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ARTÍCULO

Macroeconomic Impact of Mandatory Retirement Age Policy to Population Aging in Thailand

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Abstract: This paper develops a stochastic overlapping generations (OLG) model to investigate the effects of mandatory retirement age policy in an aging economy. The model has been constructed using a calibration and simulation approach with a view to analyze the impact of extending the retirement age on macroeconomic variables in Thailand. The results show that a higher mandatory age of retirement is always beneficial in the long run for PAYG pension budgets, government transfers for the elderly, and lifetime consumption. In this way, the future generations enjoy more consumption than the current generations. On the contrary, the policy of increasing the mandatory age may be harmful not only in the long run-in terms of capital accumulation but also in terms of the output. The mechanisms for driving this are two-fold: (1) there is a direct positive effect consisting in an increase of labor supply and lower the length of the retirement period and (2) there is an indirect effect due to the negative change in the wage.

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1. Introduction

In recent years, much attention has been paid to the macroeconomic consequences of population aging across the world. Low fertility rates and high life expectancy are two primary determinants influencing this global trend. These have shifted the age structure toward a greater share of the elderly. In 2017, some ASEAN members, i.e., Singapore, Thailand, and Vietnam are qualified as aged societies. It has been estimated that the elderly population (age 60 or over) is increasing at the rate of 4% per year, and the share of the oldest cohort (age 80 or over) is increasing at an even faster rate (6% per year ((TGRI), 2018)((TGRI), 2018) The rapid change in the demographic structure of the Thai population poses major challenges to the country's economic development (National Statistical Office, 2016) In general, the rise in the dependency ratio stems from two factors: (1) a decline in the fertility rate, and (2) an increase in longevity. The aforementioned factors have highly deteriorated the Thai population's aging. By looking at these two factors separately (Table1), the consequences of lower fertility and greater longevity, the study has been able to offer key implications for policymakers.

Population projections for Thailand conducted by the (NESDB, 2013) predicted that the total fertility rate of Thai people will be declining further from 1.6 in 2015 to 1.3 in the next 20 years. Life expectancy will, in all likelihood, be in an upward trend from 74 years at present to 80 years in the next twenty years (NESDB, 2013) Combined with the fact that people born between 1963 and 1983 are now becoming elderly, a precipitous increase in the rate of population aging in the near future can be expected (Prasartkul, 2013)The dependency ratios of the elderly population in Thailand will reach 54% in 2050, which will be above the average for Southeast Asian countries (26.6%), and the country will be ranked 24th in the highest old-age dependency ratios in the world (Scherbov et al., 2018)

Table 1 Total fertility rate and elderly survival rates in Thailand

Year	Total fertility rate (Per woman)	The survival rate of 60-80 age (percentage)	Life expectancy (years)
1950-1955	6.4	-	52.0
1975-1980	4.0	-	61.4
2000-2005	2.0	36.0	70.8
2025-2030	1.9	49.5	76.8
2045-2050	1.9	56.4	79.1

Source: Population Division, DESA, United Nations (2017)

Thailand's total fertility rate has now reached an extremely low level (Jones, 2011)This has resulted in a change in the population age structure which will significantly lessen the size of the labor force of the country in the next two decades. In 2018, there were 10.67 million people who were part of the elderly population (60 years and over) and remained working in the labor market at 4.36 million people (Offic, 2019) This number is likely to increase continuously (Table 2). Among Thai workers, when people reach a retired age (mostly at the age of 60) they will most likely exit the labor force, so it will be difficult for them to earn their own income. The rapid increase in the number of the elderly and monetary inflation may lead to a situation of dire poverty for a large portion of the elderly in the future (Prasartkul et al., 2019) Thus, Thailand needs to initiate measures to mitigate the impact of a shrinking labor force with other policy options, which can be undertaken feasibly. At present, Thailand already has a pension scheme for retired officials, while for some retired workers in higher-paid private sectors, a social security fund has been established. Recently, the government has set up the old-age living allowance to provide a welfare allowance of around 600-1,000 baht per month to elderly individuals. To receive this allowance, those aged 60 years and above must register at the local administrative organization where they are residents. Those who are eligible must be neither governmental nor non-governmental organization retirees (Gazette., 2018)

Another policy is retaining the elderly in the labor force. Recently, the government will be reforming the mandatory retirement age by lengthening the retirement age from 60 years to 63 years for government and state enterprise officials. This policy was adopted in 2019 (Commission, 2018). In this study, we will only focus on the effect of retirement age policy reform

Table 2 Number of older workers (60 years and over) in Thailand.
Unit: million persons

Year	Total population aged 60 years and over*	Total older workers**	Formal employment	Informal employment
2007	6.71	2.77	0.26	2.51
2008	6.90	2.80	0.25	2.55
2009	7.18	3.07	0.28	2.80
2010	7.49	3.05	0.27	2.78
2011	7.81	3.24	0.31	2.92
2012	8.17	3.40	0.35	3.06
2013	8.73	3.45	0.32	3.13
2014	9.11	3.84	0.38	3.46
2015	9.46	3.91	0.43	3.48
2016	9.80	4.02	0.45	3.56
2017	10.23	4.06	0.48	3.59
2018	10.67	4.36	0.51	3.85

