頃に友人がいた場合、BS-A 確率はそれぞれ高かった。一方、公的な職業訓練の経験があった場合や、小学校入学前に母親が仕事をしていた場合（統計的な有意性は低いものの）、BS-A 確率はそれぞれ低かった。

図表 47　ロジット・モデルの推計結果（男性）

変　数	P_{BS-A}	
定数項	-3.877	(-2.64)
世代ダミー		
1966.4-1971.3	0.761	(0.94)
1971.4-1976.3	0.00154	(0.0021)
1976.4-1981.10	-0.0413	(-0.06)
中学校の頃に友人がいたダミー	0.848	(1.83)
最初の就職が非製造業ダミー	0.937	(1.54)
初職の職業ダミー		
ホワイトカラー	1.150	(1.89)
ブルーカラー	-0.409	(-0.68)
初職の雇用形態ダミー		
期限の定めなし	2.933	(3.88)
1ヶ月以上1年未満	0.556	(0.69)
職業訓練1回以上ありダミー	-1.878	(-3.60)
勤続2年1回以上ありダミー	1.318	(2.16)
初職から35歳までの勤務年数	0.214	(2.88)
母は小学校入学前仕事せず	-0.381	(-1.00)
尤度比（LR）	218.6	

注）サンプルは 398 人。

6.2.2　女性

女性の BS-A 確率に関する傾向は、基本的に男性のそれに同じであった。但し、最初の就職が非製造業の場合、最初の職業がブルーカラーの場合、BS-A 確率は高かった。さらに、1976 年 4 月～1981 年 10 月生まれ（30-34 歳）では、顕著に下方への世代効果が認められ、キャリアアップが進まなかったことが示唆される。

図表 48　ロジット・モデルの推計結果（女性）

変　数	P_{BS-A}	
定数項	-1.661	(-2.56)
世代ダミー		
1966.4-1971.3	-0.020	(-0.06)
1971.4-1976.3	-0.490	(-1.51)
1976.4-1981.10	-0.791	(-2.49)
最初の就職が非製造業ダミー	-0.671	(-1.81)
初職の職業ダミー		
ホワイトカラー	-0.166	(-0.60)
ブルーカラー	-1.025	(-1.62)
初職の雇用形態ダミー		
期限の定めなし	1.798	(4.19)
1ヶ月以上1年未満	-0.261	(-0.40)
職業訓練1回以上ありダミー	-0.994	(-3.39)
勤続2年1回以上ありダミー	-0.414	(-1.25)
初職から23歳までの勤務年数	0.753	(6.53)
尤度比（LR）	287.4	

注）サンプルは 615 人。

7．ＢＦの確率推計

7.1　本稿におけるＢＦの定義

日本で老齢年金を受給するためには、年金制度に 25 年以上加入する必要がある。さらに、給与に比例する年金給付があるかないかで受給する年金の水準は大きく異なる。ちなみに厚生年金加入 25 年以上の人の年金受給見込み額（平均値）は、LOSEF インターネット調査（55・59 歳のサンプル）によると、男性月額 18 万円、女性月額 14 万円（いずれも個人ベース）であった。他方、同じ調査で厚生年金加入 25 年未満（55・59 歳の男女）の場合、男性月額 9 万 2,000 円、女性月額 8 万 2,000 円であった。

そこで本稿では、BF（Bad Finish）を 60 歳時点の厚生年金加入が 25 年未満の人と定義する。

7.2　BS グループにおける生年別 BF 確率のシミュレーション

上記に述べた BF の定義にしたがって、本項では男女の BS グループに着目し、BF 確率を生年別に推計したい（注 4）。とりあえず、以下のような簡便な方法を用いて推計した。

その推計手順は次のとおりである。まず、対象サンプルを 5 歳きざみに区分し、それぞれの就業状況別（TY、AT、その他、の 3 区分）のサンプル割合、平均年齢（ねんきん定期便の起算月における年齢）、厚生年金加入月数（平均）を求める。次に過去 5 年間における就業状況の変化に関する遷移確率を 5 歳きざみで算出する。その上で、過去 5 年間における厚生年金加入年数の増加分を、T → T の場合は 60 ヶ月、T → AT（または AT → T）の場合は 45 ヶ月、AT → AT の場合は 30 ヶ月、その他 → その他の場合は 0 ヶ月、等々と仮定して、厚生年金加入が 60 歳時点で 300 月（25 年）以上となる確率をシミュレーションした。

その結果は次のとおりである。

就業状態の変化に関する遷移確率については、男性では、T（正規就労）、AT（非正規就労）の区分が5年後にも継続する確率が高いが、T → AT、AT → T といった遷移確率も20%前後となっており、両者間の移動も少なくないことがみてとれる（図表49）。一方、女性におけるT → T という継続確率は相対的には高いものの、男性に比べると低い。また、AT → T といった正規就労への遷移確率は10%以下に過ぎない（図表50）。

