Chapter 5

Covering part-time Workers by Employee's Pension Insurance: A Simulation Analysis with Overlapping Generations Model

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Abstract

Under the advancement of aging society and the increases in part-time workers, extending the application of Employees Welfare Pension (EPI) to part-time workers is important for pension reforms in Japan. By simulation analyses based on the overlapping generation model with standard workers' and part-time workers' households, we analyze the effects of covering the part-time workers by EPI from the viewpoint of economic efficiency and sustainability of pension finances. As a result, it is found that expanding the burden of pension premiums to part-time workers would improve pension finances in the short run, but might hinder sustainability of pension finances in the long term. It is also revealed that where consumption tax is used as a revenue source for the state contribution of 1/2 of basic pension benefits or the entire basic pension, economic efficiency increases in general, and in this case additional consumption tax rate would be about 5% or 10% respectively.

Keywords: social security, public pensions, part-time workers, consumption tax.

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1. Introduction

The benefits and premiums of social security in Japan continue increasing due to the rapid decline in the birthrate and aging of the population, while international competition facing Japanese businesses is growing more and more intense. Under these circumstances, the number of non-standard workers (part-time workers and dispatched workers) has been increasing since the 1990s, partly because of the economic need of employers to reduce their labor costs. According to the Labour Force Survey conducted by the Statistics Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications, the total number of employees in 2003 was about 63 million, of whom male and female part-time workers accounted for 22%. Typical examples include unstable employment of young people, symbolized by young job-hoppers, and part-time work (mostly of women) to help out with the family budget in response to the slow rate of increase of wages of heads of households; and, it is often pointed out that the social security system is unable to meet diversifying modes of work, including those mentioned above. As a result, those insured under Employees' Pension Insurance (EPI) are decreasing, although the number of employees is itself growing, and it is reported that the problems of non-participation in, and non-payment of premiums for, the National Pension are becoming serious.

One of the problems on which discussion is bogged down is the reform of the pension system in 2004, and the lack of inclusion in the reform program of an extension of EPI to part-time workers. The current criteria does not put employees whose working hours or days are less than scheduled working hours or scheduled working days under an obligation to join EPI. In addition, spouses under the employees' pension system whose annual income is less than ¥1.3 million can join a public pension plan as Class III insured persons, and do not need to pay premiums as individuals. Discussion on revising this system was continued to improve the benefit-premium equilibrium, and a proposal to extend application of EPI to those who work 20 hours or more a week or earn ¥650,000 a year was presented. But, it was finally decided that the proposal should be examined again after five years.

One of the reasons why extending the application of EPI was postponed as a subject for future debate was that there were heated arguments, mainly in economic circles, that extended application would increase the legally defined welfare expenses of businesses, which would then control labor demand and investment, which were increasing only slowly due to uncertain economic prospects, thereby having a negative impact on economic growth. But, whether extending the employees' pension system to
part-time workers and increasing premiums would really hinder economic efficiency has not necessarily been proved empirically and quantitatively.

In an environment with a decline in the birthrate and aging population\(^1\), it is important to maintain the vitality of the whole macro-economy using the latent labor force existing in the country, and also to secure and develop those who will support the social security systems, mainly health care, pensions, and long-term care. Whether adding workers from diverse working statuses to supporters of social security in order to maintain the system and sustaining the vitality of the macro-economy itself have a tradeoff relation is a problem that fundamentally affects the existence of social security systems.

The pension reform in 2004 attempted to set a ceiling on the burden of pension premiums on those in active service, thus putting the brakes on the burden imposed on future generations, while at the same time improving the sustainability of pension finances by cutting pension benefits, including those for confirmed beneficiaries. But, if a further reform is likely to reduce macroeconomic vitality and endanger the sustainability of pension finances, there will be the need to study the direction of reforms again.

Of course, theoretically speaking, there are those possible options for sustainable development of public pension system as replacing pay-as-you-go system with funded system, introducing individual accounts in addition to pay-as-you-go system, and the modification of pay-as-you-go system with maintaining its pension fund (Feldstein(1995), Feldstein(1998), Feldstein and Leibman(2002), Oshio(2004) among others). On the other hand, taking into account the transition path from pay-as-you-go system to funded system, pension reform toward funded system does not always improve the social welfare because of the liabilities of pension benefits for the current pension beneficiaries (Breyer(1989), Geanakopolos, Mitchell, and Zeldes(1998), Sinn(2000)). And the application of game theory of majority decision to political sustainability of public pension system shows that there exists a pay-as-you-go system when the expected value of net pension benefits for those generations that have been already working and approaching the age of receiving the benefits at the time of voting is positive(Konishi and Ohtake(2006)).

