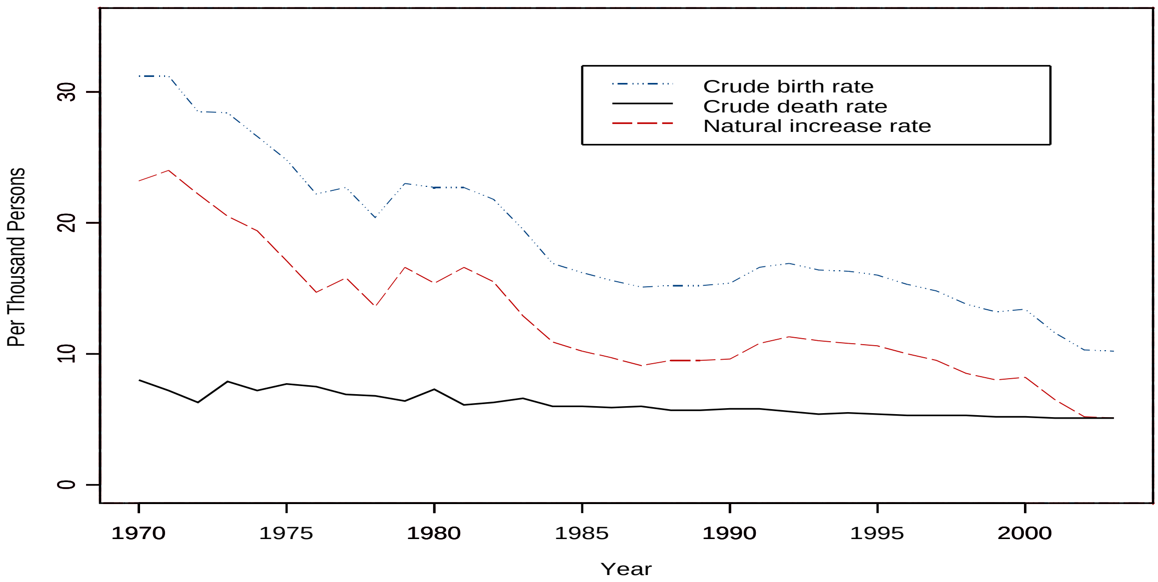
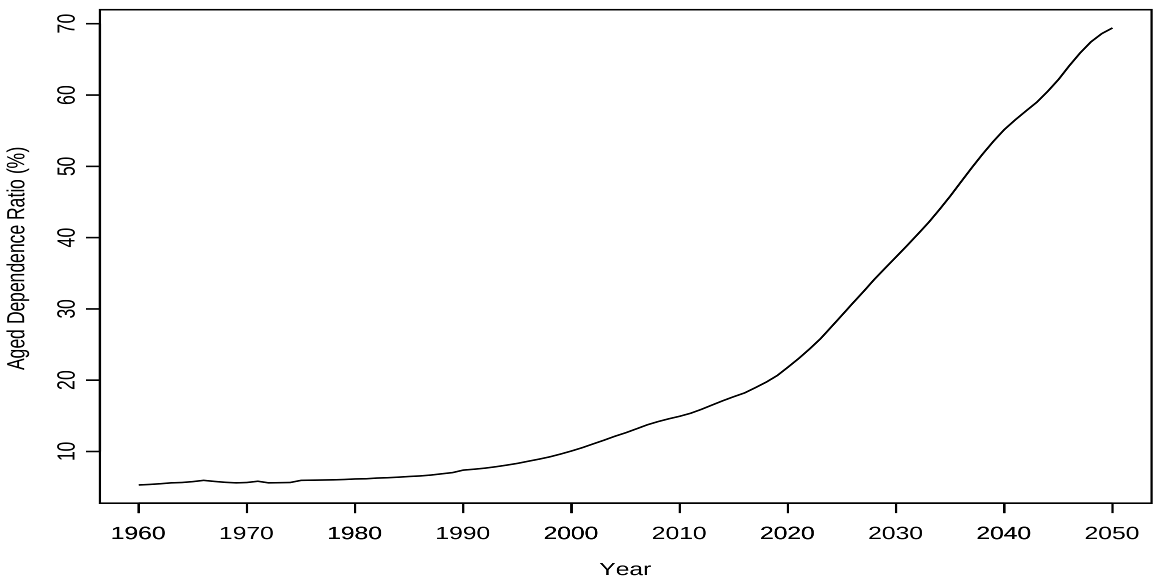
Figure 1: Population Trends in Korea

Vital Statistics, 1970-2003

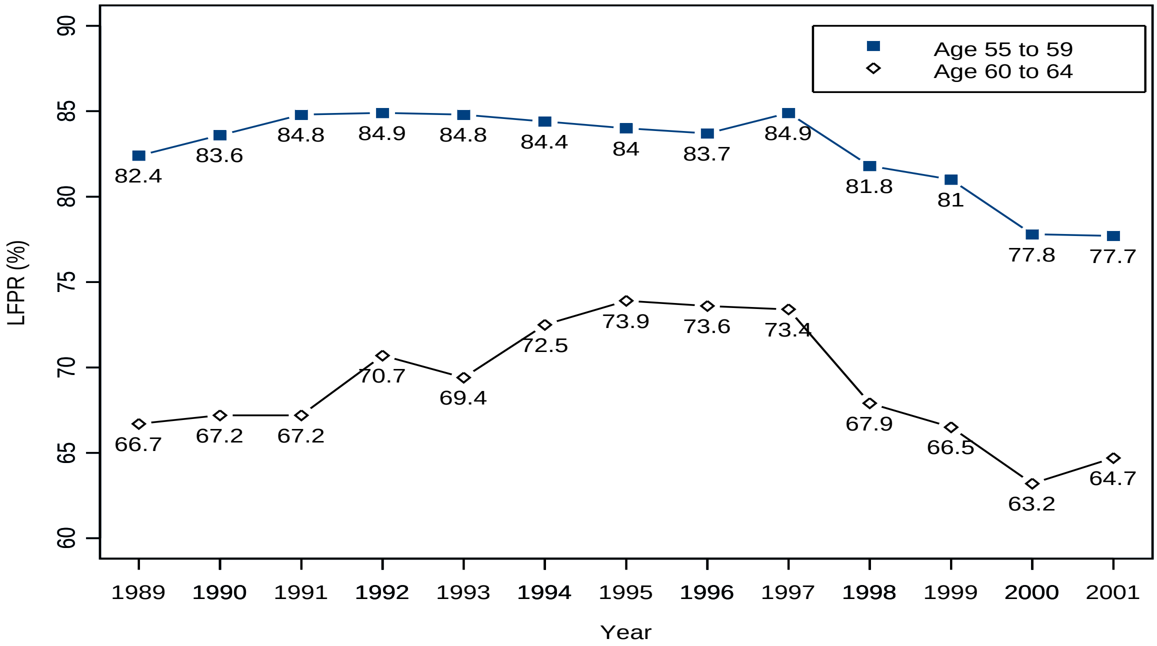


Aged dependence ratio, 1960-2050



Source: Korea National Statistical Office

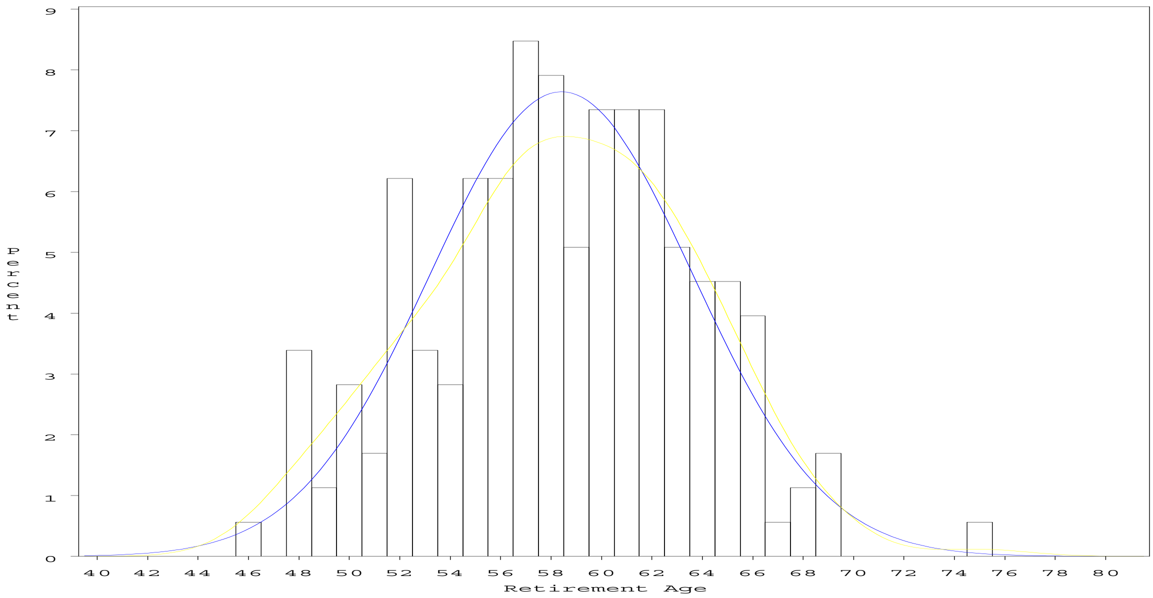
Figure 2: Labor Force Participation Rate by Age Groups, Korea, 1989-2001



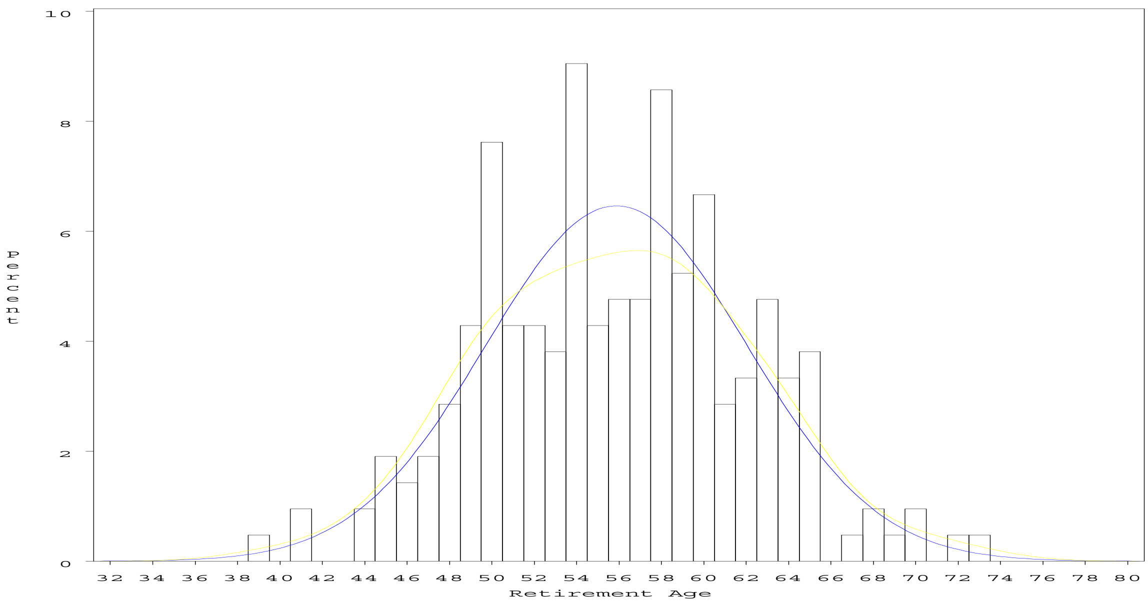
Source: Phang, 2003.

Figure 3: Distribution of Actual Retirement Ages, Korea

Korean Men



Korean Women



Source: Data are based on KLIPS Health and Retirement Survey, 2003.

