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Decomposition of effects of social security on private savings

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Abstract

The main aim of this paper is to decompose the effects of social security on private savings and quantify to what extent each factor that impacts saving behavior account for the effects of social security. For this purpose, I estimate a stochastic dynamic model in which households facing income and survival uncertainty choose optimal levels of consumption, asset holdings and labor supply. In this model, social security pensions reduce private assets by less than 10%. Bequest and precautionary savings motives are the main reasons of this partial offset. Uncertainty on future benefits has no role to play on the effect.

Keywords: Social security, savings, dynamic model.

1 Introduction

In the simplest life-cycle models, where workers save only for retirement, increases in pension are offset completely by reductions in private wealth. However, most previous empirical studies suggest an absence of offset (Kotlikoff, 1979; Gullason *et al.*, 1993) or an offset of 20% or less (King and Dicks-Mireaux, 1982; Diamond and Hausman, 1984; Hubbard, 1986; Novos, 1989; Gustman and Steinmeier, 1999)[1].

There are several reasons as to why the offset between private and pension wealth might be small. First, precautionary and bequest motives of savings are expected to weaken the substitution effect since these motives might be affected less by social security than retirement savings. Second, the effect of social security could be reduced if those who wish to borrow against future earnings are not able to do so. Third, social security benefits provide incentives for early retirement, which in turn provides incentives for workers to save more for a lengthier period of retirement (the inducement-retirement effect). Fourth, people may not be completely certain that they will receive all the benefits to which they are entitled under current law. For example, Dominitz *et al.* (2003) show empirical findings that document considerable uncertainty and heterogeneity about the level of benefits provided should the system survive. The estimated median (subjective) probability of eligibility for benefits at age 70 is 0.40 at age 30, 0.50 at age 40, 0.75 at age 50 indicating that younger Americans have no such confidence in the continuation of the system until their retirement.

[1] A few studies have found substantial offsets (Feldstein and Pellchio, 1979; Bernheim, 1987; Gale, 1998).

This uncertainty reduces the perceived value of future social security benefits and hence their effect on savings.

The main aim of this paper is to decompose the effects of social security on private savings and quantify to what extent each factor that impacts saving behavior account for the effects of social security. For this purpose, I construct a stochastic dynamic model in which households facing income and survival uncertainty choose optimal levels of consumption, asset holdings and labor supply in the presence of incomplete markets. In addition, the model allows the possibility that households may not be completely certain of future social security benefits[2].

In order to estimate the set of parameters in the model and test the validation of the model, I exploit the unique experience of Korea after pension reforms introduced in 1999. The 1999 reform to the Korean National Pension Program extended compulsory coverage to all residents in Korea. As a result of this reform, about 9.5 million people were newly covered by the pension program. However, due to limited enforcement many have been able to escape participation, especially among the self-employed. As a result, we have a very unique situation that the treatment group (those who are covered by the program) and the control group (those who are not) coexist.

The parameters in the model are estimated by the simulated minimum distance (SMD) method that minimizes the distance between the 'simulated average outcomes (consumption and program participation)' from the model and 'observed average outcomes' from the data on the treatment group. Then, using the estimated parameters and the model, I simulate an average outcome in the absence of the social security (counterfactual experiment) and check how well the simulated outcomes fit in the observed ones of the actual data on the control group.

The estimated model in this paper produces a result that the introduction of the pension program reduces asset holdings by a range from 5% for older cohorts to 10% for younger cohorts. The average treatment effect from the structural estimation of this paper is consistent with the results from the difference-in-difference approaches in Hong (2008). Exploiting the advantage of structural estimation, I decompose those factors that account for this small offset. The results show that the small size of effect on private savings is attributed to the bequest and precautionary motives of savings. The bequest motive accounts for 30–60% of the partial offset, whereas precautionary savings accounts for 20–30%. Uncertainty on future benefits has no role to play on the effect. The results from a counterfactual experiment show that the inducement-retirement effect is very small, which implies that almost all the changes in asset holding are due to the substitution effect.

The model and the estimation method of this paper are similar to that of French (2005). Gourinchas and Parker (2002) estimate stochastic dynamic models in which they consider only savings decisions excluding labor supply choices. This paper is also related to previous studies that estimate structural models exploiting the coexistence

[2] Many quantitative papers on social security suggest that a substantial decline in interest rates due to increased overall saving by households has feedback on individual savings decisions. If savings decision changes little due to social security, the general equilibrium effect can be ignorable, which is the case for this paper. I believe general equilibrium approach in this case makes computation much harder but results in little differences in results.

of the treatment and control group to evaluate policy changes. Todd and Wolpin (2007) estimated a structural model to evaluate the effect of the Mexican PROGRESA program, a school subsidy program, on child schooling in this way. Lise *et al*. (2004) calibrate a structural model with experimental data to evaluate Canadian Self-Sufficiency Project.

The remainder of the paper is organized as follows. In Section 2, I describe the structure of the Korean National Pension Program. In Section 3, the life cycle model is developed. Sections 4 and 5 discuss the data and the estimation method. Parameter estimates are presented in Section 5. Section 6 discusses estimation results and the effects of social security and other results from counterfactual experiments.

2 Overview of the Korean National Pension Program

In this section, I describe the structure of the Korean National Pension Program. The social security system in Korea, called the National Pension Act, came into effect in January 1988. The Korean National Pension Program is a funded and defined benefits scheme. In this scheme, the government accumulates funds in pension accounts and pays benefits to retirees which depend on the number of years the individual has paid payroll tax and his past level of earnings. Since it is a defined benefit scheme, the benefits that an individual will receive are independent of the actual investment performance of the funds. Unlike a pay-as-you-go system, current retirees do not receive benefits from the pension program under the Korean National Pension Program.

At its initial stage, the National Pension covered only those who were working in workplaces with more than ten full-time employees. Since then, the National Pension has extended coverage to workplaces with more than five full-time employees (January 1992), and farmers and fishermen (July 1995). In April 1999, the National Pension Program extended compulsory coverage to all residents aged 18–60 in Korea. Despite limited enforcement, the number of insured persons spiked from about 6.5 million in 1998 to about 16 million in 1999. The new participation of about 9.5 million persons accounted for 44.4% of the total labor force and 26.9% of the population over 15 years of age.