Source: *Department of Provincial Administration, Ministry of Interior (2019)
**The Informal Employment Survey, National Statistical Office, Ministry of Digital Economy and Society (2019)

Based on the background that has been described by the author, the purpose of this paper is to investigate the impact of mandatory retirement age policy on the macroeconomy in Thailand. Given the population aging in Thailand, this paper develops a dynamic stochastic general equilibrium (DSGE) model with the OLG framework to explore the effects. The OLG model based on the study of Cipriani (2016) to support the study of population aging are the uncertainty of the time of death (longevity) and retirement. With the OLG model at hand, this paper first obtains the simulated impact of a lengthening of retirement age on the economy and sets the simulated do-nothing policy as the benchmark model (full retirement). This paper then obtains a sensitivity analysis of the length of the retirement period and compares the results with that of the benchmark model to draw conclusions.

2. Literature Review

There is a vast amount of literature exploring the link between demographic composition and economic activity. Starting with the work by Auerbach (1987), the large-scale OLG model improves the period under the two-period OLG because the whole population can be separated into any age group along the year since birth. Additionally, it departs from the finite household from the assumption of infinite life in a representative household by assuming that the last group is restricted to die. Although this framework is more realistic than the two-period OLG, the yearly period provides such little frequency that details of analyzing temporary shocks are not represented under this framework. Their model is used to evaluate the impact of demographic transitions on economic activity in the U.S. economy. They demonstrate that the OLG model is considered to be the workhorse model for analyzing the economic consequences of demographic transitions and the associated fiscal policy. Miles (1999) also utilizes an OLG model to explore the demographic impact, focusing on the U.K. and European countries. Within a growth accounting framework, for instance, Angela Maddaloni et al. (2006) analyzes the effects of population aging on economic growth, financial markets, and public finance in the Euro area, taking into consideration the fertility rate, longevity, and immigration.

However, while the literature has developed (especially in the framework of the two-period OLG model) a normative analysis of the optimal retirement age (Hu, 1979; Michel & Pestieau, 2013) as well as models of political games for voting on the age of retirement (Casamatta et al., 2005; Conde-Ruiz & Galasso, 2004). However, what seems to be less extensively investigated is a positive analysis of the effects of the often-advocated mandatory postponement of the retirement age on both economic growth and sustainability of PAYG pension systems. In most countries, especially in Europe and Japan, retirement is compulsory (i.e. workers must retire at the fixed age by law to obtain a pension transfer). But, in the U.S., old agents can contemporaneously work and receive a pension transfer. Jorgensen and Jensen (2010) employed the DSGE model with the OLG framework to study a policy rule for the retirement age aiming at offsetting the effects on the supply of labor following fertility changes in the context of Brazilian population aging. This study found that the retirement age should increase more than proportionally to the direct fall in labor supply caused by a fall in fertility.

Recently, the effect of raising the retirement age policy on the economic growth and sustainability of the PAYG pension system has drawn a lot of attention from researchers. Fanti (2014) studied the effects of raising the mandatory age in the OLG model. This study found that early retirement reduces economic growth (i. e. GDP) and poses a threat to the PAYG pension system viability is warranted, obtaining the following result: when the capital share is sufficiently high, a reduction in the retirement mandatory age may favour economic growth and even pension payments. Indeed, it is shown that short-run and long-run effects may be of opposite sign: a postponement of retirement increases the GDP in the short run, but this positive effect considers only the generation which is young at the time of postponement. For any subsequent generation, the GDP is reduced, rapidly approaching the lower long-run level. Thus, one policy implication is that in developed countries beset by strong population aging, the compulsory raising of the retirement age might not, in the long run, be the appropriate policy to keep the PAYG pension budget balanced.

Hsu (2017) studied the multigenerational OLG model to investigate the effects of four reform programs aiming to enhance the sustainability of the pension system in Taiwan. Scenario simulations were 1) an increase in pension contribution, 2) a reduction in pension benefit, 3) an extension of mandatory retirement age, and 4) a combination of program 2) and 3). As a result, an extension of mandatory retirement age does less harm to the current generations' lifetime utility, but the extension gradually improves future generations' lifetime utility. On the contrary, an increase in pension contribution reduces the lifetime utility of the current generation without benefitting the future generation.

In addition, Cipriani (2016) also studied endogenous retirement decisions when there is a PAYG social security system in an aging economy with the OLG model. As a result, the effects of aging on pensions may not be negative if the elderly are free to choose their retirement age. The negative effect on pensions in the specific case of full retirement. Like, Chen (2016) employed exogenous retirement age in the OLG framework. This study found that an increase in the fertility rate may raise pensions when the output elasticity of capital is low. From a different perspective, Cipriani (2014) showed that aging has always had a negative effect on pension benefits.