Figure 4: Option Value Sensitivity Tests on Parameter k, Korean Men

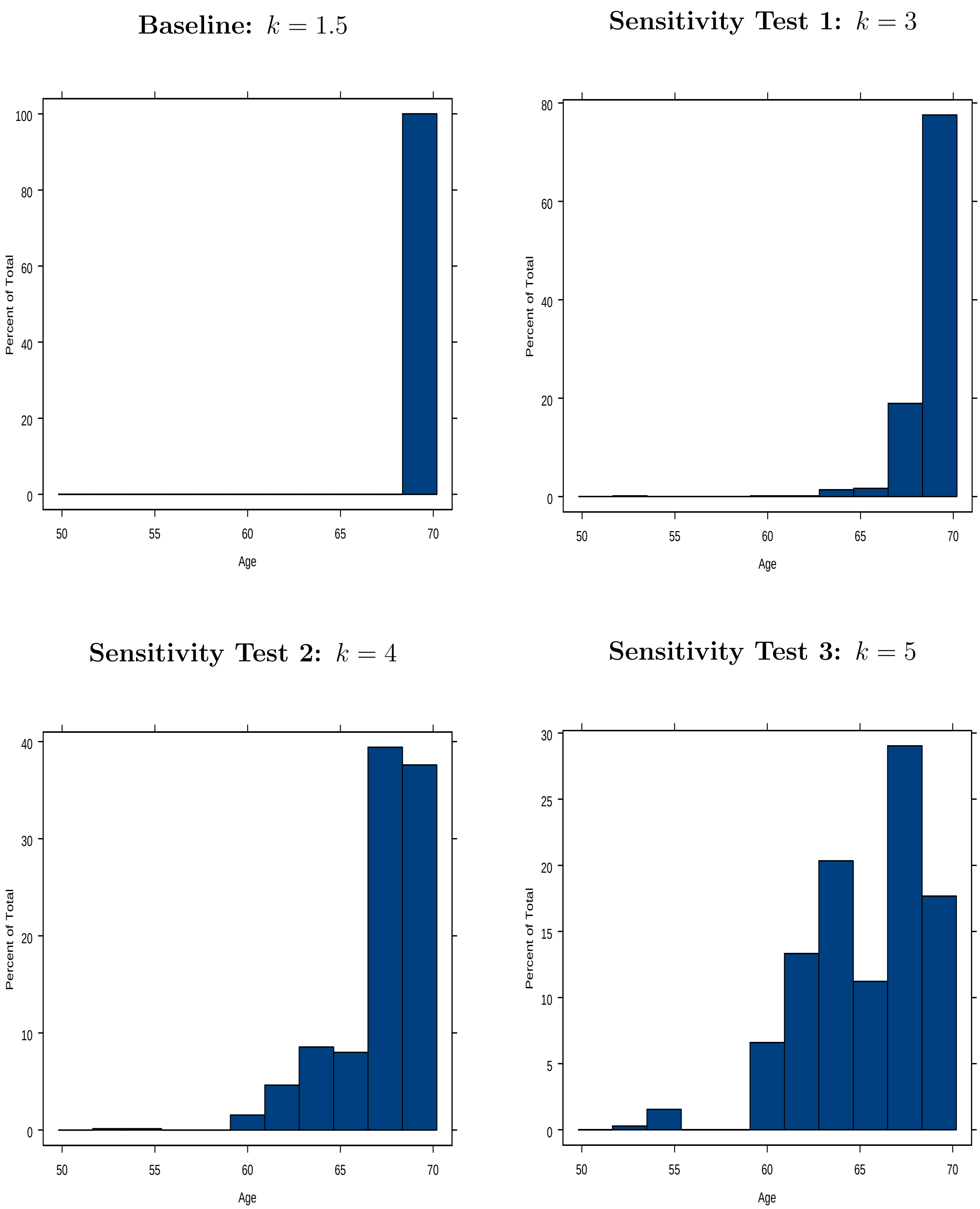


Figure 5: SSW Evolution, Korean Men

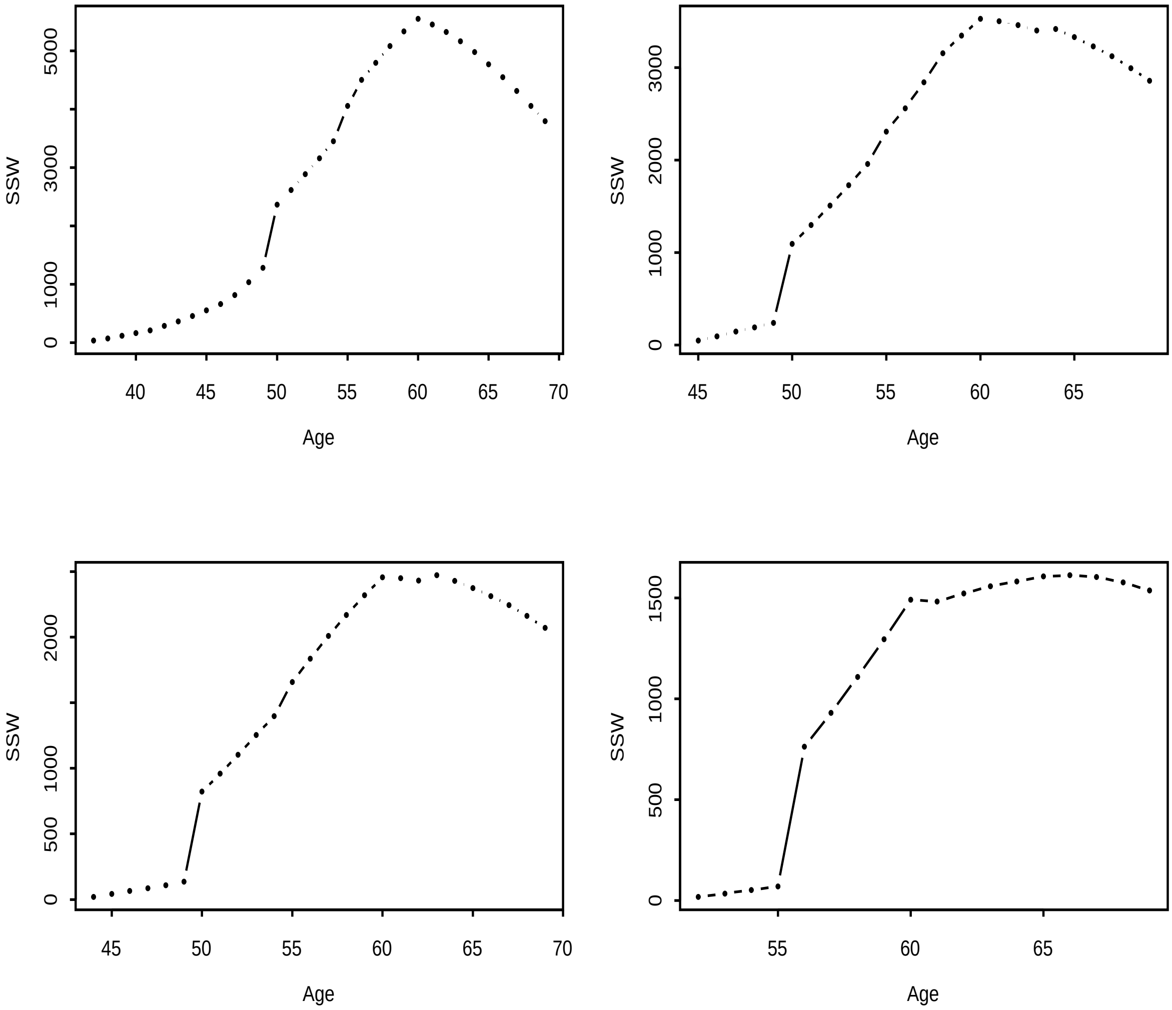


Figure 6: Accrual Evolution, Korean Men

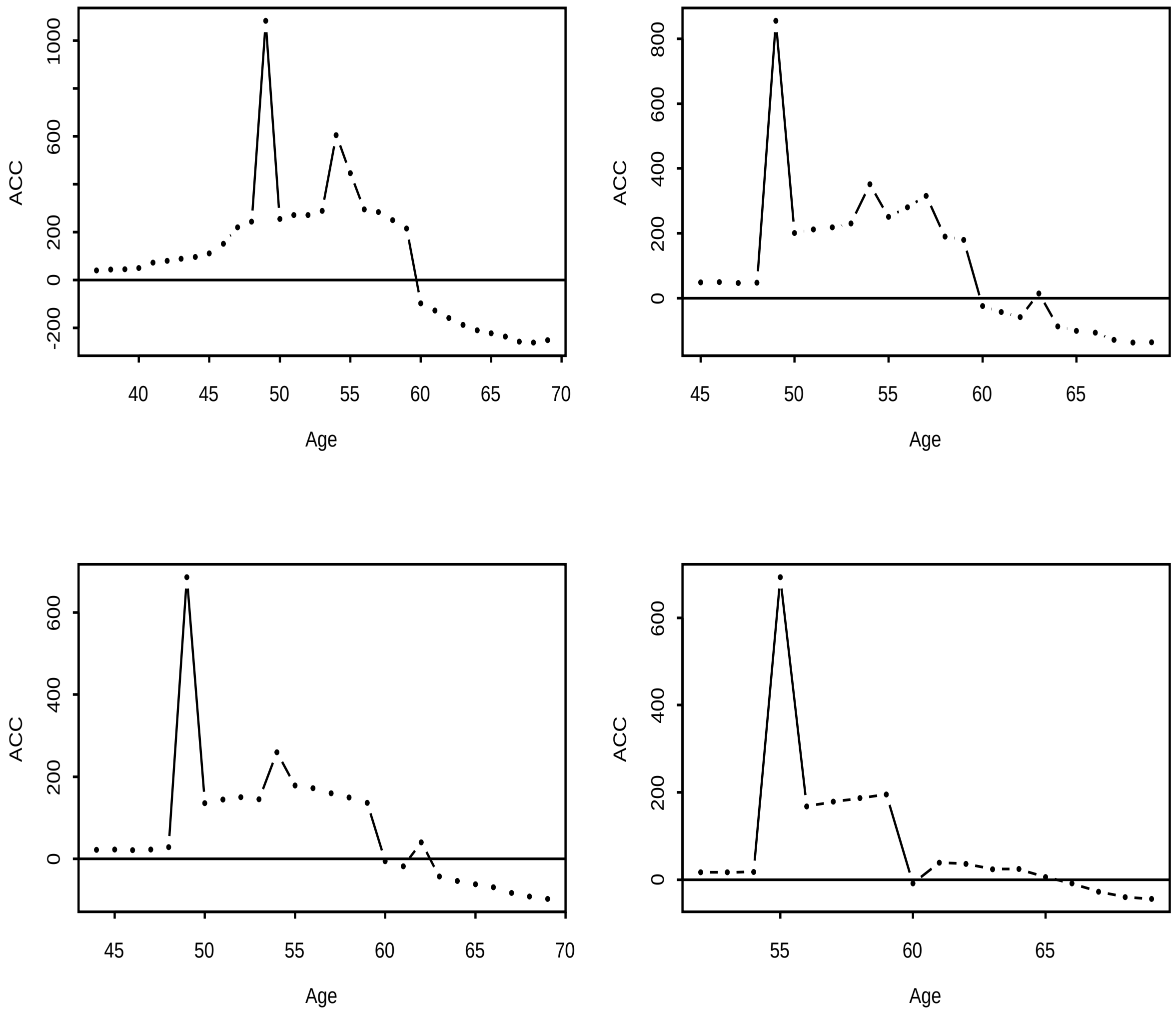


Figure 7: SS Tax (or Subsidy) Evolution, Korean Men

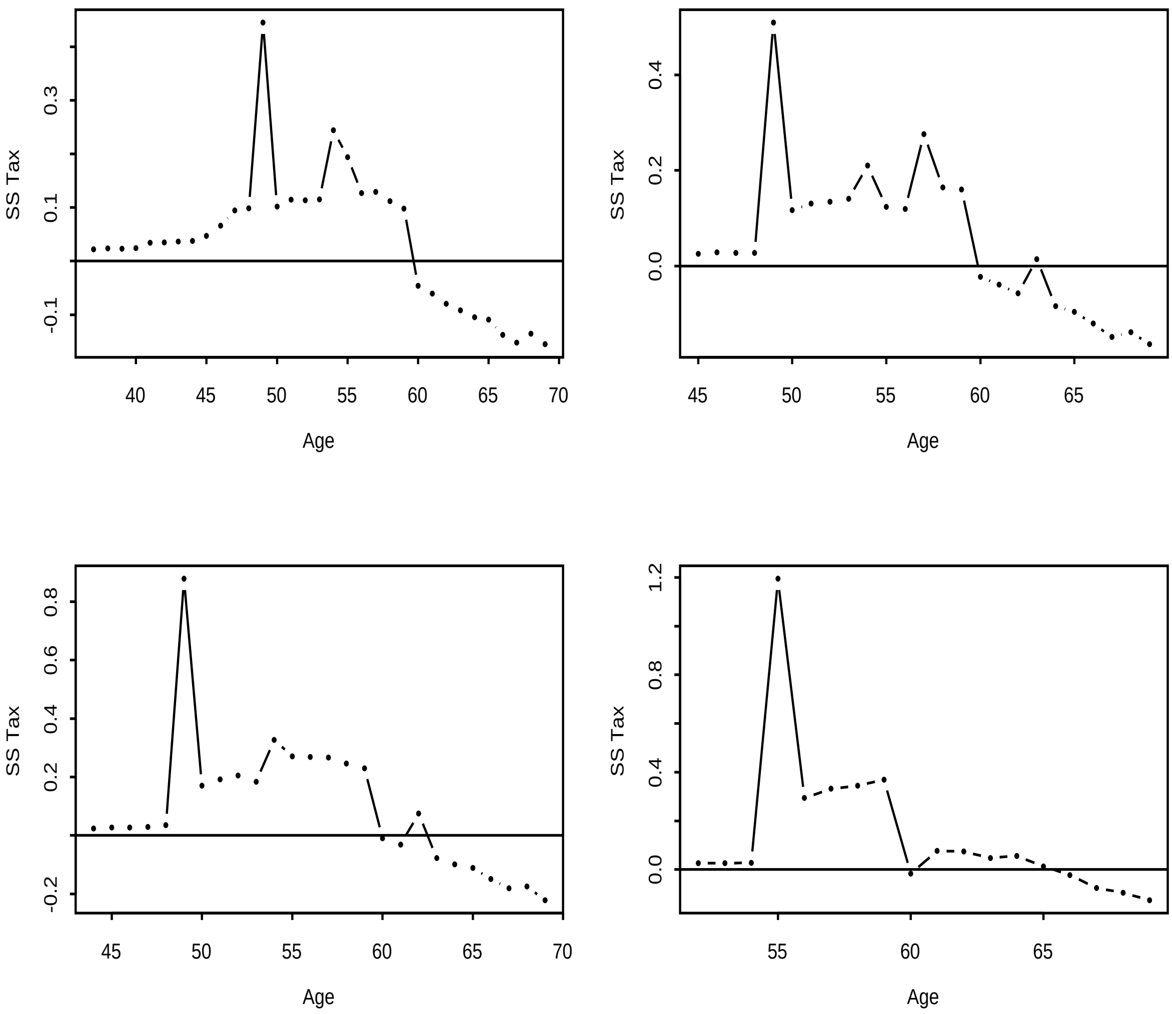


