EFFECTS OF THE NATIONAL SOCIAL SECURITY SYSTEM ON THE INDONESIAN ECONOMY: AN OVERLAPPING GENERATION MODEL

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ABSTRACT

Law 40 of 2004, which legislates for a national social security system, requires that the Indonesian government establish a social security system for all Indonesians. There are two models for pension schemes: pay as you go (PAYG) and fully-funded. This paper evaluates the effects of establishing a universal pension program under different pension schemes and uses an overlapping generation model to simulate the Indonesian economy. It is argued that the economic equilibrium would not be as high if a PAYG system were to be used; but a fully-funded scheme will not alter the competitive equilibrium. GDP under a PAYG scheme would be 8 per cent lower than it would be under a competitive or a fully-funded scheme. A simulation of the economy under different technology growth and population growth models found that both schemes would be sustainable as long as technology growth and productivity growth are higher than any decrease in population growth. However, if technology growth is lower than a decrease in population, and if the pension scheme is PAYG, then the government should inject funds to the pension scheme if it is to avoid budget deficit problems similar to those currently in European countries.

Keywords*: Social Security System, Overlapping Generation, Indonesian Economy, PAYG, Fully-funded.*

JEL classification: H530, H550, C540

I. BACKGROUND

Law 40 of 2004, otherwise known as Sistem Jaminan Sosial Nasional (SJSN) or the national social security system, requires the Indonesian Government to establish a social security system for all Indonesians. There will be five separate programs under the SJSN: pensions, old-age savings, health, worker compensation, and death benefits.

According to the Ministry of Finance's white paper on the SJSN, the definitions of the programs under SJSN are as follows:

1) *Pensions*: a program that will pay a lifetime monthly annuity to workers following their retirement, to workers who become disabled and to survivors of deceased workers or pensioners.
2) *Old-age savings*: a program that will pay a one-off benefit to workers at retirement. Under this program, workers will make contributions to individual accounts throughout their working lives. These contributions will be invested and the account balance will be paid as a lump sum at retirement (it is to be a fully-funded program).

3) *Health insurance*: a program that will provide comprehensive medical benefits to all Indonesians based on medical need.
4) *Workers compensation*: a program that pays benefits for those who are injured or die as a result of employment-related accidents or sickness.
5) *Death benefits*: a program that pays a modest lump-sum death benefit to the beneficiaries of a deceased worker to cover funeral expenses and may provide additional compensation to the family.

Based on when the benefit is delivered, there are two categories of program. The first category is direct benefit: in this category, people make contributions and may apply for and receive a benefit in the same period; in effect an insurance scheme. Health insurance and workers compensation belong in this category. The second category is indirect benefit: in this category, people make contributions while they are working and the benefit will be delivered when they have retired. Pension programs, old-age savings programs, and death benefits belong in this indirect-benefit category. This paper focuses on the indirect benefit category because it involves intergeneration transfer and can alter the dynamics of macroeconomic equilibrium. For the purposes of this paper I shall refer to the indirect-benefits category simply as the pensions program because it is similar to pension schemes in other countries.

Today, the economies of many countries have difficulties caused by an economic downturn ascribed to a rapid increase in public pension liabilities. The Greek Government's deficit, mainly caused by a too-generous pension system, has forced that government to ask for bailout funding from the European Union (EU) and the International Monetary Fund (IMF). The OECD has reported that the pressure of government deficits has made some other members of the EU increase the retirement age to 67 years, reduce the associated pension benefits, and increase the contribution period to 40 years. Sooner or later, the subsidy to sustain a universal pension system will affect all countries that have established such pension schemes based on the PAYG model. Table 1 shows the Implicit Pension Debt (IPD) for selected countries. All the countries that have an IPD more than their GDP will face serious problem sooner or later.

In the case of Indonesia, I found only two studies about social security reform. The first study is the SJSN white paper itself, which gives a detailed estimation of the cost and the establishment process of a national social security system but without any estimation of the effects on the Indonesian economy. The second study is by Arifianto (2004). He investigated qualitatively the costs and benefits of various ways to implement an SJSN and concluded that a fully-funded scheme (defined contribution) should be preferred rather than a PAYG scheme (defined benefit) because a fully-funded scheme can increase savings and these funds can be used for productive investments.

This paper will study the effect of a universal pension scheme on the Indonesian economy. I shall use the standard computable overlapping generation (OLG) model to simulate Indonesian economy.