Furthermore, OECD (2005) ”Pension at a Glance” pointed out that there are two major functions in public pension systems in the current OECD countries: one is

\(^1\) Total fertility rate in 2004 is 1.28 and the percentage of the elderly persons in the total population is forecast to increase into the future, reaching the 25% mark in 2013 and the 33% mark in 2034 (December 2006 Future Population Projection, National Institute of Population and Social Security Research).
the risk sharing of retirement periods longer than that people expect in the working periods, and the other is income redistribution that has two ways of transfers: one is income transfer from the working population to the elderly persons, and the other is transfer from the richer pension beneficiaries to the poorer beneficiaries. For example, in Canada\(^2\), the former type of income redistribution is performed by the basic pension (Old Age Security) that is a pay-as-you-go system financed by tax revenues and the later type of income redistribution is done by a supplementary benefit with means test for lower income beneficiaries (Guaranteed Income Supplement) and the tax on basic pension benefits for higher income beneficiaries to support financing the basic pension itself (the Claw-back System).

Taking into account the recent rise in concerns about the income disparity and the increase in part-time workers whose wage is lower than standard workers, extending the application of EPI to the part-time workers is necessary to strengthen income security for the lower income groups. On the other hand, for the purpose of sustainable development of public pension system in Japan, the reform should keep the balance between equity and economic efficiency. Hence, in this paper, we shall assess and examine the possible impacts of changes in the treatment of part-time workers and Class III insured persons, which were put off in the 2004 pension reform, on both pension finances and macroeconomic efficiency using a general equilibrium dynamic simulation with the overlapping generation model developed by Auerbach and Kotlikoff (1987), which has been used for forecast assessments of policies.

First, we explain the composition of the model used for the analyses in detail in Section 2, and then describe the assumptions, including the method used for the simulation analyses and scenarios, in Section 3. We discuss the results of the analyses in Section 4, and present summary and future tasks in Section 5.

2. Composition of model

In this study, to analyze the impacts of changes in the treatment of part-time workers and Class III insured persons on consumption and savings in the national economy, and also on the sustainability of pension finances, the dynamic general equilibrium model (overlapping generation model), where economic variables are

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\(^2\) The public pension system in Canada has those two tires as in Japan: one is the basic pension of lump sum benefits (Old Age Security) and the other is the earnings related pension (Canada Pension Plan) financed by payroll tax (contributions). In Canada, there is no issue of extending the application of part-time workers to CPP, because with very few exceptions, every person in Canada over the age of 18 who earns a salary must pay into the Canada Pension Plan. In this section, in order to concentrate on the income redistribution within public pension, we mention only Old Age Security.
determined endogenously, is extended so that the sector comprising part-time workers and self-employed insured under the National Pension and the sector of firm production composed of persons insured under EPI respectively have income groups based on sex and working status, and simulation analyses are conducted on the model. This study differs greatly from past studies in that while all past studies covered the EPI alone, this study conducts simulations both for National Pension and EPI. In other words, while the total population changes according to the median estimate of the future population for December 2006 made by the National Institute of Population and Social Security Research, individuals in the economy are divided into the self-employed sector and the firm employment sector according to their working status. Each sector carries out production activities according to its own production function. Here, the self-employed sector is assumed to perform production activities using only labor, and the firm sector, using both of the factors of production, i.e., capital and labor. In addition, the government sector of the model has not only pension finances but also general accounts, and is extended to cover government expenditure, including the state contribution to the basic pension.

The income groups of each of the production sectors are fixed groups defined according to a certain wage gap index during a lifetime given to each cohort, and we decided to apply the ratio of the group to the sectors according to sex and working status as follows: first, the firm sector composed of insured persons of the EPI has three groups: (1) male standard workers, (2) female standard workers, and (3) part-time workers. The part-time worker/self-employed sector composed of those insured under the National Pension has two groups: (4) male workers and (5) female workers. It is also assumed that the economy has a certain ratio of (6) unemployed persons. Let us call the workers in (1) to (6) j-type employees, respectively. The regular employees in the firm sector are charged with pension premiums at a certain ratio of their income while in active service. After retirement, they receive employees' pension, including the remuneration-related part. Workers in the self-employed sector are charged with fixed pension premiums regardless of their income while in active service, and after retirement, are paid the basic pension (National Pension) only. The basic pension less the state contribution is contributed by the sum of pension premiums of the two sectors, whereas the premiums of other employees of firms are allocated to the remuneration-related part of the employees' pension.

But, the treatment of pension premiums of part-time workers and unemployed

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3 Therefore, it is assumed that there exists no mobility between the groups, and that the group at birth does not change during a lifetime.
persons is assumed to differ according to the working status of their spouses, in line with the present system. In this study, to simplify the analysis, it is assumed that all households are couples composed of a male and a female. In addition, also for simplification, part-time workers and unemployed persons are assumed all to be women. Using these simplified methods, we introduce into the model the present pension system where the pension premiums of part-time workers and unemployed persons differ according to whether their male spouses are working in the firm sector or in the self-employed sector. In other words, the part-time workers and unemployed persons whose husbands are employees of firms pay no premiums and receive the basic pension after retirement as Class III insured persons, while those whose husbands are self-employed pay national pension premiums at a fixed rate regardless of their income, and receive the basic pension after retirement. Therefore, this economy has eight income groups according to sex and employment sector: (1) husband employed by a firm/wife employed by a firm; (2) husband employed by a firm/wife unemployed; (3) husband employed by a firm/wife self-employed; (4) husband employed by a firm/wife, part-time worker; (5) husband self-employed/wife self-employed; (6) husband self-employed/wife employed by a firm; (7) husband self-employed/wife, part-time worker; and (8) husband self-employed/wife unemployed. Let us call each of these income groups i-type household.