Figure 8: Option Value Evolution, Korean Men

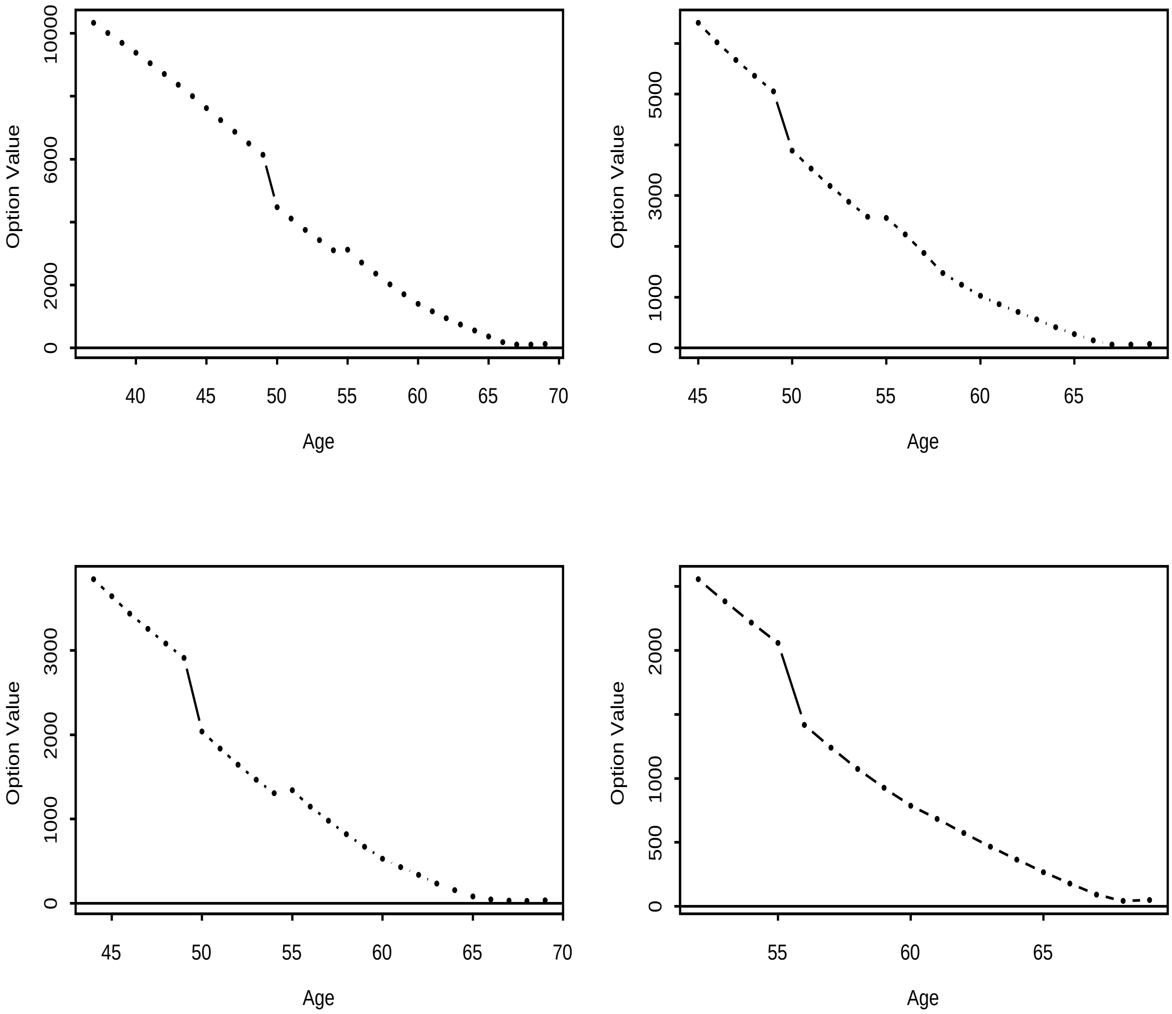


Figure 9: Peak Value Evolution, Korean Men

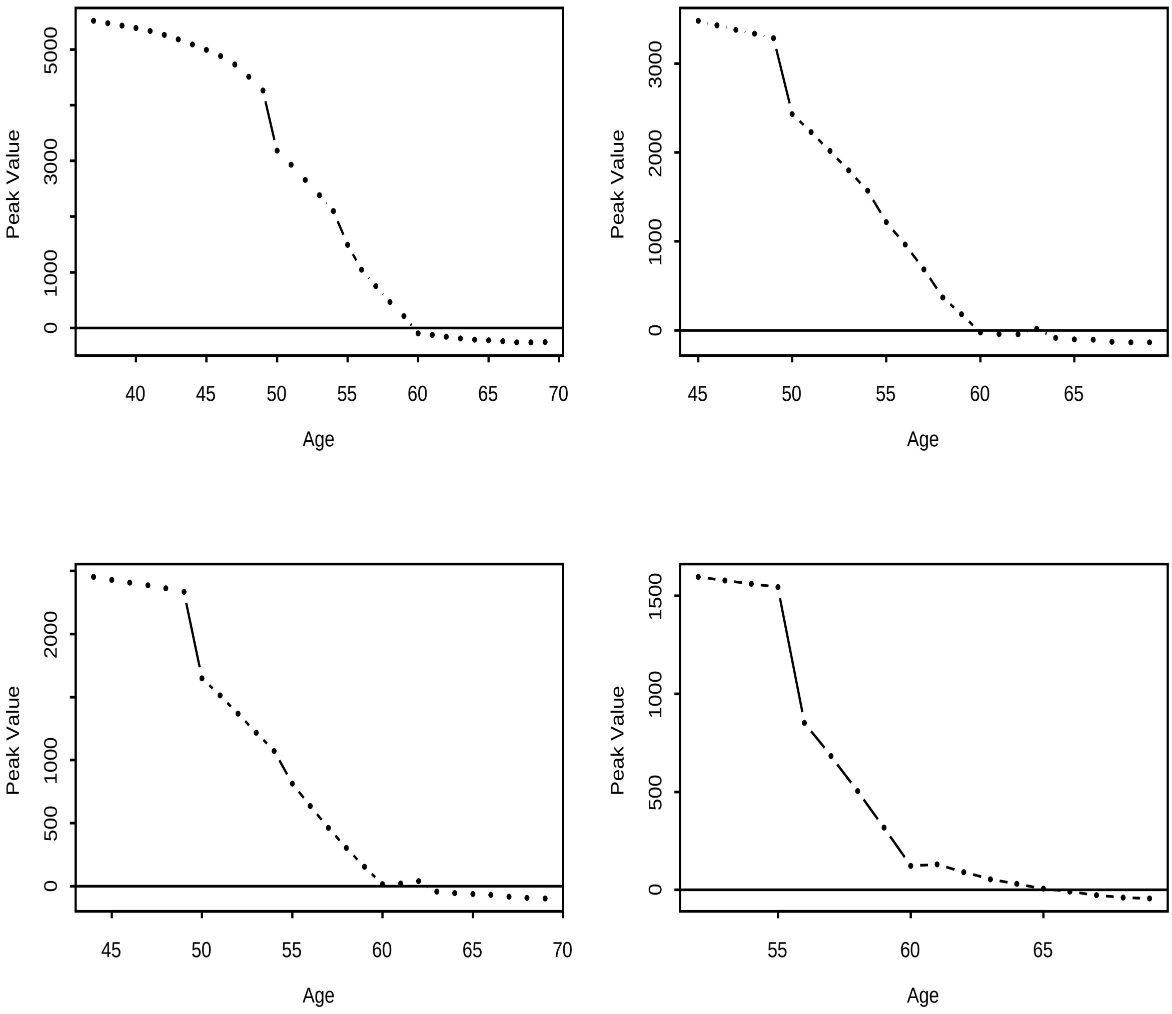


Figure 10: Normalized Peak Value Evolution, Korean Men

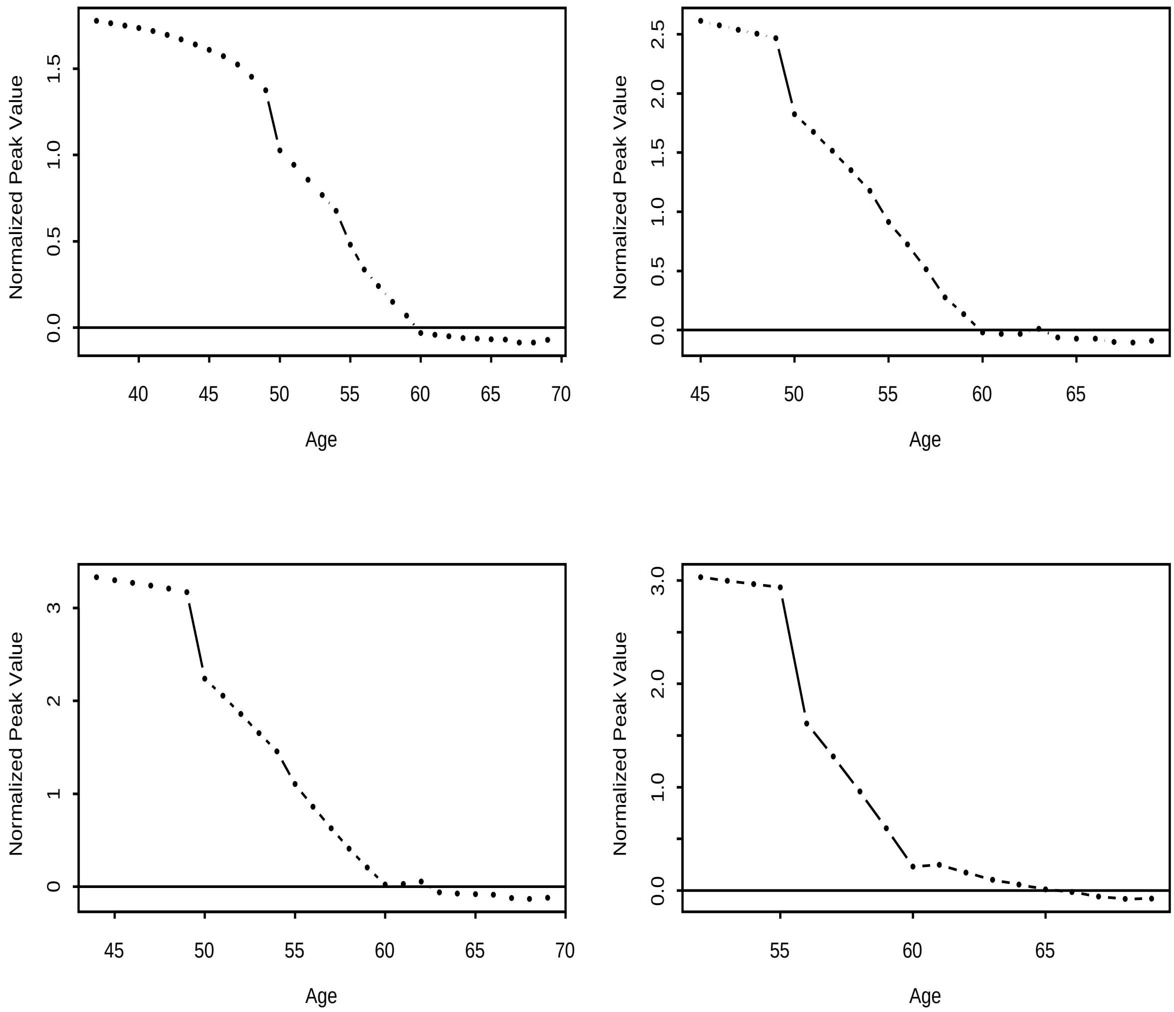


Figure 11: Retirement Hazard and Age Dummies, Korean Men