Table 1. IPD in Latin American and OECD countries, 1998

Country	IPD/GDP (%)
Latin America	
Argentina	86 (305)
Bolivia	48 (31)
Chile	100 (131)
Colombia	40 (35)
Mexico	42 (37)
Peru	37 (45)
Uruguay	214 (289)
OECD	
USA	113
Japan	162
Germany	157
France	216
Italy	242
Canada	121
Australia	115
UK	184
Netherlands	188
Denmark	189
Switzerland	189
Sweden	210
Hungary	213
Poland	220

Latin America countries; from Brooks and James (1999) and figures in parenthesis from Bravo and Uthoff (1999). OECD Countries from World Bank database. Source: Yi (2008).

II. THE ECONOMY

The OLG models are developed for the Indonesian economy without a social security system, for the economy with a PAYG social security system, and for the economy where the social security system is fully funded. The details of the models are presented in Appendix 1.

In this model, the endogenous variable that differentiates the equilibrium conditions is the savings rate only, which determines the level of capital stock. Table 2 shows the comparison of savings rates under different regimes.

An economy without a pension system will generate the highest savings rate. Comparing such an economy with an economy with a PAYG pension scheme, the PAYG system will reduce savings by $(1-\mu-\frac{\mu.N_t}{\beta.R_{t+1}})$. A higher pension contribution (μ) will cause a lower private savings rate because individual disposable income is reduced proportionally with pension contribution.

Table 2. Savings rate

	No-pension system	PAYG	Fully-funded
Private savings	$\frac{\beta}{1+\beta}$	$s=\frac{\beta}{1+\beta}(1-\mu-\frac{\mu.N_t}{\beta.R_{t+1}})$	$\frac{\beta}{1+\beta}-\mu$
Public savings	0	0	µ
Total savings	$\frac{\beta}{1+\beta}$	$s=\frac{\beta}{1+\beta}(1-\mu-\frac{\mu.N_t}{\beta.R_{t+1}})$	$\frac{\beta}{1+\beta}$

The return on pension contributions in the PAYG system depends on the population growth (*n*) because with population growth there will be an increase in the number of the younger generation that can support the old-age generation increases. Therefore, a higher population growth allows individuals to save less. Meanwhile, the return on private savings is the market interest rate. Therefore, a higher interest rate will induce individuals to save more.

Comparing an economy that has a fully-funded pension scheme with an economy without a pension system, a fully-funded scheme is able to replicate the command optimum under a no-pension system as long as the pension contribution is less than the private savings rate under the economy without pension system ($\frac{\beta}{1+\beta} > \mu \frac{\beta}{1+\beta} > \mu$). In this setting, a fully-funded scheme will only transfer part of private savings to public savings. It can be said that fully-funded pension scheme is macroeconomically neutral.

However, if the contribution to a fully-funded pension scheme is set higher than the private savings rate in an economy without a pension system ($\frac{\beta}{1+\beta} < \mu \frac{\beta}{1+\beta} < \mu \frac{\beta}{1+\beta} < \mu \frac{\beta}{1+\beta} < \mu$), it will force individuals to save beyond their optimal rate (the savings rate in the competitive equilibrium). As a result, it will reduce total utility gained from consumption (consumption by the younger generation will decrease and consumption by the older generation will increase); however, the total capital stock and GDP per effective worker will be higher than in the economy without a pension system.

III. SIMULATION

3.1 Calibration

As a first step to simulation, calibration should be done, which will give values to the parameters such that the model will correspond to the real economy. We use Indonesian data from 1980 to 2009 taken from the International Monetary Fund's international finance statistics.

Each time period has been set to 30 years, which is common in the literature of the two-period OLG model. I impose steady-state conditions because non-steady-state calibration needs at least two OLG periods (60 years) in a data set and I have data from 1980 only (labour data are from 1985). This is reasonable because the average growth of GDP per worker is already 3 per cent per year as is the growth in other steady-state countries. The goodness of fit can be seen in Figure 1.

The yearly labour growth (n) is set to be 2 per cent per year as the average in the data set. It is implicitly assumed that the average GDP growth is 5.06 per cent; the product of (1+n) and (1+g). The private discount factor (β) is set to be 0.3 to match the quarterly private discount factor of 0.99, which is the common value in the literature of real business cycles.[1]

The capital share (α) is a third as in Mankiw, Romer and Weil (1992). The

[1] See Gali and Monacelli (2005) and Gertler, Gilchrist and Natalucci (2003).