図表49　男性BSグループの就業状態の変化に関する遷移確率

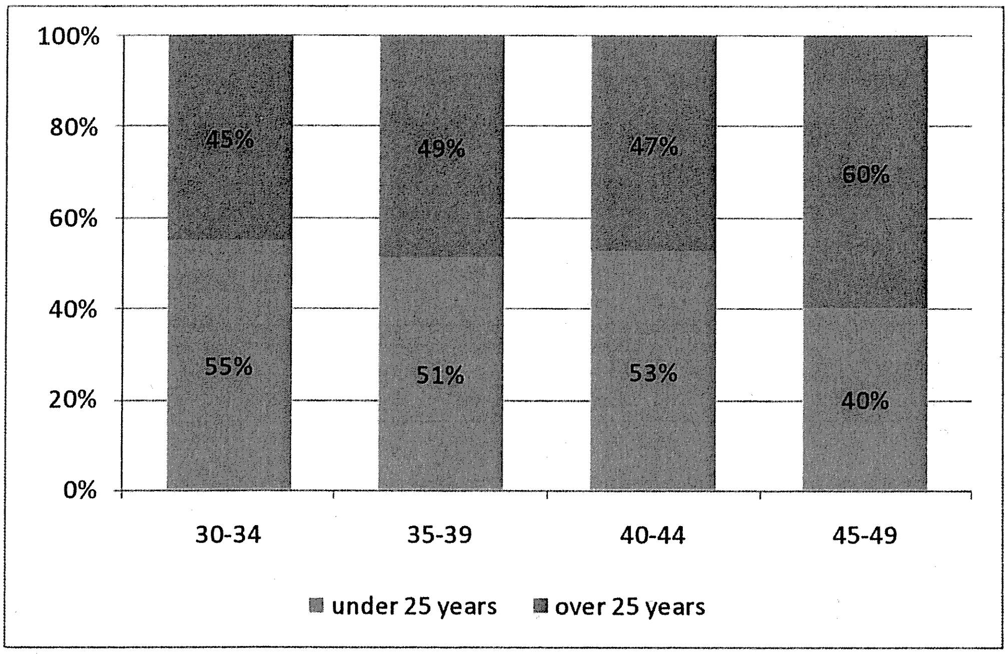
年令階層の移動		(30-34) -> (35-39)	(35-39) -> (40-44)	(40-44) -> (45-49)	(45-49) -> (50-54)	(50-54) -> (55-59)
遷移確率	T→T	89%	80%	67%	78%	93%
	T→AT	6%	12%	24%	19%	0%
	T→その他	5%	7%	9%	4%	7%
	小計	100%	100%	100%	100%	100%
	AT→T	18%	10%	20%	22%	22%
	AT→AT	77%	79%	75%	78%	72%
	AT→その他	5%	10%	5%	0%	6%
	小計	100%	100%	100%	100%	100%
	その他→T	13%	10%	0%	0%	0%
	その他→AT	6%	20%	0%	17%	7%
	その他→その他	81%	70%	100%	83%	93%
	小計	100%	100%	100%	100%	100%

図表50　女性BSグループの就業状態の変化に関する遷移確率

年令階層の移動		(30-34) -> (35-39)	(35-39) -> (40-44)	(40-44) -> (45-49)	(45-49) -> (50-54)	(50-54) -> (55-59)
遷移確率	T→T	53%	44%	71%	60%	60%
	T→AT	15%	32%	21%	7%	15%
	T→その他	32%	24%	8%	33%	25%
	小計	100%	100%	100%	100%	100%
	AT→T	7%	6%	2%	2%	4%
	AT→AT	71%	76%	78%	87%	86%
	AT→その他	22%	18%	20%	11%	10%
	小計	100%	100%	100%	100%	100%
	その他→T	2%	0%	2%	0%	0%
	その他→AT	2%	14%	17%	18%	5%
	その他→その他	97%	86%	81%	82%	95%
	小計	100%	100%	100%	100%	100%