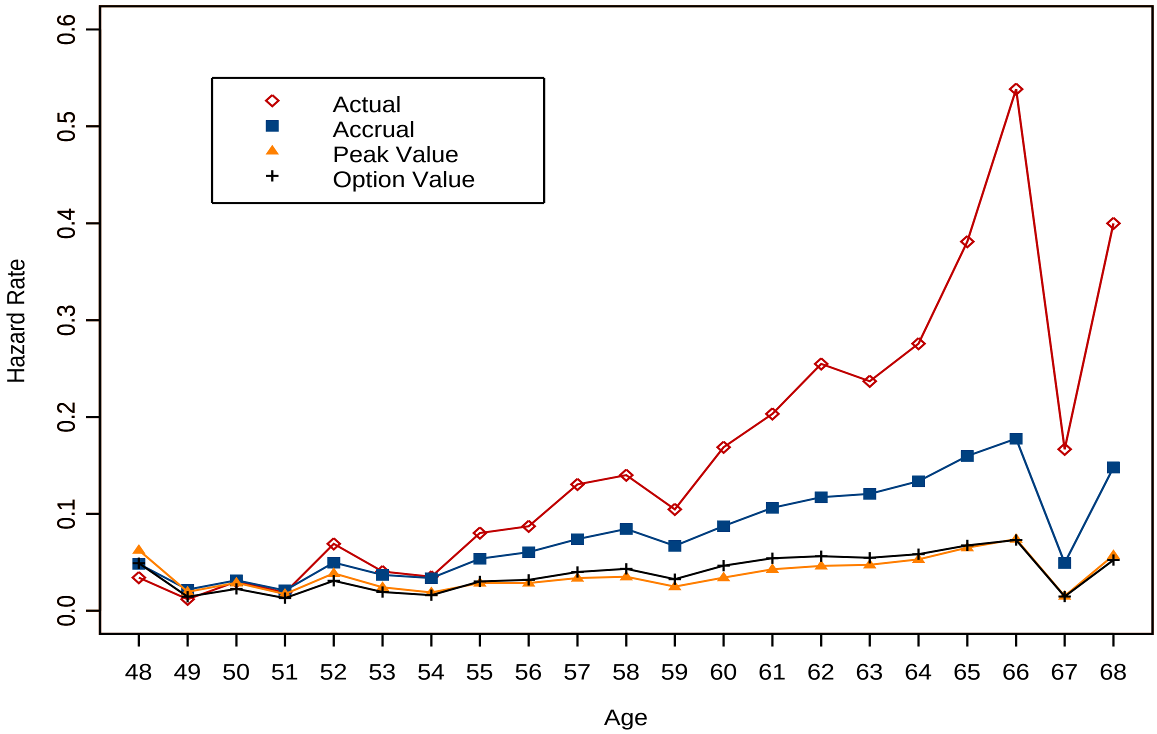


Figure 12: Nonparametric Age Effect Estimation, Korean Men

Accrual

Peak Value

Option Value

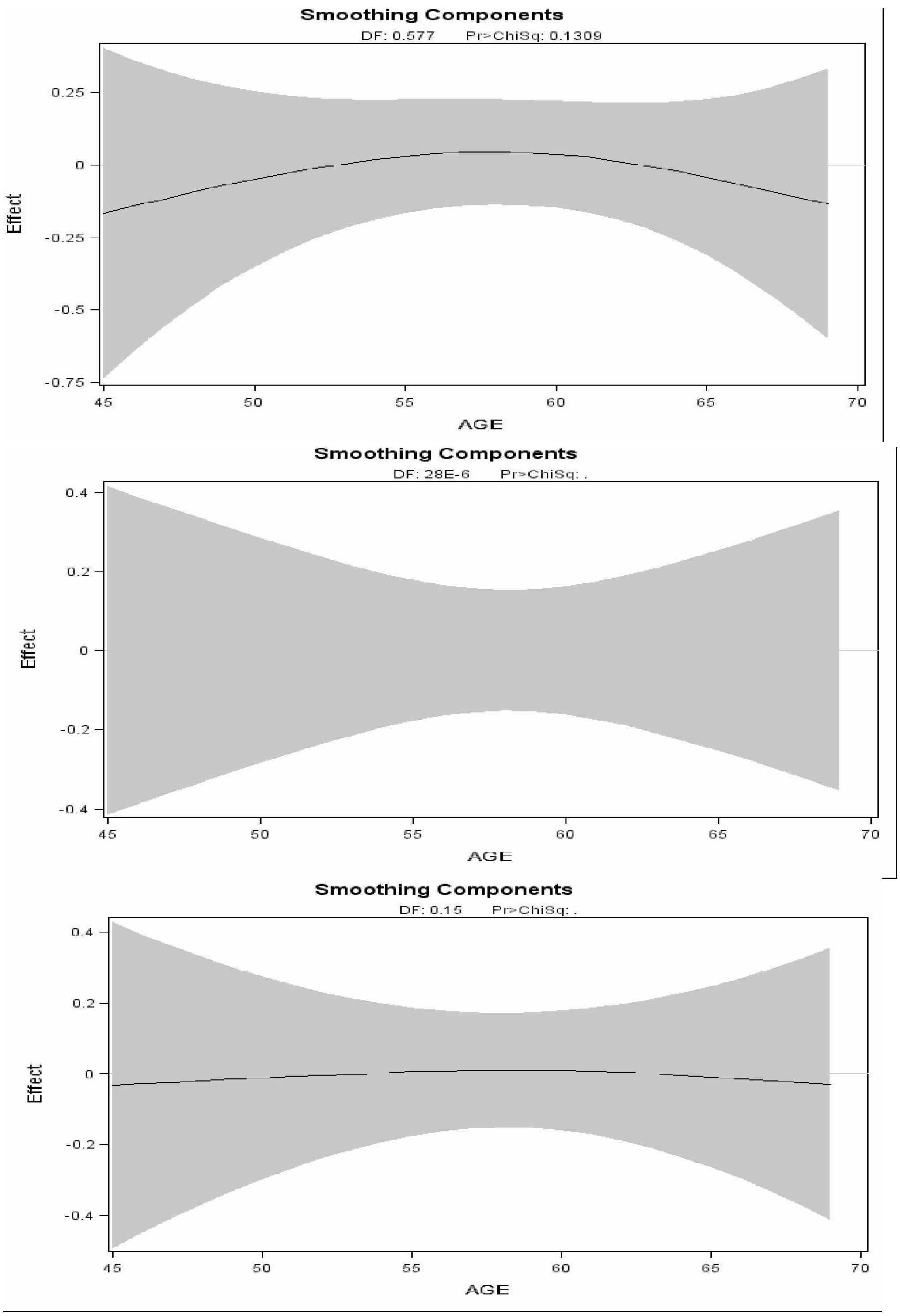


Figure 13: Plus-Five-Year Simulation 1, Korean Men

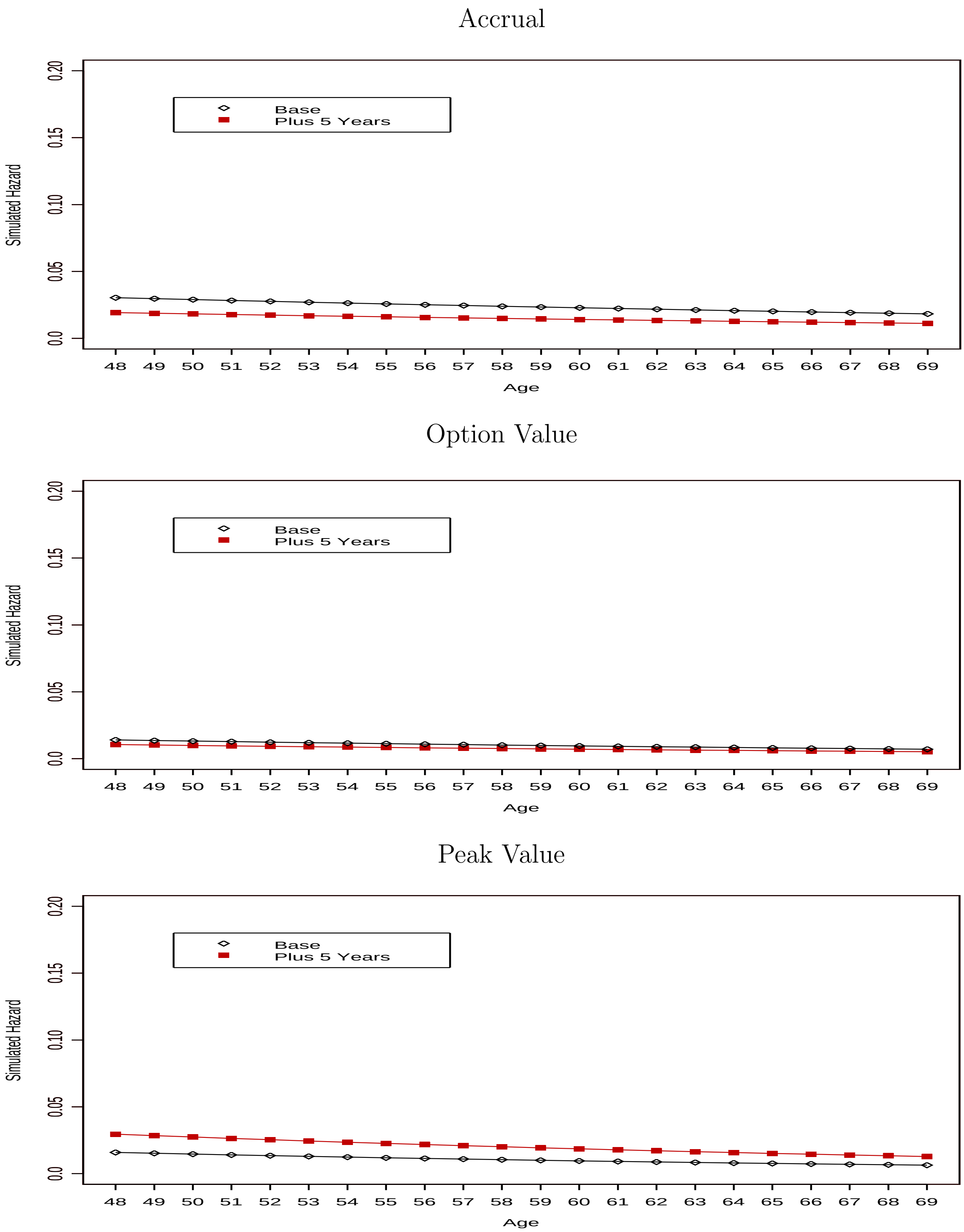
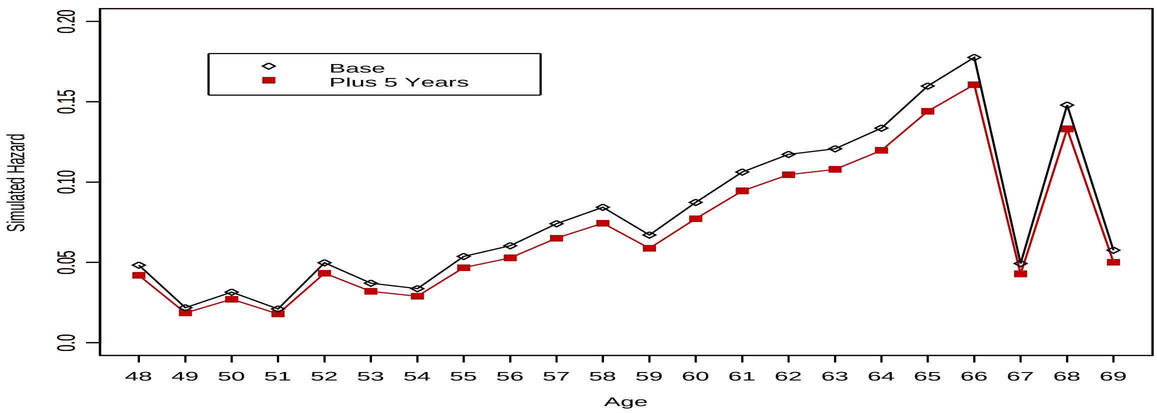
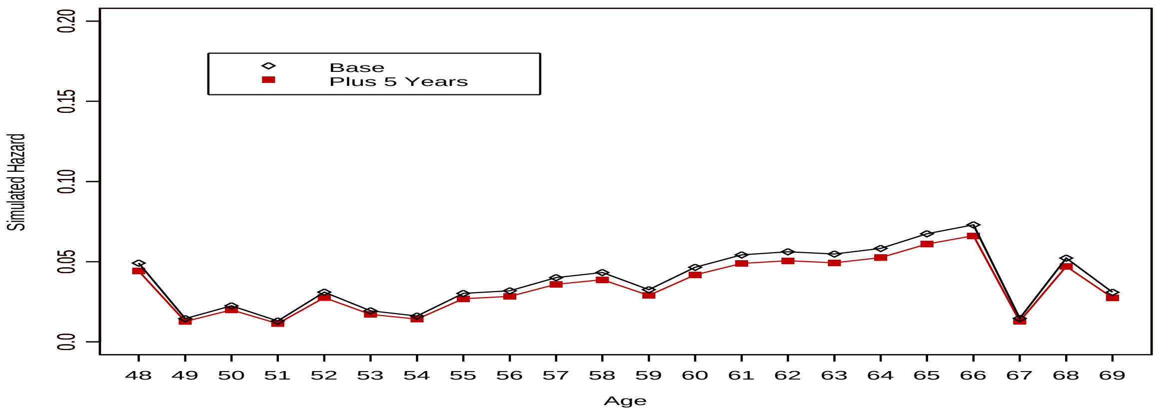


