"Three Differential Losses" of Individual Account and Dynamic Adjustment of Annuity Divisor in China's Public Pension for Enterprise Employees

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The individual account of CPPEE

- The individual account of **China's Public Pension for Enterprise Employees** (CPPEE) is based on fully funded, with participants contributing 8% of their salary every month.

Contribution Rate	8%
Interest	Booking Interest Rate (BIR) published by Government
Initial Pension	The balance of Individual Account/Annuity Divisor
benefit growth rate	Set by Government
Inheritability	Account Balance Transfers to Heirs upon Death

Annuity Divisor

Annuity Divisor

- is an estimate of the benefits payment duration.
- is determined by the average life expectancy after retirement, retirement age, interest rates, and other factors.

- The current unisex annuity divisor table, known as the *05 table*, was developed in 2005 based on a life expectancy of 75 years for the urban population (Meng, 2008).

05 table

Problems of 05 Table:

- **Parameter definition error**. The table use average life expectancy at birth minus retirement age as the average life expectancy after retirement (Zeng et al., 2013).
- **No updates for a long time**. The table has not been revised for nearly two decades, and the assumptions used, such as average life expectancy, are lower than the current level. This results in individual accounts deviating from actuarial fairness (Yang, 2021).

Data from China's Seventh National Population Census (the 7th Census) show that in 2020, the average life expectancy in urban areas reached 79.77 years for men and 85.09 years for women.

The necessity of revising the annuity divisor table

- Thus, the 05 table underestimates the duration of benefit payments, resulting in the need to continue paying benefits even after individual account reserves are depleted. These additional payments are covered by the CPPEE pooling account or the government.
- The CPPEE has only been able to break even since 2014 with fiscal subsidies. From 2018 to 2022, fiscal subsidies for this pension fund exceeded 500 billion Yuan, accounting for an average of 15.81% of its total revenue.

Two issues

The 14th Five-Year Plan for the Development of Human Resources and Social Security proposes revising the individual account's annuity divisor table of the CPPEE. Many scholars have suggested establishing a dynamic adjustment mechanism for the annuity divisor table and updating it regularly. However, two issues need to be further explored regarding the dynamic adjustment of the annuity divisor.

- Besides the increasing life expectancy, the low **actual return rate** (ARR) is another key factor causing the individual account shortfall. How much can adjusting the annuity divisor help mitigate this shortfall?
- Which table should be adopted in the future, **the unisex annuity divisor table** or **the gender-specific annuity divisor table**?

BIR,ARR and benefit growth rate (1)

- The ARR of the pension is calculated by dividing the sum of interest revenue and entrusted investment income (collectively referred to as "investment returns") by the previous year's fund balance. Based on the data published in the *China Finance Yearbook* from 2019 to 2023, the average ARR of CPPEE from 2018 to 2022 is 3.53%.
- Before 2016, the BIR of individual account was set separately by provinces based on bank deposit rates, which were close to the ARR. After 2016, the Chinese government decided to unify the BIR nationwide, resulting in a sharp increase. From 2016 to 2022, the average BIR was 7.17%, significantly higher than the ARR.

BIR,ARR and benefit growth rate (2)

- The government uniformly announces the annual benefit growth rate of individual account pensions. From 2016 to 2022, the average benefit growth rate was 4.86%, higher than the average ARR.

	2016	2017	2018	2019	2020	2021	2022	Mean
ARR	2.92	\	4.13	3.47	5.11	3.53	2.02	3.53
BIR	8.31	7.12	8.29	7.61	6.04	6.69	6.12	7.17
Benefit growth rate	5.74	5.25	4.62	5.61	4.63	4.84	3.33	4.86

Book/Actual accumulation

Therefore, in addition to the **longevity differential loss** (LDL) caused by longevity risk, we must also calculate the interest and growth differential losses in the individual account due to excessively high BIR. Initially, we define the book and actual accumulations of the account based on BIR and ARR.

- **Book accumulation**:The accumulated amount of the participant's individual account calculated based on **BIR** when they retire.
- **Actual accumulation**:The accumulated amount of the participant's individual account calculated based on **ARR** when they retire.
- **Book initial pension**:Book accumulation/Annuity divisor.
- **Actual initial pension**:Actual accumulation/Annuity divisor.

Introduction of IDL and GDL

- Calculating interest on individual account funds at artificially high rates.
- **Consequence 1:** Book accumulation is higher than actual accumulation.
  - Discrepancy results in booked initial pension exceeding actual initial pension.
  - Refund upon participant's death is greater than actual balance, incurring **interest differential loss**(IDL).
- **Consequence 2:**
  - Inflated pension increases based on book balance and benefit growth rate.
  - Total pension increase during retirement surpasses total investment returns on actual account balance.
  - Leads to **growth differential loss** (GDL).