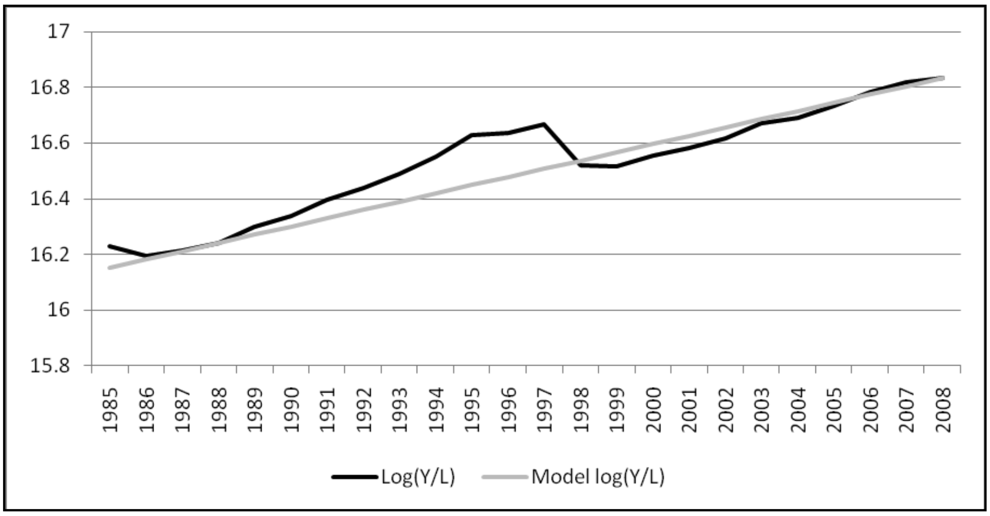

Figure 1. GDP per worker

pension contribution (μ) for simplicity is set to be 10 per cent. It is taken from estimations of the indirect benefit contribution in the SJSN white paper, which is 8 to 11 per cent. First-period, labour-augmented technology (A) is assumed equal to 1 and the level of endowment (E) is set to match log GDP per worker in 2008 in the production function. Other variables and parameters are determined in the model. A summary of the parameters setting is in Table 3.

3.2 Introduction of a Universal Pension Scheme

Table 4 shows the steady-state equilibrium in an economy without a pension system, in an economy with a PAYG scheme and in an economy with fully-funded scheme. In general, fully-funded schemes could replicate the equilibrium in the competitive economy (with no pension). The only difference is that the private savings rate under the fully-funded scheme is

Table 3. Parameters settings

Parameters	Setting	Reason
Year in t	30	Standard in two periods OLG model
G	3%	Average Y/L growth in the data set
N	2%	Average labour growth in the data set
α	⅓	Mankiw (1992)
µ	10%	SJSN white paper, with simplicity
A	1	Initial value, for simplicity
E	20.1	To match Y/L in 2008
B	0.3	To match a quarterly discount rate of 0.99 or annual real interest rate of 4 per cent in the real business cycle model

lower than in the competitive economy by as much as the contribution rate. Under a fully-funded scheme, the contribution rate will become the public savings rate.

Table 4. Economics variables in the steady state

Variables	No pension	PAYG	Fully-funded
s (private)	23%	19%	13%
s (public)	0%	0%	10%
k^*	0.587	0.457	0.587
y^*	16.83	15.48	16.83
r	7.8%	8.4%	7.8%
w	11.22	10.32	11.22
c_t^{y*}	8.64	8.31	8.64
c_t^{o*}	5.61	5.16	5.61
c_{t+1}^{o*}	24.67	22.69	24.67
Utility	3.11	3.05	3.11

If the government introduces a public pension system using the PAYG model, the savings rate will decrease by 4 percentage points to 19 per cent. As a result, the supply of capital in the market will decrease, which will force the interest rate to increase. It can be seen that the interest rate will increase from 7.8 to 8.4 per cent.

A lower savings rate leads to lower capital accumulation. In a steady-state system, capital per effective worker in PAYG is 22 per cent lower than in the fully-funded system. It leads to a lower GDP per effective worker by the difference of capital stock powered by capital share (α) or by 8.7 per cent. The other variables, such as consumption and wages, are just a constant portion of GDP per worker. Therefore, the level of the difference will follow the level of the difference in the GDP per worker.

If we assume that an economy with a PAYG scheme can reach a new equilibrium within one period or 30 years and that the adjustment is smooth, then the growth of the GDP per effective worker will be 2.7 per cent or slightly lower than in a competitive economy where it would be 3 per cent. At the end of first period (t+30), the economy will reach a new stable equilibrium. At the new equilibrium, GDP per worker with a PAYG system will be 8 per cent lower than the GDP per worker in the competitive or fully-funded system and this difference will be persistent. From this point forward, the GDP per worker in all economies will grow at the rate of technology growth, which is assumed to be 3 per cent per year. The evolution of GDP per worker can be seen in Figure 2.