Figure 14: Plus-Five-Year Simulation 2, Korean Men

Accrual



Option Value



Peak Value

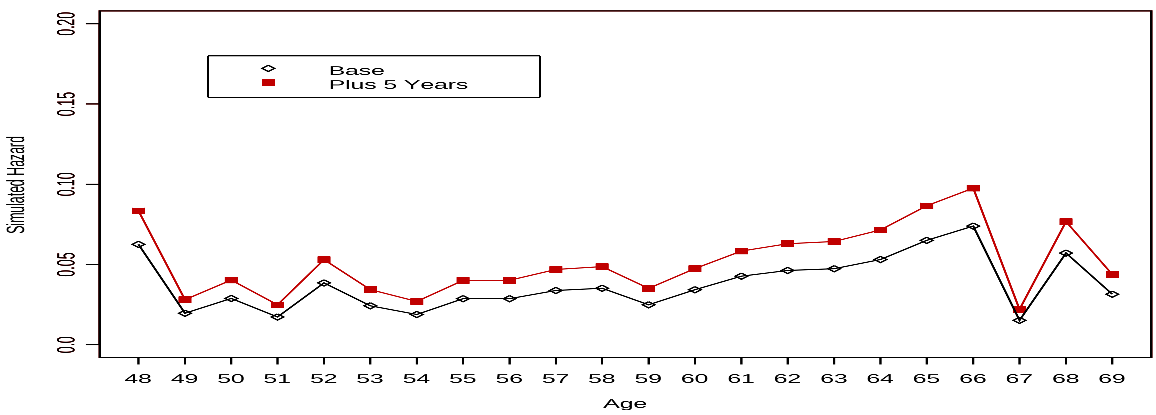
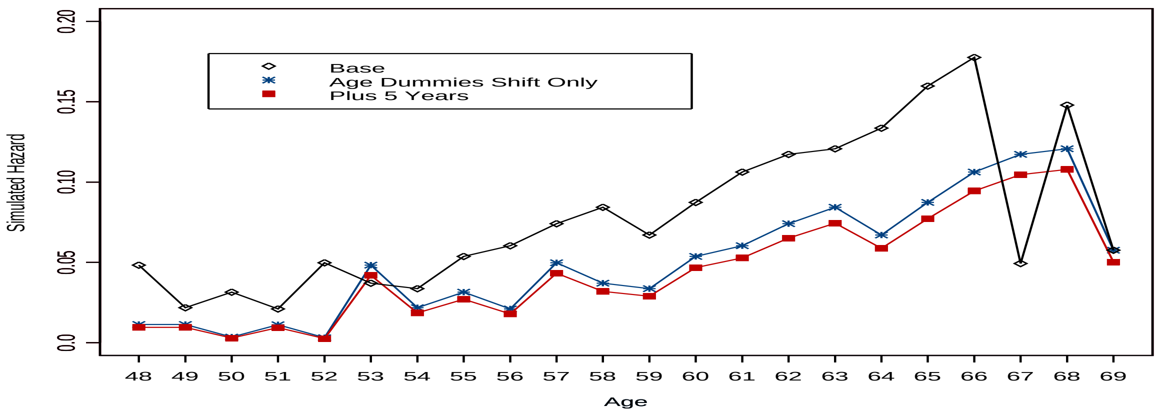
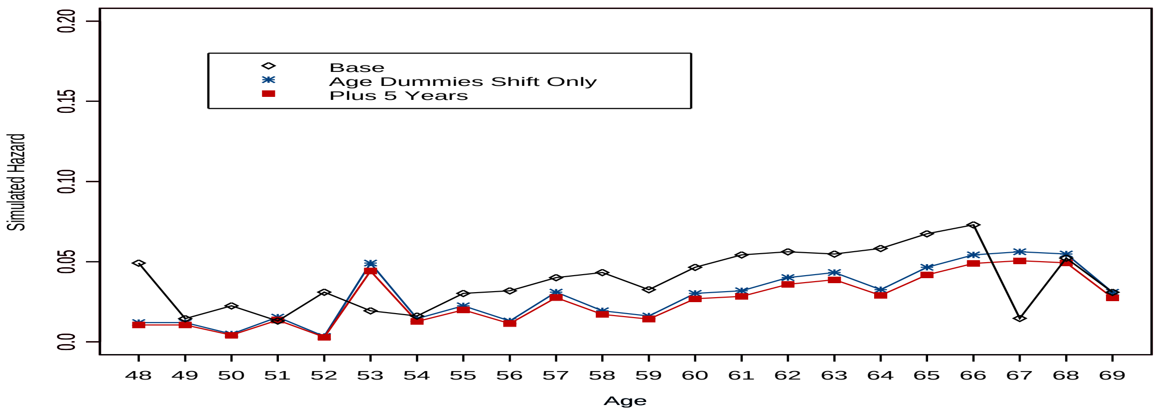


Figure 15: Plus-Five-Year Simulation 3, Korean Men

Accrual



Option Value



Peak Value

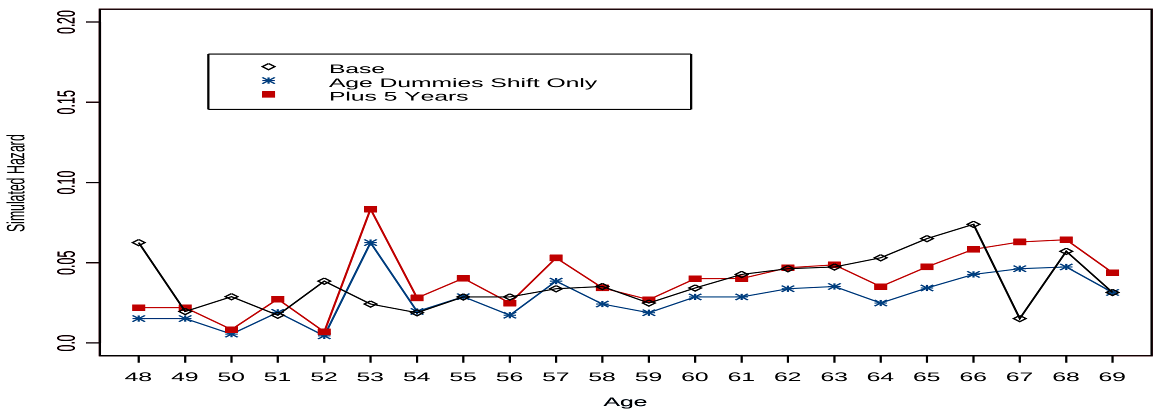


Table 1: Labor Force Participation Rate, 1999 to 2002

Year	Total	Male	Female
1995	64.9	78.7	51.3
1996	64.9	78.4	51.8
1997	65.2	78.0	52.7
1998	63.9	77.8	50.2
1999	63.9	77.3	50.7
2000	64.2	76.9	51.8
2001	64.7	77.0	52.6
2002	65.4	77.7	53.4

Note: The data are from International Labor Organization, 2007.

Table 2: Percentage of the Population Aged 65 and Above, 1950 to 2050

Year	Korea
1950	3.0
1955	3.7
1960	3.3
1965	3.3
1970	3.3
1975	3.6
1980	3.8
1985	4.3
1990	5.0
1995	5.8
2000	7.4
2005	9.4
2010	11.3
2015	13.3
2020	15.7
2025	19.6
2030	23.4
2035	26.9
2040	30.5
2045	32.9
2050	35.1

Note: The data is from World Population Prospects: the 2006 Revision, United Nations Population Division.

Table 3: Summary Statistics of Key Predictors

	Male Sample		Female Sample	
Variable	Mean	SD	Mean	SD
Age	55.43	5.54	55.13	5.60
Married	0.96	0.20	0.75	0.43
Education: less than high school	0.45	0.50	0.78	0.41
Education: high school	0.35	0.48	0.17	0.38
Education: some college	0.20	0.40	0.05	0.21
Health: poor	0.14	0.350	0.25	0.43
Health: fair	0.28	0.45	0.34	0.47
Health: good	0.58	0.49	0.41	0.49
Employment				
Annual wage earnings (10,000 Won)	1,658.62	1,184.62	856.95	709.50
Experience	30.55	8.88	21.65	13.05
Regular	0.69	0.46	0.53	0.50
Full-time	0.94	0.24	0.86	0.35
Government or related	0.19	0.39	0.11	0.31
Private companies	0.65	0.48	0.72	0.45
Others	0.16	0.36	0.17	0.38
Residence Area				
City of Pusan	0.12	0.32	0.13	0.33
City of Taegu	0.07	0.25	0.07	0.26
City of Taejeon	0.05	0.21	0.04	0.19
City of Inchon	0.05	0.23	0.06	0.23
City of Kwangju	0.03	0.18	0.02	0.15
City of Ulsan	0.03	0.18	0.02	0.12
Kyonggi Province	0.15	0.36	0.15	0.36
Kangwon Province	0.02	0.14	0.01	0.09
North Choongchung Province	0.04	0.18	0.02	0.12
South Choongchung Province	0.02	0.14	0.05	0.21
North Cholla Province	0.05	0.21	0.07	0.25
South Cholla Province	0.02	0.15	0.03	0.17
North Kyungsang Province	0.02	0.15	0.05	0.21
South Kyungsang Province	0.06	0.24	0.06	0.24
City of Seoul	0.27	0.44	0.24	0.43
No. of observations	3,333		1,992	
No. of individuals	713		493	

Note: SD = standard deviation

Table 4: Wage Projection Estimation, Age 45 to 70

	Male Sample		Female Sample	
Independent Dummies	Coefficient	SE	Coefficient	SE
Age (Default: Age 45)				
46	-0.062	0.119	-0.152	0.155
47	-0.121	0.115	-0.107	0.145
48	-0.129	0.112	-0.189	0.143
49	-0.069	0.111	-0.115	0.139
50	-0.106	0.111	-0.117	0.143
51	-0.087	0.110	-0.164	0.149
52	-0.144	0.110	-0.187	0.157
53	-0.149	0.111	-0.190	0.155
54	-0.113	0.111	-0.255	0.162
55	-0.132	0.111	-0.355	0.170
56	-0.216	0.111	-0.437	0.189
57	-0.218	0.112	-0.579	0.200
58	-0.282	0.113	-0.478	0.208
59	-0.272	0.113	-0.513	0.200
60	-0.300	0.113	-0.664	0.221
61	-0.345	0.114	-0.581	0.224
62	-0.351	0.115	-0.599	0.222
63	-0.417	0.116	-0.756	0.245
64	-0.391	0.118	-0.895	0.271
65	-0.406	0.122	-0.866	0.293
66	-0.390	0.123	-1.121	0.327
67	-0.561	0.126	-1.416	0.393
68	-0.570	0.131	-1.253	0.399
69	-0.426	0.140	-1.400	0.458
70	-0.593	0.151	-1.474	0.438
Marital Status (Default: Married)				
Unmarried	-0.164	0.038	0.256	0.115
Health Status (Default: Fair)				
Poor	-0.065	0.030	-0.177	0.054
Good	0.072	0.018	0.051	0.025
Education (Default: High School)				
Less than high school	-0.115	0.018	0.041	0.066
College and above	0.157	0.028	0.286	0.084

(Continued)

Table 4: Wage Projection Estimation, Age 45 to 70 (cont.)