Thailand's population aging has been investigated by using the OLG model in past works. The first study we consider focuses on technological progress which helps to improve the aggregate productivity to offset the decline in the number of workers and work hours. Technological progress plays an important role in providing a buffer against the negative impact of what would happen (Bisonyabut, 2012). The second, Cheewatrakoolpong and Boonprakaikawe (2010) focuses on the effects of population aging on economic growth with the reform pension system. The study called for investing in pension tax in public education in order to build up human capital accumulation. The numerical method simulated the effect of several pension systems on the economic variables and is calibrated with Thailand's data during 1980-2008. This study found that the mandatory public pension system yields the highest economic growth, saving, output per effective labor, and capital per effective labor in the balanced growth path. Also, the mandatory public pension system is the best for economic growth because informal family support for the elderly in other systems leads to a lower amount of saving and capital accumulation which in turn brings about lower economic growth and output per capita.

Furthermore, Hsu et al. (2015)applied the DSGE model with the OLG framework to examine the effects of population aging and informal employment across three tax options for financing the universal health insurance coverage (UHI) in Thailand. The simulated numerical method found that when labor income tax is used to finance the cost of UHI, an additional 11–15% of labor tax will be required with the 2050 population age structure compared with the 2005 benchmark economy. As results showed, an expansion of income tax base to the informal sector could substantially alleviate the tax burden. Based on welfare comparisons across alternative tax options, the labor income tax will be the most preferred because the informal labor sector was large. If the informal sector could not avoid labor income tax, the capital tax will be preferred over labor and consumption taxes.

Another empirical study, for example, Adhikari, (Adhikari et al., 2011) studied the factors affecting labor force participation among the elderly in Thailand. The analysis was used to the logistic regression model with the data from the survey of older persons in 2007. Study results found that place of residence, functional status, and the number of chronic diseases were the most significant predictors. The health status of the elderly was necessary to encourage employment among older persons. Like, Chansarn (2013)investigated the determinants of the economic preparation for retirement by utilizing binary logistic regression analysis. This study found that, on average, the working-age population aged 50 – 59 years old in Thailand had moderate economic preparation for retirement. Moreover, the finding also revealed that age, income, income sufficiency, year of schooling, and health condition had positive influences on the opportunity to have above-average economic preparation for retirement. These studies have recommended the government to carry out an effective campaign for promoting the awareness of the necessity of economic preparation for retirement in order to encourage working-age people to prepare for retirement in advance. By doing so, Thailand will be able to enjoy the economic benefit from the increasing proportion of the old-age population who will become the source of sustainable economic growth of the nations in an aging society.

In summary, the prime question in the investigation of the effects of mandatory retirement age on the economy is as follows; “Is a mandatory postponement of the retirement age really beneficial for the pension system? If so, how could it happen?” The OLG model has been applied intensively in the search for answers to the key research question of this study. Usually, it is used to explore the impacts of population aging on the pension system (e.g. see Cipriani (2016) for an introduction) However, not much of the existing literature on the subject investigates the effect of a lengthening of retirement age on macroeconomic variables. The paper aims to bridge this gap by incorporating exogenous retirement decisions into an OLG model setting and uses this approach to investigate the effects of retirement age policy reform.

3. The Model

The model presented in this section is a stochastic OLG model that allows us to analyze the effect of a lengthening of the mandatory retirement age policy on macroeconomic variables. There are four sectors in the economy: households, firms, the government, and the social security system. There is a representative individual for each generation in the household sector. Each individual has a fixed lifetime up to the age of 80. Each individual with an age less than 14 is nurtured by parents and receives education. The individual starts working at the age of 15 and retires at age 60. Each individual earns wage income and builds up savings for old age. The representative agent maximizes the intertemporal utility function with consumption. Firms maximize profits. The government collects taxes with a balanced budget. The social security system, that is, the pension sector collects social security contributions rate and runs a balanced budget.

A period, t, in the model corresponds to one year. At each time period, a new generation of households is born. These models consider only the working and retired generations. Newburn’s have a real-life age of 15, corresponding to the working-age group in the model. So, retire at age 60 and lives up to a maximum age of 80, corresponding to the elderly group in the model. From age 60 to 79 years, 20 different generations coexist. At t, all agents of age j survive until age $j+1$ with probability p_{jt}, where $p_{60t}=1$ and $p_{80t}=0$, $j=60,61,\dots,80$. This study uses the officially published survival probability of Thailand estimated by the Nations. (2017)

The policy of a lengthening of the mandatory retirement age model presents an extended retirement age from 60 to 63 years. This study has been conducted under labor supply and retirement decisions exogenously determined.

4. Households

The young population N_t grows at a constant fertility rate g_{t-1} and agents are assumed to belong to an OLG structure with finite lifetimes. Adult life is separated into two periods: young and old age. Individuals belonging to generation t have a conventional logarithmic utility function defined over young age $(c_{1,t})$ and old age consumption $(c_{2,t+1})$. Each person born at (the beginning of period) t lives for two periods and provides one unit of labor per period.