3.3 Changing Population Growth

To simulate the dynamic effect of population growth, we assume that it will change straight after the economy has reached the new steady state at t+1. We assume that population growth will be 1 per cent and -1 per cent annually. Meanwhile, technology growth will be constant at 3 per cent. As we assumed before, the economy would reach the new equilibrium point smoothly within one period. The effect of the change in population growth can be seen in Table 5.

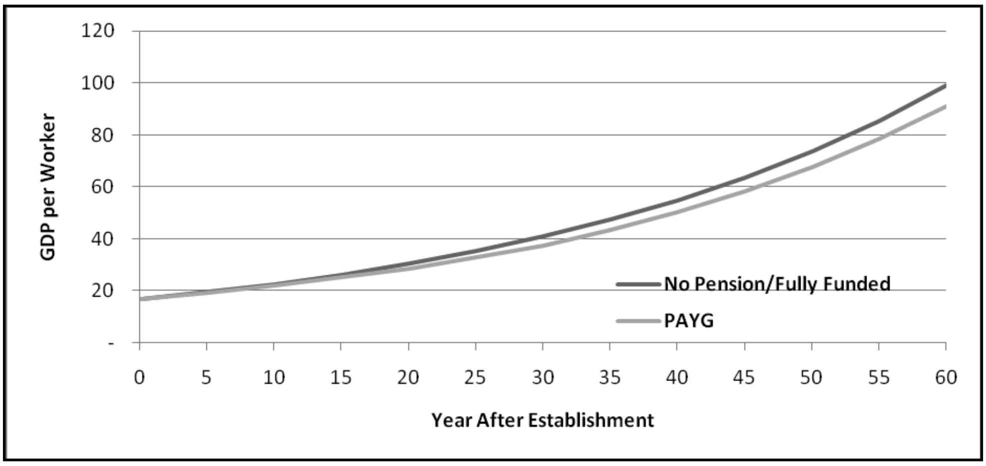

Figure 2. Evolution of GDP per worker

Table 5. Economic variables in various population growth scenarios

Variables	n_{t+2} = 2%		n_{t+2} = 1%		n_{t+2} = -1%	
	PAYG	Fully-funded	PAYG	Fully-funded	PAYG	Fully-funded
k^* (capital per effective worker)						
t	0.587	0.587	0.587	0.587	0.587	0.587
t+1	0.457	0.587	0.457	0.587	0.457	0.587
t+2	0.457	0.587	0.712	0.915	1.751	2.249
t+3	0.457	0.587	0.712	0.915	1.751	2.249
y^* (GDP per effective worker)						
t	16.83	16.83	16.83	16.83	16.83	16.83
t+1	15.48	16.83	15.48	16.83	15.48	16.83
t+2	15.48	16.83	17.95	19.51	24.23	26.34
t+3	15.48	16.83	17.95	19.51	24.23	26.34
$\frac{Y}{L}$ (GDP per worker)						
t	16.8	16.8	16.8	16.8	16.8	16.8
t+1	37.6	40.9	37.6	40.9	37.6	40.9
t+2	91.2	99.2	105.8	114.9	142.8	155.2
t+3	221.4	240.7	256.7	279.0	346.5	376.7
Y (GDP)						
t	16.8	16.8	16.8	16.8	16.8	16.8
t+1	68.1	74.0	68.1	74.0	68.1	74.0
t+2	299.2	325.3	258.2	280.6	191.3	207.9
t+3	1315.6	1430.4	844.7	918.1	343.4	373.3

**t*: initial equilibrium; *t+1*: pension reform; *t+2*: population growth change

When population growth is lower, the steady state of capital stock per effective worker (k*) will be higher because current capital is utilised by fewer workers. Compared with k* at 2 per cent population growth; k* at 1 per cent and at -1 per cent population growth is higher by 60 per cent and 280 per cent respectively. Meanwhile, k* under a PAYG scheme is lower than k*under a no-pension or a fully-funded scheme by 22 per cent in all population growth scenarios.

GDP per effective worker (y*) and GDP per worker (Y/L) have the same values in all scenarios. Smaller population growth means higher y* and Y/L. Compared with y* and K/L at 2 per cent population growth; y* and K/L at 1 per cent and -1 per cent population growth is higher by 16 per cent and 57 per cent respectively. Meanwhile, y* and K/L under a PAYG scheme is lower than y* and K/L under a no-pension or a fully-funded scheme by 8 per cent in all population growth scenarios.

Because the GDP (Y) is calculated as the product of (y) with N and G, a higher population growth will lead to a higher GDP. Compared with Y at a 2 per cent population growth; Y at 1 per cent and at -1 per cent population growth will be lower by 14 per cent and 36 per cent after one period, then by 36 per cent and 74 per cent after two periods. Meanwhile, Y under a PAYG scheme is lower than Y under a no-pension or a fully-funded scheme by 8 per cent in all population growth scenarios.