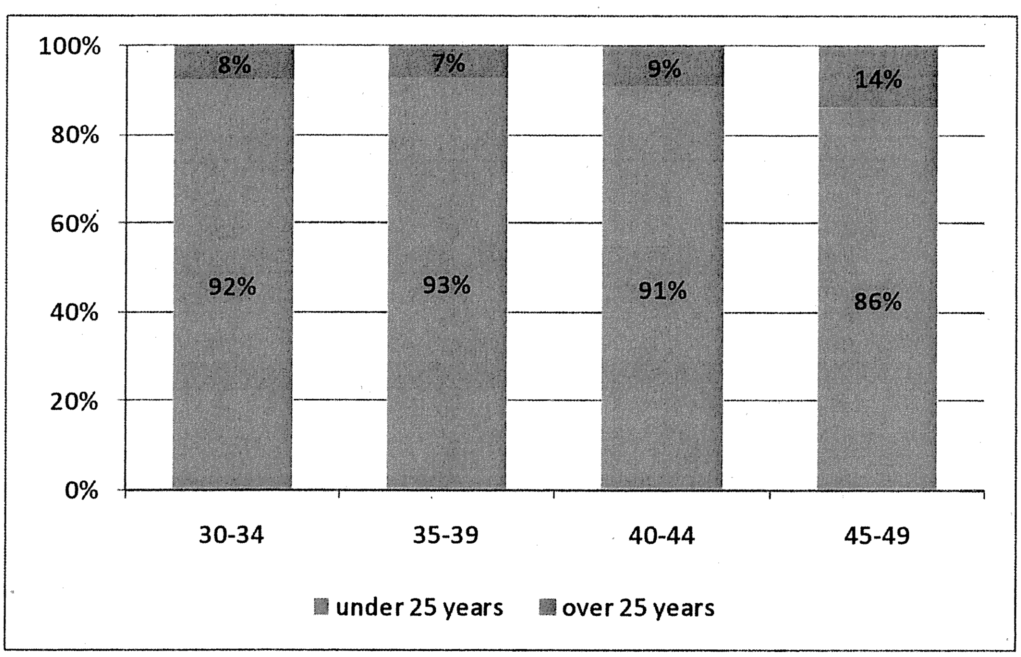
上述の遷移確率を用いて、2011年10月時点で30-34歳、35-39歳、40-44歳、45-49歳の各世代について、60歳時点におけるBF確率（厚生年金の加入年数が25年未満となる確率）を推計してみた。推計結果によると、BF確率は総じて世代が若くなるにつれて高くなる。そして、現在30-34歳世代のBF確率は男性で50%強、女性で90%強であった（図表51、図表52）。

図表 51　男性 BS グループの BF 確率



注）加入年数 25 年未満が BF 確率を示す。

図表 52　女性 BS グループの BF 確率



(注)

1．本調査はインターネット調査であり、ねんきん定期便の保持者に調査対象を限定している。そのため、サンプルには高学歴バイアスがある。詳細は稲垣（2010）参照。

2．本稿では GS グループを最短卒業年プラス 1 年以内の入職者に限定している。

3．経年的に高学歴化が進行してきたにもかかわらず、BS グループの割合が上昇してきた理由

は何か。それは、別途、究明する必要がある。

4．女性の場合、どのような男性と結婚するかによって夫婦合計の年金額は著しく違う可能性がある。日本の女性は夫の財布（や夫名義の銀行キャッシュカード）も管理している人が、これまで多かった。つまり、個人ベースで推計された BF 確率は、女性の場合、あまり意味を持たないおそれがある。ただ、最近の若い女性については共働きが多く、さらに、未婚率や離婚率も上昇しているので、個人ベースで試みた BF 確率のシミュレーションには、それなりの意味があるかもしれない。

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Social Security Reforms and Labor Force Participation of the Elderly in Japan

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Abstract

We examine how social security programs have affected the labor force participation (LFP) of the elderly over the past forty years in Japan. Using publicly available data, we construct incentive measures for inducing retirement, to ascertain actual changes in the generosity of the programs and to explore the impact of the reforms on the labor supply of the elderly. We show that the LFP of the elderly is significantly sensitive to the measures, and our counter-historical simulations show that social security reforms since 1985 featuring reduced generosity have significantly encouraged the elderly to remain longer in the labor force.

Key words: social security program, social security wealth, labor force participation of the elderly

JEL classification codes: H55, J26

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1. Introduction

In addition to health status, the generosity of social security programs is considered to be one of the key determinants of retirement decisions. A significant amount of literature concerning the relationship between social security benefits and the labor force participation (LFP) of the elderly has highlighted the importance of policy reforms in many developed countries. In particular, a series of studies by Gruber and Wise (1999, 2004, 2007), which are recent examples of cross-country studies on this issue, reveal that social security incentives have a sizeable effect on retirement decisions across countries with different labor market institutions and other social characteristics. In recent years, Japan has also experienced major reforms of the social security and employment policy for the elderly, motivated by serious concerns about the sustainability of the current system and future deterioration of fiscal balances. However, in contrast to the significant number of discussions on the fiscal effects of such reforms, the impact of the changing generosity of social security programs on the labor supply of the elderly has been largely disregarded.

Quantifying the labor supply effect of social security programs is important to both academics and policymakers in the context of future reforms, which will take place under conditions of harsher demographic pressures and reduced feasibility of further raising the mandatory retirement age. Moreover, separating out the effects of social security programs from other factors is also critical to explore why Japanese people are motivated to retire later than people in other developed countries. It has often been argued that less generous social security programs encourage Japanese workers to remain longer in the labor force. However, most preceding studies in Japan are limited to analyses of the effects of changes in the income-tested (*Zaishoku*) pension program. A more important issue that is yet to be examined concerns the effects of a series of major reforms of the main body of social security programs on the LFP of the elderly.