The main sources of the new participants in 1999 (which are also the main sources of non-participants) are: (1) the self-employed, (2) employees in small business (i.e. workplaces with less than five workers) and (3) part–time workers. Self-employed workers aged 26–59 account for 34% of total employment and 74% of them participated in the program. Full-time workers account for 53% of total employment and 80% of these are covered by the program. The remaining 20% (who are therefore non-participants) are either workers in small businesses or irregular full-time workers.

Lax enforcement results from the fact that the audit or tax gathering system in Korea is incomplete and hence the government relies on voluntary reporting by the self-employed. Once a self-employed person is identified by the National Pension administration, he is sent notification that he is eligible for the pension program. The notification includes a request that the individual report his annual income on which the contribution rate would be based. If he fails to reply by the due date, the administration sends a notice for the payment of a contribution based on an estimated annual income. However, the administration has no enforcement mechanism for those who wholly refuse to participate in the pension program. A warning letter or threats of fines have been ineffective. Under the current system it is virtually impossible for the government to obtain information on the earnings of the self-employed. Therefore, because of the government's reliance on voluntary self-reporting, many of the self-employed escape participation. Workers in small businesses and irregular full-time workers are similarly able to avoid participation.

The contribution of workers is equally shared by the employer and the employee, while individually insured persons (the self-employed) pay their contributions entirely by themselves. The contribution rate was set low at the initial stage of the program and has gradually been increased. Since 1999, the contribution rate for laborers has been 4.5%, whreas the self-employed pay 9%. This contribution of 9% is used to finance both old age insurance and disability insurance. At present, the age at which individuals are eligible for the old-age pension is 60 years of age, but this increases to 61 years in 2013 and thereafter increases by 1 year every 5 years until it reaches 65 in 2033. A means test is not applied to benefits. The pension eligible age is given and not tied to labor supply decision.

The benefit of the National Pension program is determined by the insured period, the average income of all of the mandatorily insured persons, and the insured person's average income during his insured period. The formula for calculation of basic pension amount (B) is

$$B=1.5(c+y)(1+0.05n)/12.$$

Here c is the average of the yearly income of all insured persons for the 3 years prior to pension payment. y is the average yearly income of an insured person during his insured period. n is the number of insured months in excess of 20 years. The income replacement rate is defined as B/y. Under the Korean National Pension Program, the income replacement rates are high for lower–income households and low for higher–income households.

Figure 1 compares income replacement rates by income class in Korea and the U.S. In this figure, income levels are normalized by the average monthly earnings of entire labor force. For example, those whose earnings are half of the average income of total population and contribute for 20 years would receive 45% of their previous earnings after the age of 65. Those whose earnings are one and half times as much as the average income would get 21% of their previous earnings. The social security payroll tax for the self-employed in Korea (9%) is lower than that in the U.S. (12.4%), whereas benefits are similar in both countries[3]. The Korean National Pension Program is more generous than the U.S. pension program.

Since the Korean National Pension Program began as a funded system, the contribution and benefits structures are different across cohorts. Table 1 shows the differential structure of the program across cohort. For younger cohorts, the contribution period is long and hence the replacement rate is high, whereas for older cohorts the replacement rate is very low due to the very short period of contribution.

[3] According to my calculation, the ratios of social security wealth to social security contribution are about 2.5 for all cohorts in Korea.

Table 1. *Korean National Pension structure by cohort as of 2002*

Cohort	Eligible age	Contribution years	Replacement rate
25–29	65	36–40	0.54
30–34	64–65	30–35	0.45
35–39	63–64	24–29	0.36
40–44	62–63	18–23	0.26
45–49	60–61	11–16	0.16
50–54	60	6–10	0.10

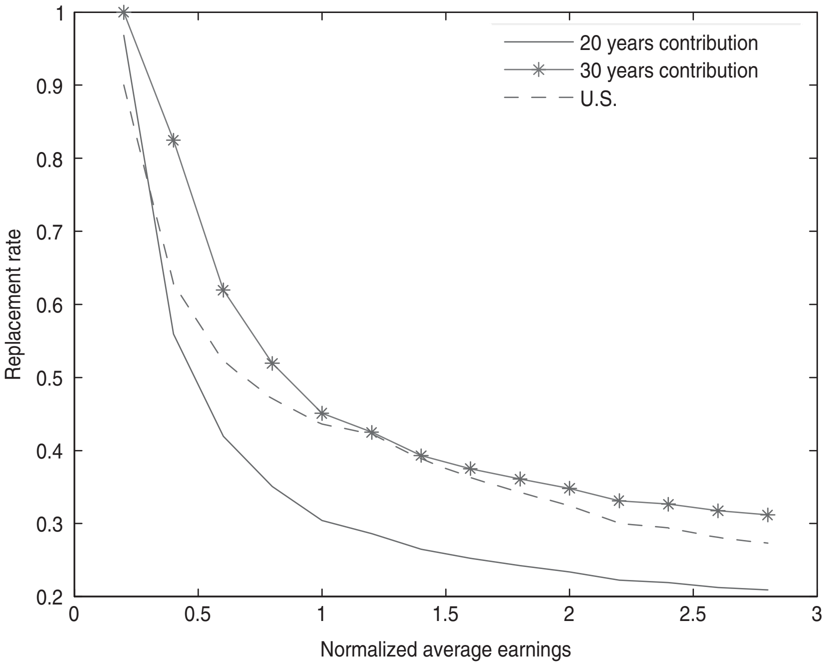

Figure 1. Replacement rates by insured period in Korea and the U.S.

For example, the replacement rate for cohorts aged 30–34 is 45% and that for cohorts aged 50–54 is only 10%.

3 A life-cycle model of consumption and participation

3.1 Model

In this section, a discrete-time, life-cycle model of households consumption and labor supply behavior is described. Household is composed of husband and wife. Households live for T periods, where T is exogenous and fixed. Households face random survival from age (or equivalently, year) $t-1$ to t, denoted by $\psi_t \in (0, 1)$.