	Male Sample		Female Sample	
Independent Dummies	Coefficient	SE	Coefficient	SE
Employment (Default: Regular)				
Irregular	-0.299	0.023	-0.151	0.025
Employment (Default: Full-time)				
Part-time	-0.263	0.032	-0.293	0.032
Firm Type (Default: Private Companies)				
Government or related	0.182	0.032	-0.036	0.064
Others	0.012	0.024	-0.244	0.038
Industry (Default: Construction)				
Agriculture and forestry	-0.199	0.135	-0.611	0.152
Fishing	0.136	0.126	-0.669	0.221
Mining and quarrying	-0.192	0.106	-0.642	0.211
Manufacturing	-0.095	0.028	-0.246	0.060
Electricity, gas and water supply	-0.056	0.103	0[27]	0.000
Wholesale and retail trade	-0.195	0.049	-0.398	0.079
Hotels and restaurants	-0.343	0.091	-0.077	0.066
Transport	-0.206	0.038	-0.276	0.131
Post and telecommunications	0.079	0.105	-0.005	0.277
Financial institutions and insurance	-0.036	0.059	-0.136	0.091
Real estate and renting and leasing	-0.314	0.066	-0.145	0.139
Business activities	-0.260	0.032	-0.356	0.066
Public admin. and defense, compulsory SS	-0.155	0.041	-0.253	0.085
Education	-0.114	0.045	-0.122	0.090
Health and social work	0.023	0.072	-0.111	0.089
Recreational, cultural and sporting activities	0.040	0.090	-0.347	0.109
Other community, repair and personal service activities	-0.283	0.051	-0.082	0.083
Private households with employed persons	0.437	0.136	-0.108	0.069
Extra-territorial organizations and bodies	-0.447	0.216	0[27]	

(Continued)

[27]The female sample dos not have workers from this industry.

Table 4: Wage Projection Estimation, Age 45 to 70 (cont.)

	Male Sample		Female Sample	
Independent Dummies	Coefficient	SE	Coefficient	SE
Occupation (Default: Elementary Occupations)				
Legislators, senior officials and managers	0.812	0.044	0.949	0.274
Professionals	0.719	0.048	0.737	0.114
Technicians and associate professionals	0.547	0.036	0.216	0.076
Clerks	0.294	0.036	0.045	0.068
Service workers	0.506	0.050	0.056	0.038
Sales workers	0.229	0.069	0.414	0.069
Skilled agricultural, forestry and fishery workers	0.156	0.130	0.171	0.143
Craft and related trades workers	0.196	0.025	0.023	0.046
Plant, machine operators and assemblers	0.232	0.029	0.047	0.053
Residence Area (Default: City of Seoul)				
City of Pusan	-0.112	0.027	0.026	0.060
City of Taegu	-0.140	0.033	-0.007	0.052
City of Taejeon	-0.053	0.039	0.094	0.084
City of Inchon	-0.142	0.036	-0.013	0.049
City of Kwangju	-0.167	0.045	-0.224	0.071
City of Ulsan	0.036	0.045	-0.130	0.093
Kyonggi Province	0.007	0.026	-0.019	0.035
Kangwon Province	0.043	0.062	-0.630	0.208
North Choongchung Province	-0.088	0.045	-0.198	0.094
South Choongchung Province	-0.033	0.057	0.137	0.117
North Cholla Province	-0.152	0.044	0.088	0.072
South Cholla Province	-0.173	0.053	0.188	0.120
North Kyungsang Province	-0.074	0.052	0.195	0.086
South Kyungsang Province	-0.119	0.035	0.081	0.050
Constant	-148.905	8.196	-108.360	11.294
Year	0.078	0.004	0.057	0.006
Inverse Mill's ratio	0.083	0.156	0.684	0.258
Adjusted R-Square	0.563		0.455	
No. of observations	3,333		1,992	

End of the table

Note: SE = standard error.

Table 5: Distribution of SSW, Age 55 to 69

Age	10th Percentile	Median	90th Percentile	SD
Male Sample				
55	95	2,124	3,724	1,222
56	236	2,353	4,107	1,282
57	1,012	2,559	4,431	1,318
58	1,244	2,738	4,687	1,345
59	1,475	2,942	5,001	1,361
60	1,676	3,132	5,281	1,369
61	1,687	3,125	5,250	1,300
62	1,759	3,106	5,150	1,238
63	1,771	3,052	5,026	1,176
64	1,837	2,997	4,900	1,115
65	1,822	2,927	4,750	1,042
66	1,836	2,853	4,545	975
67	1,823	2,761	4,360	906
68	1,793	2,659	4,122	838
69	1,753	2,532	3,909	768
Female Sample				
55	16	1,402	2,343	877
56	34	1,578	2,596	911
57	55	1,744	2,777	931
58	90	1,913	2,955	951
59	890	2,077	3,133	965
60	1,063	2,238	3,301	966
61	1,154	2,277	3,282	916
62	1,233	2,300	3,254	874
63	1,252	2,321	3,203	805
64	1,329	2,317	3,133	744
65	1,399	2,329	3,053	694
66	1,386	2,306	2,968	647
67	1,413	2,267	2,852	599
68	1,438	2,218	2,728	550
69	1,455	2,162	2,608	503

Note: SD = standard deviation. Unit = 10,000 won in 2000.

Table 6: Distribution of Accrual, Age 55 to 69

Age	10th Percentile	Median	90th Percentile	SD
Male Sample				
55	72	225	379	166
56	160	210	343	149
57	157	205	324	135
58	147	189	286	116
59	137	177	280	114
60	-65	0	85	133
61	-89	-20	63	99
62	-113	-38	47	85
63	-140	-57	33	72
64	-166	-67	26	98
65	-183	-81	18	76
66	-203	-90	10	77
67	-220	-115	-17	75
68	-238	-125	-23	76
69	-243	-125	-38	73
Female Sample				
55	14	173	256	145
56	16	173	229	137
57	27	169	216	119
58	121	165	200	109
59	109	159	201	107
60	-21	30	90	113
61	-29	21	79	83
62	-44	15	71	117
63	-66	0	59	91
64	-87	-13	47	65
65	-93	-28	41	51
66	-107	-43	31	53
67	-125	-55	18	54
68	-132	-63	13	52
69	-133	-73	1	50

Note: SD = standard deviation. Unit = 10,000 won in 2000.

Table 7: Distribution of SS Tax (Subsidy), Age 55 to 69

Age	10th Percentile	Median	90th Percentile	SD
Male Sample				
55	0.04	0.19	0.28	0.14
56	0.11	0.18	0.26	0.15
57	0.12	0.19	0.28	0.14
58	0.11	0.17	0.26	0.14
59	0.11	0.17	0.27	0.15
60	-0.05	0.00	0.09	0.15
61	-0.07	-0.02	0.07	0.10
62	-0.09	-0.04	0.06	0.08
63	-0.10	-0.06	0.04	0.06
64	-0.12	-0.07	0.03	0.10
65	-0.13	-0.08	0.02	0.06
66	-0.17	-0.11	0.01	0.07
67	-0.20	-0.14	-0.03	0.06
68	-0.18	-0.13	-0.03	0.06
69	-0.21	-0.15	-0.06	0.06
Female Sample				
55	0.04	0.49	0.80	0.48
56	0.07	0.57	0.90	0.62
57	0.10	0.51	0.82	0.41
58	0.27	0.53	0.85	0.46
59	0.35	0.60	0.94	0.49
60	-0.08	0.10	0.35	0.48
61	-0.10	0.08	0.33	0.47
62	-0.17	0.06	0.36	0.84
63	-0.30	0.00	0.36	0.51
64	-0.38	-0.07	0.28	0.34
65	-0.57	-0.17	0.29	0.36
66	-0.90	-0.36	0.28	0.47
67	-0.88	-0.40	0.13	0.40
68	-1.10	-0.53	0.11	0.47
69	-1.26	-0.67	0.01	0.50

Note: SD = standard deviation.

Table 8: Distribution of Option Value, Age 55 to 69

Age	10th Percentile	Median	90th Percentile	SD
Male Sample				
55	1,404	2,064	3,721	1,033
56	1,250	1,826	3,323	897
57	1,105	1,611	2,948	783
58	927	1,395	2,585	692
59	765	1,190	2,244	615
60	595	987	1,938	540
61	481	828	1,641	472
62	369	677	1,369	407
63	264	530	1,108	347
64	170	405	875	293
65	81	272	654	234
66	57	151	443	173
67	38	73	252	107
68	34	64	147	59
69	46	73	153	43
Female Sample				
55	158	549	1,216	412
56	104	471	1,045	367
57	62	375	875	335
58	59	284	710	294
59	52	189	603	269
60	5	85	477	247
61	6	46	383	205
62	2	35	288	168
63	-9	21	200	117
64	-17	11	120	76
65	-18	8	60	48
66	-28	-7	26	34
67	-38	-18	10	25
68	-34	-16	12	20
69	-37	-22	3	17

Note: SD = standard deviation. Unit = 10,000 in 2000.

Table 9: Distribution of Peak Value, Age 55 to 69

Age	10th Percentile	Median	90th Percentile	SD
Male Sample				
55	862	1,081	1,677	440
56	673	855	1,438	359
57	494	641	1,059	303
58	314	430	710	266
59	150	228	441	243
60	-65	27	206	227
61	-89	-1	141	180
62	-113	-37	96	143
63	-140	-57	59	121
64	-166	-66	36	116
65	-183	-81	21	86
66	-203	-90	10	82
67	-220	-115	-17	78
68	-238	-125	-23	77
69	-243	-125	-38	73
Female Sample				
55	834	946	1,432	377
56	672	775	1,221	321
57	492	611	845	283
58	318	438	663	264
59	155	273	543	271
60	-21	113	382	279
61	-29	80	291	239
62	-44	54	205	213
63	-66	28	159	149
64	-87	1	109	98
65	-93	-26	76	70
66	-107	-43	44	62
67	-125	-55	26	58
68	-132	-63	16	54
69	-133	-73	1	50

Note: SD = standard deviation. Unit = 10,000 won in 2000.

Table 10: Distribution of Normalized Peak Value, Age 55 to 69

Age	10th Percentile	Median	90th Percentile	SD
Male Sample				
55	0.48	0.79	1.52	0.52
56	0.37	0.63	1.29	0.49
57	0.28	0.47	1.01	0.46
58	0.18	0.31	0.73	0.42
59	0.08	0.17	0.47	0.35
60	-0.03	0.02	0.22	0.27
61	-0.05	0.00	0.16	0.21
62	-0.06	-0.03	0.11	0.17
63	-0.07	-0.04	0.07	0.14
64	-0.08	-0.05	0.04	0.13
65	-0.09	-0.06	0.02	0.06
66	-0.09	-0.06	0.01	0.05
67	-0.12	-0.09	-0.02	0.04
68	-0.13	-0.09	-0.03	0.04
69	-0.11	-0.08	-0.04	0.03
Female Sample				
55	1.23	2.87	7.53	3.81
56	1.19	2.39	6.96	3.65
57	0.95	1.91	6.46	3.17
58	0.64	1.38	5.17	3.17
59	0.34	0.88	4.37	3.54
60	-0.06	0.37	3.09	3.39
61	-0.07	0.26	2.36	3.06
62	-0.10	0.18	1.69	2.57
63	-0.17	0.10	1.21	1.40
64	-0.24	0.00	0.92	0.85
65	-0.27	-0.09	0.61	0.50
66	-0.40	-0.18	0.32	0.37
67	-0.62	-0.31	0.17	0.34
68	-0.54	-0.30	0.10	0.27
69	-0.67	-0.39	0.01	0.27

Note: SD = standard deviation. Unit = 10,000 won in 2000.

Table 11: Probit Retirement Models, Korean Men

	Accrual		Peak Value		Option Value	
	Linear	Age	Linear	Age	Linear	Age
Variable	Age	Dummies	Age	Dummies	Age	Dummies
SSW	0.460 *	0.164 †	-0.053	-0.003	0.005	-0.045
	(0.048)	(0.069)	(0.084)	(0.091)	(0.080)	(0.091)
10^7 won	[0.046]	[0.021]	[-0.002]	[0.000]	[0.000]	[-0.003]
Incentives	-0.481 ‡	-0.209	-0.518 *	-0.334 *	-0.037 *	-0.025 *
	(0.248)	(0.254)	(0.074)	(0.111)	(0.005)	(0.007)
10^6 won	[-0.003]	[-0.002]	[-0.002]	[-0.002]		
$\text{Wage}_{i,t+1}$	-1.049 *	-0.682 †	-0.532 ‡	-0.731 †	-0.732 †	-0.676 †
	(0.334)	(0.324)	(0.320)	(0.320)	(0.323)	(0.320)
AVG	-0.945 †	-1.505 *	0.387	-0.741	0.415	-0.592
	(0.429)	(0.370)	(0.442)	(0.451)	(0.459)	(0.456)
$\text{Wage}^2_{i,t+1}$	-0.076	-0.057	-0.026	-0.055	-0.124	-0.101
	(0.209)	(0.185)	(0.181)	(0.183)	(0.206)	(0.191)
AVG^2	0.146	0.371 ‡	-0.119	0.122	-0.209	0.069
	(0.245)	(0.205)	(0.215)	(0.225)	(0.241)	(0.231)
Wage × AVG	0.304	0.212	0.212	0.335	0.474	0.426
	(0.418)	(0.353)	(0.353)	(0.355)	(0.410)	(0.374)
Age	-0.010 *		-0.016 *		-0.012 *	
	(0.004)		(0.004)		(0.004)	
1 year change	[-0.001]		[-0.001]		[-0.000]	
Age Dummies (Default: Age 69)						
Age 45		-1.120 †		-0.683		-0.715
		(0.518)		(0.569)		(0.569)
Age 46		-0.708 †		-0.214		-0.292
		(0.314)		(0.336)		(0.328)
Age 47		-1.158 †		-0.756		-0.836
		(0.511)		(0.553)		(0.550)
Age 48		-0.086		0.326		0.215
		(0.187)		(0.223)		(0.204)
Age 49		-0.443		-0.202		-0.317
		(0.274)		(0.279)		(0.265)
Age 50		-0.284		-0.039		-0.137
		(0.177)		(0.197)		(0.183)

(Continued)

*The coefficient is significant at a 1 percent confidence level.
†The coefficient is significant at a 5 percent confidence level.
‡The coefficient is significant at a 10 percent confidence level.