In the first period, t, he or she works full time, earning a wage income of w_t while paying a labor income tax rate t_{wt} and a social security tax according to the contribution rate t_{pt} (Equation 2).

In the second period, $t+1$, he or she works a fraction of the time (l_i), and then retires (i.e. when $l_i=0$ each person is retired for the whole second period of life, which is the assumption of the conventional OLG model of Diamond (1965) During old age, agents’ earnings, therefore, consist of (1) the savings (s_t) plus the accrued interest at the rate $\frac{R_{t+1}}{p_t}$, (2) the net wage income of $(1-t_{wt}-t_{pt})w_{t+1}l_i$, (3) the pension of $(1-l_i)P_{t+1}$, which is publicly provided and financed at a balanced budget by the social security system, and (4) the government transfers for elderly (Tr_t) (Equation 3). The length of the retirement period $(1-l_i)$ is mandatory fixed by the government.

Thus, the representative individual faces the following utility function as

$$U=\ln c_{1,t}+bp_t\left(\ln c_{2,t+1}+g\ln(1-l_i)\right) \tag{1}$$

The first period budget constraint is

$$c_{1,t}+s_t=(1-t_{wt}-t_{pt})w_t \tag{2}$$

The second period budget constraint is

$$c_{2,t+1}=\frac{R_{t+1}}{p_t}s_t+(1-t_{wt}-t_{pt})w_{t+1}l_i+(1-l_i)P_{t+1}+Tr_t \tag{3}$$

By combining constraints in the first and second period, the lifetime budget constraint of the individual is

$$(1-t_{wt}-t_{pt})w_t+\frac{p_t(1-t_{wt}-t_{pt})w_{t+1}l_i}{R_{t+1}}+\frac{p_t(1-l_i)P_{t+1}}{R_{t+1}}+\frac{p_tTr_t}{R_{t+1}}=c_{1,t}+\frac{p_t}{R_{t+1}}c_{2,t+1} \tag{4}$$

Firms

Concerning the production sector, competitively firms have the Cobb-Douglas technology of production is

$$Y_t=A_tK_t^{a}L_t^{1-a} \tag{5}$$

where Y_t, K_t, and L_t denote aggregate output, capital stock, and labor in the economy in the period t, respectively, A_t is the exogenous process for the technology productivity and a is the capital share of output, $0 < a < 1$.

The time t labor force (labor input) is $L_t = N_t + p_{t-1}N_{t-1}l_i$, consists of the working-age and elderly group. It can be written as

$$L_t = \left(1 + g_{t-1} + p_{t-1}l_i\right)N_{t-1} \tag{6}$$

Population N_t grows at a constant fertility rate g_{t-1} or $N_t = \left(1 + g_{t-1}\right)N_{t-1}$.

The intensive form production function may be written as $y_t = A_t k_t^a$. As usual, it is assumed that physical capital totally depreciates at the end of each period and that the price of the final output is normalized to one. Profit maximization problem is written as

$$\max_{\{K_t,L_t\}} \tilde{O}_t = A_t K_t^a L_t^{1-a} - R_t K_t - W_t L_t \tag{7}$$

Profit maximization then leads to the following marginal conditions for capital and labor, respectively:

$$f\left(k_t\right) - k_t f'\left(k_t\right) = w_t \tag{8}$$

$$\left(1 - a\right)A_t k_t^a = w_t \tag{9}$$

$$f'\left(k_t\right) = R_t \tag{10}$$

$$aA_t k_t^{a-1} = R_t \tag{11}$$

Equation (9) shows that the marginal product of labor is equal to the wage, and equation (11) shows that the marginal product of capital is equal to the rental rate.

5. Government Sector

The government collects income tax to finance its expenditures on government consumption $\left(G_t\right)$ and transfers for elderly people $\left(Tr_t\right)$. The government's tax revenues $\left(T_t\right)$ are given by

$$T_t = t_{wt} w_t L_t \tag{12}$$

$$T_t = t_{wt} w_t \left(1 + g_{t-1} + p_{t-1}l_i\right)N_{t-1} \tag{13}$$

And the government transfer for elderly people $\left(Tr_t\right)$ is given as

$$Tr_{t-1}p_{t-1}N_{t-1} = t_{wt} w_t L_t \tag{14}$$

Equation (14) shows that the left-hand side represents the government expenditure for transfer payment for the elderly and the right-hand side the tax receipts. This scheme leads to the following:

$$Tr_{t-1} = \frac{t_{wt} w_t \left(1 + g_{t-1} + p_{t-1}l_i\right)}{p_{t-1}} \tag{15}$$

Also, the government transfer can be written in the period t as

$$Tr_t = \frac{t_{wt+1} w_{t+1} \left(1 + g_t + p_t l_i\right)}{p_t} \tag{16}$$

where t_{wt} is the labor income tax rate, w_t is wage, and labor force is given by $L_t = \left(1 + g_{t-1} + p_{t-1}l_i\right)N_{t-1}$, when N_t represents young worker and N_{t-1} old worker.

