Verifying the Proposed Public Pension Reform from the Perspective of Risk Management

by Tomoki Kitamura (kitamura@nli-research.co.jp)
and Kunio Nakashima (nakasima@nli-research.co.jp)
Pension Forum, Financial Research Group

Introduction

Numerous reform proposals have been presented ahead of the public pension reform slated for the next fiscal year. From the government alone, proposals have been presented by the Public Pension Subcommittee of the Social Security Council (Ministry of Health, Labor and Welfare), Council on Economic and Fiscal Policy (Cabinet Office), Fiscal System Council (Ministry of Finance), and Ministry of Economy, Trade and Industry.

In evaluating the proposals, the key concern is sustainability, which requires that we study each proposal in terms of both flow (annual contributions and benefits) and stock (pension liabilities and reserves). In this paper, based on the reform proposal presented by the MHLW, we examine possible trends in the flow and stock in the future, as well as the uncertainties and risks involved. Using financial engineering methods, we formulate a proprietary stochastic pension finance model, and simulate and verify results.

Figure 1　Comparison of Current System and Proposal (Fixed Premium Rate)

<table>
<tr><th></th><th>Present</th><th>Proposed (fixed premium rate)</th></tr>
<tr><td>Calculation of contribution</td><td colspan="2">Average standard cash earnings (after revaluation) × Coverage period × Benefit multiplier
= Cumulative standard cash earnings (after revaluation) × Benefit multiplier</td></tr>
<tr><td rowspan="2">Sliding scale for newly determined pension (rate after revaluation)</td><td rowspan="2">Nominal wage growth rate per person</td><td>(Macroeconomic sliding scale adjustment period)
Nominal wage growth of all participants
= Wage growth rate per person + Growth rate of participants
(negative if participants decrease)</td></tr>
<tr><td>(After completion of macroeconomic sliding scale adjustment)
Wage growth rate per person</td></tr>
<tr><td rowspan="2">Sliding scale for existing pension</td><td rowspan="2">Inflation rate (can be negative)</td><td>(Macroeconomic sliding scale adjustment period)
Inflation rate ＋ Growth in number of participants
(negative if participants decrease)</td></tr>
<tr><td>(After completion of macroeconomic sliding scale adjustment)
Inflation rate (can be negative)</td></tr>
<tr><td>Premium rate</td><td>Standard premium rate from 2025</td><td>Stepped-up premium to 2022
Fixed at 20% thereafter</td></tr>
</table>

1. The MHLW Proposal

The pension reform proposal released last December (*Direction and Issues Regarding the Pension Reform Framework*) contained two reform proposals: (1) keeping future benefit levels unchanged while increasing premiums, which would extend the current system, and (2) a new fixed premium rate method. The benefit maintenance method assumes that benefits are maintained at the current level of 59% of salary before retirement, and calculates the premium necessary to achieve this. Under this method, based on a standard scenario, the final premium rate is 23.1%. By comparison, the fixed premium rate method assumes a final premium level of 20%, and reduces pension levels in steps so that pension finances become balanced in the future.

As we pointed out an earlier paper,[1] pension anxiety among working persons has grown in recent years. Under such circumstances, the fixed premium rate method, which should alleviate pension anxiety by reducing final premium rates more than the current method, appears to be the preferred choice of the MHLW. Below we examine the fixed premium rate method is more detail.

As Figure 1 shows, if participants decrease in number, the fixed premium rate method reduces pensions step by step in what is called a macroeconomic sliding scale. This means that the sliding rate for new retirees will change from nominal wage growth rate per person, to nominal wage growth rate of all participants (that is, nominal wage growth rate per person + growth rate of participants). Moreover, the sliding rate for existing retirees will change from the inflation rate, to inflation rate + growth rate of participants. This method attempts to stabilize pension finances by adjusting benefits to premiums as the number of participants changes.

By reducing pension benefits step by step using the macroeconomic slide, the premium rate necessary to keep pension finances in balance (level premium) gradually declines. Since the macroeconomic slide is designed to continue until the level premium rate reaches 20%, under the standard scenario, adjustments are expected to continue until 2032. Moreover, two types of minimum pension levels have been proposed: a nominal pension minimum, and inflation minimum. In the former, barring a decrease in wages per person or deflation, the nominal pension amount is maintained, but the real pension amount decreases with inflation. With the latter, an inflation slide guarantees that the real pension amount is maintained.