Current Research on Issue 1 (1)

- Yang and Shi (2016) argued that the individual account's shortfall is equivalent to the LDL, which represents the total actual initial pension received by the participant during the years beyond the predetermined payment period while they are alive. Many studies later adopted this definition. However, it is evident that this definition is incomplete.
- Zhou (2009) argues that a lower ARR compared to the BIR can result in "empty accounts" within individual accounts. Zhang et al. (2021) first provided a clear definition of IDL and estimated the IDL in individual accounts of participants under the assumptions of a 3% ARR and an 8% BIR. They concluded that even by adjusting the annuity divisor, it is difficult to achieve actuarial fairness when the BIR is greater than the ARR. However, they did not calculate the IDL due to the participant dies during the contribution period, nor did they calculate the annual pension deficit of all participants' individual accounts under the assumption of IDL.

Current Research on Issue 1 (2)

- Zhu and Huang (2012) found that an excessively high benefit growth rate can undermine the actuarial fairness of individual accounts. Yang (2015) decomposed the shortfall of individual accounts into LDL and GDL.
- However, to date, no literature has comprehensively studied all three differential losses (LDL, IDL, and GDL).
- Actuarial fairness, which requires that the present value of lifetime contributions equals the present value of lifetime benefits. Actuarial fairness relates to the entire lifetime of contributions and benefits (Queisser and Whitehouse, 2006).

Issue 2: Unisex or Gender-specific table

- The 05 Table is a unisex annuity divisor table, where the annuity divisors for male and female participants at the same retirement age are identical. This eliminates gender differences in the annuity divisor.
- However, most studies, including Jin (2016), Mu and Li (2020), and Wang and Li (2022), recommend that the CPPEE adopt a gender-specific annuity divisor table in the future. They argue that this option is the most conducive to achieving actuarial fairness in individual accounts, given that women have a higher average life expectancy than men.
- In contrast, countries with notional defined contribution (NDC) pension systems typically use unisex annuity divisor tables (Boado-Penas et al., 2022). Vidal-Meliá et al. (2019) contend that single-gender annuity factor tables can narrow the gender gap in pension benefits through redistribution effects.

Innovations (1)

- The comprehensive measurement of individual account deficit is crucial for assessing the effectiveness of dynamic adjustments to the annuity divisor. Utilizing the latest projections for indicators such as life expectancy, we have compiled both gender-specific and unisex annuity divisor tables, with adjustments made every five years. In comparison to existing literature, the novel contributions of this paper are as follows:

Decomposition of Individual Account Shortfall by Causes

- Derived calculation formulas for three differential losses (LDL, IDL, GDL).
- Clarified meanings from sufficiency and necessity perspectives.
- Investigated changes under various interest rate scenarios and annuity divisor tables.

Innovations (2)

Classification of Annual Deficit Across Participants

- Categorized annual deficit into in-service death return gap, pension payable gap, and inheritance gap.
- Provided macro-level analysis of annuity divisor adjustments' effects.

Comparative Analysis of Gender-Specific and Unisex Divisor Tables

- Contrasted impacts on individual account annual deficits and participant benefits.
- Offered recommendations for table selection.
- Highlighted practical implications and trade-offs associated with each method.

Symbol and Definition (1)

Symbol	Term	Definition
t	Year	
e,r,x,ω	Age	The e is entry age,r is retirement age,ω is the maximum age and x represents any age.
$\xi_{t,r}$	Annuity divisor	The annuity divisor for a participant who retires at age x in year t.
σ_t	benefit growth rate	
$Q_{t,r}^{+/-}$,$A_{t,r}^{+/-}$	Book/Actual accumulation	The superscripts "+" and "-" indicate the states before and after the payment of individual account benefits.
$I_{t,r}^{Q}$,$I_{t,r}^{A}$	Book/Actual initial pension	

Symbol and Definition (2)

Symbol	Term	Definition
$I^Q_{t,r}$, $I^A_{t,r}$	Book/Actual initial pension	The definitions have been explained.
${}_np_{t,r}$	Survival probability	The probability that a participant aged r at year t survives for an additional n years
i_t,j_t	ARR/BIR	The ARR/BIR in year t
$\hat{i}_t$	Expected return rate	The return rate used to calculate the annuity factor
λ	Contribution rate	
a	Continuous rate	The ratio of contribution years to working years, considering possible contribution breaks
π	Collection Rate	The ratio of CPPEE's actual contributed income to payable income. Because some wage items are included in the statistical wage but excluded from the contribution base

The annuity divisor under the actuarial fairness

The total present value of the participant's benefits under actuarial fairness is equal to the book accumulation at retirement::

$$Q_{t,r}^{+} = I_{t,r} \cdot \left[1 + \sum_{n=1}^{\omega - r} {}_{n}p_{t,r} \prod_{k=0}^{n-1} \left(\frac{1 + \sigma_{t+k}}{1 + \widehat{i}_{t+k}} \right) \right] \tag{1}$$

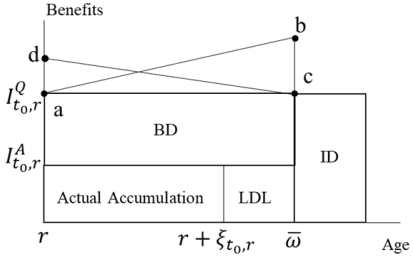
The annuity divisor $\xi_{t,r}$ for a participant at age r in year t is:

$$\xi_{t,r} = 1 + \sum_{n=1}^{\omega - r} {}_{n}p_{t,r} \prod_{k=0}^{n-1} \left(\frac{1 + \sigma_{t+k}}{1 + \widehat{i}_{t+k}} \right) \tag{2}$$