In addition, g_{t-1} is the exogenous fertility rate and p_t is the probability of survival to the last period of life (longevity).

By assuming that the government runs the balanced budget, it can be written as:

$$G_t + Tr_t = T_t \tag{17}$$

Social Security System

The pension sector runs a defined contribution pay-as-you-go social security scheme with a balanced budget. Hence, social security tax $\left(t_{pt}\right)$, both for the young and the old individuals, and to pay a pension for the retired $\left(P_{t+1}\right)$. Therefore, pension benefits are

$$\left(1 - l_i\right)P_t p_{t-1} N_{t-1} = t_{pt} w_t L_t \tag{18}$$

or it can be written as

$$\left(1 - l_i\right)P_t p_{t-1} N_{t-1} = t_{pt} w_t \left(1 + g_{t-1} + p_{t-1}l_i\right)N_{t-1} \tag{19}$$

Concerning equation (19), as shown, the left-hand side represents the social security expenditure, and the right-hand side represents the tax receipts. This scheme leads to the following formula for pension benefits:

$$P_t = \frac{t_{pt} w_t \left(1 + g_{t-1} + p_{t-1}l_i\right)N_{t-1}}{p_{t-1}\left(1 - l_i\right)N_{t-1}} \tag{20}$$

or it can be written as

$$P_{t+1} = \frac{t_{pt+1} w_{t+1} \left(1 + g_t + p_t l_i\right)}{p_t\left(1 - l_i\right)} \tag{21}$$

Equation (21) shows the rate of return on the PAYG pension system is equal to $\dfrac{\left(1 + g_t + p_t l_i\right)}{p_t\left(1 - l_i\right)}$.

Market Equilibrium and Model Solution

The household maximizes (1) subject to the budget constraint (2) and (3) taking wage, the interest rate, and the pensions benefit as given. After substituting for P_{t+1} from (21), the first order condition with respect to savings is

$$c_{2,t+1} = bR_{t+1}c_{1,t} \tag{22}$$

Equation (22) is the consumption Euler equation. It can be written as $\dfrac{c_{2,t+1}}{bc_{1,t}} = R_{t+1}$, where the left-hand side of the equation is the *marginal rate of intertemporal substitution* between consumption in old age and consumption in young age (MRIS ($c_{2,t+1}, c_{1,t}$)) and the right-hand side is the *marginal rate of intertemporal transformation* (and measures the rate at which one unit of currency can be transferred into the future; in other words, it measures the return on savings).

By substituting equation (2) and (3) in equation (22), the following equation can be obtained as

$$\frac{R_{t+1}}{p_t}s_t + \left(1 - t_{wt} - t_{pt}\right)w_{t+1}l_i + \left(1 - l_i\right)P_{t+1} + Tr_t = bR_{t+1}\left(\left(1 - t_{wt} - t_{pt}\right)w_t - s_t\right) \tag{23}$$

$$s_t = \frac{\left(1 - t_{wt} - t_{pt}\right)\left(bR_{t+1}w_t - w_{t+1}l_i\right) - \left(1 - l_i\right)P_{t+1} - Tr_t}{\frac{R_{t+1}}{p_t}\left(1 + bp_t\right)} \tag{24}$$

Using equation (16) and (21) to substitute in equation (24), the first order conditions with respect to savings (s_t) is written as

$$s_t = \frac{(1 - t_{wt} - t_{pt})(bR_{t+1}w_t - w_{t+1}l_i) - \dfrac{(t_{pt} + t_{wt})w_{t+1}(1 + g_t + p_t l_i)}{p_t}}{\dfrac{R_{t+1}}{p_t}(1 + bp_t)} \tag{25}$$

Equation (25) shows the effect of a lengthening of the working period on savings. A lengthening of the working period (i.e. a mandatory increase in the retirement age) reduces savings (as regards wage and interest rate), $s_{li} = \dfrac{\partial s_t}{\partial l_i} < 0$.

The rationale behind this is that when the working period in old age is reduced, individuals' saving is higher allowing him or her better sustain consumption for retirement. Indeed, the length of such a period is increased jointly with the reduction in old age wage income.

In addition, the market-clearing condition in goods as well as in capital markets is expressed by the equality

$$K_{t+1} = N_t S_t \tag{26}$$

or, in per worker terms, the dynamic of capital is written as

$$\frac{K_{t+1}}{L_{t+1}} = \frac{N_t S_t}{L_{t+1}} \tag{27}$$

$$k_{t+1} = \frac{N_t s_t}{(1 + g_t + p_t l_i)N_t} \tag{28}$$

$$k_{t+1} = \frac{s_t}{1 + g_t + p_t l_i} \tag{29}$$

while equation (29) shows how future capital is linked to current savings with a PAYG system.

