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GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

A trade-off between old-age financial adequacy and state budget sustainability: Searching a government optimum solution to the pension system in Indonesia

Ahmad Irsan A. Moeis^{1*}, Nachrowi Djalal Nachrowi², Aris Ananta² and Vid Adrison²

Abstract: A generous PAYG defined benefit pension system can guarantee retirees to have comfortable life, but the state budget may not be sustainable when the population is ageing. On the other hand, a defined contribution pension system guarantees state budget sustainability, but making retirees' standard of living depends fully on their labour market performance (before retiring). The choice is even more difficult in developing countries with low budgets such as Indonesia. The defined contribution system is even more uncertain in promising old-age financial adequacy as people's income and investment rates are low. This paper uses a simple OLG model to find an optimal solution from the government perspective—how much state budget should be allocated for the PAYG defined benefit system. It concludes that with a small state budget allocation, as part of a PAYG defined contribution system, to supplement a defined contribution system, the government

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PUBLIC INTEREST STATEMENT

This paper develops a conceptual framework to the trade-off between old-age financial adequacy and state budget sustainability in the Indonesian pension system. It examines to what extent the government can use a small amount of state budget as a PAYG defined benefit pension system to supplement the defined contribution pension system. The solution is expected to both support the creation of old-age financial adequacy and maintain state budget sustainability.

of Indonesia can guarantee that retirees will not live under poverty while maintaining the state budget sustainability. It recommends that Indonesia combine a defined contribution system, to make a sustainable state budget, and a small budget allocation for a defined benefit system, to ensure that there is no old age poverty.

Subjects: Economics; Political Economy; Finance

Keywords: old-age financial adequacy; state budget sustainability; optimum solution; pension system; poverty

1. Introduction

Retirement is a celebration. It is a reward for years of working hard. During the retirement period, people do not have to work for money. They can be active socially. Old-age financial adequacy is guaranteed. This is what is often seen in rich countries with a generous pay-as-you-go (PAYG), defined benefit system, where pension pay-out is financed by current tax-payers. The state has full responsibility for providing old-age financial adequacy. However, with the ageing population, where people live longer, the ratio of the number of tax-payers to the number of pensioners becomes much smaller, resulting in a burden for the tax-payers and endangering the sustainability of the state budget (OECD, 2015).

Policies to solve this burden may include—among others—(1) raising the retirement age to delay the time to distribute the pension pay-out and make people contribute longer to the tax revenue, (2) increasing labour force participation and tax-payers' productivity to raise the tax revenues, and (3) increasing the tax rate (Kudrna et al., 2016). However, this policy on raising the retirement age can be politically challenging as people may not be happy to delay enjoying the retirement—the celebration, the reward. The option to increase tax revenue may also be politically challenging as the working-age population may feel that they are exploited to share the higher burden of financing the retirees.

Another option is to change the system from an unfunded defined benefit system to a fully funded defined contribution system. With the fully funded defined contribution system, state budget is sustained because the responsibility to provide old-age financial adequacy is shifted from the government to the individuals themselves, their families, and/or their communities. In the fully funded defined contribution system, individuals are forced to save during their working period. The saving is invested and the accumulated saving at the end of working time is distributed as a pension pay-out during the retirement period.

The issue is that those who do not perform well in the labour market, including those who are not in the labour market, will have small savings (or even worse, no savings). Therefore, they cannot invest. There will be a small, or no, accumulated saving by the end of the working time, and workers will retire poorly (Anderson & Klinger, 2016). For civil servants, military and police in Indonesia, a fully funded defined contribution system alone may not be sufficient to avoid old-age poverty (Ananta et al., 2021).

To solve this issue, the government may intervene by providing social assistance/social benefit, which can be targeted, stratified according to segments of the population, and/or given to all population (universalism). Whatever the type of social assistance, the government must set aside a certain amount of money from the tax revenue (Ravallion, 2016). With ageing population, the government's need for social assistance may rise rapidly. Consequently, the government faces a trade-off between helping create old-age financial adequacy and to minimizing the use of the state budget, to ensure budget sustainability.

The challenge in developing countries such as Indonesia is more daunting. Indonesia still faces the challenge of eradicating poverty of the whole population while its population is ageing.¹ As in other Asian countries, Indonesian older people used to have their financial support informally, from the families and/or communities. Nevertheless, population ageing and economic development have resulted in the erosion of informal old-age support, such as disappearing filial piety (Thang, 2019). At the same time, a formal pension system is yet to be developed. Even, pension pay-out in the civil servants, police, and military is meagre (Aris et al., 2021; Ananta et al., 2021). Therefore, being old can become suffering for both the older people themselves and the younger generations who want to take care of their parents/older generations.