Under the above assumptions, the dynamic general equilibrium model is composed as follows:

<Households> It is assumed that households appear in the economy as decision-making entities composed of a husband and a wife (couples) at age 21, survive up to age 100, but die with a certain probability within each term during the lifetime. Therefore, considering survival probability in the future, households make decisions on consumption, savings, and labor supply so as to maximize life cycle utility during a lifetime. But, it is here assumed that the labor supply of the husband is

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4 In the actual situation, there is a condition whereby the annual incomes of these groups should be less than ¥1.3 million and their working hours should be less than three-fourths of that of regular employees, but they are assumed here to be unconditionally regarded as Class III insured persons if their husbands are insured persons under EPI. Because the supply of female workers is a dependent variable in the model used in this study, it is possible to cause the type of insurance system they join to change endogenously depending on the labor supply. But, because no stable result was obtained with the selection of parameters, we adopt these simplified assumptions.
inputted by one unit each time inelastically, whereas only the labor supply of women changes elastically. Here, $U^i$, the life-cycle utility function of the household, is expressed as the sum total of $u^i_{s,t}$, instantaneous utility function, a CES-type utility function of consumption, and leisure at a given point in time. That is,

$$u^i_s(t) = (c^i_s(t)^{1/\rho} + \theta l^i_s(t)^{1/\rho})^{\frac{1}{1-\rho}}$$

(1)

$$U^i = \sum_{s=0}^{16} S_s (1-\delta)^{(s-1)} \frac{u^i_s(t)^{1-\gamma}}{1-1/\gamma}$$

(2)

where $S_s$ represents the probability that the household at age 21 survives until age 20+s, which is based on the conditional probability of survival in the next term starting from age 20, $c$ consumption, $l$ leisure, $\delta$ rate of time preference, $\gamma$ elasticity of substitution between different points of time, $\rho$ elasticity of substitution of consumption and leisure within the same point of time, and $\alpha$ weight parameter for leisure, respectively. In the analysis in this paper, one term is five years, which means a household appearing at age 20 would work for nine terms (retiring at age 65) and survives up to 16 terms on pensions and savings.

Next the budget constraint at age $s$ would be

5 Assuming the conditional probability that household age $J+20$ survives at age $j+21$ is $q_{j+1,j}$, $S_s$, the probability that the household aged 21 survives until age $s+20$, is expressed as follows:

$$S_s = \prod_{j=0}^{s-1} q_{j+1,j}$$

In this analysis, the value of the life table of the National Institute of Population and Social Security Research is used for $q_{j+1,j}$ so that a population structure that is the same as that of the future population estimate for December 2006 is reconstructed.
where \( a'_i(t) \) represents the asset balance the i-type household owns at the beginning of age \( s \), \( r \) interest rate, \( g(t) \) government expenditure per household, and \( A_s(t) \) the assets the household inherits in t term. In this model, there is no altruism between households, assets are left in an unintended form, and it is assumed that the assets left in t term are all collected and equally distributed to households existing during the term by the government. \( \sigma'_i(t) \) represents the take-home wage earned by the i-type household after deduction of taxes and premiums, and is the total of the take-home incomes of husband and wife; it differs according to working status as follows: their take-home income would be given by \( (1 - \tau_{gy}(t) - \tau_y(t))w'_i(t)(1-l'_s(t)) \) if they are employed in the firm sector and by \( (1 - \tau_{gy}(t))w'_i(t)(1-l'_s(t)) - \tau^S(t)\bar{w}^S(t) \) if they are in the self-employed sector. Here, \( \tau_{gy}(t) \), \( \tau_y(t) \) and \( \tau_{gr}(t) \) represent wage income tax rate, consumption tax rate, and capital income tax rate in the general account for j-type employees, respectively, and \( \tau(t) \) is the premium rate of EPI. \( \tau^S(t) \) represents the fictitious premium rate of the National Pension imposed on \( \bar{w}^S(t) \), the average wage of workers in the self-employed sector, and \( \tau^S(t)\bar{w}^S(t) \) the premium rate of the National Pension at the point of time t. \( \tau_c(t) \) represents the consumption tax rate additionally levied to cover the state contribution to the basic pension. \( b'_i(t) \) is the amount of public pension benefits for the i-type household and the total of pension benefits of the husband and wife. Standard workers in the firm sector are paid employees' pension, including both basic and remuneration-related portions, and other individuals, the basic pension only. That is, assuming that the pensionable age is age \( R \), the rate of employees' pension benefits \( \beta \), the average annual remuneration at the point of time t \( \bar{w}^E(t) \), and the fictitious rate of basic pension benefits set for the average annual remuneration \( \kappa \), the amount of benefits received by a beneficiary of employees' pension is expressed by

\begin{equation}
\alpha'_i(t) = [1 + (1 - \tau_{gy}(t) - \tau_y(t))]a'_i(t) + A_s(t) + g(t) + \sigma'_i(t) + b'_i(t) - (1 + \tau_{gr}(t) + \tau_c(t))c'_i(t) \tag{2}
\end{equation}