Table 11: Probit Retirement Models, Korean Men (cont.)

	Accrual		Peak Value		Option Value	
	Linear	Age	Linear	Age	Linear	Age
Variable	Age	Dummies	Age	Dummies	Age	Dummies
Age 51		-0.457 †		-0.254		-0.359 ‡
		(0.192)		(0.206)		(0.196)
Age 52		-0.072		0.092		0.001
		(0.138)		(0.150)		(0.140)
Age 53		-0.210		-0.113		-0.199
		(0.162)		(0.167)		(0.164)
Age 54		-0.254		-0.219		-0.273
		(0.171)		(0.170)		(0.169)
Age 55		-0.035		-0.042		-0.010
		(0.139)		(0.137)		(0.138)
Age 56		0.024		-0.041		0.013
		(0.138)		(0.137)		(0.137)
Age 57		0.129		0.032		0.118
		(0.136)		(0.135)		(0.132)
Age 58		0.199		0.050		0.153
		(0.139)		(0.143)		(0.137)
Age 59		0.077		-0.103		0.023
		(0.159)		(0.164)		(0.156)
Age 60		0.218		0.038		0.188
		(0.151)		(0.163)		(0.151)
Age 61		0.329 †		0.139		0.263 ‡
		(0.153)		(0.166)		(0.154)
Age 62		0.387 †		0.177		0.280 ‡
		(0.159)		(0.173)		(0.162)
Age 63		0.404 †		0.189		0.267
		(0.176)		(0.191)		(0.181)
Age 64		0.466 †		0.244		0.298
		(0.188)		(0.203)		(0.195)
Age 65		0.580 *		0.346		0.373 ‡
		(0.197)		(0.212)		(0.206)
Age 66		0.651 *		0.412 ‡		0.414 ‡
		(0.213)		(0.227)		(0.224)
Age 67		-0.077		-0.306		-0.312
		(0.393)		(0.404)		(0.402)
Age 68		0.530		0.280		0.244
		(0.340)		(0.352)		(0.352)

(Continued)

Table 11: Probit Retirement Models, Korean Men (cont.)

	Accrual		Peak Value		Option Value	
	Linear	Age	Linear	Age	Linear	Age
Variable	Age	Dummies	Age	Dummies	Age	Dummies
Marital Status (Default: Married)						
Unmarried	0.124 ‡	0.222 *	0.161 †	0.225 *	0.131 ‡	0.217 *
	(0.074)	(0.072)	(0.077)	(0.072)	(0.076)	(0.072)
Health Status (Default: Fair)						
Good	0.033	0.048	0.026	0.043	0.037	0.048
	(0.049)	(0.051)	(0.050)	(0.051)	(0.050)	(0.051)
Poor	-0.019	-0.035	0.014	-0.021	-0.018	-0.032
	(0.063)	(0.065)	(0.065)	(0.065)	(0.064)	(0.065)
Education (Default: High School)						
Lower	-0.278 *	-0.312 *	-0.179 *	-0.281 *	-0.229 *	-0.292 *
	(0.062)	(0.061)	(0.064)	(0.062)	(0.063)	(0.061)
College	0.328 *	0.296 *	0.203 †	0.268 *	0.275 *	0.287 *
	(0.081)	(0.082)	(0.083)	(0.083)	(0.082)	(0.082)
Fixed Retirement Age (Default: No Age Limit)						
45-59	0.222 *	0.264 *	0.254 *	0.266 *	0.240 *	0.266 *
	(0.074)	(0.075)	(0.077)	(0.076)	(0.076)	(0.076)
60-64	0.141 ‡	0.140 ‡	0.123	0.138 ‡	0.135 ‡	0.135 ‡
	(0.079)	(0.081)	(0.082)	(0.082)	(0.082)	(0.082)
65-70	-0.068	-0.027	-0.152	-0.053	-0.117	-0.044
	(0.128)	(0.124)	(0.136)	(0.126)	(0.135)	(0.127)
Industry (Default: Construction)[§]						
I	0.008	-0.053	0.105	-0.062	0.049	-0.070
	(0.311)	(0.304)	(0.313)	(0.303)	(0.312)	(0.302)
II	-0.679	-0.610	-1.069	-0.670	-0.975	-0.684
	(0.719)	(0.549)	(1.032)	(0.572)	(0.925)	(0.574)
III	0.227	0.358	0.068	0.298	0.160	0.313
	(0.404)	(0.381)	(0.449)	(0.391)	(0.431)	(0.391)
IV	0.101	0.082	0.168	0.095	0.133	0.082
	(0.111)	(0.107)	(0.127)	(0.108)	(0.122)	(0.108)
V	0.464	0.585 ‡	0.395	0.557 ‡	0.441	0.549 ‡
	(0.332)	(0.314)	(0.350)	(0.318)	(0.343)	(0.320)

(Continued)

[§]We use Roman numbers to indicate the industry classification to save space. To check the details on this classification, please refer to Table 4.

Table 11: Probit Retirement Models, Korean Men (cont.)

	Accrual		Peak Value		Option Value	
Variable	Linear Age	Age Dummies	Linear Age	Age Dummies	Linear Age	Age Dummies
VI	-0.071	-0.144	-0.074	-0.146	-0.080	-0.146
	(0.176)	(0.176)	(0.188)	(0.177)	(0.185)	(0.177)
VII	0.513 ‡	0.515 ‡	0.666 †	0.570 †	0.582 †	0.548 ‡
	(0.287)	(0.289)	(0.300)	(0.290)	(0.294)	(0.288)
VIII	-0.311 ‡	-0.383 †	-0.244	-0.368 †	-0.271	-0.365 †
	(0.160)	(0.161)	(0.172)	(0.162)	(0.168)	(0.161)
IX	0.511 ‡	0.387	0.429	0.389	0.432	0.355
	(0.299)	(0.295)	(0.322)	(0.302)	(0.315)	(0.306)
X	0.250	0.266	0.372	0.307	0.318	0.303
	(0.266)	(0.262)	(0.274)	(0.262)	(0.271)	(0.263)
XI	-0.357	-0.523 †	-0.224	-0.465 ‡	-0.270	-0.472 ‡
	(0.269)	(0.266)	(0.279)	(0.267)	(0.276)	(0.268)
XII	-0.276 †	-0.468 *	-0.124	-0.409 *	-0.181	-0.414 *
	(0.118)	(0.107)	(0.133)	(0.109)	(0.127)	(0.109)
XIII	-0.030	-0.071	0.090	-0.047	0.063	-0.038
	(0.115)	(0.109)	(0.131)	(0.110)	(0.126)	(0.111)
XIV	-0.146	-0.307 ‡	-0.138	-0.311 ‡	-0.087	-0.277
	(0.168)	(0.167)	(0.180)	(0.170)	(0.175)	(0.169)
XV	0.502 ‡	0.317	0.271	0.253	0.401	0.302
	(0.260)	(0.259)	(0.275)	(0.264)	(0.270)	(0.263)
XVI	-0.076	-0.054	-0.071	-0.059	-0.041	-0.036
	(0.400)	(0.375)	(0.425)	(0.381)	(0.419)	(0.383)
XVII	-0.525 ‡	-0.535 †	-0.479 ‡	-0.538 †	-0.480 ‡	-0.519 ‡
	(0.271)	(0.269)	(0.287)	(0.270)	(0.281)	(0.270)
XVIII	0.550	0.726 ‡	0.427	0.668	0.451	0.663
	(0.423)	(0.408)	(0.448)	(0.409)	(0.445)	(0.412)
XIX	-0.473	0.148	-0.483	0.147	-0.519	0.118
	(0.784)	(0.599)	(1.105)	(0.620)	(0.994)	(0.625)
Residence Area (Default: Seoul)						
Pusan	-0.069	-0.051	0.003	-0.040	-0.061	-0.066
	(0.114)	(0.118)	(0.117)	(0.119)	(0.116)	(0.119)
Taegu	-0.036	-0.032	0.023	-0.014	0.022	-0.004
	(0.128)	(0.131)	(0.132)	(0.132)	(0.129)	(0.131)
Taejeon	-0.122	-0.041	-0.081	-0.033	-0.093	-0.039
	(0.185)	(0.186)	(0.190)	(0.187)	(0.186)	(0.186)
Inchon	-0.032	-0.023	0.014	-0.017	0.005	-0.010
	(0.142)	(0.144)	(0.144)	(0.144)	(0.144)	(0.144)

(Continued)

Table 11: Probit Retirement Models, Korean Men (cont.)

	Accrual		Peak Value		Option Value	
	Linear	Age	Linear	Age	Linear	Age
Variable	Age	Dummies	Age	Dummies	Age	Dummies
Kwangju	0.211	0.274 ‡	0.284 ‡	0.288 ‡	0.240	0.265 ‡
	(0.156)	(0.159)	(0.157)	(0.159)	(0.159)	(0.160)
Ulsan	0.008	0.036	-0.044	0.016	-0.021	0.025
	(0.205)	(0.209)	(0.210)	(0.210)	(0.211)	(0.211)
Kyonggi	0.003	0.009	-0.051	-0.010	-0.040	-0.013
	(0.100)	(0.104)	(0.104)	(0.104)	(0.103)	(0.105)
Kangwon	0.658 *	0.562 *	0.590 *	0.546 *	0.614 *	0.548 *
	(0.165)	(0.171)	(0.172)	(0.174)	(0.172)	(0.174)
North	0.096	0.187	0.090	0.163	0.106	0.175
Choongchuang	(0.165)	(0.167)	(0.168)	(0.168)	(0.167)	(0.168)
South	-0.238	-0.338	-0.364	-0.348	-0.304	-0.335
Choongchuang	(0.252)	(0.249)	(0.265)	(0.252)	(0.260)	(0.252)
North Cholla	-0.264	-0.251	-0.247	-0.245	-0.238	-0.237
	(0.178)	(0.179)	(0.185)	(0.181)	(0.181)	(0.180)
South Choolla	-0.198	-0.204	-0.230	-0.207	-0.229	-0.211
	(0.244)	(0.244)	(0.265)	(0.250)	(0.262)	(0.251)
North	-0.036	-0.093	-0.056	-0.090	-0.032	-0.079
Kyungsang	(0.189)	(0.194)	(0.198)	(0.196)	(0.194)	(0.195)
South	-0.053	-0.062	0.014	-0.032	-0.034	-0.046
Kyungsang	(0.136)	(0.143)	(0.140)	(0.143)	(0.138)	(0.142)
c	0.777	0.807	0.802	0.810	0.799	0.811

End of the table

Note: Numbers in parentheses are standard errors, and numbers in square brackets are marginal effects.

Table 12: Significance Tests, Korean Men

Likelihood Ratio Test

Null Hypothesis: Neither the level of the SSW nor the inherent incentive measures affect retirement decisions.

	Accrual		Peak Value		Option Value	
$-2\log(L)$	Linear Age	Age Dummies	Linear Age	Age Dummies	Linear Age	Age Dummies
With SSW and Incentives	1,528	1,429	1,482	1,475	1,490	1,473
Without SSW or Incentives	1,652	1,491	1,652	1,491	1,652	1,491
Likelihood ratio	124	62	170	16	162	18

$\chi^2(2)$ statistics: 9.21 when $\alpha = 0.01$.
The null hypothesis is rejected in all six models at a 0.01 significance level.