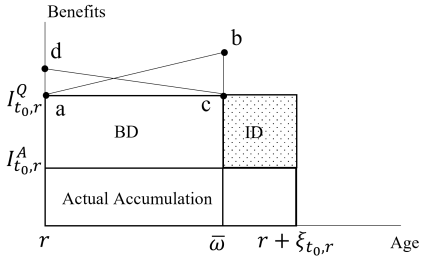
Three differential losses during retirement

Assuming $BIR > ARR$, $\sigma_t > 0$, the participant retires at age x in year t, and death occurs at age $\bar{\omega}$. We will discuss two case based on whether the remaining life expectancy after retirement is greater than the pre-estimated payment duration.

- Case1:the remaining life greater than the pre-estimated payment duration



- Case2:the remaining life **not** greater than the pre-estimated payment duration



Case1: longevity differential loss

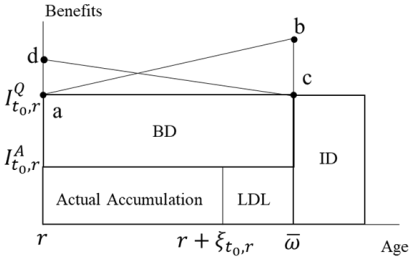


Figure 1: the remaining life greater than the pre-estimated payment duration

longevity differential loss (LDL)

The LDL is the total actual initial pension received by the participant during the years beyond the pre-estimated payment duration while they are alive.

$$I^A_{t_0,r} \cdot (N - \xi_{t_0,r})$$

- where, $N = \bar{\omega} - r + 1$ is the number of pension payment years.

Case1: Interest Differential Loss (1)

Interest Differential Loss (IDL)

The IDL represents the difference between the book accumulation and the actual accumulation resulting from a BIR that is higher than the ARR, equaling the sum of BD (benefit difference) and ID (inheritance difference).

- The **BD** represents the excess pension received by the participant due to the inflated BIR. It is calculated as the difference between the book initial pension and the actual initial pension, multiplied by the number of pension payment years:

$$N \cdot I_{t_0,r}^{QA}$$

where $I_{t_0,r}^{QA} = I_{t_0,r}^{Q} - I_{t_0,r}^{A}$.

Case1: Interest Differential Loss (2)

- The **ID** represents the excess inheritance amount from an individual account. As Labour [1997] No. 116, the individual account balance continues to accrue interest at the BIR after retirement payments. If BIR exceeds ARR, the actual balance may be depleted upon the participant's death, while a book balance remains for inheritance.
- The ID is:

$$\phi_{t_0+N-1,r+N-1} Q^{-}_{t_0+N-1,r+N-1}$$

- where $\phi_{t,x} = \begin{cases} 1 & , Q_{t,x} \geq 0 \\ 0 & , Q_{t,x} < 0 \end{cases}$ is the indicator variable, used to indicate whether an individual's account balance is zero.

Case1: Interest Differential Loss (3)

- $Q^{-}_{t_0+N-1,r+N-1}$ which is equal to the individual account's book accumulation at retirement, minus the pension expenditures, plus the interest accrued on the book balance for each year:

$$Q^{-}_{t_0+N-1,r+N-1} = Q^{+}_{t_0,r} - \sum_{n=0}^{N-1} I^{Q}_{t_0+n,r+n} + \sum_{n=0}^{N-1} R^{Q}_{t_0+n,r+n}$$

  - where $R^{Q}_{t_0+n,r+n} = \phi_{t_0+n-1,r+n-1} \cdot Q^{-}_{t_0+n-1,r+n-1} \cdot j_{t_0+n-1}$ denotes the interest generated by the book balance in t_0+n $(1 \leqslant n \leqslant N-1)$.

- So the IDL is:

$$N \cdot I^{QA}_{t_0,r} + \phi_{t_0+N-1,r+N-1} Q^{-}_{t_0+N-1,r+N-1}$$

Case1:Growth Differential Loss (1)

Growth Differential Loss (GDL)

The GDL is equal to the benefits increment minus the entire investment return on the actual balance of the individual account, which is the difference in the area abc and area adc.

- The area abc is the sum of the incremental benefits of the participants during retirement period. The participant' s benefit in $t_0 + n$ year is:

$$I^Q_{t_0+n,r+n} = I^Q_{t_0,r} \prod_{k=0}^{n-1} (1 + \sigma_{t_0+k}) = I^Q_{t_0,r} + \Delta I^\sigma_{t_0+n,r+n}$$

- where $\Delta I^\sigma_{t_0+n,r+n} = I^Q_{t_0,r} \left[\prod_{k=0}^{n-1} (1 + \sigma_{t_0+k}) - 1 \right]$ is the difference between the payable pension and the book initial pension in year $t_0 + n$.