Let $\Psi_t = (\Pi_{k=1}^{t} \psi_k)$ denote the unconditional probability of being alive at age t. The households goal is to maximize discounted utility over a finite lifetime.

$$u(C_{1,}, H_1) + E_1 \left[\sum_{j=1}^{T} \beta^j \Psi_{j+1} \left[\psi_{j+1} u(C_{j+1}, H_{j+1}) + (1 - \psi_{j+1}) b(A_j) \right] \right], \tag{1}$$

where β is the time discount factor and C_t, H_t, A_t represent consumption, leisure and asset holdings at time t, respectively. Households have a possibility to leave bequests valued b with the probability $1 - \psi_{t+1}$. C_t and A_t are continuous choice variables. H_t is assumed to be discrete, so households can choose full-time work, part-time work, or drop out of the labor force.

3.3.1 Decisions in the absence of social security

In the absence of a social security system, the households maximize equation (1) given an initial asset level A_0 and the budget constraint:

$$C_t^0 = RA_{t-1}^0 + W_t(1 - H_t^0) - A_t^0,$$

where R is the constant gross interest rate. The superscript 0 is attached to variables without social security and superscript 1 to variables with social security.

W_t represents a wage rate at time t. This paper incorporates uninsurable idiosyncratic income uncertainty. The wage rate process is decomposed into a deterministic permanent component P_t and a transitory component ϵ_t:

$$W_{t,g} = P_{t,g} \epsilon_{t,g}$$

for $t = 1, \ldots, T$ and $g \in \{l, m, h\}$, where l, m, h denote low, middle and high education, respectively. The low, middle and high–seducation corresponds to junior high–school graduate or less, high–school graduate and college graduate, respectively. Hence, permanent income paths are different across education groups.

Transitory shocks are also different across education groups. Transitory shocks, $\epsilon_{t,g}$, are independent and identically distributed and assumed to be log-normally distributed, $\ln \epsilon_g \sim N(-\sigma_g^2/2, \sigma_g^2)$.

In this model agents may not have negative assets at any age. Hence, the restriction on the amount of assets is that

$$A_t^0 \geqslant 0 \quad \text{for all } t.$$

The period utility function takes the Constant Relative Risk Aversion (CRRA) form, with the coefficient of relative risk aversion γ (or intertemporal elasticity of substitution $1/\gamma$):

$$u(C_t, H_t) = \frac{(C_t^{\alpha} H_t^{1-\alpha})^{1-\gamma}}{1-\gamma},$$

where $\alpha \in [0, 1]$ is a share of consumption in utility. The bequest function is of the form

$$b(A_t) = \eta \frac{A_t^{\alpha(1-\gamma)}}{1-\gamma},$$

where $\eta > 0$ is a coefficient that represents the strength of the bequest motives. The bequest function is increasing and concave. With this form of bequest function, it is possible to get an analytical solution at period T, which increases the accuracy of computation and to decrease a number of parameters.

Defining the value function when the agent does not participate in the social security program at time t as V_t^0, above maximization problem can be rewritten in the recursive form:

$$V_t^0(A_{t-1}^0, \epsilon_t) = \max \quad u(C_t^0, H_t^0) + \beta E_t\left[\psi_{t+1} V_{t+1}^0(A_t^0, \epsilon_{t+1}) + (1-\psi_{t+1}) b(A_t^0)\right]$$

subject to the same constraints as above.

3.1.2 Decisions under social security

If the household participates in the social security program, its maximization problem faces a different budget constraint. Each period households who are below the eligible age for social security benefits t_R face a stochastic wage rate W_t. After t_R the households receive a pension S. By the current law S is different across cohort. The after-tax income of an individual is given by

$$Q_t = (1-\tau)(1-H_t^1)W_t, \quad t \in [1, t_{R-1}], \tag{2}$$

$$= \lambda_c S + (1-H_t^1)W_t, \quad t \in [t_R, T], \tag{3}$$

where τ is the social security payroll tax rate. The parameter $\lambda_c \in [0, 1]$, which is cohort-varying (not age varying), reflects the fact that households might not receive the full amount of benefits. Due to the lengthy waiting period before households become eligible for benefits, younger generations are more likely to have lower value of λ_c.

Under the Korean National Pension Program, individuals can unconditionally receive social security benefits after the eligible age regardless of their labor market status. Taking this fact into consideration, this paper allows flexible labor supply decisions even after the eligible age for social security benefits is reached.

Under the social security system, the household head maximizes equation (1) given an initial asset level A_0 and the budget constraint:

$$C_t^1 + A_t^1 = RA_{t-1}^1 + Q_t, \tag{4}$$

$$A_t^1 \geqslant 0, \quad \text{for all } t. \tag{5}$$

Let V_t^1 be the value function when the household participates in the social security program at time t. Then V_t^1 can be written as

$$V_t^1(A_{t-1}^1, \epsilon_t) = \max \quad u(C_t^1, H_t^1) + \beta E_t\left[\psi_{t+1} V_{t+1}^1(A_t^1, \epsilon_{t+1}^1) + (1-\psi_{t+1}) b(A_t^1)\right]$$

subject to the constraints (5).

3.1.3 Participation decision

The presence of non-participants enables us to have a separate control group from the treatment group. This is a clear advantage to identify the effects of social security, and also raises the possibility of self-selection problem. Participants of the social security program may have different characteristics from non-participants. If these are unobservable characteristics, they become difficult to control for. For example, participants might decide to join the program because they have a higher propensity to save or more concerned about the future than non-participants. This paper includes the participation choice in the model to control for this self-selection problem.

At time t, households decide whether to participate in the social security program based on

$$d_t = 1, \quad if\ V_t^1(A_{t-1}^1, \epsilon_t^1) > V_t^0(A_{t-1}^0, \epsilon_t^0) - \Phi_g(Y_t), \tag{6}$$

$$= 0, \quad \text{otherwise}, \tag{7}$$

where d_t is equal to one if participate in the program at t and zero otherwise. The non-participation cost function, $\Phi_g(Y_t)$, is assumed to take the following form:

$$\Phi(Y_t) = \phi_g(Y_t - \min(Y))^2,$$

for $g \in \{l, m, h\}$. $\Phi_g(Y_t)$ is a function of the level of education and current level of income. With this functional form, I assume that of those who refuse to participate in the pension program, self-employed workers with high income are more likely to get attention and be pressed by the pension administration to participate. The cost includes the psychological pressure that non-complaints would have and real pecuniary cost in the form of a monetary fine. $\phi_g \geqslant 0$ is a coefficient to be estimated that represents the strength of the pressure. I assume ϕ_g is positive because $\Phi_g(Y_t)$ represents the cost of non-participation or non-compliance. The participation decision is assumed to be an absorbing state. That is, once households participate in the program, they are not allowed to exit.