[1] See the February 2003 issue of *Nissay Kisoken Report*, in Japanese.

2. Responding to Uncertainty

The MHLW proposal examines the average future outcome for EPI benefits and contributions based on a certain scenario. However, because of uncertainties in factors such as population, labor force, economic growth rate, inflation rate, and asset prices, we must consider these risks when evaluating public pension finances.

Specifically, EPI finances are affected by changes in both population and the economic environment. Changes in the population or labor force will alter the number participants and beneficiaries, which in turn affect premium income and pension outlays. Moreover, changes in the economic environment such as inflation and wage growth rate will affect the cash earnings of participants and hence premium income. And if the inflation rate changes, so too will the slide rate of existing pensions and newly determined pensions, which will cause pension amounts to change.

However, thus far nobody has discussed the impact that such a chain of uncertainties and combination of risk factors could have on pension finances. In this paper, based on the MHLW proposal, we analyze the financial condition and risks of the EPI system using a Monte Carlo simulation.[2]

We calculate the flow (financial balance) and stock (reserves) of the EPI to 2030. We assume that the labor force changes deterministically, and that the two economic variables of inflation rate and rate of return on reserves fluctuate stochastically.[3] The analysis compares four models: ① current benefit and premium calculation model,[4] ② fixed premium rate model with nominal pension protection (macroeconomic sliding scale),[5] ③ fixed premium rate model without nominal pension protection, and ④ current premium rate model (maintaining the current 13.58% premium rate). The state's burden of the national pension increases to one-half for models ①, ② and ③, but stays at the current level of one-third for model ④. In addition, for models ① through ③, we used the stepped premium rates set forth in the respective models of the MHLW proposal.[6]

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[2] This method is similar to risk management methods used by financial institutions such as value at risk (VaR), in which calculations resemble thousands of dice throws by a computer. VaR measures the maximum possible loss incurred subject to a particular period of time and probability.

[3] We calculated financial balances using the method and data in the *Fiscal 1999 Fiscal Recalculation Results for the Employees' Pension Insurance and National Pension System,* issued by the Ministry of Health and Welfare's Pension Bureau, Actuarial Section. NLI Research Institute has made assumptions regarding the numerous categories that are undisclosed. Simulation results for the case that probability does not fluctuate are almost identical with the results of the MHLW proposal.

[4] This refers to an extension of the current system being proposed by the MHLW.

[5] While the fixed premium rate model also considers other patterns, this one is at the center of debate.

[6] See MHLW, *Directions and Issues Regarding the Framework of Pension Reform*, p. 140 and 142.

3. Model Outline and Simulation

In this paper, the inflation rate and return on reserve are treated as stochastic variables. We use the values presented in the MHLW proposal for expected inflation rate μ_i, real wage growth rate per person κ, and expected return of reserve μ_A. The fluctuation model for inflation rate r_i is

$$r_i = \mu_i + \sigma_i \varepsilon_i \qquad (1)$$

Here, expected inflation rate μ_i is 0% to fiscal 2007, and 1.0% thereafter. Inflation rate volatility σi is 1.2%. The ε_i term is a standard normal random variable with mean 0 and standard deviation 1.

The fluctuation model for wage growth rate per person r_k (disposable income growth rate) is given by

$$r_k = \kappa + r_i \qquad (2)$$

The term κ represents real wage growth per person, and is assumed to be 0.3% until 2007, 0.8% until 2004, and 1.0% thereafter. We assume that the inflation rate and wage growth rate per person are perfectly correlated. Moreover, the fluctuation model for reserve A is given by,

$$\Delta A = \mu_A A + \sigma_A A \varepsilon_A \qquad (3)$$

Here, expected return on reserves μ_A is 1.75% until 2007, and 3.25% thereafter. Reserve volatility σ_A is assumed to be 3.0%.[7] Error term ε_A is a normally distributed random variable with mean 0 and standard deviation 1. Furthermore, correlation coefficient $\rho(\varepsilon_i, \varepsilon_A)$ between the inflation rate and reserve is assumed to be 0.04. Volatility and correlation coefficient settings are based on past data.[8] According to Ito's lemma, Equation (3) can be expressed as follows:

$$A_{t+1} = A_t \exp\left\{\left(\mu_A - \frac{1}{2}\sigma_A^2\right) + \sigma_A \varepsilon_A\right\} \qquad (4)$$

This model expresses the change in reserve from period *t* to *t+1*, and means that the reserve has a lognormal distribution.

