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Structural Reforms to Enhance the Sustainability and Intergenerational Equity of the National Pension System[†]

By KANG KOO LEE*

This paper examines reform measures for the National Pension System, analyzing their fiscal impacts. Despite past reforms adjusting contribution and replacement rates, the system faces ongoing sustainability challenges. We forecast that the reserve fund, peaking at 1,972.0 trillion KRW in 2039, will be depleted by 2054. A scenario analysis suggests that raising the contribution rate from 9% to 18% would extend solvency but not maintain long-term stability under the current DB structure, which promises benefits that exceed contributions. This highlights the difficulty of sustaining the fund through rate increases alone.

This paper proposes a structural shift to a new cohort-based DC system (“New Pension”), which would provide benefits based on contributions and investment returns, avoiding depletion even with low birth rates. Under this plan, the “Old Pension” deficit would be supported by government funds, ensuring all generations receive at least their contributions back. For the Old Pension, the shortfall is projected to be 609 trillion KRW if limited to contributions through 2023, rising to 869 trillion KRW if extended to 2028. These results stress the importance of early reforms to ease the fiscal burden.

Key Word: Structural Reforms, National Pension System, Defined Contribution, Separation of Old/New Pension Systems
JEL Code: H55, H68, I38

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I. Introduction

The National Pension System in South Korea was introduced in January of 1988. In its early stages, the income replacement rate was set to 70% to emphasize the provision of retirement income during the industrialization era, while the contribution rate was set at only 3% of income. In other words, the National Pension System began without inherent financial sustainability. Since then, efforts have been made to address this financial issue by gradually reducing the income replacement rate to 40% and raising the contribution rate to 9%.

Despite these efforts, the severe financial challenges of the National Pension remain unresolved. Ensuring the financial sustainability of the National Pension is a crucial policy task for a securing stable retirement for all citizens. According to 2022 population projections, the decline in the working-age population has widened (a decrease of 1.77 million over five years), and the total fertility rate is projected to fall to 0.70. Additionally, the results of the 5th National Pension financial recalculation in 2023 moved forward the timeline for the onset of the fiscal deficit (from 2042 to 2041) and the depletion of the reserve fund (from 2057 to 2055) compared to the 4th recalculation five years earlier. Specifically, if the current National Pension system is maintained, the reserve fund is expected to grow until 2040, reaching a peak of 1,755 trillion KRW, but will turn to a fiscal deficit starting in 2041, with the fund projected to be depleted by 2055. Assuming other factors (such as the income replacement rate and enrollment/benefit age) remain unchanged, maintaining the reserve fund through 2093 (the projection period) would require

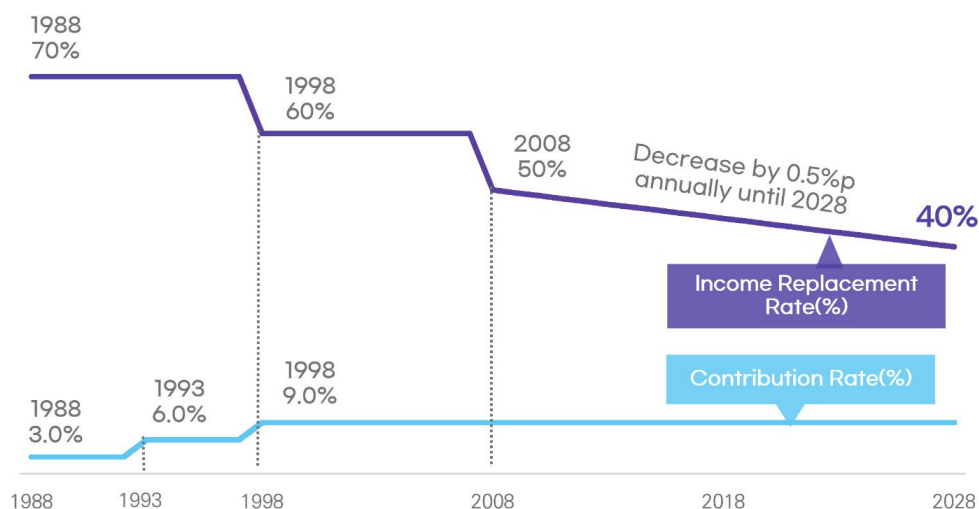


FIGURE 1. CHANGES IN THE CONTRIBUTION RATE AND INCOME REPLACEMENT RATE OF THE NATIONAL PENSION

Source: Prepared by the author, based on data from the National Pension Financial Projection Expert Committee (2023).

raising the contribution rate to 17.9% starting in 2025. The pay-as-you-go cost rate, which represents the contribution rate needed to cover annual benefit expenditures with annual premium revenues, is projected to rise from 6.0% in 2023 to 35.0% in 2078, before decreasing to around 29.7% by 2093.

Therefore, there is an urgent need to develop reform measures to sustain the National Pension system. Reform options for public pensions can be broadly classified into parametric reforms and structural reforms. While current discussions on stabilizing the finances of the National Pension focus on parametric reforms, these measures may alleviate the sustainability issue but do not fully address the problem of intergenerational equity. Relying solely on parametric reforms for public pensions is insufficient to achieve both financial sustainability and intergenerational equity.

In light of this, this paper seeks to explore structural reform measures for the National Pension that can simultaneously secure both financial sustainability and intergenerational equity, differing from previous research. To this end, it compares scenarios involving contribution rate increases with those implementing a DC-type structural reform and evaluates the potential financial outcomes using a National Pension projection model. The Defined Contribution (DC) pension system has already been discussed in several studies, including Park (2023), due to demographic changes in Korea. Park (2023) explores the introduction of a funded DC pension system, citing concerns that parametric reforms aimed at ensuring the long-term fiscal sustainability of the National Pension System may fail to improve intergenerational equity.

However, among the various DC pension system models, the Swedish notional defined contribution (NDC) system is not suitable for countries such as Korea with similar demographic challenges, and the individual account-based DC pension system has the drawback of failing to address the longevity risk when contributors live longer than expected, while also undermining the role of a public pension system as the remaining funds are passed on to heirs if contributors die earlier than anticipated. This paper proposes the introduction of a cohort-based account DC pension system to maintain the functionality of a funded DC pension while preserving the role of a public pension system. Despite the advantages of the proposed new pension system, the suggestion to separate the old and new pension schemes presents a drawback: failing to address the shortfalls in the old pension could undermine the feasibility of the reform. In other words, the structural reform proposed in this study can enhance its feasibility if the current generation is willing to relinquish some of their vested interests for the benefit of future generations.

The structure of this paper is as follows: Chapter 2 constructs the National Pension projection model. Chapter 3 analyzes the projection results of the contribution rate increase scenario, while Chapter 4 reviews the outcomes of structural reform measures for the proposed “New Pension.” Chapter 5 calculates the financial shortfalls arising from the existing “Old Pension” system. The final chapter summarizes the suggested directions for reforming the National Pension system.

II. Construction of the National Pension Projection Model

This chapter constructs a National Pension financial projection model to analyze the impact of reform measures on the pension's finances. A representative international model for public pension projections is the World Bank's PROST (Pension Reform Option Simulation Toolkit). This actuarial model calculates data such as contributors, beneficiaries, pension contributions, benefit expenditures, and reserve funds by inputting demographic, macroeconomic, and policy variables as exogenous factors.

In South Korea, various institutions, such as the National Pension Research Institute, the Korea Institute of Public Finance, the Korea Institute for Health and Social Affairs, and the National Assembly Budget Office, have developed and utilized their own projection models for the National Pension. The academic community has also engaged in research on National Pension projection models.

This paper aims to build a fiscal projection model for the National Pension based on models from the National Pension Research Institute (2017) and the National Assembly Budget Office (2020). These models are selected for their relative simplicity and effectiveness in analyzing the effects of pension reform measures on the financial stability of the National Pension. They can enable estimations of revenues, expenditures, the fiscal balance, and the reserve funds of the National Pension.

A. Overview of the Projection Model

The model used in this study, similar to existing National Pension projection models, is structured to estimate the revenues and expenditures of the National Pension based on demographic projections and macroeconomic forecast variables.