Under all scenarios, a universal pension system will be sustainable because exogenous, labour-augmented technology growth is higher than the change or decrease of the population. The technology growth effect in this setting will be greater than the effect of labour growth.

3.4 Decrease in The Growth of Labour-Augmented Technology

To isolate the effect of population decrease, we assume in this section that technology growth is lower than the change of population and is assumed to be 0. This condition is close to the conditions in some advanced economies that are currently facing massive government deficits because of the increase in their social security system's subsidy. Other reasons to support this assumption are that the future is uncertain: nobody can guarantee future growth rates. We might have no or even declining technology growth in the future. When the Indonesian economy becomes mature, productivity improvements will be more difficult and productivity might stagnate. Indonesia straddles part of the circum-Pacific seismic belt or the Pacific Ring of Fire and volcanic activity causes many natural disasters: earthquakes, volcanic eruptions and tidal waves, which can destroy infrastructure and decrease productivity.

Assume that in the period t+2 (30 years after the establishment of a pension system) the economy faces a recession that is characterised by no growth in labour-augmented technology. Table 6 shows what will happen to other economic variables under the difference scenarios of labour growth.

When population growth is lower, the steady state of capital stock per effective worker (k^*) will be higher because current capital is utilised by fewer workers. The increase in capital stock will be amplified by an increase in savings in the years after the change in technology growth because people should save more to maintain their current standards of consumption. Compared with k* at 2 per cent population growth; k* at 1 per cent and at -1 per

Table 6. Economic variables in various population growth scenarios without technology growth

Variables	n_{t+2} = 2%		n_{t+2} = 1%		n_{t+2} = -1%	
	PAYG	Fully-funded	PAYG	Fully-funded	PAYG	Fully-funded
*k** (capital per effective worker)						
t	0.587	0.587	0.587	0.587	0.587	0.587
t+1	0.457	0.587	0.457	0.587	0.457	0.587
t+2	1.523	2.22	2.38	3.46	5.86	8.51
t+3	1.523	2.22	2.38	3.46	5.86	8.51
*y** (GDP per effective worker)						
t	16.83	16.83	16.83	16.83	16.83	16.83
t+1	15.48	16.83	15.48	16.83	15.48	16.83
t+2	23.16	26.22	26.85	30.40	36.24	41.04
t+3	23.16	26.22	26.85	30.40	36.24	41.04
$\frac{Y}{L}$ $\frac{Y}{L}$ (GDP per worker)						
t	16.8	16.8	16.8	16.8	16.8	16.8
t+1	37.6	40.9	37.6	40.9	37.6	40.9
t+2	56.2	63.6	65.2	73.8	87.96	99.6
t+3	56.2	63.6	65.2	73.8	87.96	99.6
Y (GDP)						
t	16.8	16.8	16.8	16.8	16.8	16.8
t+1	68.1	74.0	50.6	55.1	27.8	30.2
t+2	184.4	208.8	159.1	180.2	117.9	133.5
t+3	334.1	378.2	214.5	242.8	87.2	98.7
T+4	605.2	685.1	289.1	327.3	64.5	73.0

**t*: initial equilibrium; *t+1*: pension reform; *t+2*: population and technology growth change cent population growth is higher by 60 per cent and 280 per cent respectively. Meanwhile, k* under a PAYG scheme is lower than k* under a no-pension or fully-funded scheme by 32 per cent in all population growth scenarios.

GDP per effective worker (y*) and GDP per worker (Y/L) share the same properties in all scenarios. Smaller population growth means higher y* and Y/L. Compared with y* and K/L at 2 per cent population growth; y* and K/L at 1 per cent and at -1 per cent population growth is higher by 16 per cent and 57 per cent respectively. However, y* and K/L under a PAYG scheme is lower than y* and K/L under a no-pension or a fully-funded scheme by 12 per cent in all population growth scenarios.

Because population growth is the only source of GDP growth in this setting, a higher population growth will lead to a higher GDP. Compared with Y at 2 per cent population growth; Y at 1 per cent and at -1 per cent population growth is lower by 14 per cent and 36 per cent after one period, and then by 36 per cent and 74 per cent after two periods. However, Y under a PAYG scheme is lower than Y under a no-pension or a fully-funded scheme by 8 per cent in all population growth scenarios.