3.2 Assumptions and model solution

In this paper, one period is equivalent to 5 years. Households begin their life at age 25 and live up to 94. Hence $T = 14$ given this choice of period. Initial assets are set to zero for every household. Households in the model may work until age 79 and take full retirement after that.

Korea Labor and Income Panel Study (KLIPS) shows that household heads who do not work at all account for only 1.4% of household heads aged 25–59. Ninety-three percent of working household heads work 40 hours or more per week. So, part-time self-employed heads are rarely found. Given this fact, I assume that households may only work full time during the 25–59 age period. From age 60 to 79, households can choose full-time work, part-time work, or drop out of the labor force. Concretely, $H_t \in \{0.3, 0.75, 1\}$. Each element of H_t corresponds working 12 hours, 4.3 hours and 0 hours per day, respectively.

This paper assumes that the introduction of social security is not anticipated by households. For example, since households of age 35–39 ($t = 3$) have not been covered by the social security program, their optimal consumption profile until age 34 was$\{C_{i,1}^0, C_{i,2}^0\}$. When a social security program is introduced, evaluating the value functions, they make decisions on the participation and consumption. The optimal choice of consumption is conditioned on the choice of participation. If they decide to join the pension program, they would choose an optimal consumption $\{C_3^1\}$. Otherwise, they would choose $\{C_3^0\}$. Taking into this account, I solve each cohort's dynamic problem separately and calculate a series of choices $\{C_{i,t}^j\}_{t=1}^6$, $\{d_{i,t}\}_{t=1}^6$ for $j=0$, 1, and for each education group.

The solution to the above maximization problem consists of a set of consumption rules $\{C_t^j(A_{t-1}^j,\epsilon_t^j)\}_{t=1}^T$, asset holdings rules $\{A_t^j(A_{t-1}^j,\epsilon_t^j)\}_{t=1}^T$, labor supply decision rules $\{H_t^j(A_{t-1}^j,\epsilon_t^j)\}_{t=1}^T$, for $j=0$, 1, and participation decisions $\{d_t\}_{t=1}{}^T$ for each cohort and education group. Since these policy functions have no closed-form solutions, the model is numerically solved by backward recursion. The state variables are discretized into a finite number of points on a grid and the value function is evaluated at those points. I use interpolation within the grid and extrapolation outside of the grid to evaluate the value function points that were not directly computed. When selecting the finite number of points at which the value function is computed, the point is more finely discretized at low levels of choice variables.

4 Data

I use the KLIPS to construct life-cycle profiles of income, consumption, and participation rates. The KLIPS is a longitudinal survey of the labor market and income activities of households and individuals residing in urban areas. The KLIPS is administrated by the Korea Labor Institute, which started the survey in 1998. The KLIPS is a sample of households from urban areas and was designed to yield 5000 households whose members (aged 15 and over) interviewed annually. The KLIPS contains information about consumption, savings, income and demographics[4]. This paper uses the KLIPS data from 2000 to 2002 to estimate the model. Data from 1998 and 1999 are used for out-of-sample tests. I drop households that are incomplete labor income reporters and those for which values of crucial variables are missing. Through this procedure, 3,222 households remain.

Table 2 shows summary statistics for non-participants and participants among self-employed from 24 to 54 years of age those who are actually affected by the pension program. Participants and non-participants are determined according to whether the household head takes part in the program or not. Households in which only the spouse of the head participates account for 1.27 % of self-employed workers who are eligible.

In the statistics presented, labor income and consumption are measured in ten millions Korea Won in 1998 terms. The exchange rate as of 2001 was approximately 1,300 Won per U.S. dollar. Consumption is the sum of expenditures on non-durable goods, durable goods, services and rent. The table shows that participants have more labor income than non-participants. This is attributed to the difference in the level of education and family size. Hours of labor by head and by whole household members

[4] The KLIPS does not have information on asset in 1998. Since the moment conditions for asset holdings cannot be used, this paper focuses on consumption behaviors.

Table 2. *Summary statistics of self-employed aged 24–54*

	Non-participants	Participants	Difference
Yearly labor income	2.09 (1.56)	2.52 (1.55)	0.43 (0.07)*
Yearly consumption	1.50 (0.78)	1.79 (0.89)	0.29 (0.04)
Hours of labor by household	4206.3 (2250.1)	4200.7 (2177.2)	−5.69 (176.74)
Hours of labor by head	3204.1 (47.4)	3251.7 (24.5)	47.56 (50.3)
Health (index)	1.96 (0.83)	2.07 (0.71)	0.11 (0.06)
Education (year)	11.19 (3.21)	11.72 (2.99)	0.53 (0.15)*
Family size (persons)	3.81 (1.19)	4.06 (1.00)	0.25 (0.05)*
Observation	576	1701	

Note: Labor income and consumption are measured in tens of millions of Korean Won. Standard deviations are in parentheses in the second and the third columns. The parenthesis in the last column shows standard errors of the differences. * Indicates that differences are significant at 5% level. Health is categorized as follows: 1, very good; 2, good; 3, moderate; 4, poor; 5, very poor.

are not significantly different across the two groups. There is no significant difference in health across the two groups.

In order to generate the average wage profile, I divide the sample into three educational groups and estimate the equation

$$W_{i,g} = a + \sum_{t=2}^{11} \Pi_{t,g} I\{\text{age}=t\} + u_i$$

for each education group separately. Here $I\,\{\text{age}=\text{k}\}$ is a binary variable that is one if the age of an household head belongs to $k=2, \ldots, 11$.