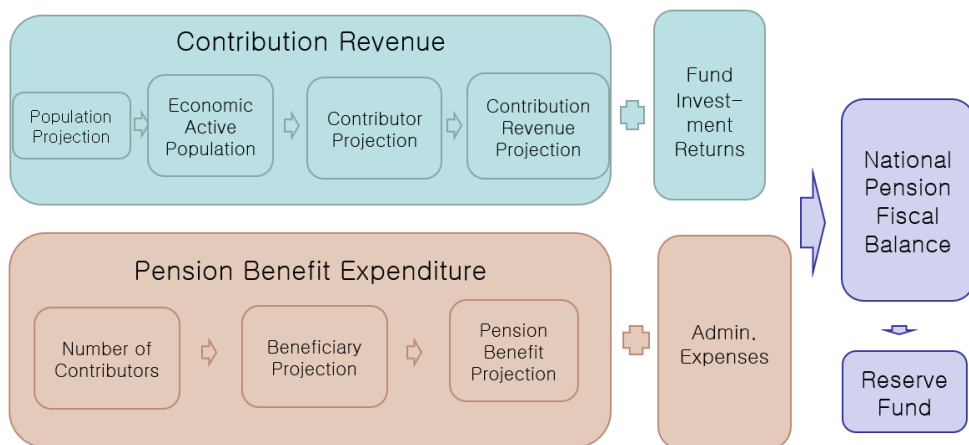


FIGURE 2. OUTLINE OF THE NATIONAL PENSION PROJECTION MODEL

Source: Prepared by the author.

Specifically, the projection of National Pension revenue consists of estimating the number of contributors, contribution income, and investment returns on the reserve fund. On the expenditure side, the model includes estimates of the number of beneficiaries, pension benefit payments, and administrative costs.

B. Demographic Projections, Macroeconomic Forecasts, and Key Policy Parameters

The demographic projections are based on *the Future Population Projections* (February 2022) by Statistics Korea, using the medium-variant scenario. These projections are calculated using data from the 2020 Population Census and account for population changes due to births, deaths, and international migration. According to the projections, the total fertility rate is expected to decline from 0.73 in 2023 to a low of 0.70 in 2024, before rebounding to 0.96 by 2030 and then stabilizing at 1.21 from 2046 onward.

The macroeconomic projections applied in the National Pension projection model include variables such as the nominal GDP, consumer price inflation rate, nominal wage growth rate, government bond yields, and labor force participation rate, based on the forecasts provided by KDI.

The policy parameters of the National Pension system include factors such as the participation rates of workplace and regional contributors, exemption rates, new enrollment rates, collection rates, income index, lifetime income scores, disability incidence rates, and survivor rates. These parameters were set based on sources such as materials from the National Pension Financial Projection Expert Committee, the Ministry of Health and Welfare, the National Pension Research Institute, and the National Assembly Budget Office.

The assumed fund return rate is based on figures from the 5th National Pension financial recalculation materials provided by the National Pension Financial Projection Expert Committee (2023). The committee estimated expected returns by asset class based on macroeconomic forecasts and weighted these according to asset allocation ratios to derive the overall investment return rate. The projections for the 2023-2093 period estimate an average annual return rate of approximately 4.5%, breaking down into 4.9% for 2023-2030, 4.6% for 2031-2040, 4.5% for 2041-2060, and 4.4% for 2061-2080. While this indicates a gradual downward trend over time, this study applies the period average rate directly.

Additionally, it is important to note that before a fiscal deficit occurs in the National Pension, long-term investments can be made, allowing for a higher allocation to riskier assets and potentially higher returns. However, after the onset of a fiscal deficit, the need to secure funds for pension payouts would require investments in more liquid and lower-yielding assets, potentially reducing the overall return rate. Although this aspect should ideally be factored into projections, it was not accounted for in the financial projections presented here.

C. Revenue Projections

National Pension contribution revenue is calculated by multiplying the annual number of contributors by the contribution rate and the collection rate.

Contribution Revenue

$$\begin{aligned} &= \text{Number of Contributors} \times \text{Standard Monthly Income} \\ &\quad \times \text{Contribution Rate} \times \text{Collection Rate} \end{aligned}$$

Contributors are categorized by gender, type of membership (e.g., workplace, regional, pending contributors), and other characteristics. Based on these categories, projections are made by applying the National Pension participation rate, transition rates between types, new entry rates, and mortality rates by gender and age.

Number of Contributors

$$\begin{aligned} &= \min \{ (\text{Economically Active Population} \times \text{National Pension Participation Rate}), \\ &(\text{Previous Year Contributors} \times \text{Transition Rate by Contributor Type} + \text{New Entrants}) \} \end{aligned}$$

For regional members, only those who report income and are not exempt from payments are subject to making contributions. Therefore, projections are adjusted by excluding those with contribution exemptions, calculated by applying the proportion of exempt members by year, gender, and age to regional members.

The total number of contributors is then adjusted to ensure that it does not exceed the economically active population for each year, gender, and age group, by comparing it to the projected number of contributors based on National Pension participation rates.

The contribution unit price is determined differently for workplace and regional contributors. For workplace contributors, it is calculated by applying the nominal wage growth rate to the standard monthly income and then multiplying this value by the contribution rate. For regional contributors, it is calculated by adjusting the standard monthly income using the income ratio between regional and workplace contributors and then applying the contribution rate. During this process, the standard monthly income for both workplace and regional contributors, segmented by gender and age, is estimated using income indices categorized by contributor type, gender, and age. The specific formula for estimating revenue can be found in Appendix A.

The total number of National Pension contributors is projected to decrease from 29.87 million in 2023 to 17.15 million in 2100, in line with declines in both the total population and the economically active population. National Pension revenue is expected to rise from 101.3 trillion KRW in 2023 to 189.3 trillion KRW by 2043,

driven by increases in contributions and investment returns. However, due to a reduction in investment returns, total revenue is projected to decrease to 128.2 trillion KRW by 2055, after which it will gradually increase again as contribution revenue grows. This increase in contribution revenue, despite a decline in the number of contributors, is primarily attributed to a rise in per capita contributions resulting from individual income growth.