The interesting feature in this setting is that when population decreases, GDP will decrease and the number of workers to support the pension system will decrease too. This will not be a problem under a fully-funded scheme because workers get their pension benefit from their pension account. In a PAYG scheme, current workers basically pay for current pension beneficiaries, which means that those benefits will decrease proportionally with a decrease in population. If this happens, that is, there is a population decrease then those eligible (in the main, the elderly) will receive pension benefits that are not commensurate or are less than they could expect or might be entitled to from the payments they made in the previous (or the contribution) period. If it is not politically possible for a government to reduce the benefit, it should inject funding to the pension system to ensure that the value to the beneficiaries is in line with the real value of their contributions and with their expectation. The amount of funding required as a percentage of GDP (θ) could be calculated as follows,

$$\theta_t = \frac{n_{t-1}.\mu.w_{t-1}}{y_t} = n_{t-1}.\mu.(1-\alpha)$$

Each year that the population decreases by 1 per cent, the government subsidy will need to be 0.067 per cent of GDP or in each model period it will be 1.73 per cent of GDP.

In the above equation, we see that the government deficit is proportional to the decrease in population and to the contribution rate. If population decreases faster, the deficit will become bigger. Furthermore, the deficit is also proportional to the size of the universal pension system, which is solely determined by the contribution rate. The bigger contribution rate in the PAYG scheme means that the government's contingent liability will become bigger.

IV. SENSITIVITY ANALYSIS

In the first exercise, I assume the capital share ratio (α) to be 0.53 as in Kariastanto (2009). In the second exercise, I assume the quarterly private discount rate to be 0.988 or the private discount rate to be 0.235, which implies an annual real interest rate of 5 per cent in the real business cycle model. As the baseline, and as is common in the literature, the quarterly private discount rate is set to be 0.99, which implies an annual real interest rate of 4 per cent. The result of the exercises can be seen in Table 7.

When the capital share increases from 0.33 to 0.53, people have a greater incentive to save. Therefore, the introduction of social security with a PAYG scheme only reduces savings rate by 2.8 per cent (in the baseline model, it reduces by 4 per cent). Because capital's share increases, the small decrease in the savings rate is translated to a bigger decrease in capital stocks and in GDP, by 25 per cent and 14 per cent respectively (in the baseline model, capital stocks and in GDP decrease by 18 per cent and 8 per cent respectively).

Table 7. Sensitivity analysis

Variables	No pension	PAYG	Fully-funded
α = 0.53			
s (private)	23%	20.2%	13%
s (public)	0%	0	10%
*k**	0.415	0.312	0.415
*y**	16.83	14.49	16.83
r	10.77%	11.26%	10.77%
w	7.91	6.81	7.91
$c_t^{y*} c_t^{y*}$	6.09	5.43	6.09
$c_t^{o*} c_t^{o*}$	8.92	7.68	8.92
Utility	2.91	2.74	2.91
β= 0.235			
s (private)	19%	16%	9%
s (public)	0%	0%	10%
*k**	0.485	0.376	0.485
*y**	16.83	13.7	16.83
r	8.5%	9.12%	8.5%
w	11.22	10.31	11.22
$c_t^{y*} c_t^{y*}$	9.09	8.65	9.09
$c_t^{o*} c_t^{o*}$	5.61	5.15	5.61
Utility	2.96	2.89	2.96

When we change private discount rate from 0.3 to 0.235, people will value current consumptions more than future consumption and as a result, they will save less. Table 7 shows the savings rate in the competitive equilibrium to be 19 per cent (in the baseline, the savings rate is 23 per cent) and consumption by the younger generation becomes much greater. Compared with the baseline, the effects of the introduction of social security under a PAYG scheme will also be greater; The savings rate, capital stocks and GDP decrease by 3 per cent, 22 per cent and 19 per cent respectively.

Overall, the effects of the establishment of a social security system in the sensitivity analysis are in the same direction as the effects in the baseline model. However, increases in capital share and decreases in private discount rate amplify the effects of the establishment of a social security system on the level of capital stocks and the GDP.

V. CONCLUSION

Introducing a universal pension system to the economy will cause changes in macro dynamic equilibrium. Under a PAYG scheme, the new equilibrium will be lower in all scenarios. If population and technology remain constant in the future, capital stock and GDP under a PAYG scheme will be 22 per cent and 8 per cent lower than if there were no pension scheme. Under a fully-funded scheme, the equilibrium will not change as long as the contribution to the pension system is lower than the current savings rate.

A fully-funded scheme will be sustainable under all scenarios but a PAYG scheme's sustainability is dependent on productivity and on technology growth and population growth. As long as technology grows faster than the increase in the labour force, the PAYG scheme will be sustainable.

If technology growth is lower than a decrease in population, a PAYG pension scheme will be under threat and the government should give subsidies to the system. In the simulation section, where I assume no technology growth, a government subsidy, as a percentage of GDP, will be proportional to the rate of population decrease and the contribution rate. It means that if the population decreases faster, the government subsidy must increase faster too. It also implies that a higher contribution rate (a bigger pension system) will create higher government contingent liabilities.