6 The wage income tax rate is given in stages according to wage gaps with a ceiling of 37%, and the consumption tax rate and the capital income tax rate are fixed at 5% and 6%, respectively.
and the amount of benefits for other individuals is

$$b_i^j(t) = \kappa \pi(t) \bar{w}_t^B(t),$$

(5)

where $\pi(t)$ is the rate of change of the consumption tax rate, and is expressed by the following equation, playing the role of an indexation rate in this kind of a single-goods model.

$$\pi(t) = \frac{1 + \tau_c(t) + \tau_{gc}(t)}{1 + \tau_c(t-1) + \tau_{gc}(t-1)}$$

(6)

Under the constraint of Equation (3), a household decides consumption path, savings path, and labor supply path of its lifetime to maximize the life cycle utility of Equation (2). As a result of this optimization, the optimum consumption and leisure paths of the household are derived as follows:

$$c_{s+1}^i = \left( \frac{S_{s+1}^j}{S_s^i} \frac{1 + (1 - \tau_c(t + 1)) \tau_c^i(t + 1)}{(1 + \delta) \zeta^i(t)} \right)^{1/n} \frac{\nu_i^j}{\nu_s^i} c_s^i,$$

(7)

$$l_{s+1}^j = \left\{ \begin{array}{ll} \left( \frac{S_{s+1}^j}{S_s^i} \frac{1 + (1 - \tau_c(t + 1)) \tau_c^i(t + 1)}{(1 + \delta) \zeta^i(t)} \right)^{1/n} \frac{\nu_i^j}{\nu_s^i} f_{s+1}^j l_s^j, & \text{if } s \leq 9 \\ \frac{f_{s+1}^j}{j_s^j} f_s^j, & \text{if } s > 9 \end{array} \right.$$

(8)

The production sector consists of two sectors, i.e., firm sector and self-employed sector. It is assumed that the firm sector has the Cobb-Douglas production function and the self-employed sector has a production function dependent only on labor input. That is, the production $Y_q^i(t)$, where $q = E, S$, of each of the sectors at term $t$ is expressed by

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7 For the method of deriving optimum paths, see the supplementary discussion.
where $A(t)$ represents the variable showing the technical level of the entire economy, $K(t)$ the total amount of capital, $\alpha$ the parameter showing the capital share in firm production and $H_q(t)$ the total labor supply of workers in each sector as measured by the efficiency unit. The total labor supply is also expressed as the total of labor supplied by each household, and the total capital as the total assets of each household and the reserve fund in pension finances, as follows:

\[
Y^B(t) = A(t)K(t)^\alpha H^B(t)^{1-\alpha}
\]
\[
Y^S(t) = A(t)H^S(t)^\theta
\]

where $\alpha$ represents an index showing the labor efficiency of each category of worker. $N^j_{i}(t-s)l^j_{i}$ is the total labor supply at the beginning of a term of $j$-type employees in the $t$-$s$ generation, and $N^j_{i}(t-s)$ is the number of households at the beginning of a term of the $i$-type households in the $t$-$s$ generation. Wage gaps arise between each category of worker according to labor efficiency. That is, the wage rate of $j$-type employees can be expressed as $w^j_{i}(t) = e^jw^j(t)$, where $w^j(t)$ represents the wage rate per worker in the $i$ sector.

\[
H^q(t) = \sum_{j}^{g} \sum_{s=1}^{S} N^j_{i}(t-s)e^j(1-t^j_{s})
\]
\[
K(t) = \sum_{i}^{S} \sum_{s=1}^{16} S^i_{j}(t-s)\alpha^j_{s}(t) + F^j(t)
\]

where $\alpha$ represents an index showing the labor efficiency of each category of worker. $N^j_{i}(t-s)l^j_{i}$ is the total labor supply at the beginning of a term of $j$-type employees in the $t$-$s$ generation, and $N^j_{i}(t-s)$ is the number of households at the beginning of a term of the $i$-type households in the $t$-$s$ generation. Wage gaps arise between each category of worker according to labor efficiency. That is, the wage rate of $j$-type employees can be expressed as $w^j_{i}(t) = e^jw^j(t)$, where $w^j(t)$ represents the wage rate per worker in the $i$ sector.

<Government>

Government finance consists of the general account and the pension account. In the base case, the state contribution to basic pension benefits is covered by the present tax revenue structure, i.e., tax on personal income (personal income tax; maximum 37%), tax on consumption (5%), tax on capital income (6%), and tax on firms (corporation tax: 30%). Other pension benefits are met by premium revenues, which are determined by the pay-as-you-go method, and by the balance of the reserve fund. As for expenditure from the general account, according to the concept of the incidence of tax, the part of total tax revenues that exceeds the state contribution to the basic pension is assumed to be distributed to all households in the same amount, $g(t)$. 

140
But, it is also possible to cover the state contribution to the basic pension by levying an additional consumption tax, while keeping the present tax revenue structure of the general account unchanged, as an alternative revenue resource.