***c*-statistics**

	Accrual		Peak Value		Option Value	
c-statistics	Linear Age	Age Dummies	Linear Age	Age Dummies	Linear Age	Age Dummies
With SSW and Incentives	0.777	0.807	0.802	0.810	0.799	0.811
Without SSW or Incentives	0.686	0.805	0.686	0.805	0.686	0.805
Difference	-0.091	-0.002	-0.116	-0.005	-0.113	-0.006

Table 13: Probit Retirement Models, Korean Women

	Accrual		Peak Value		Option Value	
	Linear	Age	Linear	Age	Linear	Age
Variable	Age	Dummies	Age	Dummies	Age	Dummies
SSW	0.304 *	0.090	0.150 †	0.040	0.070	-0.090
	(0.055)	(0.064)	(0.066)	(0.069)	(0.079)	(0.080)
10^7 won	[0.040]	[0.016]	[0.015]	[0.006]	[0.007]	[-0.011]
Incentives	0.201	0.030	-0.247 *	-0.159 ‡	-0.033 *	-0.035 *
	(0.157)	(0.193)	(0.066)	(0.083)	(0.009)	(0.010)
10^6 won	[0.002]	[0.001]	[-0.002]	[-0.002]		
$\text{Wage}_{i,t+1}$	-1.710 †	-2.545 *	-1.304 ‡	-2.654 *	-1.634 †	-2.539 *
	(0.810)	(0.863)	(0.779)	(0.834)	(0.785)	(0.836)
AVG	-1.160	-1.769 †	0.189	-0.993	0.231	-0.433
	(0.810)	(0.795)	(0.852)	(0.860)	(0.859)	(0.849)
$\text{Wage}^2_{i,t+1}$	-2.300	-2.886	-2.850	-3.251	-2.776	-3.481 ‡
	(2.003)	(2.107)	(1.940)	(2.051)	(1.988)	(2.066)
AVG^2	-0.668	-1.683	-2.932 ‡	-3.077 ‡	-2.489 ‡	-3.419 †
	(1.378)	(1.513)	(1.508)	(1.692)	(1.471)	(1.604)
Wage × AVG	3.871	6.255 ‡	6.018 ‡	7.787 †	5.746 ‡	8.240 †
	(3.067)	(3.322)	(3.131)	(3.410)	(3.151)	(3.376)
Age	-0.018 *		-0.020 *		-0.017 *	
	(0.004)		(0.004)		(0.004)	
1 year change	[-0.002]		[-0.002]		[-0.001]	
Age Dummies (Default: Age 69)						
Age 45		-0.249		-0.094		-0.074
		(0.217)		(0.230)		(0.223)
Age 46		-0.313		-0.159		-0.140
		(0.236)		(0.246)		(0.240)
Age 47		-0.306		-0.155		-0.157
		(0.213)		(0.224)		(0.216)
Age 48		-0.047		0.090		0.086
		(0.194)		(0.205)		(0.196)
Age 49		0.095		0.243		0.206
		(0.199)		(0.187)		(0.179)
Age 50		0.267 ‡		0.331 †		0.275 †
		(0.139)		(0.144)		(0.140)
Age 51		-0.008		0.039		-0.034
		(0.155)		(0.157)		(0.157)

(Continued)

Table 13: Probit Retirement Models, Korean Women (cont.)

	Accrual		Peak Value		Option Value	
Variable	Linear Age	Age Dummies	Linear Age	Age Dummies	Linear Age	Age Dummies
Age 52		0.012		0.038		-0.033
		(0.152)		(0.154)		(0.154)
Age 53		-0.078		-0.060		-0.138
		(0.155)		(0.156)		(0.157)
Age 54		0.253 †		0.267 †		0.208 ‡
		(0.123)		(0.123)		(0.124)
Age 55		-0.092		-0.086		-0.110
		(0.151)		(0.151)		(0.152)
Age 56		-0.098		-0.099		-0.103
		(0.153)		(0.153)		(0.153)
Age 57		0.054		0.035		0.040
		(0.150)		(0.150)		(0.150)
Age 58		0.403 *		0.356 *		0.365 *
		(0.133)		(0.135)		(0.133)
Age 59		0.088		0.043		0.082
		(0.159)		(0.160)		(0.158)
Age 60		0.360 †		0.291 ‡		0.335 †
		(0.151)		(0.156)		(0.152)
Age 61		0.007		-0.068		-0.033
		(0.195)		(0.199)		(0.196)
Age 62		0.101		0.029		0.063
		(0.191)		(0.195)		(0.192)
Age 63		0.280		0.206		0.245
		(0.185)		(0.189)		(0.186)
Age 64		0.201		0.121		0.154
		(0.208)		(0.213)		(0.209)
Age 65		0.396 ‡		0.315		0.353
		(0.220)		(0.223)		(0.220)
Age 66		-0.948		-1.050 ‡		-1.037 ‡
		(0.597)		(0.611)		(0.622)
Age 67		-0.287		-0.376		-0.353
		(0.398)		(0.402)		(0.404)
Age 68		0.038		-0.045		-0.017
		(0.352)		(0.354)		(0.354)

(Continued)

Table 13: Probit Retirement Models, Korean Women (cont.)

	Accrual		Peak Value		Option Value	
Variable	Linear Age	Age Dummies	Linear Age	Age Dummies	Linear Age	Age Dummies
Marital Status (Default: Married)						
Unmarried	0.118 †	0.185 *	0.072	0.170 *	0.103 †	0.170 *
	(0.047)	(0.046)	(0.048)	(0.047)	(0.047)	(0.047)
Health Status (Default: Fair)						
Good	-0.061	-0.013	-0.081	-0.021	-0.071	-0.026
	(0.052)	(0.052)	(0.052)	(0.052)	(0.052)	(0.052)
Poor	0.014	-0.041	0.053	-0.025	0.032	-0.020
	(0.052)	(0.051)	(0.053)	(0.052)	(0.052)	(0.052)
Education (Default: High School)						
Lower	0.444 *	-0.426 *	0.490 *	-0.403 *	0.477 *	-0.391 *
	(0.123)	(0.084)	(0.126)	(0.085)	(0.125)	(0.085)
College	-0.241 †	0.804 *	-0.197 †	0.751 *	-0.219 †	0.750 *
	(0.095)	(0.150)	(0.096)	(0.153)	(0.095)	(0.151)
Fixed Retirement Age (Default: No Age Limit)						
45-59	0.599 *	0.493 *	0.487 *	0.508 *	0.555 *	0.508 *
	(0.164)	(0.119)	(0.166)	(0.120)	(0.164)	(0.120)
60-64	-0.162	-0.143	-0.130	-0.128	-0.115	-0.105
	(0.139)	(0.133)	(0.141)	(0.134)	(0.140)	(0.135)
65-70	-0.201	-0.148	-0.284	-0.180	-0.279	-0.209
	(0.210)	(0.190)	(0.221)	(0.194)	(0.217)	(0.195)
Industry (Default: Construction)						
I	-0.580 *	-0.880 *	-0.457 †	-0.823 *	-0.507 †	-0.799 *
	(0.200)	(0.189)	(0.205)	(0.191)	(0.202)	(0.190)
II	-1.014	-0.469	-1.123	-0.501	-1.093	-0.530
	(0.892)	(0.548)	(1.062)	(0.561)	(0.977)	(0.569)
III	0.154	-0.135	0.257	-0.083	0.213	-0.059
	(0.263)	(0.256)	(0.270)	(0.258)	(0.265)	(0.258)
IV	0.084	0.045	0.080	0.035	0.069	0.028
	(0.105)	(0.096)	(0.111)	(0.097)	(0.107)	(0.097)
VI	-0.146	-0.139	-0.171	-0.159	-0.169	-0.168
	(0.164)	(0.158)	(0.170)	(0.159)	(0.168)	(0.161)
VII	0.357 *	0.413 *	0.314 *	0.389 *	0.326 *	0.376 *
	(0.111)	(0.101)	(0.117)	(0.102)	(0.114)	(0.103)

(Continued)

Table 13: Probit Retirement Models, Korean Women (cont.)

	Accrual		Peak Value		Option Value	
	Linear	Age	Linear	Age	Linear	Age
Variable	Age	Dummies	Age	Dummies	Age	Dummies
VIII	0.486 ‡	0.531 ‡	0.457	0.514 ‡	0.470	0.505 ‡
	(0.290)	(0.274)	(0.294)	(0.276)	(0.292)	(0.277)
IX	0.754 ‡	0.993 †	0.701	0.968 †	0.724	0.946 †
	(0.434)	(0.398)	(0.446)	(0.403)	(0.442)	(0.405)
X	0.286 ‡	0.391 †	0.219	0.364 †	0.266	0.371 †
	(0.173)	(0.166)	(0.177)	(0.167)	(0.175)	(0.167)
XI	-0.624	-0.609 ‡	-0.650	-0.603 ‡	-0.607	-0.576
	(0.417)	(0.361)	(0.421)	(0.362)	(0.420)	(0.366)
XII	-0.075	-0.230 ‡	-0.056	-0.222 ‡	-0.073	-0.220
	(0.142)	(0.134)	(0.146)	(0.135)	(0.144)	(0.135)
XIII	0.011	-0.117	0.033	-0.109	0.015	-0.108
	(0.135)	(0.128)	(0.140)	(0.129)	(0.138)	(0.129)
XIV	0.121	0.118	0.146	0.140	0.146	0.129
	(0.236)	(0.238)	(0.237)	(0.236)	(0.235)	(0.236)
XV	0.274	0.261	0.273	0.266	0.285	0.281
	(0.198)	(0.197)	(0.201)	(0.197)	(0.199)	(0.196)
XVI	-0.395	-0.323	-0.386	-0.340	-0.375	-0.326
	(0.373)	(0.336)	(0.375)	(0.338)	(0.373)	(0.339)
XVII	0.134	0.151	0.125	0.145	0.124	0.138
	(0.211)	(0.208)	(0.213)	(0.208)	(0.211)	(0.208)
XVIII	0.087	-0.019	0.145	-0.007	0.106	-0.006
	(0.131)	(0.125)	(0.136)	(0.125)	(0.133)	(0.126)
Residence Area (Default: Seoul)						
Pusan	-0.012	-0.066	-0.030	-0.068	-0.006	-0.050
	(0.109)	(0.110)	(0.110)	(0.110)	(0.110)	(0.111)
Taegu	0.190	0.221 ‡	0.179	0.214 ‡	0.194	0.221 ‡
	(0.123)	(0.123)	(0.124)	(0.123)	(0.124)	(0.124)
Taejeon	-0.091	0.048	-0.151	0.012	-0.106	0.023
	(0.241)	(0.232)	(0.244)	(0.234)	(0.242)	(0.234)
Inchon	0.128	0.121	0.109	0.114	0.104	0.098
	(0.156)	(0.158)	(0.157)	(0.158)	(0.157)	(0.158)
Kwangju	-0.235	-0.511 †	-0.169	-0.473 †	-0.214	-0.470 †
	(0.205)	(0.208)	(0.206)	(0.208)	(0.204)	(0.206)
Ulsan	-0.392	-0.191	-0.371	-0.191	-0.413	-0.221
	(0.384)	(0.326)	(0.394)	(0.329)	(0.394)	(0.333)

(Continued)

Table 13: Probit Retirement Models, Korean Women (cont.)

	Accrual		Peak Value		Option Value	
Variable	Linear Age	Age Dummies	Linear Age	Age Dummies	Linear Age	Age Dummies
Kyonggi	0.082	-0.004	0.068	-0.011	0.076	-0.006
	(0.097)	(0.096)	(0.098)	(0.096)	(0.097)	(0.096)
Kangwon	-0.237	-0.200	-0.003	-0.094	-0.164	-0.152
	(0.430)	(0.395)	(0.448)	(0.402)	(0.437)	(0.401)
North	-0.019	-0.016	0.020	-0.012	-0.019	-0.021
Choongchuang	(0.230)	(0.227)	(0.234)	(0.228)	(0.232)	(0.228)
South	-0.045	0.019	-0.064	0.013	-0.029	0.032
Choongchuang	(0.173)	(0.173)	(0.175)	(0.174)	(0.175)	(0.175)
North Cholla	0.116	0.132	0.058	0.106	0.101	0.118
	(0.140)	(0.140)	(0.141)	(0.141)	(0.141)	(0.141)
South Choolla	0.397 †	0.432 †	0.335 ‡	0.407 †	0.389 †	0.426 †
	(0.177)	(0.177)	(0.178)	(0.177)	(0.177)	(0.177)
North	-0.047	-0.049	-0.126	-0.077	-0.071	-0.067
Kyungsang	(0.155)	(0.154)	(0.157)	(0.154)	(0.156)	(0.155)
South	0.063	-0.009	0.054	-0.005	0.063	0.001
Kyungsang	(0.149)	(0.152)	(0.151)	(0.152)	(0.151)	(0.153)
c	0.697	0.716	0.711	0.718	0.712	0.725

End of the table

Note: Numbers in parentheses are standard errors, and numbers in square brackets are marginal effects.

Table 14: Average Retirement Ages, Korean Men

	Accrual		Peak Value		Option Value	
	Linear Age	Age Dummies	Linear Age	Age Dummies	Linear Age	Age Dummies
Baseline	59.0	66.0	62.3	66.5	65.8	66.7
Simulation 1	60.2		63.4		66.1	
Change	1.2		1.2		0.4	
Simulation 2		68.3		68.6		68.8
Change		2.7		2.1		2.0
Simulation 3		70.0		70.0		70.0
Change		4.0		3.5		3.3