By substituting s_t from (24) into equation (29), exploiting (9) and (11), and assuming that households have perfect foresight, the dynamic equilibrium sequence of capital is determined by

$$k_{t+1} = \frac{(1 - t_{wt} - t_{pt})(bR_{t+1}w_t - w_{t+1}l_i) - (1 - l_i)P_{t+1} - Tr_t}{\dfrac{R_{t+1}}{p_t}(1 + bp_t)(1 + g_t + p_t l_i)} \tag{30}$$

$$k_{t+1} = \frac{(1 - t_{wt} - t_{pt})(bR_{t+1}w_t - w_{t+1}l_i) - (t_{pt} + t_{wt})\dfrac{w_{t+1}(1 + g_t + p_t l_i)}{p_t}}{\dfrac{R_{t+1}}{p_t}(1 + bp_t)(1 + g_t + p_t l_i)} \tag{31}$$

We can get the dynamic of capital as

$$k_{t+1} = \frac{1}{(1 + bp_t)}\left\{ bp_t(1 - t_{wt} - t_{pt})(1 - a)A_t k_t^a \left(\frac{1}{1 + g_t + p_t l_i}\right) - k_{t+1}\frac{(1 - a)\left((1 - t_{wt} - t_{pt})p_t l_i + (t_{pt} + t_{wt})(1 + g_t + p_t l_i)\right)}{a(1 + g_t + p_t l_i)} \right\} \tag{32}$$

Assuming perfect foresight, the steady state implies $k_{t+1} = k_t = k^*$. We can get the steady-state value of k^* from equation (32) as

$$k^* = \left(\frac{a(1 - a)pbA}{(a(1 + bp) + t_p + t_w)(1 + g + pl_i) + (1 - a)pl_i}\right)^{\frac{1}{1 - a}} \tag{33}$$

Equation (33) shows that capital accumulation is always reduced by raising the mandatory retirement age.
The steady-state value of output is written as

$$y^* = A\left(\frac{a(1 - a)pbA}{(a(1 + bp) + t_p + t_w)(1 + g + pl_i) + (1 - a)pl_i}\right)^{\frac{a}{1 - a}} \tag{34}$$

Equation (34) recalling from equation (33), $\dfrac{\partial k^*}{\partial l_i} < 0$ that an increase in the retirement age may reduce long-run output.
The steady-state value of saving is written as

$$s^* = (1 + g + pl_i)\left(\frac{a(1 - a)pbA}{(a(1 + bp) + t_p + t_w)(1 + g + pl_i) + (1 - a)pl_i}\right)^{\frac{1}{1 - a}} \tag{35}$$

Equation (35) shows that savings is reduced by raising the mandatory retirement age.
We can get the steady-state value of pension from equation (21) as

$$P^* = \frac{t_p w^*(1 + g + pl_i)}{p(1 - l_i)} \tag{36}$$

or it can be written as

$$P^* = \frac{t_p(1 - a)A}{p(1 - l_i)}\left(\frac{a(1 - a)pbA}{a(1 + bp + g) + t_p + t_w + pl_i}\right)^{\frac{a}{1 - a}}(1 + g + pl_i)^{\frac{1 - 2a}{1 - a}} \tag{37}$$

Equation (36) and (37) reveal that the effect of an increase in the retirement age on the long-run pension payment depends on two things (1) a direct effect due to the length of the retirement period and (2) an indirect effect due to wage.
We can get the steady-state value of government transfers from equation (16) as

$$Tr^* = \frac{t_w(1 + g + pl_i)}{p}(1 - a)Ak^{*a} \tag{38}$$

or it can be written as

$$Tr^* = \frac{t_w(1 + g + pl_i)}{p}(1 - a)A\left(\frac{a(1 - a)pbA}{(a(1 + bp) + t_p + t_w)(1 + g + pl_i) + (1 - a)pl_i}\right)^{\frac{a}{1 - a}} \tag{39}$$

Equation (39) shows the effect of an increase in the retirement age on the long-run government transfers depending on the length of the retirement period.

Exogenous Process

The random variation in l_{it} capture respectively shock to the policy of a lengthening of retirement age. This shock follows the stochastic processes:

$$\ln Z_{li,t} = \rho_{li} \ln Z_{li,t-1} + u_{li,t}$$

$$, \; u_{li,t} \sim N\left(0, s_{li}^{2}\right) \quad (40)$$

where r_{li} measures the persistence of those shocks, and $u_{li,t}$ is $i.i.d., \sim N\left(0, s^{2}\right)$.

6. Calibration and Simulation

This study selects the values of parameters based on empirical findings of the Thai economy and other developing countries it deems necessary. Most parameters, otherwise specified, follow Tanboon (2008a) which corresponds firmly to stylized facts of the Thai economy, and many studies relevant to the OLG model provide a strongly consistent basis for policy analysis in Thailand's economic environment. Their value can be summarized in Table 3 below.

A number of parameters are excluded from the estimation and need to be calibrated. This is because they are either notoriously difficult to estimate or can be better identified using other information.