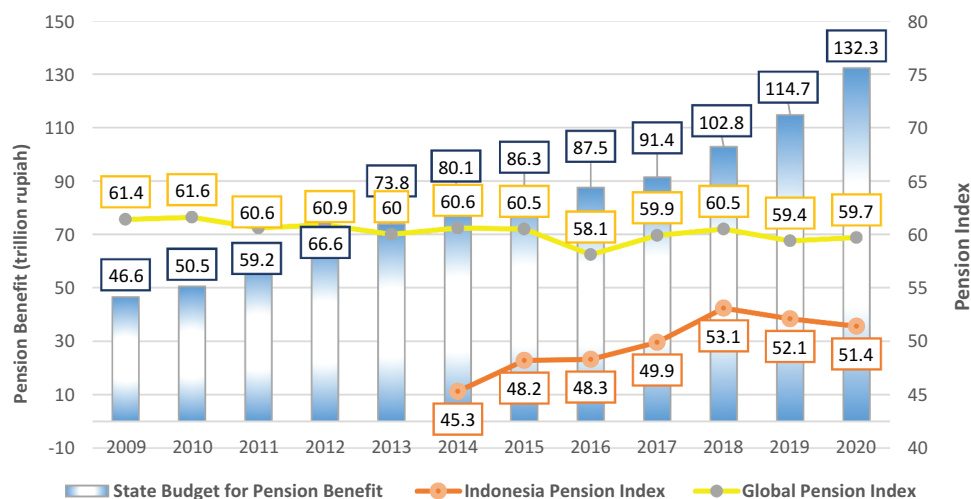
Therefore, the retirement period is not a celebration, not a reward. The retirement period may result in poverty or having a standard of living lower than the pre-retirement standard of living, if they simply rely on the current system. As a result, unlike in rich European countries with generous pension pay-out, higher retirement age is welcomed by the older workers in Indonesia, as their retirement pay-out is very small. However, this policy may be resisted by the younger workers who are afraid that their promotion can be delayed, if not prevented, because their seniors stay longer in the high positions.²

Similar to the trend in rich countries, the government of Indonesia has been considering changing the PAYG, a defined benefit system for the civil servants, military, and police into a fully funded defined contribution system, solving the issue of maintaining state budget sustainability. Nevertheless, Ananta et al. (2021) argued that by calculating the present values of possible future pension pay-out, the proposed defined contribution system still faces challenges on raising the rate of return from the investment of the saving and low premium (because of low income). They concluded that the retirees will have difficulties in having old age financial adequacy and maintaining the pre-retirement standard of living if the retirees depend solely on the pension system. They will suffer more as they age if the pension pay-out is constant in nominal value during the entire retirement period.

With the above situation, the government needs to intervene through its social assistance programmes. As in rich countries, the programmes are financed from tax revenue and hence may jeopardize state budget sustainability. However, taxation coverage in Indonesia is still low and the income of the people is lower than that in rich countries, resulting in low tax revenue. At the same time, the state budget has to pay an increasing amount of pension benefit in nominal term from 2007 until 2020 as shown in Figure 1.³ Yet, the pension adequacy remains low.

Figure 1. State budget for pension benefit and Indonesia pension index.

Source: *Nota Keuangan dan APBN Indonesia 2009–2020* and Melbourne Mercer Global Pension Index 2009–2020.



According to Melbourne Mercer Global Pension Index,⁴ Indonesia's pension index is lower than the world average and it has been declining since 2019. It was 51.4, near the lowest index (ranking at 30 out of 39 countries). The sub-index of pension adequacy is even worse, ranking at 33 from 39 countries.

The government then faces a trade-off between improving old-age financial adequacy and maintaining state budget sustainability. This paper contributes to this debate by examining a possible government's optimal solution to the trade-off.

This paper uses a mixed model, a fully funded defined contribution system supplemented with a PAYG defined benefit system in the form of a small state budget allocation to help the poor and enhance the pension pay-out of the non-poor. It therefore combines private and public saving for funding the retirees. Australia, for example, uses this system, using mean-tested, with a PAYG defined benefit system (Kudrna et al., 2022). It can also be in the form of the zero pillar or the first pillar (PAYG, defined benefit) of the World Bank's five pillar system (Holzmann & Hinz, 2005; Holzmann et al., 2008), where the benefit is allocated to everybody.

The specific question is how much the government should intervene to help achieve old-age financial adequacy while minimizing the fiscal burden. This paper responds to this question by developing a mathematical model to find an optimal solution from the government side. A simulation is carried out to find scenarios of improving old-age financial adequacy, while minimizing state fiscal burden.

This paper consists of five sections. The next section elaborates literature on who should be responsible to finance the older people, the pension systems, and old-age financial adequacy in Indonesia. The third section constructs the mathematical model to develop a government optimum solution for the pension system. The fourth section carries out a simulation to provide scenarios of the required state budget allocation according to the targeted pension pay-out, followed by a concluding remark in section 5.