Case1:Interest Differential Loss (2)

- The area abc equtal $\sum_{n=0}^{N-1} \Delta I^{\sigma}_{t_0+n,r+n}$, where:

$$\Delta I^{\sigma}_{t_0+n,r+n} = \begin{cases} 0 & ,n=0 \\ I^{Q}_{t_0,r} \sum_{k=0}^{n-1} \sigma_{t_0+k} \prod_{h=k+1}^{n} \frac{1+\sigma_{t_0+h}}{1+\sigma_{t_0+n}} & ,1 \le n \le N-1 \end{cases}$$

- The area adc represents the total investment return of the actual balance in the individual account during retirement:

$$\sum_{n=0}^{N-1} R^{A}_{t_0+n,r+n}$$

  - the actual return in t_0+n year is $R^{A}_{t_0+n,r+n} = \phi_{t_0+n-1,r+n-1} \cdot A^{-}_{t_0+n-1,r+n-1} \cdot i_{t_0+n-1}$

- So the GDL is $\sum_{n=0}^{N-1} (\Delta I^{\sigma}_{t_0+n,r+n} - R^{A}_{t_0+n,r+n})$

Case1: The three differential losses

So in Case 1, the individual account' s shortfall when the participant's death is the sum of the LDL, IDL and GDL:

$$\underbrace{\left(N-\xi_{t_0,r}\right)\cdot I^{A}_{t_0,r}}_{LDL}+\underbrace{\left(N\cdot I^{QA}_{t_0,r}+\phi_{t_0+N-1,r+N-1}Q^{-}_{t_0+N-1,r+N-1}\right)}_{IDL}+\underbrace{\sum_{n=0}^{N-1}\left(\Delta I^{\sigma}_{t_0+n,r+n}-R^{A}_{t_0+n,r+n}\right)}_{GDL}$$

Case2: The three differential losses

- The LDL is 0, and the BD is $N \cdot I_{t_0}^{QA}$

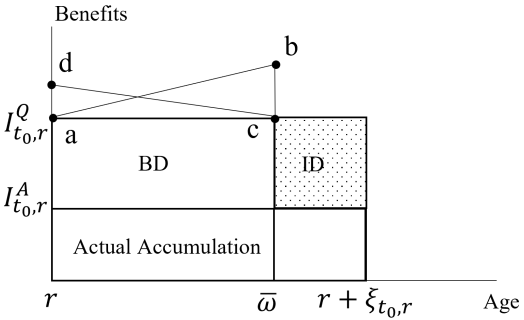


Figure 2: the individual account's shortfall in Case 2

- The inheritance difference is the shaded in figure 2, which equal to the book balance less the unpaid pension. The unpaid pension is the actual initial pension multiplied by the remaining payment duration.

$$\phi_{t_0+N-1,r+N-1} \cdot Q^{-}_{t_0+N-1,r+N-1} - (\xi_{t_0,r} - N) \cdot I^{A}_{t_0,r}$$

- The individual account' s shortfall when the participant death is the sum of the IDL and the GDL:

$$\underbrace{\left[N \cdot I_{t_0,r}^{QA} + \phi_{t_0+N-1,r+N-1} Q^{-}_{t_0+N-1,r+N-1} - \left(\xi_{t_0,r} - N\right) I^{A}_{t_0,r}\right]}_{IDL} + \underbrace{\sum_{n=0}^{N-1} \left(\Delta I^{\sigma}_{t_0+n,r+n} - R^{A}_{t_0+n,r+n}\right)}_{GDL}$$

Annual deficit of all participants' individual accounts

According to the "three differential losses", the annual deficit of the individual accounts of all participants can be summarized into three parts, namely, the in-service death return gap SG_t, the (pension) payable gap PG_t and the inheritance gap IG_t:

$$TG_t = SG_t + PG_t + IG_t$$

In-service Death Return Gap

- The in-service death gap refers to the difference between the individual account book accumulation and the actual accumulation if the participant death in contribution period.This gap come from IDL in contribution period:

$$SG_t = \sum_{x=e}^{r-1} \left[A^S_{t,x} - Q^S_{t,x} \right] \cdot D_{t,x}$$

- where the $D_{t,x}$is the number of active participants who died in year t age x $(e \leq x < r)$
- $A^S_{t,x}$ and $Q^S_{t,x}$ refers to the individual account's actual and book accumulation of the participant at age x in year t respectively:

$$Q^S_{t,x} = a\pi\lambda \cdot S_{t-1,x-1} \sum_{n=1}^{x-e+1} \left(\frac{1+g_{t-1}}{1+j_t} \prod_{k=1}^{n} \frac{1+j_{t-k+1}}{1+g_{t-k}} \right)$$

By replacing the BIR $j_t$with the ARR $i-t$in the formula, we can obtain the $A^S_{t,x}$.