Firstly, the calibration of aging parameters is based on a period of one year. Agents are born at the real lifetime age of 15 which corresponds to $t = 1$. They work $T = 45$ years corresponding to a real lifetime age of 59. They live a maximum life of 60 years $\left(T^{R} = 20\right)$ so that agents do not become older than real lifetime age 80. We use the same survival probabilities that are presented by United Nations (2017), p which is set equal to 0.473.

Secondly, the discount factor for households $\left(b\right)$ is fixed at 0.9926 which implies an annual interest rate of 3% in line with Tanboon (2008a). The household's elasticity of labor supply is calibrated by Tanboon (2008b) g is set equal to 3.0303.

Thirdly, the capital income share $\left(a\right)$ is set equal to 0.328 according to Cheewatrakoolpong and Boonprakaikawe (2010)'s calculation based on data from the National Statistical Office and the National Economic and Social Development Board for 2003 to 2008.

Fourthly, for the government sector, the parameter t_{w} or the labor income tax rate is set equal to 0.10 which is the rate for the middle-class taxpayer in Thailand. In addition, the parameter l_{i} represents the mandatory retirement age policy. In this study, it is set equal to 0.066 for raising the retirement age to 3 years according to the Office of the Civil Service Commission (2018). Assume he/she works a fraction l_{i} of the time, we may interpret $1 + l_{i}$ as the total time devoted to labor over the life-cycle while, of course, the length of retirement is $\left(1 - l_{i}\right)$. This also means that, for instance, by assuming conventionally one period of 45 years and an age of entry in adult life (i.e. in the labor market) of about 15 years, then the age of retirement would be 60 years when $l_{i} = 0$, 63 years when $l_{i} = 0.066$, 65 years when $l_{i} = 0.110$, and so on as in Fanti (2014).

Finally, the social security system $\left(t_{p}\right)$ represents the degree of pension contribution rate is set equal to 6 per cent from employer and employee each paying equal contributions of 3 per cent of the worker's salary according to the Social Security Act, B.E. 2533 (1990), provides mandatory insurance (Section 33) (Paitoonpong et al. (2016)

We do estimate standard Solow's procedure to obtain the shock from the residual with retirement age policy. This is done to estimate the use of data on the number of older workers (60 years and over) from the Thai Informal Employment Survey. This is done by taking the log values for the older workers at annual frequencies for 2007-2018 (Offic, 2019) We obtained a value of standard deviation which is equal to 0.0881 and the autocorrelation coefficient which is equal to 0.9758 $\left(r_{li}\right)$. The technological growth parameter A_{t} is equal to 2.4 per cent per year according to Sutthasri's (2007) calculation based on data from 1978 to 2006. This value is comparable with Chuenchoksan and Nakornthab (2008) finding that Thailand's total factor productivity (TFP) growth is 1.8 per cent over 1987-1996 and 2.0 per cent over 2000-2007 (the average TFP growth during the financial crisis years registers -6.7 per cent).

Table 3 Calibration of the model

Parameter	Value	Interpretation	Reference
Aging parameter			
p	0.473	the probability of survival rate	Thai data, UN (2017)
Household			
b	0.9926	discount factor	Tanboon (2008a)
g	3.0303	the parameter measuring preference for leisure or retirement	Tanboon (2008a)
Firm			
a	0.328	capital income share	Cheewatrakoolpong and Boonprakaikawe (2010)
Government			
t_{w}	0.10	labor income tax rate	Thai policy (2018)
l_{i}	0.066	raising retirement age 3 year	Thai policy (2018)
		(fraction of the work times)	
Social security system			
t_{p}	0.06	social security tax (or pension contribution rate)	Thai policy (2018)

Source: Author's study

7. Results and Discussions

7.1 Long-Run Effects

In this section, we compare the long run of a mandatory retirement economy with a lengthening of the retirement age from 60 to 63 years by aggregate outcomes. Aggregate variables and factor prices for steady states are presented in Table 4.

Table 4 shows that the length of the retirement period assumes a rather complicated role. In particular, postponement of the retirement age has (1) a direct effect consisting of an increase in pension benefits first because pensions must be paid for a shorter period and secondly, because the composite number of contributions (which includes both the young and old generation) is raised due to the increased number of old workers and (2) an indirect effect due to the negative change in the wage induced by such a postponement. In regard to the latter effect, a change in the retirement period affects wages through two channels: (1) the effects on the capital stock input and (2) the effects on the labor input. Regarding the former, since savings are reduced when the retirement age increases (consumption in young age is decreased and consumption in old age is increased), the capital stock and output will decrease as well. Interest rate increases in the long run depending on the marginal rate of intertemporal substitution between consumption in old age and consumption in young age (MRIS ($c_{2,t+1}, c_{1,t}$)). Government transfers for the elderly increased because tax receipts are raised due to the increased number of old workers.

In reference to the latter point, an increase in the retirement age clearly entails a higher labor supply and thus, through this channel, a tendency towards a lower wage. Therefore, the overall effect on wages will be even more negative than that on sole capital accumulation.