2. Literature review

2.1. Who should finance the older people?

There are four sources of financial support for all individuals, including older people. What is seen in a country is very likely to be a combination of these four sources, with various weights given to each source. The best combination depends on the political economy and stage of economic development of the country.

The first source is the labour market, where people have to work hard and save for their retirement. The higher their earning and rate of return from the investment of the saving, the higher is the accumulated saving by the end of the working period. Therefore, they will have a better pension pay-out during their retirement time. This is what can be called a system with a very high degree of commodification. On the other hand, the system is characterized with de-commodification when people's welfare is detached from the labour market—when old-age financial adequacy is decoupled from people's labour market performance before retirement time. The term “de-commodification” was first used by Karl (1944), and later used and elaborated by Esping-Andersen (1990).

Closely related to de-commodification, Esping-Andersen (1990) also discussed de-stratification in the labour market. The labour market is highly stratified if the social insurance varies by occupation and social status. De-stratification means that social insurance does not depend on the occupation and social status of the individuals.

The second source is family. In an extended family system, family is likely to be the main source of old-age financial adequacy. On the contrary, a system where an individual, especially a woman, does

not much depend on the family for their financial support, is called a system characterized by de-familiarization (Esping-Andersen, 1999). De-familiarization can be important for older people during the second demographic transition, where family support (including filial piety) is disappearing.

The third source is from the community, which can provide informal social protection. In many developing countries, social protection may mainly depend on the community and family. The patron–client relationship is dominant here. De-clientelization is therefore a process of detachment from dependency on informal patrons (Wood & Goh, 2006). Yet, dependency on the community may also be in the form of philanthropy, religious obligation and/or mutual self-help.⁵

The fourth source is from the state, where the state guarantees the welfare of each individual, including the older people. It may mean the existence of a high degree of de-commodification, a high degree of de-stratification, a high-degree of de-familiarization, and a high degree of de-clientelization.

2.2. Pension systems

A generous pay-as-you-go (PAYG), defined benefit system, can guarantee comfortable life at old age. This system is found in most European countries, where the generous pension pay-out is financed by tax revenue from the current labour force (a PAYG system) and the benefit (pay-out) is guaranteed by the state. However, ageing population has threatened the state budget sustainability, as the ratio of the number of tax-payers to the number of retirees becomes smaller (Danzon et al. 2016, Mertl et al. 2019, and Wang 2021). As a result, young people need to save much more and/or postpone their retirement age to obtain pension benefits at the level enjoyed by current retirees (Amaglobeli et al. 2019).

Therefore, the European countries have been considering reforming their PAYG, defined benefit pension system and/or shifting to a defined contribution pension system, where individuals save from their income, invest the income, and use the accumulated saving to finance their old-ages (OECD 2016). The reform on the PAYG system includes increasing retirement age, raising labour participation rates, making eligibility rules more rigid, and making small pension pay-outs (Amaglobeli et al., 2021). A defined contribution system guarantees state budget sustainability as the responsibility to provide old-age financial adequacy is shifted from the state to the individual themselves.

Unlike in the generous PAYG system, the old-age financial adequacy in a defined contribution system depends much on individual performance in the labour market and the success in investing the saving. Those who do not earn much money, those who do not work, will have no pension pay-out. Furthermore, as shown in De Santis (2021), shifting from a PAYG, defined benefit pension system to a defined contribution pension system is complicated because the young generation will have to pay more—financing both the current older people and preparing the financing of themselves when they are old.

The PAYG system has also been used in some Asian countries such as South Korea and China. They faced the challenge to maintain their state budget sustainability as their populations have been ageing rapidly, with fertility rates much below replacement level. However, a system of social assistance such as universalism, where funding is spent on people without any socio-economic criteria and paid from the state budget, is also found in some “productivist”⁶ countries, e.g., Hong Kong, Taiwan, South Korea, and Singapore (Gee and Fong 2019).

Therefore, old-age financial adequacy and state budget sustainability are often seen as a trade-off (Babajanian, 2010; Baulch & Wood, 2008; Clark, 2012; Diamond, 2012). Countries have been then trying to solve the issue of state budget sustainability and old-age financial adequacy by

making programs with a combination of PAYG defined benefit system (state responsibility) and a defined contribution system (individual responsibility).

The question is which one is better—reforming the PAYG system or shifting to a defined contribution system (Clements, Eich, and Gupta, 2014). Lin et al. (2021) compared the two systems with respect to GDP per capita and long-run economic growth. They concluded that reform within the PAYG system provided better results than shifting to a defined contribution system. The reform can include higher retirement age, rising labour force participation rate, and low benefit applied to the new cohort.

On the other hand, rather than choosing either system, World Bank publications (Holzmann & Hinz, 2005; Holzmann et al., 2008) suggested a five-pillar pension system to overcome the trade-off. It is a combination of PAYG and defined contribution systems, expecting to reap the advantages of each system to create old-age financial adequacy and maintain state budget sustainability.