Payable Gap

- The payable gap PG_t is the difference between the payable pension and the individual account's actual balance in year t:

$$PG_t = \sum_{x=r}^{\omega} L_{t,x} PG_{t,x}$$

- $L_{t,x}$is the number of surviving retirees aged x in year t, and the benefits gap $PG_{t,x}$ for retiree at age x in year $t$is:

$$PG_{t,x} = \begin{cases} 0 & ,\phi_{t-1,x-1} A^{-}_{t-1,x-1} (1+i_{t-1}) \geq I^{Q}_{t,x} \\ \phi_{t-1,x-1} A^{-}_{t-1,x-1} (1+i_{t-1}) - I^{Q}_{t,x} & ,\phi_{t-1,x-1} A^{-}_{t-1,x-1} (1+i_{t-1}) < I^{Q}_{t,x} \end{cases}$$

Inheritance Gap

- The inheritance gap IG_t is the difference between the inheritable amount and the actual balance of the individual account in year t for all deceased participants:

$$IG_t = \sum_{x=r}^{\omega} D_{t,x} IG_{t,x}$$

- $IG_{t,x}$ is the inheritance gap for a retired participant who dies at age x in year t:

$$IG_{t,x} = \begin{cases} 0 & , A^-_{t,x} \geq Q^-_{t,x} \\ \phi_{t,x} A^-_{t,x} - \phi_{t,x} Q^-_{t,x} & , A^-_{t,x} < Q^-_{t,x} \end{cases}$$

Parameter Assumption (1)

- Assuming the annuity divisor table will be adjusted starting from 2025, with updates every **5 years**.
- Due to the lack of detailed mortality statistics in China, we use the gender-specific and neutral mortality rates forecasted by the United Nations Population Division's WPP2022 for 2025-2060 to calculate the dynamic gender-specific annuity divisor table (*gender table*) and the dynamic unisex annuity divisor table (*unisex table*), respectively.

Parameter Assumption (2)

The main parameter settings:

Parameter	Setting
Contribution Rate,Continuous contribution rate,Collection Rate	8%, 85%, 55%
Entry Age	20 years old
Retirement Age	Male: 60 years old, Female Officials: 55 years old, Female Workers: 50 years old
Potential GDP Growth Rate	Forecasted by Zhang and Wang (2023) in the baseline scenario
Wage Growth Rate	GDP growth rate plus 3 percentage points
benefit growth rate	60% of the wage growth rate of the previous year
The gender- and age-specific wage structure	the proportion of the average wage of participant, categorized by gender and age group, to the overall average wage

Parameter Assumption (3)

- The BIR was 3.27% in 2015 and prior years (Yang and Shi, 2016), while for the period from 2016 to 2022, it was based on the data published by the government. Assuming the ARR was 3.22% up to 2022. Three interest rate scenarios were set for the forecast period depending on the relative sizes of the BIR and the ARR. For ease of comparison, it was assumed that both the BIR and the ARR were set as certain percentages of the wage growth rate of the previous year.

Table 1: Table: Interest Rate Scenario

Scenario	**Ratio of BIR to the wage growth rate**	**Ratio of ARR to the wage growth rate**
Difference	70%	30%
Same High	70%	70%
Same Low	30%	30%

Dynamic Annuity Divisor Table

- The annuity divisor in Table 05 is significantly lower than in the other two tables.
- Gender differences in annuity divisors will affect pension benefits for both males and females.

Year	Age	05 Table	Difference、Same High			Same Low		
			Gender Table		Unisex Table	Gender Table		Unisex Table
			Female	Male		Female	Male	
2025	50	16.25	29.39	25.81	27.60	41.03	34.77	37.88
	55	14.17	25.80	22.34	24.08	34.48	28.87	31.68
	60	11.58	22.15	18.88	20.54	28.37	23.44	25.94
2050	50	16.25	33.11	30.36	31.73	52.62	46.70	49.67
	55	14.17	29.21	26.54	27.88	43.83	38.60	41.24
	60	11.58	25.26	22.72	24.01	35.83	31.31	33.61

Overview

Part 1: Individual Account shortfall of Standard Participant

- We construct three types of standard participants: male worker, female official, and female worker.
- In 2025, they begin work and participate in the pension scheme at age 20, contributing at the statutory rate without interruption throughout their working life. The retirement ages are 60 for male, 55 for female official, and 50 for female worker. According to the WPP2022, the remaining life expectancy after retirement is set at 26, 33, and 37 years, respectively.

Part 2: Replacement Rate of Standard Participant

- Analyzes the redistribution effect of the unisex annuity divisor table.

Part 3: Annual Deficit

- For all participants,from 2025 to 2060

Difference Scenario（1）

- In Table 05, all individual accounts of the three standard participants experience significant shortfalls, with the GDL showing the most significant. In the two dynamically adjusted annuity divisor tables, these shortfalls decrease significantly.

(Thousand Yuan)

	Worker Type	Annuity Divisor	Shortfall	LDL	IDL	BD	ID	GDL
05 Table	Male	11.58	-10338.20	-2996.77	-2577.56	-2577.56	0	-4763.87
	Female Offical	14.17	-6712.88	-1753.05	-1296.67	-1296.67	0	-3663.16
	Female Worker	16.25	-4858.65	-1200.73	-769.97	-769.97	0	-2887.94
Gender Table	Male	24.29	-3513.54	-251.08	-1228.82	-1228.82	0	-2033.63
	Female Offical	30.18	-2313.00	-158.56	-608.81	-608.81	0	-1545.64
	Female Worker	33.63	-1740.01	-116.57	-372.05	-372.05	0	-1251.39
Unisex Table	Male	25.45	-3349.51	-137.06	-1300.22	-1172.82	-127.41	-1912.22
	Female Offical	28.91	-2488.91	-220.55	-635.55	-635.55	0	-1632.81
	Female Worker	32.29	-1864.97	-158.64	-387.49	-387.49	0	-1318.84

Difference Scenario（2）

- The two dynamic tables can directly reduce the LDL, and indirectly reduce both the IDL and GDL by decrease the book initial pension.
- Under the unisex table, when the male dies, the actual balance in his individual account was fully depleted, while the book balance remained at 127,410 yuan, resulting in a legacy difference of 127,410 yuan.