Based on the above, the budgetary constraint of the government's general account is expressed by

\[ GR(t) = G(t) + \Omega FB(t) \]  

(14)

Here \( FB(t) = \sum_j \sum_s \Omega_s^j N_s^j (t-s) \kappa \pi(t) \bar{w}^B(t) \), and the government revenues are represented by

\[
GR(t) = \sum_i \sum_j N_i^j (t) [\tau_{\text{x}}^j (t) w_i^j (t)] \\
+ \sum_j \sum_s N_s^j [\tau_{\text{B}}^j (t) \sigma(t) \alpha_s^j (t) + (\tau_{\text{g}}^j (t) + \tau_{\text{c}}^j (t)) \alpha_s^j ] \\
+ \tau_{\kappa} (t) [Y^B (t) - \sum_j w_i^j (1 - l_i^j) N_i^j ]
\]

(15)

where \( \tau_{\kappa} (t) \) represents the corporation tax rate.

In the pension account, the revenue of pension finances, \( PR(t) \), can be obtained by pension premiums and the investment profit on the balance of the reserve fund at the end of the previous term, \( F(t-1) \). The expenditure of pension finances, \( PE(t) \), is the amount obtained by deducting the state contribution to the basic pension from the term's total pension benefits provided.

\[
PR(t) = \sum_j \sum_s N_s^j [\tau_{\text{x}}^j w_i^j (t)(1 - l_i^j)] + r(t) F(t-1)
\]

(16)

\[
PE(t) = \sum_j \sum_s b_i^j - \Omega FB
\]

(17)

The equilibrium of pension finances in each term is attained by transferring the difference between expenditure and revenue of pension finances to the reserve fund if it is in the black or by withdrawing the reserve fund if it is in the red\(^8\). If the

\(^8\) In the analysis of pension finance using the overlapping generation model, the most commonly used method is to endogenously determine the premium rate schedule attaining the equilibrium in each term of pension finance of the pay-as-you-go method by fixing the benefit level, or conversely to endogenously determine the benefit level attaining the equilibrium in each year of the pay-as-you-go method by fixing the premium rate schedule. In this paper, to consider the
equilibrium of pension finances for a single term excluding the withdrawal of the reserve fund is expressed as  \( PB(t) = PR(t) - RE(t) \), the balance of the reserve fund at term \( t \) carried forward to the next term can be represented by

\[
F(t) = F(t-1) + PB(t) 
\] (18)

<Market equilibrium>

If gross private consumption and gross private savings in the term in question are expressed as

\[
C(t) = \sum_i \sum_j N^i_j c^j_i 
\] (19)

\[
S(t) = \sum_j \sum_i N^i_j s^j_i 
\] (20)

The equilibrium condition in the capital, goods, and labor markets would be described as follows: First, in the capital market, the total amount of assets of the household and the reserve fund of pension finances are used for production.

\[
K(t) = S(t) + F(t) 
\] (21)

In the goods market, the output of goods becomes equal to the total of gross consumption, investment, and government expenditure.

\[
Y(t) = Y^C(t) + Y^G(t) = C(t) + [K(t) - K(t-1)] + G(t) 
\] (22)

Finally, in the labor market, the sum total of labor supply becomes labor demand.

\[
L(t) = \sum_j \sum_s S^j_s N^j_s (t-s) \rho^j (1-l^j_s) 
\] (23)

3. Assumptions of simulation analysis

3.1 Specification of parameters

We conduct a dynamic general equilibrium simulation analysis under the decreasing schedule of the equilibrium of the reserve fund of pension finance by taking as a model the limited equilibrium method adopted in the 2004 pension reform as the assessment standard for sustainability of pension finance, the balance of the reserve fund is endogenously determined by fixing both premium rate and benefit level.
above assumptions; and, to do this, we have to specify various parameters. In this analysis, we define the initial steady state as that in 2000, and exogenously give the schedule of premium rate increases decided in the 2004 pension reform (from 2017 onward, the premium rate of EPI would be fixed at 18.3% and the premium amount of the National Pension at ¥16,300), and the income replacement ratio in the standard case of actuarial revaluation (from 2023 onward, 50.2%) to the level of premium rate and the benefit level after the initial point in time. But, in this analysis, because we use five-year age groups and conduct the simulation analysis for five-year terms, we calculate and use the average value every five years. For the premium of the National Pension, we use the ratio of the premium level of the National Pension to the average wage at firms with 99 or fewer employees in “the 2000 Wage Census”\(^9\) as the fictitious premium rate of the National Pension, \(\tau(t)\). The income replacement ratio based on the macroeconomic indexation method adopted in the 2004 pension reform is assumed to continue decreasing until 2023, and the income replacement ratio when payment of pension is started (at age 65) is assumed to be applied to each cohort during its lifetime\(^10\). The final income replacement ratio shown in the 2004 actuarial revaluation is that for a model household (husband, age 40, insured by the EPI; wife, full-time housewife). The estimate is based on the fact that the benefit ratio used in this analysis is not for take-home income but for tax-inclusive income, showing that the income replacement ratio for average double-income households would be about 40%. Using this as the initial value, we calculate the schedule of income replacement ratios that would decline at the same rate for the model household, and give the ratio to each beneficiary as their income replacement ratio.