The World Bank publications elaborated that the “zero pillar” is to guarantee that no older people live in poverty. It can be in the form of a demogrant (universal scheme) for all older people, means-testing, or social assistance to targeted groups. This pillar is funded by the state budget. The first pillar is mandatory saving, but the pension pay-out is paid from current tax revenue—a defined contribution, with the PAYG system. The first pillar aims to help retirees achieve their pre-retirement standard of living. The second pillar is also mandatory, but this is not a PAYG. The retirees will obtain the cumulated invested saving by the time they start retiring. This is to improve the old-age financial adequacy. The third and fourth pillars are voluntary. The third pillar is a defined contribution system. The workers find their financial institutions to invest their voluntary savings, to be reaped when they retire. The fourth pillar is non-financial transfer. It can be an in-kind transfer from other family members and/or communities. A summary of issues of the World Bank’s five pillars is described in Table 1.

Table 1. Issues in World Bank’s five pillars

No	Pension scheme/ multi pillar	Issues	
		Adequacy/ Affordability	State financial sustainability
1.	Basic Needs Security/Zero Pillar	Provide security for the poor groups to live at a subsistence level	Potentially create fiscal burden as the number of older people rises
2.	PAYG/Defined Benefit/First Pillar -mandatory	Provide security for retirees to have a certain amount of financial adequacy in their retirement life	Potentially create fiscal burden with a rising number of older people and decreasing number of working people, assuming no increase in labour productivity
3.	Defined Contribution/Fully Funded/Second Pillar-mandatory	Not everybody is able to pay the contribution	Guarantee sustainability of the state budget
4.	Individual Savings/ Third Pillar -voluntary	Not everybody has sufficient income to save	Guarantee sustainability of the state budget
5.	Family Support/The Fourth Pillar -voluntary	How much the family must support; is the family rich enough to serve the support? Who should take the responsibility of taking care of older people?	Reduce state financial responsibility to take care of older people.

Source: Synthesized by the authors from the two World Bank publications (Holzmann & Hinz, 2005; Holzmann et al., 2008).

Countries may use different combinations and weights of the five pillars, depending on the condition in each country (Holzmann & Hinz, 2005; Holzmann et al., 2008). Park (2009) recommended that people (individuals, families, and communities) work together to find consensus on the relative weights given to the five core pension pillars. It should fit each country's needs, preferences, and capabilities. It becomes a political decision.

It should be noted here that the discussion on the pension system has been limited to examining contributions from individuals and the state only. A wider discussion on the pension system should include a possible contribution from family members and the community as discussed in Section 2.1.

2.3. Old-Age financial adequacy in Indonesia

Unlike rich European countries which started experiencing population ageing after they become rich, Asian emerging countries (e.g. China, India, Indonesia, Vietnam, and Thailand) face population ageing before they are rich. This phenomenon results in more challenges in financing older people in Asia, where informal old-age support is disappearing. Consequently, most older people in these countries are still working to create their old-age financial adequacy (Arifin and Ananta 2009; Teerawichitchainan et al. 2019).

Furthermore, as elaborated in ILO and ASEAN (2020), there are no Southeast Asian countries (with Indonesia as one of them) that have reached the same stage of old-age financial adequacy as those in European countries. The pension systems function simply as an “accessory”, to subsidize the needed old-age financial adequacy. The older people should find other sources, other than through the formal pension systems. Ananta et al. (2021) showed that civil servants, military, and police in Indonesia, under the proposed defined contribution system, will be able to maintain their pre-retirement standard of living only when the saving during the working period is invested with rate of return at least 9.0% annually and continue being invested with the same rate of return during the retirement period, as well as having high premium rate from total income (not basic salary).

It is then not surprising that, as shown in Aris et al. (2021), Indonesian older people may not be able to have financial adequacy. The current young people (future older people) perceived that merely depending on saving from their own labour market performance will not be sufficient to create their old-age financial adequacy, including maintaining the pre-retirement standard of living.

It is therefore important to discuss beyond the pension system to create old-age financial adequacy while maintaining state-budget sustainability. For example, it can employ the concept of Active Ageing (pioneered by WHO 2002), which can result in higher retirement ages, more productive workers, and healthier retirees implying less health expenditure.

3. Research method

3.1. Conceptual framework

This is a simple overlapping generation (OLG) model, combining a PAYG defined benefit system (state responsibility, in the form of an allocated budget to help the poor and enhance the pension pay-out of the non-poor), and a defined contribution system (individuals' responsibility). It has two time periods: working and retirement periods. People may work or may not work during the working period, and nobody is working in the retirement period. This model is expected to provide an optimal solution to the trade-off between assisting the creation of old-age financial adequacy and maintaining state financial sustainability from the government side.