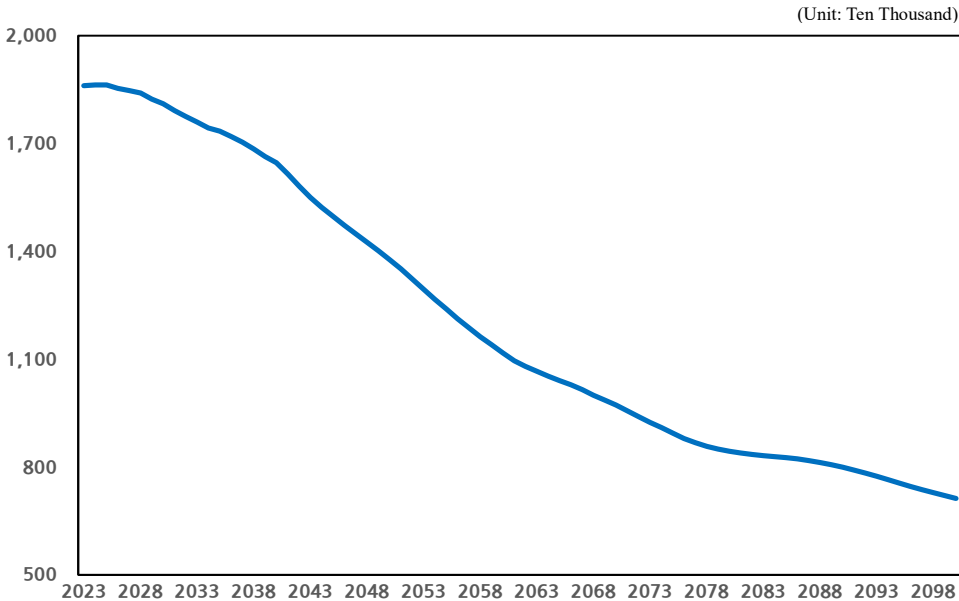


FIGURE 3. PROJECTION OF NATIONAL PENSION CONTRIBUTORS

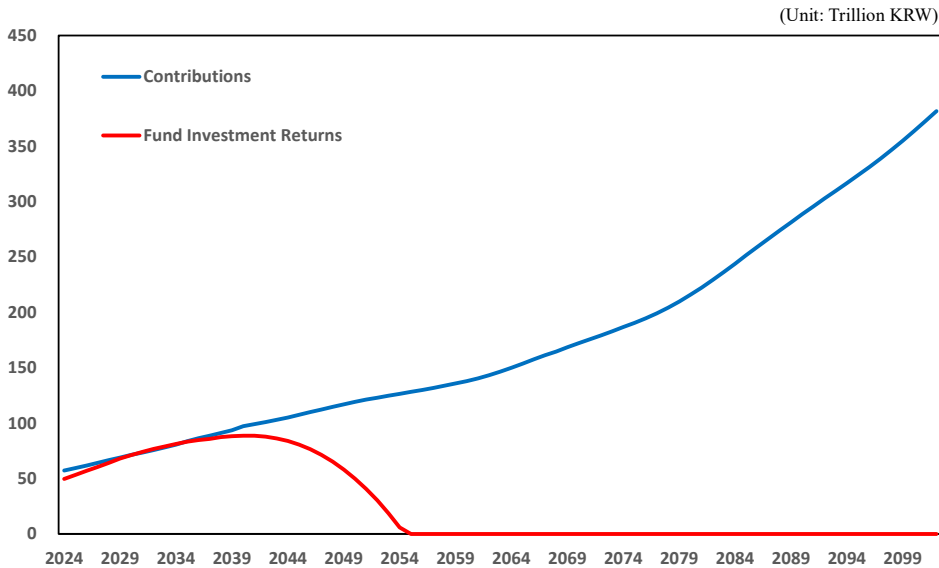


FIGURE 4. BASELINE PROJECTION RESULTS FOR NATIONAL PENSION REVENUE

Fund investment returns, which are influenced by the size of the reserve fund and its yield, are expected to peak at 88.7 trillion KRW in 2040 when the reserve fund reaches its maximum. However, from 2041 onward, as the reserve fund begins to decline, investment returns are also projected to decrease. After the reserve fund is depleted in 2054, no further investment returns are expected.

D. Expenditure Projections

The expenditure on National Pension benefits is projected primarily by multiplying the number of beneficiaries by the pension benefit unit price. Pension benefit expenditures are estimated separately for old-age pensions, early old-age pensions, survivor pensions, and disability pensions.

Total Pension Benefit

$$= \text{Old - Age Pension} + \text{Early Old - Age Pension} \\ + \text{Survivor Pension} + \text{Disability Pension}$$

The number of beneficiaries is projected by applying gender- and age-specific beneficiary incidence rates to contributors as they reach the pension benefit eligibility age. The specific formulas for calculating the number of pension beneficiaries and the benefit unit prices can be found in Appendix B.

Administrative expenses are projected based on the scale of pension benefit payments and the nominal wage growth rate. It is assumed that administrative expenses will maintain a constant proportion of the total pension benefits paid, while increasing at least at the nominal wage growth rate.

The number of National Pension beneficiaries is expected to grow from 5.975 million in 2023 to a peak of 18.111 million in 2053 before declining to 8.812 million by 2100. By beneficiary type, old-age pension recipients are projected to increase from 4.81 million in 2023 to a peak of 15.112 million in 2052 and then decline to 7.741 million by 2100. Survivor pension beneficiaries are expected to grow from 1.066 million in 2023 to 2.88 million in 2055 before decreasing to 1.004 million by 2100. Disability pension beneficiaries are projected to increase from 0.1 million in 2023 to 0.137 million in 2048 and subsequently fall to 0.068 million by 2100.

Comparing the projections for the number of contributors and beneficiaries, the number of contributors is expected to decline continuously due to demographic changes, while the number of beneficiaries will increase until the pension system reaches maturity in 2053, after which it will start to decrease. The number of contributors and beneficiaries is anticipated to equalize around 2042 at approximately 15.74 million. This gap will widen until 2061 and then gradually narrow.

National Pension expenditures are projected to increase from 29.2 trillion KRW in 2023 to 1,368.9 trillion KRW by 2100. By category, old-age pension payments are expected to rise from 25.1 trillion KRW in 2023 to 1,260.4 trillion KRW in 2100. Survivor pension payments are projected to increase from 2.8 trillion KRW in 2023 to 72.3 trillion KRW by 2100, and disability pension payments are expected to

increase from 0.5 trillion KRW in 2023 to 5.4 trillion KRW in 2100, though these amounts will remain smaller compared to old-age pensions. Administrative expenses are expected to grow from 0.8 trillion KRW in 2023 to 20.4 trillion KRW by 2100.

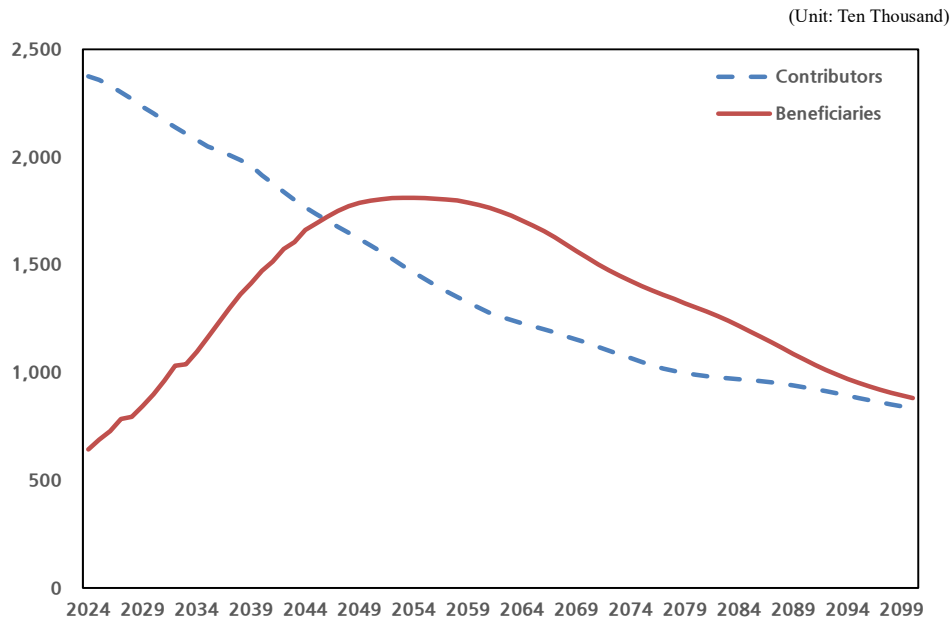


FIGURE 5. COMPARISON OF BENEFICIARY AND CONTRIBUTOR PROJECTIONS

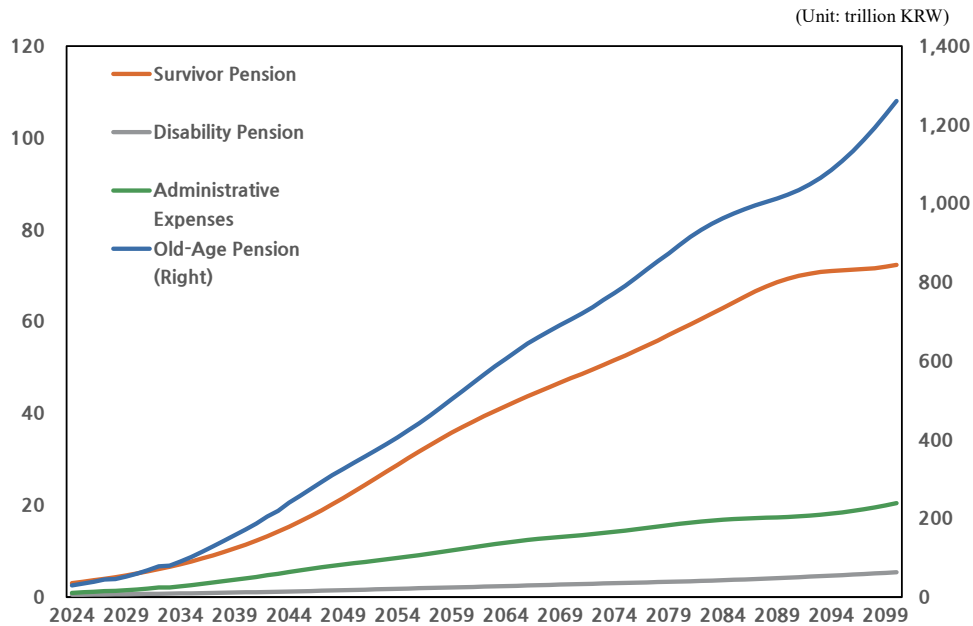


FIGURE 6. PROJECTION RESULTS BY EXPENDITURE CATEGORY

E. Fiscal Balance and Reserve Fund Projections

The fiscal balance of the National Pension is projected to shift from a surplus of 72.1 trillion KRW in 2023 to a deficit by 2040, expanding further to a deficit of -1,005.2 trillion KRW by 2100. The fiscal balance as a percentage of GDP is expected to decline gradually from 3.2% in 2023, turning negative in 2040, and increasing to -8.1% by 2080 before slightly recovering to -6.9% by 2100.