This paper investigates the manner in which the changing generosity of social security programs has affected the withdrawal of the elderly from the labor force in Japan over the past 40 years. To examine the relation between social security programs and the retirement decisions of the elderly, we construct some forward-looking measures that provide an incentive to retire, on the basis of publicly available year-by-age data. These measures are based on the notion of social security wealth (SSW), which is defined as the expected present value of net social security benefits received over a lifetime (see Gruber and Wise (1999)). Retirement decisions are determined not only by income at the time of retirement but also by the flow of future social security benefits and their present value (see Stock and Wise (1990a, 1990b)). Moreover, a rational individual is likely to determine his/her retirement age by considering potential gains from postponing his/her retirement (see Coile and Gruber (2000, 2004)). To address these issues, we construct three incentive measures for inducing retirement—social security wealth accrual (SSA), peak value (PV), and option value (OV)—derived from or related to SSW and, subsequently, examine the effects of these measures on the labor supply of the elderly.

In addition to understanding the dynamic elements of incentive measures for inducing retirement, two econometric issues need to be resolved. The first is the simultaneity bias in estimations. Relating the incentive measures to the actual probability of retirement is not free from a simultaneous estimation bias because observed decisions and social security benefits are determined jointly. Thus, we focus solely on variation in benefits that arise from institutional changes in social security programs that are exogenous to individual retirement decisions. The second is the limited availability of data in Japan. We recognize that it is advantageous to utilize household-level data on households who are provided with a variety of incentive measures. Unfortunately, there is no micro-level dataset with longitudinal information that entails a long period and several social security reforms.

This analysis focuses on aggregate year-by-age-group data of LFP and incentive measures for inducing retirement because only data concerning five-year age groups are available from the

Labor Force Survey compiled by the Ministry of Internal Affairs and Communications. Our empirical analysis is based on 120 observations of males and females belonging to the age groups of 55-59, 60-64, and 65-69 years over a period of 40 years (1968 to 2007). We adopt the following empirical strategy to address the simultaneity bias in estimations. First, we establish a typical person—specifically, one who was born in 1935 and whose earnings profile over his/her lifetime is identical to the average for his/her cohort—and assume that he/she is 55 years old. We compute his/her benefits and incentive measures under the social security programs available in each year. Second, we compute the weighted averages of the incentive measures for each age group for each year to understand the overall generosity of social security programs for each age group. Then, we estimate the regression models to relate the LFP of each age group to the estimated incentive measures along with the covariates. This typical person approach aims to mitigate the bias arising from simultaneity between the LFP and the incentive measures. Moreover, we conduct counter-historical simulations to assess the impact of key reforms on the LFP of the elderly since the mid-1980s.

This empirical analysis yielded three findings. First, the estimated age-average SSW peaked in the mid-1980s as social security programs became more generous until the 1985 Reform and has been declining since then. Second, the regression results reveal that the retirement decisions of elderly workers are significantly sensitive to incentive measures. Finally, the counter-historical simulations show that the 1985 Reform and subsequent reforms encouraged the elderly to remain longer in the labor force.

This paper proceeds as follows. Section 2 provides a historical overview of major reforms of social security programs and employment policies concerning the elderly in Japan. Section 3 explains how to construct incentive measures. Section 4 assesses changes in the generosity of social security programs over past reforms and examines the relation between incentive measures and labor supply of the elderly. Section 5 conducts counter-historical simulations to capture the impact of social security reforms on the LFP of the elderly. Finally, Section 6 presents concluding remarks.

2. Overview of social security reforms in Japan

This section provides a brief overview of major social security reforms for the elderly since the 1970s.[1] Table 1 summarizes the history of previous reforms in terms of the benefits of Employees' Pension Insurance (EPI; *Kosei Nenkin*) and National Pension Insurance (NPI; *Kokumin Nenkin*), both of which form the core of Japanese social security programs.[2] EPI benefits comprise a flat-rate component, which has been referred to as the Basic Pension benefit since the 1985 Reform, and a wage-proportional component. NPI has a flat-rate benefit only, and the amount is equal to that of the flat-rate component of EPI.

We observe a remarkable difference in the direction of reforms before and after 1985 in terms of the overall generosity of the programs. Before the 1985 Reform, the government continued to raise benefit levels by increasing the benefit multiplier for the wage-proportional benefit and/or the benefit unit for its flat-rate benefit. In addition, price indexation was introduced to accommodate a high inflation rate in 1973. These reforms sought to improve the standard of living of the elderly in accordance with a steady increase of per capita GDP during the phase of rapid economic growth.

However, falling economic growth after the oil crises in the early 1970s, as well as a declining trend of fertility, raised concerns about the financial sustainability of social security programs. In addition, structural changes in the industry and labor force led to a larger disparity in financial positions among the programs. These concerns motivated the 1985 Reform, which called for a

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[1] Komamura (2007) presents a comprehensive survey of social security reforms in Japan. Takayama (2005, Ch.6) discusses the key issues in the 2004 Reform.