A PAYG defined benefit system may help the creation of old-age financial adequacy but may threaten budget state sustainability on the other hand, while a defined contribution system can sustain the state budget, it may not be able to create old-age financial adequacy. Therefore, this model combines both systems: a fully defined contribution system and a PAYG defined benefit system. The funding (from the state budget) is used for two purposes. The first is to help non-

working people to retire just at the poverty line. The second is to increase the pension pay-out for those who work. This funding is invested in the working period and to be distributed in the retirement period.

The model has three agents: the government, workers (those who work during the working period), and non-workers (those who do not work in the working period). Each party has its own utility function.

3.2. Government utility function

The government allocates budget (B) to improve people's welfare for both workers and non-workers. With working period (t_1) and retirement period (t_2), the government invests an amount of B in pension development funds in t_1 for two purposes:

- (1) Non-workers (the poor) will receive basic needs security from the state and the amount refers to a poverty line (T_{nw}) in each period. However, to avoid market distortion in the form of working disincentives, the amount of basic needs security should not be higher than the pension benefit received by the workers
- (2) Extra payment for the workers (T_w) during their retirement period. This is necessary to provide incentives for the working group to keep them contributing to the pension system. If return (r) is too low, the low-income workers will have a lesser incentive to pay the contribution as their current income will be lower while their retirement pay-out will not be much different from the non-workers. This paper also assumes that providing additional incentives for workers will encourage non-workers to get jobs. Being a worker will increase the utility in the two periods of time.
- (3) In short, the government pays the benefit only to the non-workers in period 1 (t_1). However, in period 2 (t_2), the government pays the benefit to non-workers (the same amount as in t_1) and to workers.

The expected return of B is r . Therefore, the total amount of funding in t_2 is:

$$B_2 = (B_1 - T_{nw}^1)(1 + r) \quad (1)$$

B_2 refers to the government's fund available for retirement (t_2)

The intertemporal government's utility function is the sum of utility in period 1 and period 2.

$$U_G = U_{t_1} + U_{t_2} \quad (2)$$

The utility in each period is assumed to depend on funding available for each party: workers, non-workers, and government.

$$U_G = f\left(\left(I_w^1, I_{nw}^1, B_1\right), \left(I_w^2, I_{nw}^2, B_2\right)\right)$$

Therefore,

$$U_G = f\left(\left(I_w^1, I_{nw}^1, B_1\right), \left(I_w^2, I_{nw}^2, (B_1 - T_{nw}^1)(1 + r)\right)\right) \quad (3)$$

where, I_w^1 is workers' income in period 1; I_{nw}^1 is transfer payment received by the non-workers from the government in period 1; B_1 is budget allocation provision in period 1; I_w^2 is the available fund for

workers in period 2; I_{nw}^2 is transfer payment received by non-workers from the government in period 2; $(B_1 - T_{nw}^1)(1 + r)$ is budget allocation provision in period 2.

3.3. Workers utility function

Workers pay the premium of pension (contribution) by θ of their income I_1 during their working period. The fund will be invested with a guaranteed return of \bar{r} . The result of the investment will be distributed to the workers as a pension pay-out. Workers' utility function consists of two funds. First is the available fund in period 1. This is income after deducted with the contribution to be saved and invested. Second is the fund from the invested saving for consumption during period 2 supplemented with subsidy from the government.

Total available fund for consumption in working period (t_1) is:

$$I_w^1 = (1 - \theta)I_1 \quad (4)$$

Total available fund for consumption in retirement period (t_2) is:

$$I_w^2 = \theta I_1(1 + \bar{r}) \quad (5)$$

As workers will receive T_w from the government in period 2, their income in period 2 will be

$$I_w^2 = \theta I_1(1 + \bar{r}) + T_w \quad (6)$$

3.4. Non-workers utility function

The non-workers receive basic needs security from the government in every period. Basic needs security is equal to the poverty threshold and is equal in both periods (working and retirement periods).

Then

$$T_{nw}^1 = T_{nw}^2 = T_{nw} \quad (7)$$

Total available fund for consumption in working period (t_1) is:

$$I_{nw}^1 = T_{nw}^1 \quad (8)$$

Total available fund for consumption in retirement period (t_2) is:

$$I_{nw}^2 = T_{nw}^2 \quad (9)$$

3.5. Optimization

As the state budget is allocated to pay T_{nw} for non-workers in period 1 and period 2, and T_w for workers in period 2, equation (1) can be rewritten as:

$$(B_1 - T_{nw})(1 + r) = T_w + T_{nw} \quad (10)$$

$$B_1 = \frac{T_w + T_{nw}}{(1 + r)} + T_{nw} \quad (11)$$

Substituting equations (1), (4), (6), (8), (9), and (11) into equation (3) results in the following equation:

$$U_G = f((1 - \theta)I_1, T_{nw}, B_1), g(\theta I_1(1 + \bar{r}) + T_w, T_{nw}, (B_1 - T_{nw}^1)(1 + r)) \quad (12)$$