If the Indonesian government is to establish a universal pension system, a fully-funded scheme should be preferred to a PAYG scheme because a fully-funded scheme will not alter the competitive equilibrium in the economy and is sustainable under various conditions. A PAYG scheme will not be sustainable if the productivity growth is less than a decrease in population. However, in the SJSN white paper, the government intends to use PAYG. One reason is that a PAYG scheme is easier to implement (administratively less complicated than a fully-funded scheme) and politically more acceptable because the benefits will be directly enjoyed by the current generation.

There are limitations in this study, so more studies should be conducted to address some issues. First, there should be studies that assume population growth to be endogenous. As we are aware, there is a decrease in population in many developed countries that begins after establishing a universal pension system. Therefore, a study is needed to assess the effects of establishing the SJSN on population dynamics. Second, there should be studies that model the government's obligation to pay the contribution of the poor and unemployed. This paper does not cover this issue because we assume that all workers will contribute a fixed portion of their wages to the SJSN.

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APPENDIX 1:
THE ECONOMY

The economy is assumed to be populated by a large number of individuals who live for two consecutive time periods. In each period, the population comprises young and old generations. The agent derives utility from consumption in both time periods. We assume that the utility function is additively separable and logarithmic,

$$U(C_t^y, C_{t+1}^o) = \log(C_t^y) + \beta.\log(C_{t+1}^o) \quad (1)$$

where (β) is the private discount rate.

When young, agents supply one unit of labour (L) and get a wage (w). They save a portion of their wage (s) and use (1 - s) of the wage for financing consumption (C^y). As the result, at any time t, the budget constraint is as follows:

$$C_t^y = (1 - s).w_t \quad (2)$$

In the next period, t+1, the agent will retire and the only source of income is their savings. Their savings will earn the capital return (R). The agent will use savings and its capital return to finance his consumption after retirement (C^o). Consequently, the old-age consumption is restricted by the following budget constraint:

$$C_{t+1}^o = s.w_t.R_{t+1} \quad (3)$$

The agent maximises lifetime utility (1) subject to budget constraints (2) and (3). The optimal level of consumption is uniquely determined by the following first order condition (FOC),

$$C_{t+1}^o / C_t^y = \beta.R_{t+1} \quad (4)$$

Combining FOC in equation (4) and budget constraints (2) and (3), the optimal level of consumption and saving rates can be determined by the following equation,

$$C_t^y = \frac{1}{1+\beta}.w_t \quad (5a)$$

$$C_{t+1}^o = \frac{\beta}{1+\beta}.w_t.R_{t+1} \quad (5b)$$

$$s = \frac{\beta}{1+\beta} \quad (6)$$

On the production side, there is firm that produces the good (Y) with a constant-scale production function. Productivity is affected by two exogenous variables; first is the economic endowment (E), which reflects the natural and social condition attached to the economy, such us climate, geographical conditions and the culture.

Second is labour-augment technology (A) which determines the labour efficiency. Capital (K) and Labour (L) are endogenous in the model. Finally, the production function will be as follows,

$$Y_t = E.K_t^{\alpha}.(A_t L_t)^{(1-\alpha)} \tag{7}$$

where α is capital income share and (1-α) is labour income share.

Let y_t and k_t be output and capital per effective wor $y_t = Y_t/A_t.L_t$ oduc- $k_t = K_t/A_t.L_t$ and can be rearranged as follows,

$$y_t = E.k_t^{\alpha} \tag{8}$$

In each period, firms lease capital (K) at the market interest rate (r) and hire labour (L) at market wage rates (w) to produce goods.[2] The firm's goal is to maximise its profit subject to production function and to cost of capital and cost of labour. The solution to the firm's problem is uniquely determined by FOCs as follows,

$$R_t = \alpha.E.k_t^{\alpha-1} \tag{9}$$

$$w_t = (1-\alpha).E.k_t^{\alpha} \tag{10}$$

The economic dynamics are produced from the motion of labour, labour-augmented technology and capital stock. Let and denote the exogenous labour growth, then the motion of labour is determined by the following equation,

$$L_{t+1} = (1+n).L_t \tag{11}$$

If (g) is the exogenous growth of labour-augmented technology, the law of motion of the labour-augmented technology will become,

$$A_{t+1} = (1+g).A_t \tag{12}$$

For the capital motion, we assume that the depreciation rate is 1. This is reasonable because each period is long enough. Consequently, the level of capital will be determined solely by previous period's savings,

$$K_{t+1} = S_t \tag{13}$$

Combining equation (6) and (10) into (13), the law of motion of capital stock in the equilibrium will be determined by the following equation,

$$k_{t+1} = \frac{s_t.w_t}{(1+n).(1+g)} = \frac{\beta.(1-\alpha).E.k_t^{\alpha}}{(1+\beta).(1+n).(1+g)} \tag{14}$$