5 Estimation and model validation test

5.1 Estimation

In the estimation, the set of parameters $\theta_g = (\alpha_g, \beta_g, \gamma_g, \eta_g, \lambda_{2,g}, \ldots, \lambda_{6,g}, \phi_g)$ for each education group g is estimated by the method of SMD and $\chi = (\psi_t, R, \sigma_g)$ are calibrated using outside information. Let the vector of the mean of the observed behaviors for each education group be denoted by $\widehat{\pi}_g, g \in \{l, m, h\}$:

$$\widehat{\pi}_g = \left(\frac{1}{N_2} \sum_{i=1}^{N_2} C_{i,2,g} \cdots \frac{1}{N_6} \sum_{i=1}^{N_6} C_{i,6,g} \; \frac{1}{N_2} \sum_{i=1}^{N_2} d_{i,2,g} \cdots \frac{1}{N_6} \sum_{i=1}^{N_6} d_{i,6,g} \right)'.$$

$\widehat{\pi}_g$ is a vector of observed average level of consumptions and participation rates for each education group from $t=2$ to $t=6$. For example, $C_{i,2,g}$ indicates the household i's consumption for cohort aged 30–34 as of 2002 (equivalent to $t=2$) and belong to group g. The mean of the observed process for each group at age 25–29 as of 2002, or equivalently $t=1$ are excluded since the number of observations for this period is small. Here the number of observations is different across time periods. Let $\widehat{\pi} = (\widehat{\pi}_l, \widehat{\pi}_m, \widehat{\pi}_h)$. Since C_{it} and d_{it} are independent across cross-section units and $\widehat{\pi}$ is assumed to have expectation and a covariance matrix:

$$\pi_0(\theta_0) = E_0[\widehat{\pi}], \quad V_0(\theta_0) = Var_0(\widehat{\pi}),$$

$\widehat{\pi}$ is a consistent estimator for $\pi_0(\theta_0)$ where $\pi_0(\theta_0)$ is the true value of average outcomes under the true value of parameters.

Define the simulated auxiliary functions as

$$\widehat{\pi}_g^s = \left(\frac{1}{N_2}\sum_{i=1}^{N_2} C_{i,2,g}^s \cdots \frac{1}{N_6}\sum_{i=1}^{N_6} C_{i,6,g}^s \; \frac{1}{N_2}\sum_{i=1}^{N_2} d_{i,2,g}^s \cdots \frac{1}{N_6}\sum_{i=1}^{N_6} d_{i,6,g}^s\right)',$$

$$h_g^s(\theta) = \frac{1}{S}\sum_{s=1}^{S} \widehat{\pi}_g^s,$$

where $h_g^s(\theta)$ is a vector of the average level of simulated consumption and simulated participation rate for each education group. For example, $C_{i,2,g}^s$ is the household i's simulated consumption for cohort aged 30–34 as of 2002 and belong to group g. In order to construct $\widehat{\pi}_g^s$, given a set of parameters, I solve the numerical maximization problem for each cohort $t = 2, \ldots, 6$ and educational group g separately to get optimal consumption and participation rules for each t and g. The separate computation is necessary because the contribution rates and replacement rates of social security benefits are different across cohort, as mentioned in section 2. Then using the optimal policy rules, I construct the average simulated outcomes, $h_g^s(\theta)$, after S times of simulations starting from initial assets of zero. For the S times of simulation, the transitory shock, σ_g^2, is estimated from the second moments of the wage data, $W_{i,g}$.

The parameters are estimated by SMD, which minimizes the distance between observed behaviors and simulated ones. Denoting $h^s(\theta) = (h_l^s(\theta), h_m^s(\theta), h_h^s(\theta))$, SMD distance estimator is defined by

$$\widehat{\theta}_{\mathrm{SMD}} = \arg\min \, (\widehat{\pi} - h^s(\theta))' \, \widehat{W}(\widehat{\pi} - h^s(\theta)),$$

where W is a weighting matrix. Following McFadden (1989) and Hall and Rust (2003), the SMD estimator is consistent and asymptotically normal. The variance matrix is given by $(1+\frac{1}{S})\Lambda^{-1}$ for the optimal weighting matrix $W = V_0^1$, where

$$\Lambda = \nabla_{\theta_0} h(\theta_0)' V_0^{-1} \nabla_{\theta_0} h(\theta_0).$$

5.2 *Parameter estimates*

In the estimation, the set of parameters $\theta_g = (\alpha_g, \beta_g, \gamma_g, \eta_g, \lambda_{2,g}, \ldots, \lambda_{6,g}, \phi_g)$ for each education group g is estimated by the SMD and $\chi = (\psi, {}_tR, \sigma_g)$ are calibrated using outside information. The information on the conditional probability ψ_t is obtained from the Office of Statistics. The gross real interest rate R is obtained by calculating nominal interest rates and inflation rates for 34 years. The standard deviation of income process σ_g is obtained from the data calculating the second moment.

Table 3 presents the values of the parameters estimated by SMD. Results show that college graduates have a much higher share of consumption in their utilities ($\alpha_h = 0.653$). The lower educated group whose level of education is less than 13 years places more value on leisure than do college graduates ($\alpha_l = 0.590$, $\alpha_m = 0.550$).

Table 3. *Estimated values of parameters*

	Parameter	Lower educated	HS graduates	College graduates
α_g	share of consumption	0.590 (0.321)	0.550 (0.337)	0.653 (0.094)
β_g	discount factor	0.967 (0.032)	0.975 (0.054)	0.940 (0.107)
γ_g	relative risk aversion	4.315 (0.718)	4.204 (1.555)	4.203 (0.406)
η_g	bequest function	9.848 (3.628)	10.790 (3.597)	10.895 (3.782)
$\lambda_{2,g}$	belief on benefits	0.331 (0.121)	0.506 (0.411)	0.733 (0.419)
$\lambda_{3,g}$		0.340 (0.138)	0.440 (0.616)	0.779 (0.726)
$\lambda_{4,g}$		0.381 (0.235)	0.427 (0.302)	0.953 (0.351)
$\lambda_{5,g}$		0.519 (0.362)	0.569 (0.639)	0.626 (0.330)
$\lambda_{6,g}$		0.870 (0.747)	0.847 (0.405)	0.747 (0.085)
ϕ_g	non-participation cost	0.000 (1.129)	0.000 (1.251)	2.068 (1.395)
σ_g	standard deviation of income shock	1.16	1.38	2.04
R	gross interest rate		1.05	
ψ_t	conditional survival prob.		Office of Statistics	

Note: Standard errors are in parentheses.