The parameters for the utility function are specified from past studies as follows: rate of time preference \(\delta = -0.05\); elasticity of substitution between different points in time \(\gamma = 0.5\); elasticity of consumption and leisure at the same point in time \(\rho = 0.6\) and weight parameter for leisure \(\alpha = 0.1\).\(^{11}\) The parameters for the production function are assumed as follows: the technical development rate of the entire economy

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\(^9\) This ratio is used for convenience because it is difficult to obtain the average income of the self-employed.

\(^{10}\) In the original macroeconomic indexation method, the amount of benefits for confirmed beneficiaries is changed by indexation. But, because the model used in this analysis is a single goods model, a system for indexation cannot be introduced.

\(^{11}\) Uemura (2001) made a comprehensive survey of past studies of finance and pension finance analyses using the overlapping generation model, and also summarized the values of parameters used in these studies.
= 1% a year; the capital share of the firm sector = 0.25; and the productivity parameter of the self-employed sector $\theta = 0.75$.

Naturally, no statistical survey that fits the definition exists for the ratio of each i-type household to all households. Thus, we estimate approximate values as follows: first, we classify all households (half of total population because all households are assumed to be composed of two members—husband and wife), using the ratio of the insured under EPI and National Pension (68% for those insured under EPI) to male insured persons under the public pension systems in the annual report for 2000 of the Social Security Agency. Then, we divide the households into each type using the Basic Survey on Employment Structure (Ministry of Public Management, Home Affairs, Posts and Telecommunications). Based on the Basic Survey, we regard households where the male head is an employee and those where the male head is a self-employed worker as households covered by EPI and by National Pension, respectively, and classify these households using the ratio of households where the wife is self-employed worker, regular employee, part-time worker/contract employee, or unemployed person. As a result, we determine the ratio of each household type as follows: (1) husband employed by a firm/wife employed by a firm: 22.7%; (2) husband employed by a firm/wife unemployed: 16.9%; (3) husband employed by a firm/wife self-employed: 3.4%; (4) husband employed by a firm/wife, part-time worker: 24.8%; (5) husband self-employed/wife self-employed: 1.4%; (6) husband self-employed/wife employed by a firm: 2.3%; (7) husband self-employed/wife, part-time worker: 20.2%; and, (8) husband self-employed/wife unemployed: 7.9%.

The wage gap index $e_j$ for each category of worker is set at 1.517 for male workers, 0.923 for female workers, and 0.558 for part-time workers, based on the wage gap between general and part-time workers calculated using the gap of average standard monthly remuneration between men and women in “the Annual report on social security of the Social Security Agency”, and by “the Wage Census” for 2000.

3.2 Method of simulation

In the simulation, the initial and final steady states are calculated first, and then the transition process is computed. In this analysis, the starting point is assumed to be 2000, and it is assumed that in the initial steady state of the simulation, the population structure as of 2000 would not change. The balance of the reserve fund is assumed to become zero in the final steady state.

Care should be taken of the fact that in the transition process, while generations already in the labor market as of 2000 would exhibit the optimizing
behavior determined in the initial steady state until 2005, those entering the labor market in 2005 and after would act by foreseeing all future changes in population structure, pension system, and economic variables. This means that a household that sees 2000 during its life would exhibit consumption, savings, and labor supply behavior in the initial steady state until 2000, but would reasonably act in 2005 and thereafter based on accumulated assets then as a given condition. In other words, the household would be unable to foresee the economic environment in its behavior until 2000, but from 2005 would begin to act on the basis of foreseeing all future changes.

The transition process can be calculated using the Gauss−Seidel method according to Auerbach and Kotlikoff (1987) and Uemura (2001) as follows:

Step 1: Give the wage rate and interest rate vectors from the initial steady state to the final steady state as the initial values;
Step 2: Give the tax rate, premium rate, and benefit rate vectors from the initial steady state to the final steady state as the initial values;
Step 3: Give the initial value of the asset vector received by each generation;
Step 4: Calculate the optimizing behavior using the variables given at the initial values, and obtain the leisure and consumption path in the lifecycle;
Step 5: Sum up assets accumulated in each term, and equally distribute them to all households existing at that time. Return to Step 4, and calculate optimal consumption path, etc. again, using the assets as new initial values, and continue this until convergence occurs. When convergence occurs, proceed to the next step.
Step 6: Sum up the general and pension accounts in each term, calculate the tax rate and government expenditure vectors where the general and pension accounts are balanced in all of the terms, and return to Step 2 to make the convergent calculation. When convergence occurs, proceed to the next step.
Step 7: Calculate gross capital and gross labor supply in each term, compute the wage rate and interest rate vectors, and return to Step 1 to make the convergent calculation using these price streams as new initial values. When these prices are convergent and cease to change, the transition path would be fixed.

3.3 Simulation scenarios

This section classifies the scenarios used in the simulation analysis. All changes in the system are assumed to start in 2010 in Case 1 and in the subsequent three cases.