[2] EPI and NPI respectively cover 48.0 and 45.5 percent of population insured by public pension programs in 2007. The Mutual Aid Insurance (*Kyosai Nenkin*) covers the remaining 6.5 percent, most of whom are employees in the public sector and private schools.

reduction of the benefit multiplier and flat-rate benefit for the first time. At the same time, the Basic Pension benefit, which was commonly paid to all public pension members as a first-tier flat benefit, was introduced.

While the dependent spouses of EPI beneficiaries became eligible to receive the Basic Pension benefit without having to pay any premium in this reform, the EPI programs became less generous in terms of benefits. Under the 1985 Reform scheme, a male EPI beneficiary who earned an average income of 254,000 yen per month in 1985, paid premiums for 40 years, and had a dependent wife was eligible to receive a total of around 176,000 yen per month; this was less than the amount provided under the pre-1985 Reform scheme—approximately 198,000 yen—by more than 10 percent.

Subsequent reforms have consistently sought to improve the financial balance of the programs by reducing the benefit multiplier, scaling down benefit indexations, and raising the eligibility age as well as premium rates. Most recently, the 2004 Reform introduced automatic adjustments of benefit levels based on demographic and macro-economic factors. Meanwhile, the eligibility age for receiving EPI benefits continues to be raised. For male pensioners, the eligibility age for receiving both flat-rate and wage-proportional benefits was raised from 55 to 60 years in 1973. Since 2001, the eligibility age for the flat-rate component has been scheduled to increase by one year for every three years to reach 65 years in 2013; further, that for the wage-proportional component has been scheduled to rise from 2013 by one year for every three years to reach 65 years in 2025. For females, the eligibility age was 55 years until 1985 and was gradually raised to 60 years in 2000. The eligibility age for females is to be raised, while keeping a five-year lag relative to that for men. The eligibility age for the flat-rate benefit will be raised beginning 2006 and that for the wage-proportional benefit will be raised beginning 2018.

Another reform to the EPI scheme is the *Zaishoku* pension program. This income-tested pension program applies to those who remain in the labor force past their eligibility age. Starting with a 20 percent reduction of the benefit for working beneficiaries in the 1950s, the effective tax rate on additional work has been revised several times. Under the current scheme, 0.5 yen is reduced for each additional 1 yen of the sum of the original benefit and monthly wage in excess of 480,000 yen. Indeed, many empirical studies have estimated the impact of the *Zaishoku* pension program based on micro-level data.[3] Most found that the reforms of the program encouraged the elderly to remain longer in the labor force, although the magnitude of the estimated impact varies substantially. As discussed in the next section, we explicitly incorporate the *Zaishoku* pension program when constructing incentive measures, as well as the Additional Pension (*Kakyu Nenkin*) benefit provided to EPI beneficiaries for their dependent spouses.

In addition to the social security programs, the government introduced the wage subsidy program for the elderly in 1995. This program started by subsidizing 25 percent of the wages of individuals aged 60-64 years who continued to work for the same firm at a wage rate less than 64 percent of the pre-retirement level.[4] We interpret this wage subsidy to be a negative premium and incorporate it to calculate the SSW and incentive measures on a net basis. Since 1998, the *Zaishoku* pension benefit has been reduced for those who receive the wage subsidy, and the subsidy rate was reduced to 15 percent in 2003.

Finally, employment policies for the elderly have aimed at providing additional job opportunities to the elderly, whose eligibility age was raised. In 1973, the government began to encourage firms to raise the mandatory retirement age to 60 years, which was set as the obligatory target in 1986. In 2000 and 2004, the government proposed that firms either raise the mandatory retirement age to 65 years or completely abolish it. In response to these policy changes, the average mandatory retirement age has been rising substantially, and we take this into account in our empirical analysis by including the share of firms with a mandatory retirement age of 60 years or above as a covariate.[5]

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[3] For example, Seike (1993), Ogawa (1998a, 1998b), Iwamoto (2000), Abe (2001), Ohtake and Yamaga (2004), and Shimizutani and Oshio (2008).

[4] The wage subsidy is reduced for higher-wage earners, which is incorporated in this formula.

[5] We do not take into account income tax when constructing incentive measures because most of the income earned by the elderly has been exempted by the income tax system.

We should also keep in mind the mandatory retirement condition that prevails in Japan, which is often considered to be one of the distinctive features of the Japanese labor market. According to the 2008 *Employment Conditions Survey*, 98 percent of firms (with 30 or more employees) applied the mandatory retirement practice and 85 percent of them set the mandatory retirement age at 60. This system provides an important initial step toward retirement and in all likelihood affects the elderly labor supply. It should be noted, however, that mandatory retirement implies that an elderly worker quits his/her job but does not exit the labor force. Indeed, based on the recent *Survey on the Labor Participation of Older Workers*, Shimizutani and Oshio (2009) showed that more than 80 percent of males and 70 percent of females who experienced mandatory retirement continued to remain in the labor market. Thus, it would be interesting to examine whether—if yes, to what extent—the elderly's decisions to work are affected by retirement-related incentives provided by social security programs.