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[7] Reserves are valued at market. We assume that if the reserve turns negative, investment will be terminated, and loans will be made at an annual 1% rate.

[8] Inflation rate volatility is calculated from the consumer price index (excluding fresh foods). Reserve volatility is calculated from data in *Report of the Study Group on Investment and Basic Policies for Pension Reserves*. Since these parameters are expressed as annual rates while the reserve fluctuation model uses continuously compounding rates, values need to be adjusted, but are not in this paper.

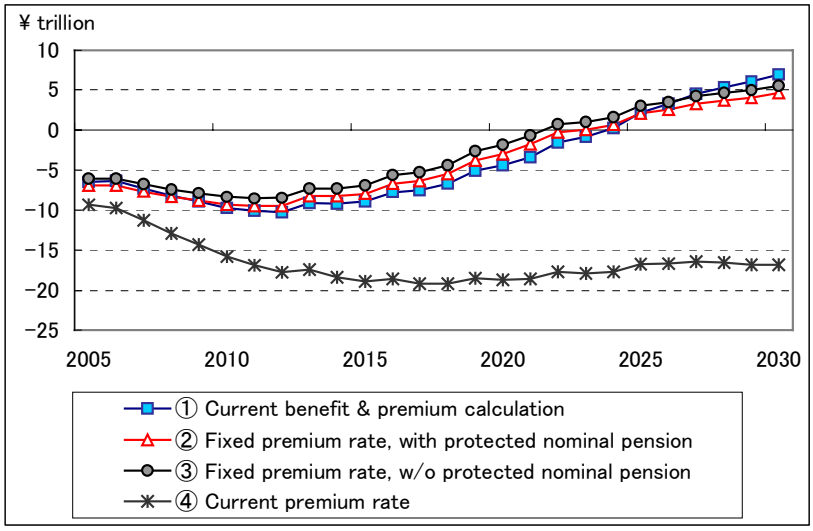
We generated random numbers with the Monte Carlo simulation, and based on our parameter settings, simulated the inflation rate, wage growth rate per person, and return on reserve. Then for each year, we calculated the number of EPI participants and beneficiaries, premium income, pension expenditure, net transfer to the national pension fund, and pension balances. The reserve amount also changes based on investment gains and other balances. We repeated the simulation 5,000 times and compiled distributions for the financial balance and reserve.

4. Analytical Results

First, looking at the financial balance (median) excluding EPI investment gains, we predict that for current premium rate model ④, pension finances will deteriorate until about 2015, generating ¥20 trillion losses each year. While the losses could be covered in a number of ways (for example, using tax revenue), if the EPI's aim is to achieve financial equilibrium, either the premium rate must be raised, or the state's burden increased to 50%, as indicated in the MHLW proposal.

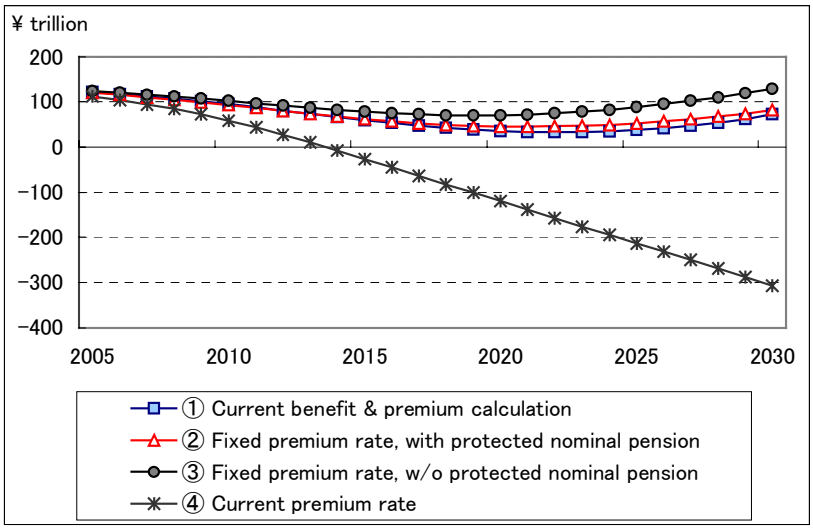
For models ① through ③, pension finances will deteriorate until 2010-2015 as the baby boom generation now in their 50s become beneficiaries. For current situation model ①, we predict approximately ¥10 trillion in losses. Fixed premium rate model ② will outperform model ①, but not significantly. Pension finances will improve more in model ③ (fixed premium rate, no nominal pension protection) than in model ②. We also note that because of the high premium rate in model ①, its pension finances will outperform that of model ② from 2025 (Figure 2).