The National Pension reserve fund is projected to grow from 1,015.8 trillion KRW in 2023 to a peak of 1,972.0 trillion KRW in 2039, after which it will begin to decline, eventually becoming depleted by 2054. As a percentage of GDP, the reserve fund is expected to rise from 44.8% in 2023 to 54.1% in 2035 before gradually decreasing.

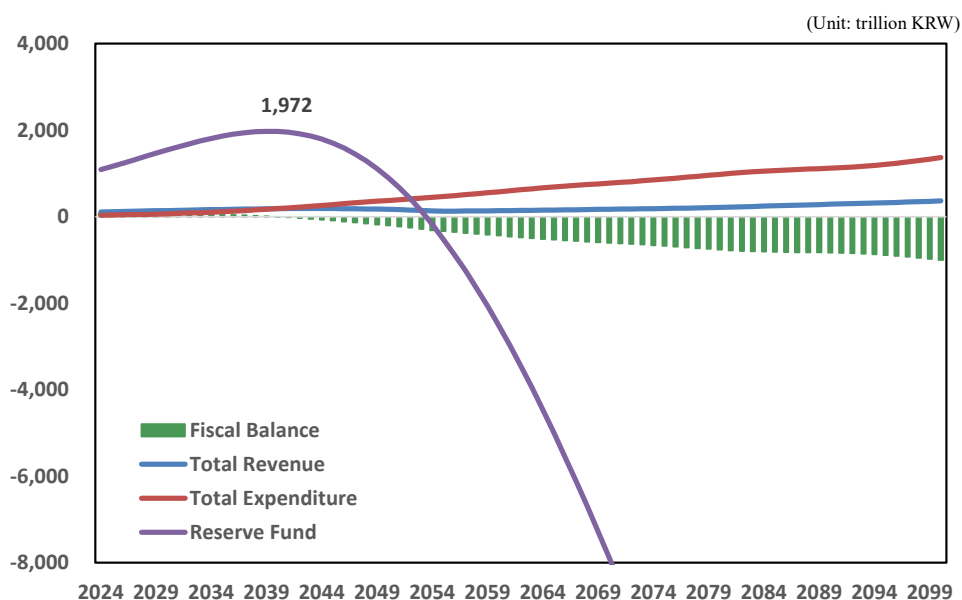


FIGURE 7. PROJECTION RESULTS FOR NATIONAL PENSION FISCAL BALANCE AND RESERVE FUND
(CONTRIBUTION RATE: 9%)

III. National Pension Contribution Rate Increase

Since the 1998 reform, the contribution rate for the National Pension has been fixed at 9%. The current contribution rate allows beneficiaries to receive more in benefits than they contribute. According to the Ministry of Health and Welfare (2023), the break-even contribution rate for a 25-year benefit period with a 40% income replacement rate is 19.8%. In other countries with benefit levels similar to those of South Korea, contribution rates are around 18%. According to OECD data (2021), the average contribution rate across OECD countries is 18.2%, placing South

Korea among the lowest in terms of contribution rates among OECD countries. Therefore, we project National Pension revenue, the fiscal balance, and reserve fund levels in scenarios where the current 9% contribution rate is increased to 18%.

A. Revenue Projections

National Pension revenue is projected to increase from 101.3 trillion KRW in 2023 to 542.0 trillion KRW by 2063, driven by growth in contributions and fund investment returns. Following this peak, total revenue may decrease slightly due to a decline in fund investment returns; however, from 2065 onward, overall revenue is expected to rise again due to an increase in contribution income.

Fund investment returns, which are influenced by the reserve fund size and return rates, are projected to reach a peak of 242.8 trillion KRW in 2058, the year following the reserve fund’s maximum level. As the reserve fund decreases, investment returns are also expected to decrease, and after the reserve is depleted in 2079, no further investment returns will be generated.

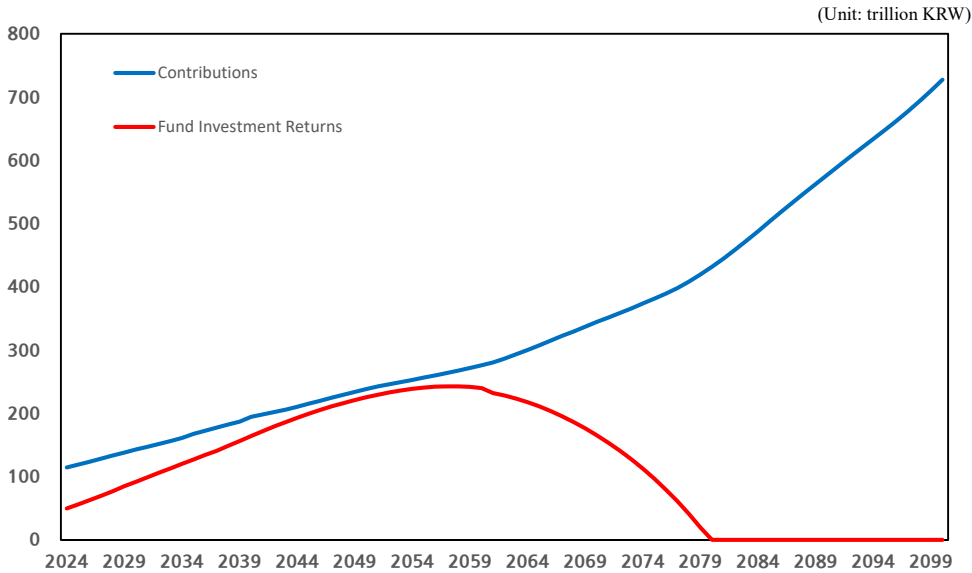


FIGURE 8. PROJECTION RESULTS FOR NATIONAL PENSION REVENUE (CONTRIBUTION RATE: 18%)

B. Fiscal Balance and Reserve Fund Projections

In a DB-based benefit system, even if contributions are increased, pension benefits remain unchanged. Therefore, if the contribution rate is raised to 18%, the National Pension’s fiscal balance is projected to shift to a deficit by 2057. The fiscal balance as a percentage of GDP is expected to rise from 3.2% in 2023 to a peak of 5.3% in 2035 before gradually declining and turning negative in 2057. By 2100, the deficit is projected to widen to -4.4% of GDP.

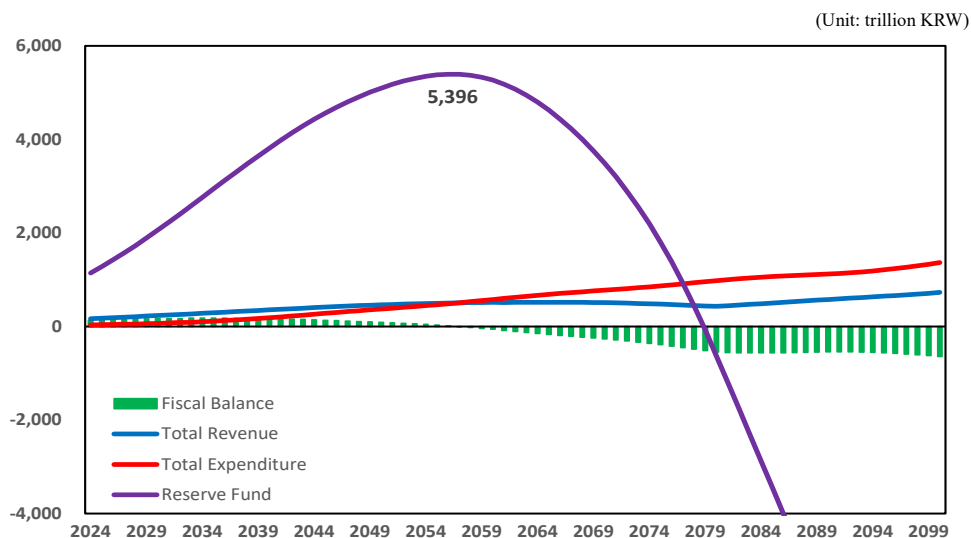


FIGURE 9. PROJECTION RESULTS FOR THE NATIONAL PENSION FISCAL BALANCE AND RESERVE FUND
(CONTRIBUTION RATE: 18%)

The National Pension reserve fund is expected to reach its peak of 5,396.0 trillion KRW in 2056 before gradually declining and ultimately becoming depleted by 2079. The reserve fund as a percentage of GDP is projected to rise to 100.6% in 2047 and then gradually decrease. In contrast, under the 18% contribution rate scenario from the 5th National Pension Financial Projection Committee's fiscal stability scenario, the reserve fund is projected to last until 2082. This discrepancy is primarily due to differences in the projected numbers of contributors and beneficiaries.