3. Incentive measures for inducing retirement

3.1 Defining incentive measures

In this section we explain how to construct incentive measures for inducing retirement, which aim to highlight key aspects of incentive measures including eligibility age, benefits given eligibility, and actuarial adjustment when retirement is delayed. The basic idea underlying these measures is that an individual is forward-looking and that his/her labor supply decision is affected not only by current economic resources but also by the discounted value of future benefits. As mentioned earlier, we consider three types of incentive measure—SSA, PV, and OV—all of which are based on or are related to SSW.[6]

To begin with, we explain how to compute SSW for an individual in a specific year and age

[6] See Gruber and Wise (1999, 2004, 2007) for more details on the concepts of these variables and the results of cross-country analyses based on them.

cohort. Suppose that an individual who is now aged t considers when he/she should retire. If he/she retires at age r ($\geq t$), his/her SSW, which is denoted by $SSW_t(r)$, is calculated as

$$SSW_t(r) \equiv \sum_{s=r}^{D} p_{s|t} d^{s-t} B_s(r), \tag{1}$$

where $B_s(r)$ is the benefit that he/she is expected to receive at age s ($\geq r$), d is the cumulative discount rate, $p_{s|t}$ is the probability of he/she being alive at age s conditional on being alive at age t, and D is the maximum age. $B_s(r)$ usually tends to rise as r increases, reflecting a longer period of premium contributions, and is equal to zero if s is below the eligibility age. $SSW_t(r)$ is likely to be an increasing function of r, provided r is not far from t. However, it may decline once r increases to a certain level because larger contributions exceed benefits received over a lifetime. Furthermore, we compute SSW on a net basis because an individual is likely to take account of the additional premium payment if he/she continues working as an employee. Finally, we set t = 55, assuming that an individual starts considering retirement at age 55. This assumption is reasonable given that the number of people who retire before 55 is extremely limited.

Then, we derive the three incentive measures. We begin with SSA, which is defined as the change in the promised social security benefits in the future derived from working for one additional year (see Gruber and Wise (1999)). The SSA at age r when the retirement age is t is given by

$$SSA_t(r) \equiv SSW_t(r+1) - SSW_t(r). \tag{2}$$

If an individual continues to work for one additional year, he/she has to give up the benefits he/she is eligible to receive in that year; however, he/she can expect a future increase in the benefits. Therefore, SSA can be either positive or negative on a net basis. If it is positive, an individual would want to continue working. Further, it should be noted that SSA is most likely to be positive before the eligibility age because although an individual does not receive any benefits until that age, he/she can expect an increase in future benefits.

However, a rational individual may be more forward-looking and take account of his/her financial position beyond one-year accruals. Coile and Gruber (2000) proposed another measure, Peak value (PV), which is a straight extension of SSA. PV is defined as the difference between SSW at the maximum expected value and SSW at the value at each age, such that

$$PV_t(r) \equiv SSW_t(r^{**}) - SSW_t(r), \tag{3}$$

where SSW is maximized at age r^{**}. If the individual retires at an age beyond r^{**}, then it is reasonable to define PV as the difference between retirement this year and the next, thereby making it identical to SSA.

Lastly, we turn to the option value (OV) model, which is proposed by Stock and Wise (1990a). The OV model assumes that an individual compares utility today with that at the optimal retirement age in the future and chooses an optimal retirement age. An individual's indirect utility function over work and leisure is expressed as follows:

$$V_t(r) \equiv \sum_{s=a}^{r-1} p_{s|t} d^{s-t} (y_s)^g + \sum_{s=r}^{D} p_{s|t} d^{s-t} [kB_s(r)]^g,\ 0 < g < 1,\ k \geq 1, \tag{4}$$

where y is wage income while working, g is parameter of risk aversion, and k is parameter that accounts for the disutility of labor ($k \geq 1$). We assume that people get more utility from income earned by not working than that earned by working. The optimal age of retirement is the age at which indirect utility is maximized; the age at which the utility gain derived from the wage increase resulting from additional work begins to be outweighed by the utility loss from the decrease of retirement income. Note that the second term on the right-hand side in (4) is reduced to $SSW_t(r)$, if $g = 1$ and $k = 1$.

OV is defined as the difference between indirect utility from retirement at optimal age r^* and indirect utility from retiring today. It can be expressed as

$$OV_t(r) \equiv V_t(r^*) - V_t(r). \tag{5}$$

Among the incentive measures, OV is the most general and flexible variable, and it is explicitly related to an individual's utility maximization. PV is a special case of OV; OV is reduced to PV if

$g = 1$ and $k = 1$ and wage income is disregarded. Hence, we use OV as the main incentive measure and compare its estimation results with those of other measures.