Figure 2　Pension Finance Simulation of EPI Models (excl. investment gains; median value)



Next, looking at the forecast for reserve amounts (median), current premium rate model ④ shows a decreasing reserve due to recurring losses that will accumulate to approximately ¥300 trillion (¥220 trillion at current prices)[9] in 2030. The other three models reserves decrease until around 2020, but are predicted to grow thereafter. Here as well, the difference between current model ① and fixed premium rate model ② is not large, while model ③ (fixed premium rate, no nominal pension protection) shows the largest reserve of the models (Figure 3).

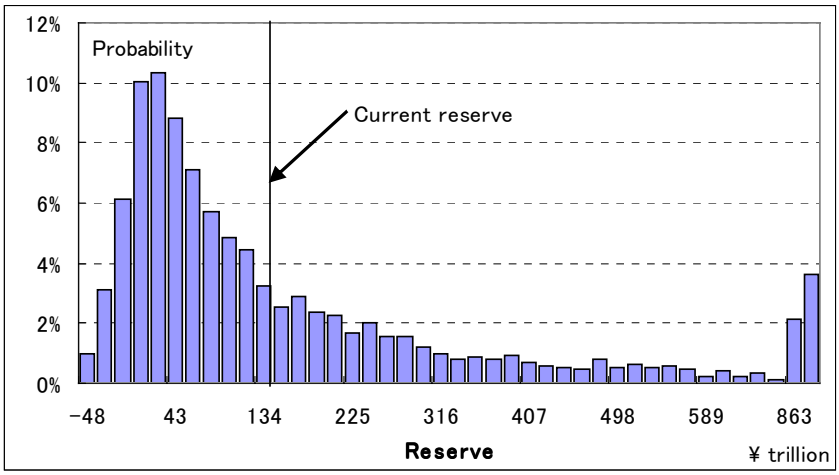
Figure 3　Reserve Simulation of EPI Models (median)



[9] Calculated using a 1% discount rate.

For current calculation model ①, the distribution of reserve in 2030 is not normal but skewed (Figure 4).[10] Distributions for model ② and model ③ are similar to model ①, except for a rightward shift that grows more pronounced in the order of model ①,②, and ③. The distribution is characterized as follows: (1) the reserve is predicted to fall below the mean with a high probability, and (2) the reserve could grow, although the probability is low. In this case, an analysis using only mean and variance is insufficient, and requires that we analyze the overall distribution.

Figure 4　Probability Distribution for Model ① (2030)



We used the statistical values for reserve distribution in 2030 from simulations to examine the downside risk for EPI. We exclude from comparison the current premium rate model ④, which has substantially larger losses than the other models. While the analysis focuses on reserves, we should note that reserves are affected not only by capital market fluctuations, but by the impact on annual financial balances from economic variables such as labor force size, inflation rate, and wage growth rate. A negative reserve value indicates that the state must shoulder the burden at that time (Figure 5).

Figure 5　Statistical Values for Reserve Distributions (2030)

(¥ trillion)