While the 5th fiscal recalculation anticipates a decrease in National Pension contributors from 21.99 million in 2023, this study projects a decrease from 18.61 million contributors in 2023. This difference in contributor numbers affects the projected number of beneficiaries. For instance, in 2080, the 5th fiscal recalculation projects 13.47 million old-age pension beneficiaries, while this model estimates 11.211 million.

C. Implications

In the National Pension contribution increase scenario, the important point is that even if the contribution rate is raised above the current level, the National Pension system is still not sustainable. The Private Advisory Committee of the National Assembly's Special Committee on Pension Reform (2023) proposed two options: Plan 1 suggests raising the contribution rate to 13% and the income replacement rate to 50%, while Plan 2 suggests raising the contribution rate to 12–15% and lowering the income replacement rate from the current 42.5% to 40%. The Special Committee reported that under Plan 1, the fund depletion point would be 2062, and under Plan 2, with a 15% contribution rate, the fund depletion point would be 2071.

Raising the current contribution rate (9%) would be a highly challenging reform

in practice. However, even if such a difficult reform were implemented, the current DB-based National Pension system structure would remain unable to maintain the reserve fund within the projection period, as pension benefits are paid under a DB model with a benefit-cost ratio exceeding 2, regardless of contributions made. Consequently, it would be challenging to guarantee pension payments for future generations after the reserve fund is depleted.

IV. Application of Structural Reform Measures

A. Structural Reform with a DC System

Public pension systems are broadly categorized based on funding methods into pay-as-you-go (PAYG) and funded systems. In a PAYG system, pensions for retirees are financed by contributions collected from the current working generation. In a funded system, pension contributions are invested to generate a fund that covers retirement benefits.

When categorized by benefit calculation methods, public pensions are typically divided into defined benefit (DB) and defined contribution (DC) schemes. In a DB scheme, benefits are determined based on an individual's work history (such as income history and years of contribution). In a DC scheme, benefits are based on the contributions made by the individual (plus interest/returns and expected life expectancy at retirement).

The core issue behind the depletion of South Korea's National Pension reserve fund lies in the current DB-based benefit calculation. As analyzed in the projection model, the old-age pension benefits in the National Pension are calculated based on a basic pension amount. The calculation formula combines (1) the average income of all contributors (the average over the three years before pension receipt, "A value") with (2) the individual's average income (income-proportional "B value") and applies a proportional constant (40% \rightarrow 1.2; a constant used to achieve a 40% income replacement rate). Finally, (3) the contribution period (with a 5% increase for each additional year based on a 20-year subscription) is considered.

In the current system, for 20-year beneficiaries, the benefit-cost ratio exceeds 1 across all income levels, meaning that recipients receive considerably more than their paid contributions. Thus, the system guarantees a predetermined pension amount based on contribution periods, independent of the total contributions paid. This structure relies on intergenerational transfers, where future generations' contributions fund the shortfall in benefits for the current generation.

Currently, many countries operate modified combinations of basic pension models. For instance, Germany and Japan (semi-PAYG, semi-DB systems) incorporate balance indices (macroeconomic adjustments) to integrate PAYG elements (income = expenditure), allowing for limited reserves or state subsidies, while partially compromising the principles of DB and PAYG. Sweden (semi-PAYG + Notional Defined Contribution, NDC) operates a quasi-PAYG system that maintains the "income = expenditure" principle. In the NDC model, individual

accounts accrue assets proportional to earned income, which are annuitized, and the financial burden of increased life expectancy is offset by benefit reductions.

Adopting an automatic stabilization mechanism, as seen in Finland, Japan, and Germany—where DB systems adjust benefits in response to demographic conditions—would not solve the sustainability issues of South Korea's National Pension. This is primarily due to South Korea's exceptionally low total fertility rate, which is unprecedented globally. Even with an automatic stabilization mechanism, the decline in future generations would result in contributions from fewer individuals being used to pay for the pensions of earlier generations, creating a high risk of a scenario in which future retirees do not receive their pensions.

In South Korea, simply raising the contribution rate while maintaining the current structure of the National Pension system, which faces potential fund depletion, is unlikely to gain support from younger generations. It is crucial to instill confidence that increased contributions will serve as a reliable source of retirement funds for contributors themselves in the future. To achieve this, a modified defined contribution (DC) system that accounts for cohort-specific life expectancies should be introduced as a "New Pension" after structural reform of the National Pension. The existing defined benefit (DB) system would then be designated as the "Old Pension," and any shortfalls in the "Old Pension" benefits would be covered through general government funds to ensure that all generations receive at least the principal repayment (an expected return ratio of 1) or more.

B. Construction of the Projection Model for the New Pension (DC System)

This section develops a financial projection model for the National Pension under a restructured defined contribution (DC) system, referred to as the "New Pension," starting in 2024.

National Pension contribution revenue is calculated by multiplying the annual number of contributors by the contribution rate and collection rate. The number of contributors, contribution rates, and collection rates for each year are also estimated following the existing projection model.

If the pension system transitions from a defined benefit (DB) model to a DC model in 2024, contributors aged 18-59 would continue paying contributions to the DB-based "Old Pension" until the end of 2023. Starting in 2024, all National Pension contributors will shift to the DC-based "New Pension." Thus, contributors aged 18-59 in 2024 will all be enrolled in the New Pension. When they reach retirement age and begin receiving old-age pension benefits, contributors who are 59 in 2024 will receive DB benefits, based on the existing formula and RI, A-value, and B-value, for contributions made up to age 58, while contributions made at age 59 will be governed under the DC model and provide DC benefits. It is assumed that there will be no provision for a lump-sum payment under the New and Old Pensions, similar to the current integration in public pension systems, even for individuals with fewer than ten years of contributions.

The DC model here adopts a cohort collective defined contribution (CCDC) approach, which provides an age-specific or cohort-specific insurance structure, ensuring a fixed annuity until death. This structure calculates contributions for each

cohort and distributes payments for each age group until death. In this design, the accumulated funds of deceased households within each cohort are transferred to the annuities of surviving members of the same age group. The cohort account remains invested, generating returns, and when all members of a particular cohort pass away, the remaining balance is fully depleted. This setup reflects social solidarity within each cohort, allowing those who pass away earlier than the average life expectancy to transfer income to those who live beyond it. It thus mitigates the risk of income gaps for individuals who live longer than the average life expectancy. This aspect differentiates the CCDC public pension model from the fully funded defined contribution (FDC) private pension system, which is based on individual accounts.

This paper examines the annual total income, total expenditures, the fiscal balance, and the reserve fund of the cohort-based DC pension model.

Table 1 below presents the projected revenue and expenditures of cohort virtual accounts and the resulting reserve fund.

In Table 1, I_t represents the average pension contribution amount for age t , r denotes the fund's investment return rate, M is the mortality rate, Ω represents the reserve fund, and d refers to the old-age pension benefit amount for cohort t . The value of d can be derived to bring the end-of-year reserve fund in cohort virtual accounts to zero by the final period $n + m$.

TABLE 1—RESERVE FUND OF COHORT VIRTUAL ACCOUNTS

t	Beginning of Year Fund	End of Year Cohort Account
1	0	$I_1(1 - M_1)$
2	Ω_1	$I_1(1 - M_1)(1 + r_1) + I_2(1 - M_1)(1 - M_2)$
3	Ω_2	$I_1(1 - M_1)(1 + r_1)(1 + r_2) +$ $I_2(1 - M_1)(1 - M_2)(1 + r_2) +$ $I_3(1 - M_1)(1 - M_2)(1 - M_3)$
\vdots	\vdots	\vdots
n (Pre-Retirement Pension Eligibility)	\vdots	$\Omega_n \equiv I_1[(1 - M_1)(1 + r_1) \cdots (1 + r_{n-1})]$ $+ \cdots + I_n[(1 - M_1) \cdots (1 - M_n)]$
$n + 1$ (Pension Benefit Start)	Ω_n	$\Omega_n(1 + r_n) - d(1 - M_{n+1})$
$n + 2$	Ω_{n+1}	$\Omega_n(1 + r_n)(1 + r_{n+1}) - d(1 - M_{n+1})(1 + r_{n+1})$ $- d(1 - M_{n+1})(1 - M_{n+2})$
\vdots	\vdots	\vdots
$n + m$ (Final Cohort Period)	Ω_{n+m-1}	$\Omega_n[(1 + r_n) \cdots (1 + r_{n+m-1})] - d(1 - M_{n+1})[(1 + r_{n+1}) \cdots (1 + r_{n+m-1})]$ $- \cdots - d[(1 - M_{n+1}) \cdots (1 - M_{n+m})]$

$$\begin{aligned} &\Omega_n [(1+r_n)\cdots(1+r_{n+m-1})] - d(1-M_{n+1})[(1+r_{n+1})\cdots(1+r_{n+m-1})] \\ &\quad - \cdots - d[(1-M_{n+1})\cdots(1-M_{n+m})] = 0 \\ \\ d &= \frac{\Omega_n [(1+r_n)\cdots(1+r_{n+m-1})]}{(1-M_{n+1})[(1+r_{n+1})\cdots(1+r_{n+m-1})] + \cdots + [(1-M_{n+1})(1-M_{n+2})\cdots(1-M_{n+m})]} \\ \\ d &= \frac{\Omega_n}{\frac{(1-M_{n+1})}{(1+r_n)} + \frac{(1-M_{n+1})(1-M_{n+2})}{(1+r_n)(1+r_{n+1})} + \cdots + \frac{[(1-M_{n+1})\cdots(1-M_{n+m})]}{[(1+r_n)\cdots(1+r_{n+m-1})]}} \end{aligned}$$