The setting above is based on the same length of the working period (t_1) and retirement period (t_2). Nevertheless, the time length between the two periods is usually different. The retirement

period is usually shorter than the working period ($t_2 < t_1$). Let τ be the ratio of length (years) of working-age period and length (years) of retirement-period. Then we have:

$$\tau = \frac{t_2}{t_1} \quad (13)$$

Including τ into equation (11), the government utility function is

$$U_G = f\left((1-\theta)I_1, T_{nw}, \widehat{B_1}^-\right), \tau g\left(\theta I_1(1+\bar{r}) + T_w, T_{nw}, \left(\widehat{B_1}^+ - T_{nw}^1\right)(1+r)\right) \quad (14)$$

$$F = U_G - \left((1-\theta)I_1, T_{nw}, \widehat{B_1}^-\right) - \tau g\left(\theta I_1(1+\bar{r}) + T_w, T_{nw}, \left(\widehat{B_1}^+ - T_{nw}^1\right)(1+r)\right)$$

Setting the total derivative of equation (14) equal to zero produces the following condition.

$$\frac{\partial F}{\partial B_1} \partial B_1 + \frac{\partial F}{\partial \tau} \partial \tau + \frac{\partial F}{\partial T_w} \partial T_w = 0$$

$$\frac{\partial F}{\partial B_1} \partial B_1 = -\frac{\partial F}{\partial \tau} \partial \tau - \frac{\partial F}{\partial T_w} \partial T_w \quad (15)$$

Dividing equation (15) with ∂T_w results in the following equation

$$\frac{\partial F}{\partial B_1} \frac{\partial B_1}{\partial T_w} = -\frac{\partial F}{\partial \tau} \frac{\partial \tau}{\partial T_w} - \frac{\partial F}{\partial T_w} \frac{\partial T_w}{\partial T_w}$$

$$\frac{\partial F}{\partial B_1} \frac{\partial B_1}{\partial T_w} = -\frac{\overbrace{\partial F}^0}{\partial \tau} \frac{\partial \tau}{\partial T_w} - \frac{\partial F}{\partial T_w}$$

$$\frac{\partial B_1}{\partial T_w} = -\frac{\frac{\partial F}{\partial T_w}}{\frac{\partial F}{\partial B_1}} \quad (16)$$

Dividing equation (15) with $\partial \tau$,

$$\frac{\partial F}{\partial B_1} \frac{\partial B_1}{\partial \tau} = -\frac{\partial F}{\partial \tau} \frac{\partial \tau}{\partial \tau} - \frac{\partial F}{\partial T_w} \frac{\partial T_w}{\partial \tau}$$

$$\frac{\partial F}{\partial B_1} \frac{\partial B_1}{\partial \tau} = -\frac{\partial F}{\partial \tau} - \frac{\overbrace{\partial F}^0}{\partial T_w} \frac{\partial T_w}{\partial \tau}$$

$$\frac{\partial B_1}{\partial \tau} = -\frac{\frac{\partial F}{\partial \tau}}{\frac{\partial F}{\partial B_1}} \quad (17)$$

Equations (16) and (17) imply that—holding r and other variables exogenous constant—the government utility can be optimized by changing T_w and the level of τ with the following features

- (1) Increasing T_w will create disutility for the government in period 1 as it reduces available funds for consumption in period 1. However, a larger T_w increases government utility in period 2, compensating the declining utility in period 1. There is a threshold, however, where further increase in T_w will decrease government total utility.
- (2) Suppose $t_1 = z - e_m$ and $t_2 = l_e - z$, where z is retirement age, e_m is the age that individuals enter the labour market and l_e is life expectancy, then z plays an important role in determining the length of the working period and retirement period. Higher z lengthens t_1 , shortens t_2 , and reduces τ . Higher z means people must work longer to finance their retirement period and a smaller government budget allocated to finance T_w . In other words, increasing the retirement age will increase government utility.