The estimated values of the share of consumption are very close to those from French (2005) whose estimated value of the share of consumption falls in the range of 0.533–615 depending on the specification.

The estimation results also show that the subjective discount factor ranges from 0.94 to 0.975 across different educational group. The estimated values of the discount factor imply that the subjective discount rates for lower educated, high school graduates, and college graduates are 0.034, 0.026 and 0.064, respectively. The results show current consumption rather than future consumption and is given much more weight in lifetime utility for higher educated people (or equivalently high income earners) than for lower educated persons. The overall level of estimated values of subjective discount rates are close to that obtained in Gourinchas and Parker (2002) and less than that obtained in French (2005). A clear pattern of association with the level of education is not evident.

There is no clear pattern in the estimated coefficient of relative risk aversion across levels of education, ranging from 4.2 to 4.3 (and thus not different across educational groups). These values are much greater than those obtained in previous studies that do not include labor supply in the utility function. For example, in Gourinchas and Parker (2002) where there is no labor supply choice, the estimates of coefficients of relative risk aversion range from 0.282 to 2.290 depending on the level of education. The larger values of the coefficient of relative risk aversion in a model with a labor supply choice are indicative of the self-insurance role of labor supply. As Low (2005) points out, ignoring labor supply flexibility leads to underestimates of the size of precautionary savings and overestimates of consumption growth. Flexible labor supply allows individuals to react to shocks to wages by changing hours of work, thus reducing the cost of uncertainty. Therefore, the value of the coefficient of relative risk aversion should be large enough to generate the hump-shaped consumption pattern which follows the hump-shaped income profile over the life cycle. Too small a value of the coefficient will generate too flat a pattern of consumption profile over the life cycle and hence the simulated consumption profiles from the model cannot be matched with observed hump-shaped consumption profiles.

The coefficient of bequest function ranges from 9.85 to 10.9. These estimated values of coefficient of bequest function are much greater than those obtained in French (2005), who finds values in the range of 1.69–2.58.

The estimated values of the coefficient on the future pension benefits show a clear pattern associated with the level of education. Households with higher level of education have higher value of λ_c. Lower value of λ_c of the lower educated group is the main force generating the low rate of participation of the lower educated (or, equivalently, low income earners) in the Korean National Pension Program in spite of its progressivity. Age plays another consistent role: younger cohorts have lower value of λ_c than relatively older cohorts. This result is very natural in the sense that younger cohorts have longer time to wait until they are able to realize pension benefits.

The estimated coefficients on the participation cost for lower–educated and middle–educated households are zero, which is the minimum value the model applies as a restriction. It implies that these households face lower pressure for participating in the pension program. On the other hand, higher–educated households (equivalently, higher–income earners) face no insubstantial pressure to participate by the Korean government. This pressure is the main reason that the higher–educated households show a higher rate of participation in the program.

5.3 Model validation tests: within sample and out of sample tests

Table 4 compares the actual and predicted choice profiles after policy changes. In this within sample test, I used the data both for the control group and the treatment group after the policy reform because data for these groups after the policy reform are used for the parameter estimation. The table also report the chi-square statistic associated with a test of null that the predicted and the actual distributions are the same. Predicted consumption profiles match well with the actual consumption profiles overall except for a few points, in particular consumption at age 45–49 for lower–educated and high–school graduates.

Table 5 presents the results of the out-of-sample test. In this test, I (1) keep the parameters that are estimated by SMD, (2) use the pre-intervention (before 1999) data for self-employed and simulate an average consumption profile and (3) check how well the 'simulated average consumption profile' fits in the 'observed average consumption profile' of the actual data. In this out-of-sample test, I use the wage data for the control group before the policy reform to examine whether the simulated and actual consumption profiles are similar.

The out-of-sample test employs a method opposite to previous studies using structural models for policy evaluation. The common method is to (1) construct a model and estimate parameters using a control group, (2) introduce a policy structure in the model and simulate impacts of the policy and (3) compare the simulated impacts with impacts observed in the treatment group. There are two reasons that I use

Table 4. *Within-sample fit: actual and predicted choice profiles*

	Consumption			Participation rate(%)		
Age	Actual	Predicted	χ^2	Actual	Predicted	χ^2
Lower educated						
30–34	1.291	1.329	0.022	53.8	54.2	0.053
35–39	1.456	1.455	0.000	64.1	64.4	0.003
40–44	1.506	1.473	0.548	66.0	66.1	0.000
45–49	1.702	1.557	8.650	64.0	63.4	0.029
50–54	1.681	1.629	1.034	76.4	76.5	0.000
High school graduates						
30–34	1.542	1.545	0.005	71.7	71.7	0.000
35–39	1.773	1.799	0.353	78.5	78.6	0.002
40–44	1.882	1.904	0.300	77.8	78.0	0.006
45–49	2.202	2.066	5.341	78.4	78.6	0.003
50–54	2.138	2.122	0.060	74.6	74.8	0.003
College graduates						
30–34	1.915	1.857	0.289	80.8	79.0	0.137
35–39	2.145	2.165	0.044	78.7	77.8	0.071
40–44	2.214	2.405	9.579	80.4	77.5	0.926
45–49	2.879	2.940	0.171	75.5	75.9	0.007
50–54	2.705	2.886	1.186	75.4	76.1	0.017

Note: Consumption is measured in tens of millions of Korean Won.