If the “New Pension” under the cohort-based DC model begins in 2024, contribution revenue is expected to grow from 60.1 trillion KRW in 2024 to 1,204.2 trillion KRW by 2100. For example, members of the 1965 cohort who make a single year’s contribution in 2024 will reach age 64 in 2029, at which point they will be eligible to start receiving pension benefits. Consequently, benefit expenditures will initially be minimal, rising from 12.4 trillion KRW in 2040 to 764.0 trillion KRW by 2100.

A key point is that in the cohort-based DC New Pension, individuals receive only the contributions they have made, along with investment returns, as pension benefits. As a result, the reserve fund will not be depleted, even with lower birth rates or an extended projection period.

In the cohort-based CDC “New Pension” system, if the contribution rate is increased from 9% to 18% in 2024, contribution revenue would rise from 120.2 trillion KRW in 2024 to 2,407.9 trillion KRW by 2100—exactly double the amount projected under the 9% contribution rate. Benefit expenditures would also increase from 24.9 trillion KRW in 2040 to 1,528.0 trillion KRW by 2100, again precisely double the expenditures in the 9% scenario. Unlike the DB pension model, where an increase in the contribution rate does not affect benefit expenditures, the cohort-based CDC model ensures that a doubling of the contribution rate results in a doubling of pension benefits.

TABLE 2—PROJECTION RESULTS FOR THE NATIONAL PENSION UNDER THE COHORT CDC SYSTEM
(CONTRIBUTION RATE: 9%)

(Unit: Trillion KRW)									
Category	2024	2030	2040	2050	2060	2070	2080	2090	2100
Revenue	60.1	96.4	177.3	285.8	412.5	549.9	714.5	937.1	1,204.2
Expenditure	0.0	0.4	12.4	57.0	155.2	303.0	460.9	563.4	764.0
Balance	60.1	96.1	164.8	228.8	257.3	247.0	253.6	373.7	440.2
Reserve Fund	60.1	542.7	1,870.3	3,877.2	6,383.9	8,842.4	11,383.9	11,481.8	18,765.8

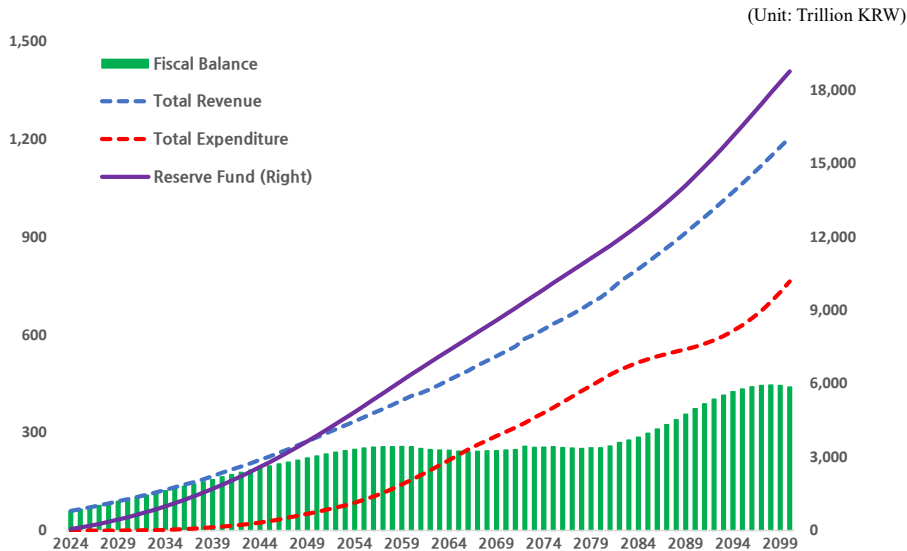


FIGURE 10. ANNUAL FISCAL BALANCE AND RESERVE FUND UNDER THE COHORT CDC SYSTEM BY YEAR
(CONTRIBUTION RATE: 9%)

TABLE 3—PROJECTION RESULTS FOR THE NATIONAL PENSION UNDER THE COHORT CDC SYSTEM
(CONTRIBUTION RATE: 18%)

(Unit: Trillion KRW)

Category	2024	2030	2040	2050	2060	2070	2080	2090	2100
Revenue	120.2	192.8	354.5	571.5	824.9	1,099.7	1,428.8	1,873.8	2,407.9
Expenditure	0.0	0.7	24.9	114.1	310.4	605.9	921.8	1,126.8	1,528.0
Balance	120.2	192.1	329.6	457.4	514.4	493.7	507.0	747.0	879.9
Reserve Fund	120.2	1,084.9	3,739.2	7,751.8	12,763.5	17,678.4	22,759.2	28,951.8	37,515.5

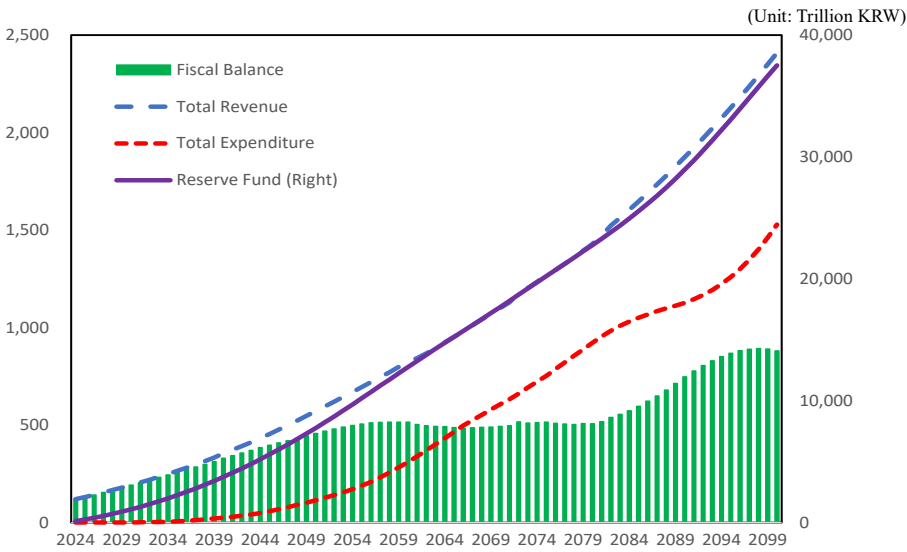


FIGURE 11. ANNUAL FISCAL BALANCE AND RESERVE FUND UNDER THE COHORT CDC SYSTEM BY YEAR
(CONTRIBUTION RATE: 18%)

V. Estimation of the Financial Shortfall in the National Pension

A. *Methods for Estimating the Financial Shortfall in Public Pensions*

The approaches used to estimate financial shortfalls in public pensions can be categorized as the “closed group without future accruals,” “closed group with future accruals,” and “open group” types, depending on whether future participants are included in the scope of the assessment.¹

The “closed group without future accruals” approach excludes new entrants and assumes that current participants, as of the evaluation date, will neither contribute further nor accrue additional benefits. The financial shortfall in this model is defined as the present value of future benefits owed to current beneficiaries and contributors at the evaluation date, less current reserves.

The “closed group with future accruals” approach, while also excluding new participants, assumes that current contributors will continue to make contributions beyond the evaluation date. Here, the financial shortfall is defined as the difference between the present value of entitlements for current beneficiaries, as well as the future benefits corresponding to both the past and projected contributions of existing participants, minus present and anticipated reserves.