3.6. Simulation

The simulation uses data UN DESA (2015) for life expectancy in Indonesia ($l_e = 74$) and data from Statistical Yearbook of Indonesia (Statistics Indonesia, 2017) for basic needs (T_{nw} : mean value of urban and rural poverty line); n_w as number of individuals in age 60^+ who worked during age 20–59; n_{nw}^1 as the number of individuals who never worked during age 20–59; and n_{nw}^2 as the number of individuals aged 60^+ who never worked before. This paper assumes that individuals enter the labour market (e_m) at age 20 and retire at (z) is 60, and $t_1 = z - e_m$, equal to 40. Then, interest ($r = 5.85\%$) refers to Indonesia Obligation Series Number 014 (ORI014) issued in 2017. Hence, equation (11) is rewritten as

$$B_1 = \frac{T_w n_w + T_{nw} n_{nw}^2}{(1+r)^{t_1}} + T_{nw} n_{nw}^1 \quad (18)$$

Equation (18) is then used as the basis of simulation. It simulates the amount of allocated government budget in period 1 (B_1) to provide a targeted pension pay-out. B_1 is used to finance non-workers in period 1, with each receiving an amount equal to the poverty line (T_{nw}), which is equal to the mean of urban and rural poverty lines. Therefore, the total amount given to non-workers in period 1 is the number of non-workers (n_{nw}^1) multiplied by the poverty line or $T_{nw} n_{nw}^1$. At the same time, B_1 is also used to complement the income invested by workers in period 1, that is to increase the amount of funding the workers invest for retirement (period 2).

In period 2, the payment for non-workers in nominal terms is the same as that in period 1 ($T_{nw} n_{nw}^2 = T_{nw} n_{nw}^1$). In period 2, each worker receives the total amount invested in period 1 (from their contribution supplemented by government contribution). The payment for workers in period 2 is therefore equal to the amount invested multiplied by the number of workers.

To be sustainable, the amount of B_1 must be the same with the summation of government spending for non-workers in period 1 and the present value of government spending (for workers and non-workers) in period 2, with t (time of working years) equal to 40.

4. Results and discussion

The results of the simulation respond to the inability of a defined contribution system alone in guaranteeing an escape from old-age poverty as discussed in general by Anderson and Klinger (2016) and De Santis (2021) as well as for Indonesia in particular by Ananta et al. (2021). The simulation introduces a PAYG defined benefit system in the defined contribution system to avoid old-age poverty and enhance pension pay-out for non-poor while maintaining state budget sustainability.

Table 2 shows the results of the simulation in thousand Indonesian rupiahs. Based on data from Statistics Indonesia (2017), it simulates the needed allocated budget in period 1 according to 9

Table 2. A simulation for universal pension system

	T_w	nw	Tnw	nnw_2	$(Tw \times nw) \cdot (Tnw \times nnw_2)$	$1 + r$	t_1	$(1 + r)^{t_1}$	nnw_1	$(Tnw \times nnw_1)$	Budget
$T_w = 2Tnw$	722,534	10,924,824	361,267	38,315	7,907,398,729,121	1.059	40	9.71929	3,493,275	1,262,004,979,425	2,075,582,882,115
$T_w = 3Tnw$	1,083,801	10,924,824	361,267	38,315	11,854,177,121,129	1.059	40	9.71929	3,493,275	1,262,004,979,425	2,481,659,747,156
$T_w = 4Tnw$	1,445,068	10,924,824	361,267	38,315	15,800,955,513,137	1.059	40	9.71929	3,493,275	1,262,004,979,425	2,887,736,612,197
$T_w = 5Tnw$	1,806,335	10,924,824	361,267	38,315	19,747,733,905,145	1.059	40	9.71929	3,493,275	1,262,004,979,425	3,293,813,477,238
$T_w = 6Tnw$	2,167,602	10,924,824	361,267	38,315	23,694,512,297,153	1.059	40	9.71929	3,493,275	1,262,004,979,425	3,699,890,342,279
$T_w = 7Tnw$	2,528,869	10,924,824	361,267	38,315	27,641,290,689,161	1.059	40	9.71929	3,493,275	1,262,004,979,425	4,105,967,207,320
$T_w = 8Tnw$	2,890,136	10,924,824	361,267	38,315	31,588,069,081,169	1.059	40	9.71929	3,493,275	1,262,004,979,425	4,512,044,072,361
$T_w = 9Tnw$	3,251,403	10,924,824	361,267	38,315	35,534,847,473,177	1.059	40	9.71929	3,493,275	1,262,004,979,425	4,918,120,937,402
$T_w = 10Tnw$	3,612,670	10,924,824	361,267	38,315	39,481,625,865,185	1.059	40	9.71929	3,493,275	1,262,004,979,425	5,324,197,802,443

Source: Calculated by authors.

scenarios of targets the government wants to spend in period 2. The table provides scenarios from pension pay-out as low as twice the poverty line to as high as 10 times the poverty line (see column 1). The payment for non-workers is the same in both periods, equal to the poverty line. The last column indicates the needed budget (B_1), calculated with equation (18).

The second row of the table is a scenario with the lowest targeted pension pay-out for each worker, in the amount of twice the poverty line. Based on equation (18), the amount needed in period 1 (B_1) is 2.1 trillion rupiahs. In other words, with 2.1 trillion rupiahs spent in period 1, the government is able to provide each worker with a pension pay-out two times the poverty line and each non-worker with the poverty line. The 2.1 trillion rupiahs is sufficient to guarantee the retirees to be out of poverty, though not necessarily live decently.