To compute OV, we need to determine the values of k and g. Stock and Wise (1990a) assumed values of 1.5 and 0.75 for k and g, respectively, and Coile and Gruber (2004) reported that the estimation results on the relation between OV and the elderly labor force are not sensitive to the choice of these two parameters in the U.S. Using data obtained from the *Labor Force Survey*, we search for the combination of k and g that maximizes the goodness of fit of the model, which regresses LFP on OV. As discussed below, we find that the combination of $k = 2.0$ and $g = 0.75$ and that of $k = 3.0$ and $g = 0.75$ are most appropriate for males and females, respectively.

3.2 Computing incentive measures

The conventional way of assessing the impact of incentive measures on LFP might be to regress the observed LFP on the observed incentive measures. However, this methodology is problematic, because due to the time-series nature of our analysis there may be omitted variables that are correlated with changes of both LFP and incentive measures. For instance, increases of aggregate productivity and human capital accumulation over time could affect both LFP and incentive measures through changes of lifetime earnings. Thus, even when we observe an inverse correlation between elderly LFP and incentive measures, it may be simply because of rising aggregate productivity.

One way to circumvent this problem is to adopt the typical person approach developed by Engelhardt and Gruber (2004). The essence of this approach is to apply the *same* earnings profile to all birth cohorts and construct incentive measures according to the social security programs available at that time. To do so, we use the 1935 birth cohort as a benchmark and assign its earnings profile to every birth cohort to construct the incentive measures. This insures that all of the variations in the incentive measures arise from institutional changes in the benefit rules and not from changes in the earnings profile caused by human capital accumulation and productivity increase.

To calculate SSW and incentive measures for this typical person approach, we follow two steps. First, we compute these measures for an individual aged 55 years for each year, assuming him/her to be a typical person, as defined earlier. Second, we aggregate them by considering the weighted averages of the three age groups (55-59, 60-64, and 65-69 years) for each year. One reasonable way to understand changes in the generosity of social security programs is to place the typical person in each year and provide him/her with the social security programs available at that time. Based on his/her earnings profile, we calculate his/her SSW and the related incentive measures under the existing social security program for each year. Then, we evaluate the benefits—more specifically, the benefit per month of contributions for both flat-rate and wage-proportional benefits as well as other nominal values of fixed benefits—at 2005 prices, using the consumer price index.

We choose male and female employees who were born in 1935 as typical persons and obtain their average wage incomes. They were 55 years of age in 1990, which is approximately the middle year of our estimation period between 1968 and 2007. Although official statistics do not provide longitudinal data on the history of workers' wage earnings, the Annual Report of the Social Insurance Agency (SIA) presents the average of the career average monthly income (CAMI) of the initial EMI beneficiaries for each year. The 1995 SIA Report showed that the average CAMI for the initial beneficiaries was 337,549 yen and that the average months of contributions was 409. The Report also showed that 56 percent of those who initially claimed EPI benefits in 1995 were aged 60 (their birth year being 1935) and were eligible for EPI benefits. For a typical female, the 1993 SIA Report showed the average CAMI to be 158,737 yen and the average months of contributions to be 276 for initial claimers, given that the eligibility age for females was 58 at that time.

Then, each year, we make the typical person aged 55 consider the timing of his/her retirement under the existing social security programs. We calculate his/her CAMI at age 55 on the basis of wage income and period of premium contributions at age 60 or 58, as obtained from the SIA Report. We also assume that the typical person expects future wage profiles beyond the age of 55, as per the actual observations made from the *Basic Survey on Wage Structure* (*Wage Census*) compiled by the Ministry of Health, Labour and Welfare.

Then, we apply the EPI benefit formula to calculate the benefit an individual who retires between 55 and 69 years of age is supposed to receive. The EPI benefits to be received at age s on condition of retiring at age r are expressed as

$$B_s(r) = k_0 m + k_1 CAMI(r, m) \text{ for } r \geq r_e; \quad (6)$$

$$= 0 \quad \text{for } r < r_e,$$

where the first and second terms of the RHS correspond to the flat-rate and wage-proportional components, respectively; k_0 and k_1 are their respective multipliers; m is the months of premium contributions; and r_e is the eligibility age.[7] If an individual works for Δr additional years after age r and earns wage income y_r per year, his/her benefit is recalculated as

$$B_s(r + \Delta r) = k_0(m + \Delta r) + k_1[mCAMI(r, m) + y_r \Delta r]/(m + \Delta r), \quad (7)$$

where social security reforms are expressed in the shape of changes in the statutory parameters k_0, k_1, and r.[8]

In addition, we take into account the following three points. First, we assume that 90.8 percent of male workers have non-working dependent wives two years their junior.[9] More specifically, we assume that they receive an additional 90.8 percent of the flat-rate Additional Pension benefit for

[7] To avoid sharp changes in the generosity of benefits, the government usually applies a gradual shift of parameter values corresponding to the year of birth. We disregard price indexation because all variables are based on 2005 prices in our calculations.

[8] The parameter values for individuals aged 55 in each year have not been reported due to space constraints; however, they are available from the authors upon request.