The “open group” approach includes both current and future participants, assuming that the system will persist into the extended future. This method evaluates whether the combination of present assets and future contributions will be adequate to meet future benefit obligations fully.

The “closed group” approach is suitable for calculating transition costs in the context of a system overhaul or structural reform, such as transitioning to a new scheme. Conversely, if the public pension system is expected to continue under a pay-as-you-go or partially funded structure, the “open group” approach, which considers both current and prospective participants’ contributions and entitlements, provides a comprehensive means by which to evaluate pension liabilities.

B. *Estimation of the Financial Shortfall in the “Old Pension” using the Closed Group Method*

If current contributors start contributing to the “New Pension” from the point of National Pension reform, it is necessary to calculate the financial shortfall of the “Old Pension” based solely on the benefits corresponding to the contributions made by current beneficiaries and contributors up to the reform date (using the “closed group without future accruals” method).

If benefits are funded only by contributions made through 2023, the benefit shortfall

¹OECD (van den Noord and Herd, 1993), World Bank (Holzmann *et al.*, 2004).

TABLE 4—ESTIMATED BENEFIT SHORTFALL BY NATIONAL PENSION REFORM TIMING

(Unit: Trillion KRW, %, %p)			
Reform Year	2024 Reform (A)	2029 Reform (B)	Difference (B-A)
Benefit Shortfall (Unfunded Liability) (% of GDP)	609.0 (26.9)	869.9 (38.4)	260.9 (11.5)

is estimated to be 609.0 trillion KRW (26.9% of GDP, present value as of 2023²). Park (2023) estimated the unfunded liabilities as of 2021 as 599 trillion KRW using the same closed group method, with differences from this study primarily due to variations in the base year and benefit projection methods.³ The shortfall in the “Old Pension” benefits should not be covered by the “New Pension” reserve fund. Instead, it would be prudent to consider gradually injecting general revenue equivalent to 1% of GDP per year over the next 25 years to improve the sustainability of the National Pension system.

If National Pension reform is delayed by five years, and benefits are funded by contributions paid through 2028, the benefit shortfall would be 869.9 trillion KRW (38.4% of GDP, present value as of 2023⁴). This represents an increase of 260.9 trillion KRW (an additional 11.5 percentage points of GDP) compared to the implementation of the structural reform in 2024.

C. Estimation of the Financial Shortfall using the Open Group Method

If the National Pension system continues for an extended period without reform, it is necessary to estimate the increase in the financial shortfall (unfunded liability) using the open group method. In this method, if the evaluation period is t , assets are defined as the sum of the current reserve fund at the evaluation date and the present value of total contributions over t years from the evaluation date. Liabilities are defined as the present value of total benefit expenditures over t years from the evaluation date. The financial shortfall (unfunded liability) is then calculated by subtracting the assets from the liabilities at the evaluation date.

As of 2023, the estimated financial shortfall for the next 77 years (until 2100) is as follows⁵: the current reserve fund is 1,015.8 trillion KRW, the present value of

²In this calculation, the benefit shortfall is derived by applying the fund’s investment return rate as the discount rate across all periods. If the three-year government bond rate is used as the discount rate instead, the shortfall is estimated to be 1,525.5 trillion KRW (67.3% of GDP, present value as of 2023). Additionally, this calculation only considers old-age pension benefits. Including survivor and disability pension benefits would increase the total benefit shortfall.

³Park (2023) employs an indirect estimation method for calculating unfunded liabilities using an intergenerational net benefit model. This approach estimates the total expected pension benefits and total contributions to be paid during the employment period. The unfunded liabilities are then calculated by assuming that, at the point of pension reform, only a portion of the total pension benefits corresponding to the ratio of contributions already paid is guaranteed.

⁴Similarly, if the three-year government bond rate is applied as the discount rate across all periods, the benefit shortfall is estimated to be 2,213.4 trillion KRW (97.6% of GDP, present value as of 2023).

⁵Here, the discount rate applied is the fund’s investment return rate used in this study, to allow for comparisons with previous research.

contributions over 77 years (until 2100) is 2,245.3 trillion KRW, and the present value of benefit expenditures over 77 years (until 2100) is 5,582.3 trillion KRW.⁶ Therefore, the financial shortfall is calculated as 2,321.3 trillion KRW (102.4% of GDP).

Shin and Choi (2022) used the results of the 4th fiscal recalculation to estimate unfunded liabilities using the “open group” method, yielding a value of 1,735 trillion KRW for the next 70 years (2018–2088) and 3,453 trillion KRW for the next 150 years (2018–2168), based on the present value as of 2022.

D. Policy Implications of the Financial Shortfall

If the transition to a defined contribution (DC) scheme introduces a “New Pension” to ensure the long-term sustainability of the pension fund, it will be necessary to establish a plan for continued pension payments under the “Old Pension” for current beneficiaries and existing contributors whose contributions were made under the defined benefit (DB) system. Additionally, the shortfall in the “Old Pension” should not be covered by the reserve fund of the “New Pension.” Instead, it would be prudent gradually to allocate general fiscal resources, secured through taxes or expenditure restructuring, to the “Old Pension” to enhance the sustainability of the National Pension system.

The analysis in this study indicates that the financial shortfall of the “Old Pension” increases rapidly the longer pension reform is delayed. To reduce the burden on general government finances related to the shortfall in the pension fund, it is advisable that reform of the National Pension be implemented as soon as possible.

VI. Conclusion

As examined in Chapter III, while raising the contribution rate is necessary for ensuring the sustainability of the National Pension system, such a strategy is insufficient to resolve the issue of fund depletion on its own. The primary reasons for this are the rapidly aging population and an unprecedentedly low birth rate, which significantly impact the demographic structure.

Therefore, it is crucial to not only increase the contribution rate but also to transition to a funded defined contribution (DC) system. This approach would allow the pension system to better adapt to demographic changes while also ensuring intergenerational equity and enhancing long-term sustainability. As discussed in Chapter 4, a DC-type structure would prevent the depletion of the pension fund even if the demographic situation deteriorates beyond current projections. In a DC system, the adequacy of retirement income would largely depend on the level of the contribution rate increase.

⁶Here, only old-age pension benefits are considered. Including survivor and disability pension benefits could increase the benefit shortfall.

If the sustainability of the National Pension can be secured through a DC-based “New Pension,” it would be necessary to consider covering the financial shortfall of the “Old Pension” through general government revenues. The key point is that pension reform should be implemented as soon as possible to minimize the burden on public finances caused by the shortfall in the pension fund.

In a cohort-based DC system, it is possible to incorporate an income redistribution function or to establish it as income-proportional. However, it is evident, even without a detailed analysis, that even with an income redistribution function, the pension benefits for low-income retirees under a cohort-based DC system are likely to fall short of providing a minimum level of retirement income compared to the current DB system.

Therefore, to ensure adequate retirement income for low-income retirees, it is essential to discuss reforms to the Basic Pension system alongside reforms to the National Pension.

APPENDIX

A. Detailed Revenue Projection Method

The detailed method for projecting the number of contributors follows the equations below.

$$\begin{aligned} Ins_t(i, j) &= pop_t(i, j) \times epop_t(i, j) \\ Ins_t(i, j, k) &= Ins_{(t-1)}(i, j-1, k) \times move(i, j, k) \\ &\quad + emem_t(i, j, k) \times npop(i, j, k) \end{aligned}$$

Here, *emem* represents the economically active population, *pop* denotes the total population, *epop* is the labor force participation rate, *Ins* indicates the number of contributors, *move* represents the transition rate, and *npop* denotes the new entrant rate. Additionally, *i* indicates gender (*m* for male, *f* for female), *j* represents age (18–59 years), and *k* classifies contributor types (*w* for workplace, *r* for regional, *h* for pending contributors).

The contribution unit price for workplace contributors is calculated by applying the nominal wage growth rate to the standard monthly income and then multiplying this value by the contribution rate. For regional contributors, the unit price is calculated by applying the income ratio of regional contributors relative to workplace contributors' income to the standard monthly income and then multiplying by the contribution rate. In this calculation, the standard monthly income for both workplace and regional contributors, segmented by gender and age, is estimated using income indices categorized by contributor type, gender, and age.

$$Income_t(i, j, k) = A_t \times Income_index(i, j, k)$$

In this equation, *Income* represents the standard monthly income, calculated by gender, age, and contributor type. *Income_index* is the income index, categorized by gender, age, and contributor type, showing its relationship to the value *A*, which represents the average income of all National Pension contributors over the past three years. Similar to contributors, *i* indicates gender (*m* for male, *f* for female), *j* represents age (18–59 years), and *k* denotes contributor type (*w* for workplace, *r* for regional, *h* for pending).