(Thousand Yuan)

	Worker Type	Annuity Divisor	Shortfall	LDL	IDL			GDL
						BD	ID	
05 Table	Male	11.58	-10338.20	-2996.77	-2577.56	-2577.56	0	-4763.87
	Female Offical	14.17	-6712.88	-1753.05	-1296.67	-1296.67	0	-3663.16
	Female Worker	16.25	-4858.65	-1200.73	-769.97	-769.97	0	-2887.94
Gender Table	Male	24.29	-3513.54	-251.08	-1228.82	-1228.82	0	-2033.63
	Female Offical	30.18	-2313.00	-158.56	-608.81	-608.81	0	-1545.64
	Female Worker	33.63	-1740.01	-116.57	-372.05	-372.05	0	-1251.39
Unisex Table	Male	25.45	-3349.51	-137.06	-1300.22	-1172.82	-127.41	-1912.22
	Female Offical	28.91	-2488.91	-220.55	-635.55	-635.55	0	-1632.81
	Female Worker	32.29	-1864.97	-158.64	-387.49	-387.49	0	-1318.84

Same High Scenario（1）

- Since the ARR is equal to the BIR, the IDL for all standard participants in the three tables is zero, wtih neither ID nor BD.
- Increasing the ARR enhances the investment returns on individual account balances, so under this scenario, the individual account shortfall for all standard participants are lower than the difference scenario.

(Thousand Yuan)

	Worker Type	Annuity Divisor	Shortfall	LDL	IDL	BD	ID	GDL
05 Table	Male	11.58	-8510.04	-4468.85	0	0	0	-4041.20
	Female Offical	14.17	-5673.62	-2509.31	0	0	0	-3164.31
	Female Worker	16.25	-4125.07	-1641.44	0	0	0	-2483.63
Gender Table	Male	24.29	-323.12	-374.42	0	0	0	51.30
	Female Offical	30.18	-188.20	-226.96	0	0	0	38.76
	Female Worker	33.63	-107.06	-159.36	0	0	0	52.30
Unisex Table	Male	25.45	127.41	-204.39	0	0	0	331.80
	Female Offical	28.91	-478.26	-315.70	0	0	0	-162.57
	Female Worker	32.29	-326.99	-216.86	0	0	0	-110.13

Same High Scenario（2）

- Since increasing the ARR also leads to a rise in the actual initial pension, the LDL under the 05 table is greater than that the "difference scenario".
- When a male standard participant dies under the unisex annuity divisor table 127,410 yuan, which can be paid to his heirs without resulting in a ID.

(Thousand Yuan)

	Worker Type	Annuity Divisor	Shortfall	LDL	IDL			GDL
						BD	ID	
05 Table	Male	11.58	-8510.04	-4468.85	0	0	0	-4041.20
	Female Offical	14.17	-5673.62	-2509.31	0	0	0	-3164.31
	Female Worker	16.25	-4125.07	-1641.44	0	0	0	-2483.63
Gender Table	Male	24.29	-323.12	-374.42	0	0	0	51.30
	Female Offical	30.18	-188.20	-226.96	0	0	0	38.76
	Female Worker	33.63	-107.06	-159.36	0	0	0	52.30
Unisex Table	Male	25.45	127.41	-204.39	0	0	0	331.80
	Female Offical	28.91	-478.26	-315.70	0	0	0	-162.57
	Female Worker	32.29	-326.99	-216.86	0	0	0	-110.13

Same Low Scenario（1）

- The LDL under these two dynamic tables are both zero. Due to the decrease in the BIR, the annuity divisors under the two dynamic tables are higher than those in the difference scenario and the same high scenario, exceeding the remaining life after retirement of the participants.
- The individual account shortfall for all standard participants under this scenario is the lowest among the three interest rate scenarios.

(Thousand Yuan)

	Worker Type	Annuity Divisor	Shortfall	LDL	IDL	BD	ID	GDL
05 Table	Male	11.58	-6072.47	-2996.77	0	0	0	-3075.69
	Female Offical	14.17	-4236.03	-1753.05	0	0	0	-2482.98
	Female Worker	16.25	-3256.01	-1200.73	0	0	0	-2055.27
Gender Table	Male	33.92	-13.45	0	459.12	0	459.12	-472.57
	Female Offical	45.54	-11.15	0	317.43	0	317.43	-328.58
	Female Worker	53.42	9.48	0	258.95	0	258.95	-249.47
Unisex Table	Male	36.04	195.76	0	564.50	0	564.50	-368.73
	Female Offical	43.04	-140.38	0	263.11	0	263.11	-403.49
	Female Worker	50.56	-86.40	0	222.86	0	222.86	-309.25

Same Low Scenario（2）

- According to the formula for calculating the ID in Case 2, under this scenario, when an participant dies, the product of the actual initial pension and the remaining payment duration for their individual account is larger, exceeding the book balance. Hence, the inheritance differences under the two types dynamic tables are positive.