First, we analyze the base case, where according to the 2004 pension reform,
the state contribution to the basic pension would gradually be raised from one-third at present to a half of the contributions from the pension systems, the premium rate of EPI and the fixed amount of the premium of the National Pension would be collected from the incomes of regular employees of firms and from self-employed workers, respectively, and no premium would be collected from, and the basic pension would be paid to, part-time workers and unemployed persons who are the spouses of male employees of firms. In this case, no additional tax would be levied on the state contribution to the basic pension, with the contribution made from the general account as is done at present, and the remaining tax revenues of the general account would be equally distributed to each household.

In Case 1, all female part-time workers, regardless of the working status of their male spouses, are assumed to be covered by EPI; thus, they are charged a fixed rate of premiums deducted from their wage income, and are paid employees' pension, including the remuneration-related part, after retirement. In this case, there arise transitional generations who come to be covered by EPI after entering the labor market. We deal with the amount of pension benefits for these generations as follows: first, we calculate the amount of pensions these generations would receive if they worked as insured under EPI in all of the nine terms of employment, and then obtain the amount of the remuneration-related part by deducting the basic pension from the total amount of their pension. We provide only the amount of the remuneration-related part for the terms of employment when they were insured under EPI. As in the base case, in government expenditure from the general account, tax revenues less state contribution are equally distributed to each household.

In Case 2, it is assumed that a fixed premium for the National Pension is charged to spouses of male employees of firms who are part-time workers and unemployed persons.

In Case 3, the insured under EPI are the same as those in the present system (same as in the base case), and the state contribution to the basic pension (1/2) is covered by an additional consumption tax, with the present consumption tax rate of 5% kept unchanged. Unlike Case 1 above, in government expenditure from the general account, all tax revenues in the term concerned are distributed equally to each household.

In Case 4, the state contribution to the basic pension is raised to 100% (i.e., the basic pension is totally covered by tax revenues), and the tax resources necessary for this are covered by imposing an additional consumption tax. As in Case 3, in government expenditure from the general account, all tax revenues for the term in
question are distributed equally to each household. In this case, it is assumed that while the premium of the National Pension is set at zero, the premium rate of EPI is based on the premium increase schedule determined by the 2004 pension reform. The premium revenues of EPI are assumed to be all transferred to the benefits of the remuneration-related part and reserve fund of EPI.

In Case 5, all female part-time workers, regardless of the working status of their male spouses, are assumed to be covered by EPI. As in case 1, they are charged a fixed rate of premiums deducted from their wage income. And the state contribution to the basic pension is raised to 100% (i.e., the basic pension is totally covered by tax revenues). As in case 4, the tax resources necessary for this are covered by imposing an additional consumption tax.

Simulation analyses are conducted for the five scenarios above.

4. Results of simulation
4.1 Comparison from the viewpoint of economic efficiency

Considering what impact a change in the treatment of pension premiums for part-time workers and Class III insured persons and an increase in, and a change in the revenue source of, the state contribution to the basic pension, would have on economic efficiency is important in an economic assessment of a pension system. Here, let us compare the trend of future capital labor ratios measured by the efficiency unit of labor, and examine which case could achieve higher production.

Figure 1 compares the trend of the capital labor ratio for the five simulation cases mentioned earlier. In all of the cases, due to the influence of the rate of technical progress (1% a year) and the influence of the decline in the level of savings caused by increases in the premium rate and resultant decreases in disposable income, the capital labor ratio measured by the efficiency unit tends to fall. In Cases 1 and 2, where pension premiums are extended to part-time workers and Class III insured persons, because disposable income is reduced by an increase in the burden of premiums, the capital labor ratio is lower than in the base case at first, but later becomes higher than in the base case because an increase in the government's premium revenues improves pension finances and increases the reserve fund flowing into the capital market.

Fig. 1. Trend of capital labor ratios measured by the efficiency unit of labor
As for the state contribution to the basic pension and the selection of revenue sources, Cases 3, 4 and 5, in which consumption tax is used as a revenue source of the basic pension, show high-level capital labor ratios in general. These are probably the effects of the smaller decline in disposable income than in the other cases, because consumption tax does not warp capital income, and has no heavy load on wage income.

Figure 2 shows the trend of GDP per person corresponding to Figure 1. However, because all cases showed relatively similar values, it is difficult to see differences if the trend is shown by absolute values. Thus, the trend is shown by the rate of divergence of Cases 1 to 5 from the base case. Here, too, roughly the same conclusion as that for Figure 1 can be obtained.

Fig. 2. Trend of GDP per person: rate of divergence from the base case
4.2. Comparison from viewpoint of sustainability of pension finances

Next, we discuss the result of the simulation from the viewpoint of the sustainability of pension finances. The standard for the sustainability of pension finances used here is the trend of the balance of the reserve fund. In the 2004 pension reform, the limited equilibrium system was adopted in an attempt to prevent the pension system from losing public trust due to excessive inter-generational inequity by withdrawing from the pension reserve fund, which has been built up as a buffer against an unexpected event, so as to reduce the burden on future generations, while keeping the income replacement ratio at a given level. The limited equilibrium system is defined as a method for determining the future level of benefits so that the level of the reserve fund after about 100 years becomes 1; that is, so that the reserve fund balance after 100 years becomes one-year's amount of benefits provided in the year and, in the case in which there is a fear that this might not be achieved, for readjusting benefits and premiums. This means that in a limited equilibrium system, it is important when assessing the sustainability of pension finances to study how the level of reserve funds in the future will change compared to the base case.