In the steady state, when the variables per effective worker grow at a constant rate, the level of steady-state capital stock (k^*) will be uniquely determined by the following equation,

$$k^* = \left(\frac{\beta.(1-\alpha).E}{(1+\beta).(1+n).(1+g)}\right)^{\frac{1}{(1-\alpha)}} \tag{15}$$

Economy with universal pension: PAYG scheme

Suppose that the government is willing to establish a PAYG public pension

[2] The return on capital (R) is equal to (1+r). If (r) is equal to yearly interest rate and one period in the OLG model is 30 years, (R) is calculated as follows, R = (1 + n)30. The equation is also valid for calculating labour and technology growth.

system. If so, the government will impose a tax rate (μ) on the current young generation's wages and pay lump sum pension benefits (B) to the current old-age generation, such that the government has the balanced budget constraint for each period,

$$B_t = (1 + n_{t-1}).\mu.w_t \tag{16}$$

Consequently, the individuals' budget constraints (2) and (3) will evolve as follows,

$$C_t^y = (1 - s - \mu).w_t \tag{17}$$

$$C_{t+1}^o = s.w_t.R_{t+1} + B_{t+1} \tag{18}$$

The first order condition (FOC) of an agent's utility function is same as the FOC in the competitive economy as in equation (4). Combining it with budget constraints (16) to (18), the level of consumption and saving rates will follow equations,

$$C_t^y = \frac{1}{1+\beta}.w_t.\left(1 - \mu + \frac{\mu.N_t}{R_{t+1}}\right) \tag{19a}$$

$$C_{t+1}^o = \frac{\beta}{1+\beta}.w_t.R_{t+1}.\left(1 - \mu + \frac{\mu.N_t}{R_{t+1}}\right) \tag{19b}$$

$$s = \frac{\beta}{1+\beta}\left(1 - \mu - \frac{\mu.N_t}{\beta.R_{t+1}}\right) \tag{20}$$

In the equilibrium, by combining equation (20) and (10) to (13), the law of motion of capital stock will be determined by the following equation,

$$k_{t+1} = \frac{s_t.w_t}{(1+n).(1+g)} = \frac{\beta.(1-\alpha).E.k_t^{\alpha}}{(1+\beta).(1+n).(1+g)} \left(1 - \mu - \mu.N_t / \beta.R_{t+1}\right) \tag{21}$$

In the steady state, the level of steady-state capital stock (k^*) will be uniquely determined by the following equation,

$$k_{PAYG}^{*} = \left\{\frac{\beta.(1-\alpha).E}{(1+\beta).(1+n).(1+g)}.\left(1 - \mu - \frac{\mu.N_t}{\beta.R_{t+1}}\right)\right\}^{\frac{1}{(1-\alpha)}} \tag{22}$$

Economy with universal pension: fully-funded scheme

Suppose that the government runs the public pension system as a fully-funded scheme. For this purpose, the government will tax the current young generation's wage at tax rate (μ) and pay pension benefits (B) to the contributors in the next period as much as total contribution plus return on investment. Consequently, the individual's budget constraints (2) and (3) will evolve as follows,

$$C_t^y = (1 - s - \mu).w_t \tag{23}$$

$$C_{t+1}^o = (s + \mu).w_t.R_{t+1} \tag{24}$$

The FOC of the agent's utility function is same FOC in a competitive economy as equation (4). Combining it with budget constraints (23) and (24), the level of consumption and saving rate will follow equations,

$$C_t^y = \frac{1}{1+\beta}.w_t \tag{25}$$

$$C_{t+1}^o = \frac{\beta}{1+\beta}.w_t.R_{t+1} \tag{26}$$

$$s = \frac{\beta}{1+\beta} - \mu \tag{27}$$

The law of motion of capital stock and the level of steady-state capital stock in the equilibrium will be determined by following equations,

$$k_{t+1} = \frac{(\mu + s_t).w_t}{(1+n).(1+g)} = \frac{\beta.(1-\alpha).E.k_t^{\alpha}}{(1+\beta).(1+n).(1+g)} \quad (28)$$

$$k_{FF}^{*} = \left(\frac{\beta.(1-\alpha).E}{(1+\beta).(1+n).(1+g)}\right)^{\frac{1}{(1-\alpha)}} \quad (29)$$