Based on this, contribution revenue can be reorganized as follows:

$$\text{Contribution Revenue} = \sum_{i=1}^2 \sum_{j=18}^{59} \sum_{k=1}^3 \text{Ins}_t(i, j, k) \times \text{Income}_t(i, j, k) \\ \times 9\% \times \text{Collection Rate}_t(k)$$

Fund investment returns are calculated by multiplying the reserve fund at the end of the previous year by the fund investment return rate. The investment return rate is based on the projections provided in the 5th National Pension Financial Calculation results.

B. Detailed Expenditure Projection Method

First, the number of old-age pension beneficiaries is projected by applying the pension eligibility age and gender-based contribution period fulfillment rates.

Old-Age Pension

$$\begin{aligned} &= \text{number of Old-Age Pension Beneficiaries} \times \text{Old-Age Pension Unit Price} \\ &= \sum_{i=1}^2 \sum_{j=S}^{100} \text{amem}_t(i, j) \times \text{age}_t(i, j) \end{aligned}$$

Here, *amem* represents the number of old-age pension beneficiaries, and *age* denotes the old-age pension unit price. *i* indicates gender (*m* for male, *f* for female), and *j* represents age (*S*~100 years, where *S* is the starting age for old-age pension benefits).

The number of old-age pension beneficiaries is calculated by excluding deceased individuals from the previous year's old-age pension beneficiaries,

$$\text{amem}_t(i, j) = \text{amem}_{(t-1)}(i, j-1) \times (1 - M_t(i, j))$$

where *M* represents the mortality rate.

The old-age pension unit price at the start of pension receipt is calculated by combining the annual income replacement rate during the contribution period with the average income of all contributors over the three years preceding benefit receipt (*A*-value) and the income by gender and contribution period for beneficiaries (*B*-value). For contribution periods exceeding 20 years, an additional 5% is added. After the pension begins, the pension amount is assumed to increase annually based on the inflation rate projected by KDI.

$$age_t(i, j) = RI \times (A_t(i, j) + B_t(i, j, k)) \times (1 + 0.05 \times n)$$

$$age_t(i, j) = age_{(t-1)}(i, j - 1) \times (1 + CPI_t)$$

In this equation, RI represents the income replacement rate at the time of enrollment, A is the average standard monthly income for the past three years (the A -value), B is the average standard monthly income of the contributor (the B -value), n represents the period exceeding 20 years, and CPI stands for the consumer price inflation rate.

For early old-age pensions, the number of beneficiaries is projected by multiplying the number of eligible contributors by the gender- and age-specific benefit take-up rate.

Early Old-Age Pension

= Number of Early Old-Age Pension Beneficiaries
 × Early Old-Age Pension Unit Price

$$= \sum_{i=1}^2 \sum_{j=(S-5)}^{100} emem_t(i, j) \times eage_t(i, j)$$

Here, $emem$ represents the number of early old-age pension beneficiaries, and $emem$ denotes the early old-age pension unit price.

The number of early old-age pension beneficiaries is calculated by multiplying the number of contributors by the early old-age pension take-up rate. Subsequently, the number of beneficiaries is adjusted each year by excluding deceased individuals from the pool of initial beneficiaries.

$$emem_t(i, j) = Ins_t(i, j) \times EP_t(i, j)$$

$$emem_t(i, j) = emem_{(t-1)}(i, j - 1) \times (1 - M_t(i, j))$$

Here, EP represents the early old-age pension take-up rate, M denotes the mortality rate, i stands for gender (m for male, f for female), and j represents age (from the early old-age pension eligibility age onward).

For the early old-age pension unit price, a rate between 70% and 94% of the standard old-age pension amount is applied, depending on the period by which the pension is advanced:

$$eage_t(i, j) = age_t(i, j) \times \varepsilon$$

$$eage_t(i, j) = eage_{t-1}(i, j-1) \times (1 + CPI_t),$$

where ε represents the early old-age pension payment rate (70–94%) and CPI denotes the consumer price inflation rate.

The survivor pension is calculated by multiplying the number of survivor pension beneficiaries by the survivor pension unit price.

Survivor Pension

= Number of Survivor Pension Beneficiaries

× Survivor Pension Unit Price

$$= \sum_{i=1}^2 \sum_{j=ba}^{100} dmem_t(i, j) \times dage_t(i, j) + \sum_{i=1}^2 \sum_{j=ba}^{100} dlns_t(i, j) \times dage_t(i, j)$$

In this equation, $dmem$ represents the number of survivor pension beneficiaries upon the death of an old-age pension recipient, $dlns$ represents the number of survivor pension beneficiaries upon the death of a National Pension contributor, and $dage$ denotes the survivor pension unit price.

The number of survivor pension beneficiaries is projected by applying the gender- and age-specific survivor rate to cases in which a contributor or pension recipient passes away and meets the eligibility conditions for the survivor pension.

$$dmem_t(i, j) = amem_t(i, j) \times M(i, j) \times f_a$$

$$dmem_t(i, j) = dmem_{t-1}(i, j-1) \times (1 - M_t(i, j))$$

$$dlns_t(i, j) = lnst(i, j) \times M(i, j) \times f_a$$

$$dlns_t(i, j) = dlns_{t-1}(i, j-1) \times (1 - M_t(i, j))$$

Here, f_a represents the survivor rate, and i indicates gender (m for male, f for female), while j represents the age of the survivor pension recipient.

The survivor pension unit price is calculated by applying a rate of 40% to 60% of the deceased contributor's or former contributor's (pension recipient's) benefit, depending on the length of their contribution period:

$$dage_t(i, j) = age_t(i, j) \times \beta$$

$$dage_t(i, j) = dage_{(t-1)}(i, j-1) \times (1 + CPI_t)$$

where β represents the survivor pension payment rate, applied as a percentage of the basic pension amount: 40% for less than 10 years of contribution, 50% for 10 to 20 years, and 60% for more than 20 years of contribution.

A beneficiary eligible for dual benefits arises when a survivor pension recipient reaches the old-age pension eligibility age. Whether they qualify for dual benefits depends on the proportion of old-age pension recipients at that age. Based on the projected number of old-age pension recipients by year and gender, the proportion of those eligible for dual benefits is calculated by year, gender, and age. This proportion is then applied to the number of survivor pension recipients reaching the old-age pension eligibility age to estimate the number of dual-benefit recipients.

The rate at which old-age pensions are chosen among eligible dual-benefit recipients is determined by the length of the contribution period and the gender of the survivor. If the old-age pension is chosen, 30% of the survivor pension amount is added to the recipient's full old-age pension, making up the total benefit amount for dual-benefit recipients. Conversely, if the survivor pension is chosen, the recipient does not receive an old-age pension and thus does not qualify for dual benefits.

The disability pension is calculated by multiplying the number of disability pension beneficiaries by the disability pension unit price.

Disability Pension

$$= \text{Number of Disability Pension Beneficiaries}$$

$$\times \text{Disability Pension Unit Price}$$

$$= \sum_{i=1}^2 \sum_{j=da}^{100} pmem_t(i, j) \times page_t(i, j)$$

Here, $pmem$ represents the number of disability pension beneficiaries, and $page$ denotes the disability pension unit price.

The number of disability pension beneficiaries is projected by applying the disability incidence rate by gender and age to the pool of National Pension contributors, based on their contribution periods:

$$pmem_t(i, j) = Ins_t(i, j) \times p(i, j)$$

$$pmem_t(i, j) = pmem_{(t-1)}(i, j-1) \times (1 - M_t(i, j)) ,$$

where p represents the disability incidence rate, with i indicating gender (m for male, f for female) and j representing the age of the disability pension beneficiary.

The disability pension unit price is calculated by applying a rate of 60% to 100%, depending on the severity level of the disability.

$$page_t(i, j) = age_t(i, j) \times \gamma$$

$$page_t(i, j) = page_{(t-1)}(i, j-1) \times (1 + CPI_t)$$

In this equation, γ represents the disability pension payment rate, applied as a percentage of the basic pension amount: 100% for Grade 1, 80% for Grade 2, 60% for Grade 3, and 225% (as a lump-sum compensation amount) for Grade 4.

Once beneficiaries are assigned to each disability grade, their numbers decrease annually by applying gender- and age-specific mortality rates.

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