Table 5. *Out-of-sample fit: actual and predicted consumption*

	Lower educated			HS graduates			College graduates		
Age	Actual	Pred.	χ^2	Actual	Pred.	χ^2	Actual	Pred.	χ^2
30–34	0.990	1.183	0.569	1.210	1.329	2.045	1.453	1.331	3.740
35–39	1.136	1.268	3.179	1.466	1.587	3.648	1.693	1.675	0.128
40–44	1.218	1.316	1.518	1.652	1.727	1.573	1.951	1.915	0.566
45–49	1.361	1.413	0.453	1.991	1.823	3.760	1.944	2.013	1.402
50–54	1.375	1.463	1.924	1.623	1.840	4.301	1.966	2.081	1.928

Note: Consumption is measured in tens of millions of Korean Won.

a different strategy. First, the presence of compliance raises the issue of self-selection, which may be attributed to unobservable characteristics. In order to control for a potential self-selection bias, I incorporate the participation decision as a choice variable in the model. Thus, both the control group and the treatment group are used in the estimation and the treatment group cannot be used for the out-of-sample test. For the out-of-sample validation test, I use pre-intervention data for the control group (the self-employed). Hence, this paper estimates the model using

Table 6. *Effects of social security on asset holdings*

Age	A^0	A^1	Effect (%)	A^0	A^1	Effect (%)
	Full model			Full expectation		
30–34	1.638	1.473	−9.9	1.638	1.462	−10.8
35–39	2.340	2.117	−9.2	2.340	2.070	−11.7
40–44	3.014	2.736	−8.7	3.014	2.645	−12.4
45–49	4.016	3.731	−7.0	4.016	3.582	−10.9
50–54	4.852	4.608	−5.2	4.852	4.557	−6.3
	Certainty with bequest			Certainty, no bequest		
30–34	0.595	0.363	−40.1	0.251	0.024	−92.6
35–39	1.089	0.683	−37.5	0.615	0.200	−69.2
40–44	1.598	1.112	−30.4	1.027	0.474	−54.4
45–49	2.636	2.152	−18.6	1.928	1.414	−26.8
50–54	3.582	3.286	−8.8	2.747	2.406	−12.4

Note: Assets are measured in tens of millions of Korean Won. A^0 and A^1 represent asset holdings without and with social security, respectively.

post-intervention data and assesses the validity of the model using pre-intervention data.

The second reason for using a different strategy is that there are more parameters in the model after policy change is implemented. Since the model includes the partial expectation of future pension wealth, the number of parameters in the model with social security is greater than in the model without. Therefore, it is appropriate to use pre-intervention data as the out-of-sample fit test. The table shows that the out-of-sample fit is good.

6 Discussion

6.1 The effect of social security on private savings

In order to measure the effect of social security on savings, one needs to estimate what would be asset holdings with and without social security for each household. This can be done by counterfactual experiments taking advantage of the structural estimation. Table 6 shows the estimated effects of social security on asset holdings. The overall effect is the weighted average of asset holdings by education group, where the proportion of each education group is weighted. The size of the effect ranges from −5.2% to −9.9%. The average treatment effect is the 0.12$ decrease of private wealth due to the 1$ increase in pension wealth. For a reference, the mean pension wealth is estimated as 23.9 million Korean Won.

The size of the effect is positively related to the age of the cohort. That is, social security has the largest effect (−9.9%) on the youngest cohort (age 30–34) and the smallest effect (−5.2%) on the oldest cohort (age 50–54). This pattern reflects the differential structure of the Korean National Pension Program across cohort. For younger cohorts, the contribution period is long and hence the replacement rate is high, whereas for older cohorts the replacement rate is very low due to the very short

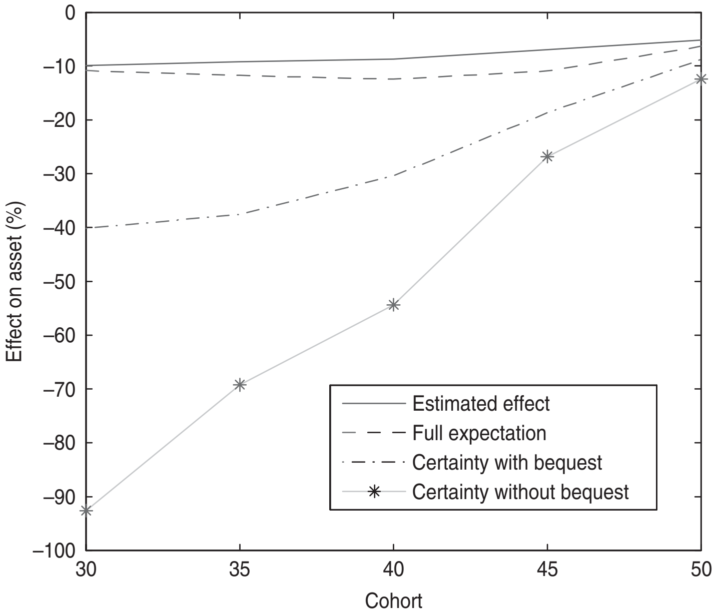

Figure 2. Decomposition of effects.

period of contribution. Therefore, younger cohorts are likely to be affected more by the pension program.

What would be the size of effect if there was no uncertainty and no bequest motive of saving? The effect in this situation is used as a benchmark to compare the effect of social security and will be called 'certainty without bequest model'. The last three columns of Table 6 show the level of asset holdings in this model. The overall level of asset holdings is lower in the certainty without the bequest model because workers save only for retirement. Changing workers' compensation from wages to pension benefits has no effect on consumption. Increases in pension are offset completely by reductions in other wealth. Again due to the differential structure of the Korean National Pension Program across cohorts, the size of perfect offset is largest (−92.6%) for the youngest cohort (age 30–34) and smallest (−12.4%) for the oldest cohort (age 50–54). Relative to the perfect offset case, the estimated effect of the pension program on asset holdings is 10%, and is the same over all cohorts.