(Thousand Yuan)

	Worker Type	Annuity Divisor	Shortfall	LDL	IDL	BD	ID	GDL
05 Table	Male	11.58	-6072.47	-2996.77	0	0	0	-3075.69
	Female Offical	14.17	-4236.03	-1753.05	0	0	0	-2482.98
	Female Worker	16.25	-3256.01	-1200.73	0	0	0	-2055.27
Gender Table	Male	33.92	-13.45	0	459.12	0	459.12	-472.57
	Female Offical	45.54	-11.15	0	317.43	0	317.43	-328.58
	Female Worker	53.42	9.48	0	258.95	0	258.95	-249.47
Unisex Table	Male	36.04	195.76	0	564.50	0	564.50	-368.73
	Female Offical	43.04	-140.38	0	263.11	0	263.11	-403.49
	Female Worker	50.56	-86.40	0	222.86	0	222.86	-309.25

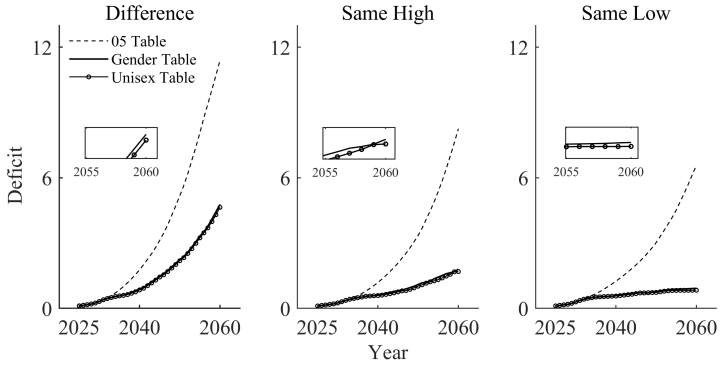
Redistribution Effect

- The replacement rates for participant are the same in the difference scenario and the same high scenario, but are the lowest in the same low scenario. The unisex annuity divisor table can reduce the gender gap in pension benefits through redistribution effects.

	Worker Type	Average Replacement Rate（%）		
		Difference	Same High	Same Low
05 Table	Male	16.12	16.12	10.81
	Female Offical	8.73	8.73	6.10
	Female Worker	6.66	6.66	4.87
Gender Table	Male	7.68	7.68	3.69
	Female Offical	4.10	4.10	1.90
	Female Worker	3.22	3.22	1.48
Unisex Table	Male	7.33	7.33	3.47
	Female Offical	4.28	4.28	2.01
	Female Worker	3.35	3.35	1.57

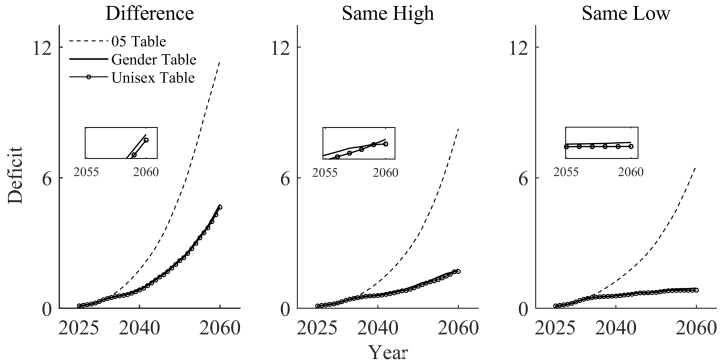
Annual Deficit(1)

- Since the two dynamic tables is only applied to new retirees in 2025 and beyond, the annual deficits differences under the three tables in the early period are small. As time goes on, the annual deficit under the two dynamic tables gradually becomes lower than that under the 2005 table.



Annual Deficit(2)

- The annuity deficits under the two dynamic tables have little difference, with the gap under the unisex table being slightly lower in the final forecast period. In the difference scenario, for example, the annuity deficits in 2060, from largest to smallest, are those of the 05 table (11.40 trillion yuan), the gender table (4.03 trillion yuan), and the unisex table (3.86 trillion yuan).



Annual Deficit (3)

- The following table shows the actuarial present values of annual deficits for individual accounts under different scenarios. If the ARR is increased while using the dynamic table, the actuarial present values of annual deficits under the gender table and the unisex table decrease by 74.76% and 75.87%, respectively. If the BIR is decreased while using the dynamic table, the corresponding decreases are 79.52% and 80.19%, respectively.