[9] The proportion of married males aged 55 in 1990 is 90.8 percent, which is estimated from the Census in 1990. Under the current social security system, a wife is regarded as a non-working dependent individual unless she earns more than 1.3 million yen annually or her weekly working hours exceed 30 hours (see Abe and Oishi (2007)).

their wives until their wives turn 65 and become eligible to receive their Basic Pension benefits.[10] Second, if one chooses to both continue working and receive EPI benefits, the benefits are reduced according to the *Zaishoku* pension program. In addition, provided an individual continues working and paying EPI premiums, his/her future benefits will increase corresponding to additional premium contributions. Third, to compute OV, the net SSW is calculated by subtracting the total pension premiums paid by the individuals from the gross SSW.[11] We disregard income and other taxes for simplicity. Although we compute the incentive measures and SSW for female EPI members in almost the same manner, we assume that a female worker considers only her own benefit even if she is married to a male who is eligible for the EPI benefit.

When computing SSW and incentive measures, we have to set up the values of the cumulative discount rate d^{s-55}, and the probability of being alive conditional on being alive at age 55, $p_{s|55}$, in (1). We assume that $d^{s-55} = (1/1.0319)^{s-55}$, where the yield on a ten-year government bond was 3.19 percent in 1990, when the typical person was aged 55.[12] We estimate the probability of being alive based on the 17th Life Table compiled by the Ministry of Health, Labour and Welfare in 1990.

Next, we proceed to the second step. After constructing SSW and the incentive measures for each year and age, we obtain the aggregates for each age group and each year. Let $SSW_r(y)$ denote SSW for those who retire at age r in year y. For example, consider the average SSW of all persons aged between 55 and 59 who withdrew from the labor force in 1990; let $\overline{SSW}_{55\text{-}59}(1990)$ denote this average. We need the SSW of those individuals aged 55 in 1990 who would have retired in this year, that is, $SSW_{55}(1990)$. Because individuals aged 56 in 1990 would have retired either at 55 in 1989 or at 56 in 1990, we need both $SSW_{55}(1989)$ and SSW_{56}

[10] We do not add the wife's Basic Pension benefit to the husband's SSW because the wife receives the Basic Pension benefit once she turns 65, regardless of the husband's employment status. There is another additional pension benefit for the wife aged 65 and above, but we disregard it for simplicity.

[11] Until 2001, workers aged 65 and above were exempt from paying EPI premiums. Since 2002, when the EPI coverage was extended to workers aged between 65 and 69, these workers have been subject to paying EPI premiums. If an individual retires before he/she turns 60, he/she has to pay NPI premiums until he/she reaches 60 years of age.

[12] We confirmed that the assumptions of different interest rates do not change the main estimation results.

(1990).

Next, we weight these wealth numbers by $q_{55}(1989)$ and $q_{56}(1990)$, where $q_r(y)$ measures the odds of exposure to retirement incentives for each age given the year. In the same manner, individuals aged 57 in 1990 would have retired at age 55 in 1988, 56 in 1989, or 57 in 1990. Thus, we need $SSW_{55}(1988)$, $SSW_{56}(1989)$, and $SSW_{57}(1990)$. Further, we weight these numbers by q_{55} (1987) and $q_{55}(1988)$, $q_{56}(1989)$, and $q_{57}(1990)$, respectively. To compute the weighted average of SSW for all persons aged between 55 and 59 who retired in 1990, we calculate the weighted average of exposure to the incentive measure provided to retired persons at a given age in 1990; then, we weight the expected exposure at the given age by the proportion of retirees at that age a using the following formula:

$$\overline{SSW}_{55-59}(y)=\sum_{s=55}^{59}\left[\frac{\gamma_s(y)}{\sum_{s=55}^{59}\gamma_s(y)}\right]\left[\frac{\sum_{t=0}^{s-55}q_{s-t}(y-t)SSW_s(y)}{\sum_{t=0}^{s-55}q_{s-t}(y-t)}\right]. \tag{8}$$

Here, we assume that weight $q_r(y)$ reflects the proportion of persons who retired at age r in year y; hence, we consider the proportion of people in the labor force at age r in year t-1, that is, $q_{r-t}(y-t) = LFP_{r-t}(y-t-1)$, where LFP is the LFP rate. Similarly, we compute the weighted average of all ages by attaching weights with the proportion of retired persons aged r in year y, denoted by $\gamma_r(y)$. In the same manner, we can calculate the weighted average of each incentive measure for each age group by gender for each year. We follow the same process to aggregate the SSW and incentive measures for persons aged 60-64 and 65-69.

Although our methodology cannot completely disregard the following two endogeneity biases, we believe they are largely mitigated. First, the wage profile of the typical person was affected by the social security programs he/she was actually provided. This bias is unlikely to substantially affect the estimation results, provided we focus on the change in the impact of incentive measures over time. In other words, we set a representative cohort (born in 1935) to separate the effects of