Figure 3 compares the trend of the balance of the reserve fund estimated by this analysis. What should be noted first is that in Cases 1 and 2 where pension...
premiums are charged to part-time workers and unemployed persons, the reserve fund balance is larger than in the base case at first, but in the long run it decreases quicker than in the base case. The reason for this is probably as follows. When the imposition of pension premiums is extended to part-time workers and unemployed persons, it becomes possible to collect premiums from part-time workers who have been treated as Class III insured persons who do not have to pay premiums (Case 1) and premiums can be collected even from unemployed persons. Therefore, total premium revenues increase in the short run. But, around the time when those groups newly charged with premiums reach pensionable age, those who receive not only the basic pension but also the remuneration-related part begin to increase. As a result, the total amount of benefits provided increases. The reason that the declining pace of Case 2 is slower than that of Case 1 is that unlike Case 1, there arise no new benefits of the remuneration-related part in Case 2. But, because increased premiums lower the substantial wage level, and lead to lower labor supply in the long run, the reserve fund balance in Case 2 is smaller than in the base case.

In addition, in Case 3, in which the state contribution to the basic pension is changed to revenues from consumption tax, the changes in the reserve fund balance are slower than in the base case. In Case 4, although the part of the basic pension to be contributed by the premiums of the EPI ceases to exist as a result of the basic pension changed to the tax method, the premium rate of EPI is at the same level as that of the base case. Thus, this works positively toward pension finance equilibrium, causing the reserve fund balance to remain at a higher level than in the other cases.
4.3. Comparison regarding additional consumption tax

In Cases 3 to 5, additional consumption tax and the tax method, which differ from the traditional tax structure and the social insurance method, are introduced as alternative revenue sources for the basic pension. These cases, especially the case in which the tax method is adopted for the basic pension, are reform plans that have not only been discussed as a solution to the problems of non-payment of premiums of, and non-participation in, the National Pension, but also are supported by economists and economic circles as steps to cope with the sense of intra-generational inequity among people arising from the system of Class III insured persons\textsuperscript{12}. Setting the level of the additional consumption tax is an important problem in the discussion of tax reform in Japan, too. In the analysis of this study, the rate of additional consumption tax is estimated at a maximum of about 5% where the present state contribution to the basic pension would be covered by consumption tax, and at a maximum of 13.3% as of 2075 where all of the basic pension would be covered by consumption tax. This suggests that the consumption tax rate would rise to about 18% together with the present rate of

\textsuperscript{12} For example, see Tachibanaki (2005) and Kitashiro (2004).
5%, which is roughly the same as the rates estimated in past studies\textsuperscript{13}.

Fig. 4. Additional consumption tax rates to finance basic pension benefits

![Figure 4](image)

Source: Authors’ estimation

5. Summary and future tasks

In this study, we expand the dynamic general equilibrium simulation model using an overlapping generation model of the Auerbach and Kotlikoff type so that the impact of the expanded application of the pension system to part-time workers and Class III insured persons could be analyzed, and to have two sectors—the firm sector where the insured of the EPI are employed and the self-employed sector where the insured of the National Pension are working—and eight types of households, and analyze the model.

In the simulation analysis, we analyze and discuss, from the viewpoint of economic efficiency and the sustainability of pension finances, several cases, including the case in which EPI is extended to part-time workers, the case in which a fixed amount of premiums for the National Pension is collected from Class III insured persons, too, and the case in which the basic pension is covered by consumption tax revenues, thus introducing the tax method into the basic pension. As a result, it is found

\textsuperscript{13} For example, see Okamoto and Tachibanaki (2000).
that expanding the burden of pension premiums to part-time workers would improve pension finances in the short run, but might hinder the sustainability of pension finances in the long term. It is also revealed that where consumption tax is used as a revenue source for the state contribution of 1/2 of basic pension benefits or the entire basic pension, economic efficiency increases in general, and in this case additional consumption tax rate would be about 5% or 10% respectively.

It is important to discuss the influence of the pension system on economic efficiency. But, because the objective of the 2004 pension reform was not only to improve the sustainability of pension finances but also to achieve inter-generational and intra-generational equity, analyses from these viewpoints would also be important when searching for the direction of future reforms. We would like to make these our future tasks.

In the model used in this study, the government's general account deficit is assumed to be zero. But, in reality, the central and local governments in Japan both have large amounts of outstanding government bonds, making the government financial deficit an important factor in determining the level of capital in the economy, together with the pension reserve fund. Considering this, it would also be important to analyze the impact of the (latent) national contribution ratio on the national economy by making these assumptions looser, and taking account of government financial deficit, too. Furthermore, it would be necessary from the theoretical viewpoint to extend the model so that it can make the comparison of the difference in social welfare after the extending the application of EPI to part-time workers between pay-as-you-go system and funded system. However, many technical problems need to be solved before adding these factors to a model that already has a very complex structure, and we would like to discuss this subject in the future, too.

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