The last row indicates a scenario with the highest targeted pension pay-out, to provide each worker with a pension pay-out 10 times the poverty line. Then, the needed allocated budget in period 1 is 5.3 trillion rupiahs. This scenario shows the importance of the amount of subsidy the government provides to supplement the workers' contribution to the retirement fund. In other words, the government needs to spend 5.3 trillion rupiahs to guarantee that non-workers are out of poverty in period 2 while the workers enjoy pension pay-out as much as 10 times the poverty lines. This is an improvement of the welfare of the workers, keeping the non-workers out of poverty, and guaranteeing state budget sustainability.

Furthermore, the amount of 5.3 trillion rupiahs is relatively a tiny amount compared to 132.3 trillion rupiahs the government spent on pension pay-out for only the civil servants, military, and police in 2020 (or a yearly average of 82.0 trillion rupiahs during 2009–2020).⁷ Therefore, the government has a much wider fiscal space to improve the pension pay-out. This improvement may not only avoid old-age poverty, but this is also a very good opportunity for the government to fulfil people's social right to decent old-age life. This finding supports Kudrna et al. (2022) where private saving and public pension can be combined to ensure that there is no old-age poverty while maintaining state budget sustainability. In particular, it also shows that the introduction of the zero or first pillar in the World Bank pension system (Holzmann & Hinz, 2005; Holzmann et al., 2008) is fiscally feasible in Indonesia. It also answers the challenge developing countries usually face in improving financial adequacy while maintaining state financial sustainability (Clements, Eich, and Gupta, 2014).

5. Conclusion and policy recommendations

The paper searches for a state optimum solution to the trade-off between state budget sustainability and old-age financial adequacy. It builds a simple mathematical model, which is then used to simulate the amount of government budget allocation needed to obtain some scenarios of targeted pension pay-out. It is a two-period model, where people are supposed to work in period 1 and to retire in period 2. A defined contribution system is built in the model, where workers contribute to their own retirement funding. However, a defined contribution system is unable to provide pension pay-out to those who do not work in period 1. Furthermore, the system may provide only a meagre pension pay-out for the workers. Therefore, the model is supplemented with a PAYG defined benefit system where the non-workers are guaranteed not to live under the poverty line when they retire; and the workers have several scenarios from pension pay-out as small as double the poverty line to as high as 10 times the poverty line.

It concludes that old-age financial adequacy, measured by escaping from being poor, can be created while sustaining the state budget by implementing a defined contribution system, supplemented with a social assistance, funded by the state. The funding needed for this social assistance is a tiny part of the current government expenditure on civil servants, the military, and police. The social assistance as a PAYG defined benefit system has two functions. First, to guarantee that non-workers do not retire below the poverty line. Second, to increase pension pay-out, as an incentive to work, by subsidizing the workers' contribution so that the workers can retire at double the poverty line.

Furthermore, the funding need is still relatively very tiny even when the workers are provided with pension pay-out at 10 times the poverty line. This implies that the government still has much wider fiscal space to improve the retirees' standard of living.

Further research should expand the model into many scenarios. For example, the model may allow shifts from non-workers to workers and vice versa; consider a change in expenditure by the individuals (not only income), especially health expenditure; permit a lower number of people at period 2 (retirement period) than in period 1 (working period); have higher ages at labour force entry and retirement, and use different rates of interest.

As the discussion on pension is limited to the two sources of old-age financial adequacy (from the individuals themselves and the government), further research should include the sources from family members and the community to create old-age financial adequacy. Further research on old-age financial adequacy should also go beyond pensions and financial aspects of old-age.

An important policy and economic implication is that a just and sustainable pension system can be carried by combining a defined contribution system and a defined benefit system. Justice is measured by a guarantee that there is no old-age poverty; and sustainability means that the state budget will not be in jeopardy.

Furthermore, policies on "active ageing" (making older people healthy, participating in social and/or economic activities, and secured socially and economically), for example, may be implemented to reduce health expenditure among older people and increase older-people labour force participation rate which will increase funding for old-age.

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Notes

1. See Arifin and Ananta (2016) for a discussion on population ageing Indonesia.
2. See Higo and Klasen (2016) for cases of resisting higher retirement age in Japan and South Korea.
3. Cited from Government of Indonesia (2007–2020), an annual Government Financial Statement and National

Budget. It elaborated the government development plans and programs, including its budget allocation.

4. See Melbourne Mercer (2009–2020).
5. For example, Muslim has *zakat* which can be mobilized to help the poor, including old-age poverty. The culture/ habit of mutual help is also found in many countries. In Indonesia and Brunei, it is called *gotong royong*.
6. "Productivist" system refers to a pension system which relies mostly on labour market—a system with a high degree of commodification.
7. See Figure 1 for the current state budget for pension.

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