		Difference	Same High	Same Low
Actuarial Present Value of Annual Deficit (Trillions Yuan)	05 Table	49.27	33.55	30.54
	Gender Table	22.96	12.43	10.09
	Unisex Table	22.36	11.89	9.76
Percentage Decrease Relative to the "Difference and 05 Table" (%)	05 Table	\	31.91	38.02
	Gender Table	53.39	74.76	79.52
	Unisex Table	54.61	75.87	80.19

Annual Deficit(4)

- We decompose the annual deficit into in-service death return gap, payable gap, and inheritance gap.

Trillion Yuan

		Difference			Same High			Same Low		
		05 Table	Gender Table	Unisex Table	05 Table	Gender Table	Unisex Table	05 Table	Gender Table	Unisex Table
In-service Death Return Gap	2025	0.0065	0.0065	0.0065	0.0051	0.0051	0.0051	0.0047	0.0047	0.0047
	2030	0.0129	0.0129	0.0129	0.0061	0.0061	0.0061	0.0049	0.0049	0.0049
	2050	0.0428	0.0428	0.0428	0.0022	0.0022	0.0022	0.0011	0.0011	0.0011
	2060	0.0609	0.0609	0.0609	0	0	0	0	0	0
Payable Gap	2025	0.1039	0.1039	0.1039	0.1019	0.1019	0.1019	0.1039	0.1039	0.1039
	2030	0.2823	0.2823	0.2823	0.2303	0.2303	0.2303	0.2823	0.2823	0.2823
	2050	4.9852	1.8578	1.7869	3.3217	0.9978	0.9110	3.0122	0.7209	0.6789
	2060	11.1510	4.0339	3.8630	8.2393	1.6784	1.5669	6.5713	0.8669	0.7697
Inheritance Gap	2025	0.0069	0.0069	0.0069	0.0059	0.0059	0.0059	0.0055	0.0055	0.0055
	2030	0.0211	0.0213	0.0213	0.0133	0.0133	0.0133	0.0100	0.0100	0.0100
	2050	0.1427	0.3350	0.3599	0.0296	0.0953	0.1059	0.0116	0.0526	0.0531
	2060	0.1863	0.6836	0.7205	0.0137	0.1214	0.1264	0.0035	0.0569	0.0643
Annual Deficit	2025	0.1172	0.1172	0.1172	0.1128	0.1128	0.1128	0.1142	0.1142	0.1142
	2030	0.3162	0.3164	0.3165	0.2497	0.2497	0.2497	0.2971	0.2971	0.2971
	2050	5.1707	2.2357	2.1896	3.3535	1.0953	1.0191	3.0249	0.7746	0.7331
	2060	11.3982	4.7784	4.6444	8.2530	1.7998	1.6934	6.5748	0.9238	0.8340

Annual Deficit(5)

We find that:

- Under the difference scenario, the in-service death return gap for each year is equal across the three tables, because the gap stems from IDL during the contribution period and is not affected by the annuity divisor.
- The payable gap under the three tables are also the same in 2030. However, in subsequent years, the payable gaps under the two dynamic tables gradually decrease. This is because the dynamic tables only apply to new retirees, and the payable gap typically emerge after several payments. Therefore, there is a lag in the effect of increasing the annuity divisor to reduce the payable gap.
- Due to the increase in the annuity divisor, the predetermined payment duration is extended, reducing the annual pension payable. Consequently, the balance inheritable upon the participant's death and the inheritance gap increase. Therefore, the inheritance gap under the two dynamic tables are larger than those under the 05 table.

Annual Deficit(6)

- Thus, under the difference scenario, when using the dynamic annuity divisor table, the individual account deficit will initially increase, then decrease.
- Under the same high and low scenarios, since the BIR equals the ARR, the in-service death return gaps under the three tables decrease to zero. The variation patterns of the payable and inheritance gap under the two dynamic tables resemble those under the difference scenario. Therefore, there is a lag in the effect of the dynamic tables reducing annual deficits under these scenarios. At the forecast's outset, the annual deficits are identical to those under the 05 table, but they gradually diminish compared to the 05 table in later years.

Conclusion I

1. Increasing the annuity divisor can directly reduce the LDL and indirectly reduce the IDL and GDL by lowering the annual pension payable.
2. When dynamic adjusting the annuity divisor while increasing the ARR to the BIR, there is a significant reduction in LDL, IDL, and GDL, with no change in the average pension replacement rate.
3. Lowering the BIR to the ARR, although it can also reduce these three losses and minimize the shortfall, results in a substantial decrease in the average replacement rate.
4. Increasing the annuity divisor has no effect on the in-service death return gap, while the effect of decreasing the payable gap exhibits a lag, and the inheritance gap widens each year. Therefore, under the difference scenario, the annual deficit of individual accounts under the two dynamic tables initially increase and then decrease. Even when the BIR equals the ARR, there is a lag in the effect of reducing annual deficit under the two dynamic tables.

Conclusion II

5. Under the unisex annuity divisor table, not only is the annual deficit at the end of the forecast period lower than that under the gender-specific annuity divisor table, but the unisex table's redistribution effect can also reduce the gender gap in pension benefits.

Recommendation

- We recommend that China should promptly implement a dynamically adjusted unisex annuity divisor table while exploring ways to enhance the investment return rate of the CPPEE.

Thank you for listening. Your attention is greatly appreciated