Then, which factors account for the partial offset of private savings? Figure 2 provides insight into this question. The figure shows how much households would change their asset holdings in different situations (numerical values are shown in Table 6). The first line represents the effect of social security that is estimated using the full model in this paper. The fourth line represents the perfect offset case in the simplest life cycle model where there is no uncertainty and no bequest motive. The third line shows the effects of social security on asset holdings in a model where there is no uncertainty but households do have bequest motives. Thus, the difference between the third line and the fourth line represents the degree to which bequest motives

Table 7. *Effects on asset by education group*

	Low educated			High school graudates			College graduates		
Age	A^0	A^1	Effect	A^0	A^1	Effect	A^0	A^1	Effect
Estimated effects									
30–34	0.965	0.864	−10.5	1.423	1.299	−8.7	2.543	2.255	−11.3
35–39	1.515	1.390	−8.3	2.127	1.937	−8.9	3.546	3.165	−10.7
40–44	1.951	1.807	−7.4	2.761	2.543	−7.9	4.522	3.997	−11.6
45–49	2.493	2.338	−6.2	3.738	3.465	−7.3	6.098	5.662	−7.2
50–54	3.172	2.988	−5.8	4.502	4.257	−5.4	7.532	7.219	−4.2
Effects under full expectation									
30–34	0.965	0.839	−13.0	2.543	2.251	−11.5	2.543	2.251	−11.5
35–39	1.515	1.317	−13.1	3.546	3.152	−11.1	3.546	3.152	−11.1
40–44	1.951	1.692	−13.3	4.522	3.993	−11.7	4.522	3.993	−11.7
45–49	2.493	2.211	−11.3	6.098	5.477	−10.2	6.098	5.477	−10.2
50–54	3.172	2.962	−6.6	7.532	7.140	−5.2	7.532	7.140	−5.2

Note: Assets are measured in tens of millions of Korean Won. A^0 and A^1 represent asset holdings without and with social security, respectively. Effects are measured by percent.

account for the partial offset. Relative to the perfect offset case, households with bequest motives in a world without uncertainty would reduce their private wealth by 40–70% if the Korean National Pension Program were introduced. Therefore, the bequest motive accounts for 30–60% of the partial offset. The proportion that bequest motives account for the partial offset is negatively related to the age of cohorts.

The second line of the figure shows the effect of social security on asset holdings when households have no uncertainty on future pension benefits. Thus, the difference between the first line and second line represents the degree to which uncertainty on future pension benefits account for the partial effect, holding all else constant. The result shows that households without uncertainty on pension benefits would reduce their asset holdings from 6.3–10.8% if the pension program was introduced. This size of reduction is a little larger than the estimated real effect in this paper but the difference is extremely small relative to perfect offset. Therefore, uncertainty on future pension benefits accounts for 10% of the partial offset for middle-aged households and almost nothing of the partial effect for younger cohorts.

One remaining factor that accounts for the partial offset of private wealth is precautionary savings. The difference between the second and the third lines represents the degree to which precautionary savings account for the partial offset. According to the results, precautionary savings account for 20–30% of the partial offset. The contribution of precautionary savings in the partial offset becomes larger as age increases. To summarize the main findings, the effect of the introduction of the Korean National Pension Program on private wealth is less than 10% in asset holdings. The precautionary savings and bequest motives are the main reasons for this partial offset.

Table 7 presents the effects of social security on asset holdings by education and cohort group. The size of the effect on assets is positively related to the level of

Table 8. *Substitution and inducement effects* (*percent*)

	Overall		Lower educated		HS graduates		College graduates	
Age	Subst.	Induce	Subst.	Induce	Subst.	Induce	Subst.	Induce
30–34	−10.0	0.1	−10.2	−0.3	−8.7	−0.2	−11.3	0.0
35–39	−9.8	0.5	−8.8	0.5	−8.9	0.1	−10.7	0.4
40–44	−9.3	0.6	−7.4	0.0	−7.9	−0.3	−11.6	0.5
45–49	−7.6	0.6	−6.2	0.0	−7.3	0.0	−7.2	1.3
50–54	−5.2	0.0	−5.8	0.1	−5.4	−0.2	−4.2	0.6

education (equivalently, level of income) being greatest for college graduates and the least for lower educated households. This result is in contrast to the intended progressive structure of the Korean National Pension Program. It was expected that the pension program would have a larger effect on lower income households' assets. Uncertainty on future pension benefits accounts for the estimated results that stand in contrast to the progressivity of the Korean National Pension Program. As seen by the estimated values of parameters shown in Table 3, lower educated households have the lowest expectation of pension benefits and college graduates have the highest expectation. As shown in Table 7, in the situation without uncertainty on future pension benefits, the effects of social security on assets are the largest for lower–educated households and the smallest for college graduates.

6.2 Substitution and inducement effects

Feldstein (1974) demonstrated that social security pension has two effects: (1) an asset substitution effect, in which social security reduces personal saving because it substitutes for household assets, and (2) an inducement effect, in which social security benefits provide incentives for early retirement and less work during retirement years, which in turn induce workers to save more for a lengthier period of retirement. The net effect therefore depends on the relative strength of these two forces. Feldstein (1974) supposed that the inducement effect is trivial, but the size of two effects have not been empirically identified and estimated. This paper estimates the substitution and inducement effects by exploiting the advantage of structural estimation.

In order to decompose the two effects, an experiment is conducted. In the experiment, the labor supply of households is fixed at levels equal to those without social security. That is, the experiment prevents households from changing their labor supply when the social security program is introduced. With a fixed labor supply, the substitution effect is the only reason that households would change their asset holdings. The difference between the substitution effect and estimated effect is therefore the inducement effect.

The results shown in Table 8 indicate that substitution effects account for almost all of the changes in asset holdings while the inducement effect is very small, as predicted by Feldstein (1974). The size of the inducement effect relative to the substitution effect ranges from 0 to 8%. Although the inducement effect for college graduates is relatively large, there is no clear pattern associated with education or cohort.

7 Conclusion

By exploiting the unique experience of Korea after pension reforms introduced in 1999, this paper estimates a stochastic dynamic model includes various savings motives, labor supply decision and program participation decision to decompose the factors that impact private savings. The estimation results show that the introduction of the pension program reduces asset holdings by a range from 5 % for older cohorts to 10 % for younger cohorts. The introduction of the pension program has a greater effect on assets of higher-educated households than on the assets of less–educated households because less–educated households have higher uncertainty on future pension benefits.

Exploiting the advantage of structural estimation, I decompose those factors that account for this partial offset. The small size of effect on private savings is attributed to the bequest and precautionary motives of savings. The bequest motive accounts for 30–60 % of the partial offset while precautionary savings accounts for 20–30 %. The substitution effect dominates the inducement-retirement effect.

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