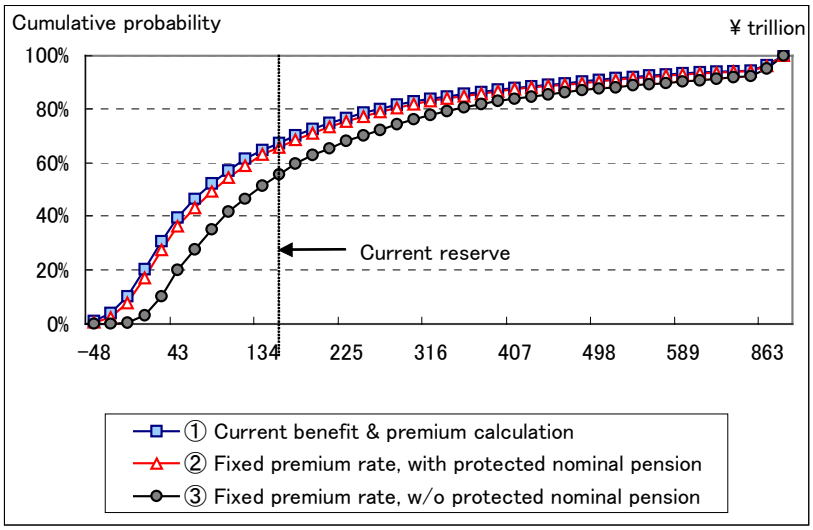
Model	Mean	Median	Standard deviation	Percentile		
				1%	5%	10%
①	177	72	339	−48	−27	−13
②	187	82	343	−40	−20	−7
③	242	128	371	−6	13	24
④	−290	−307	218	−639	−528	−472

[10] One reason is that we assume that reserves have a lognormal distribution.

At the 5 percentile risk scenario, the predicted reserve is –27 trillion yen for model ①, and –20 trillion yen for model ②.[11] Thus model ② has a slightly lower downside risk than model ①. However, the negative reserve value means that under model ②, the reserve will be depleted even if inflation and asset prices fluctuate within the assumed range, causing the state's burden to increase. It is critical that adequate disclosure is made of this possibility. Of course, new measures could be devised before the reserve is depleted. However, this means that future revisions may ensue. Model ③, with a predicted reserve of 13 trillion yen, has the least downside risk of reserve depletion.

Looking at the cumulative probability distribution of simulated reserves, we found almost no difference between models ① and ② (Figure 6). By comparison, the distribution function for model ③ shifts to the right, indicating a more limited burden increase for working persons with regard to changes in the economic environment.

Figure 6 Cumulative Probability Distribution of Reserve (2030)



5. Conclusion

We analyzed the impact of changes in the economic environment and capital markets on EPI balances and reserves, using a simulation based on a deterministic prediction for the future labor force, and stochastic models for the inflation rate, wage growth rate, and return on reserve. As we showed in analyzing model ④, it is almost impossible to maintain the current benefit and premium rate levels. The aim of public pension reform is to fill the gap between benefit payments and premium income. The reserve shortfall in 2030 is predicted to grow to approximately 220 trillion yen at current prices, which is equivalent to approximately half of

[11] This corresponds to a 95% confidence level for VaR.

current GDP. Given the immensity of the reserve shortfall, today's workers have good cause to worry about the health of the public pension system.

As with the current public pension system (model ①), the MHLW proposal (model ②) also faces an inevitable deterioration in pension finances, and is predicted to experience a reserve shortfall. The downside risk for both models is not significantly different.

The difference between the two models is the pension revision rate (slide rate). If the labor force decreases or the wage growth rate falls, the pension revision rate in model ② will also decrease, thereby containing benefit expenses.

On the other hand, model ③ (fixed premium rate, no nominal pension protection) produces a larger reserve than model ②, implying that the protection of nominal pensions impedes improvement of pension finances. In model ③, which resembles derivative security transactions in finance theory, the present value (cost) of transactions for maintaining nominal pensions is estimated at 31 trillion yen.[12] We should keep in mind that this amount will be borne by working generations.

Nonetheless, a major social issue would arise if nominal pensions decrease while prices and wages are rising. For the fixed premium method to work best, impediments to financial soundness need to be eliminated. Considering the importance of protecting beneficiaries and lessening the burden on participants, public pension reform is a vital issue that must be pursued with care.

Our analysis covered the period to 2030, and concluded that no major difference exists between model ① (current situation) and model ② (fixed premium rate). However, the fixed premium rate model could conceivably benefit from stochastic labor force changes not included in the simulation, or incur positive effects after 2030. However, we leave this as our next task. Since our analysis is based on a particular model and parameters, results will inevitably change if other models and parameters are used. Finally, we would like to point out that for the private sector to better analyze pension reform from different perspectives, public authorities need to disclose more detailed data on participants and beneficiaries.

[12] In addition to the assumptions in this paper, assumptions for this estimate include the termination of nominal pension level maintenance in 2030, and perfect markets.