Table 4: Long-run effects of lengthening the mandatory retirement age

	Aging economy (full retirement)	Mandatory retirement economy	% Δ from Aging. econ.
Aggregate Outcomes			
Capital	0.2100	0.1924	-8.3810
Output	1.4385	1.3978	-2.8293
Life-time consumption	1.9244	1.9671	2.2189
Young age consumption	0.5999	0.5887	-1.8670
Old age consumption	1.3378	1.3922	4.0664
Saving	0.2121	0.2004	-5.5163
Factor prices			
Wage	0.9667	0.9393	-2.8344
Interest rate	2.2466	2.3826	6.0536
PAYG pension system			
Pension benefits	0.1238	0.1328	7.2698
Government			
Government transfers for elderly	0.2064	0.2068	0.1938

Source: Calculated

8. Transitional Effects

The effects of a lengthening of the retirement age policy shock are shown in Figure 1 where the x-axis represents time on an annual basis, and the y-axis depicts percentage deviation from the steady state. A positive shock in the retirement age will tend to directly increase labor supply and lower the length of the retirement period. As a result, workers need to save less for a shorter retirement period. Figure 1 shows the saving reduction in 3 periods and increases to reach steady-state values for about 40 periods. The capital stock and output will be decreased as well. The net effect on the capital is negative if the retirement age has increased. In that case, the net effect on capital returns remains positive and the wage rate will fall (a negative (positive) factor price effects for workers (retirees)). The interest rate rises until 1.3 in 3 periods and declines to reach steady-state values for about 40 periods.

For the consumption effect, the future generations enjoy more income and consumption than the current generations do. With delayed retirement, this reform has a direct effect on labor supply and a time effect on the delayed payment of pension benefits by the pension system. Figure 1 illustrates that old-age consumption is positively affected after the shock and slowly decreased for more than 40 periods. The young age consumption is negatively affected, as the consumption declines immediately after the shock in 3 periods and increases to reach steady-state values for about 40 periods. The delayed retirement age policy measure causes a noticeable increase in the overall lifetime consumption.

As mentioned earlier, the government expenditure is based on the collection of income tax, therefore with an increased labor supply (which includes both the young and old generation), the government can spend more on consumption and the transfers for the elderly. Overall, the government sector has a significantly positive effect. However, the government consumption and government transfers decline immediately after the shock in 5 periods.

Studying the effect of this shock on the PAYG social security system, it is pertinent to note that the social security expenditure is based on the collection of social security tax (or pension contribution rate). The effects of a lengthening of retirement age policy are increased number of old workers. With the higher supply of labor, the pension benefit is a significantly positive effect. The pension declines slowly after the shock and lasts more than 40 periods.

9. Sensitivity Analysis

Numerical steady-state sensitivity analysis gauges the effects of raising the retirement age upon the long-run values of capital, output, and pension payments. Table 5 below clearly shows that the higher the retirement age (i.e. from 60 years to 65 years), the lower the long-run capital and output. Moreover, the effects of a postponement of retirement, starting from the beginning of old age (conventionally 60 years) to 65 years, on the level of pension benefits. The final effect of an increase in the retirement age upon the pension benefit depends on the level of the existing age of retirement. For instance, when the retirement age is fixed in the early years of the second period of life, a further increase in the mandatory retirement age will have the effect of raising the future pension benefit (a positive effect on the pension).

Table 5: Effects of an increase in the retirement age on the equilibrium capital, output, and pension

Age of retirement (in terms of l_i)	Capital	Output	Pension
60 years (i.e. $l_i = 0$)	0.2100	1.4385	0.1238
61	0.2039	1.4246	0.1267
62	0.1980	1.4110	0.1297
63	0.1924	1.3978	0.1328
64	0.1871	1.3850	0.1361
65	0.1862	1.3828	0.1368

Source: Calculated

10. Conclusions

This paper presents a four-sector, two-period overlapping generation (OLG) model to explore the effects of mandatory retirement age policy on macroeconomic variables. The four sectors of the model are the households' sector, the private sector, the government sector, and a pay-as-you-go (PAYG) pension system. The economic data and institutional setting of Thailand are used for the purpose of this study. According to the results of the simulated model, we found that:

The mechanisms driving a change in the retirement period, are the following two channels: (1) a direct positive effect consisting in an increase of labor supply and lower the length of the retirement period and (2) an indirect effect due to the negative change in the wage.

A higher mandatory age of retirement is always beneficial in the long run for PAYG pension budgets, government transfers for the elderly, and lifetime consumption. The future generations enjoy more consumption than the current generations. On the contrary, the policy of postponing the mandatory age may be harmful not only for capital accumulation in the long run but also for the output.

However, we are aware of the limitations of the present analysis, especially those resulting from the absence of human capital. Indeed, an increase in the compulsory retirement age extends the work-life planning of individuals, which provides an incentive to accumulate human capital, and this human capital accumulation could potentially reverse the results obtained in the present paper. Future research works are encouraged to overcome the present study limitations

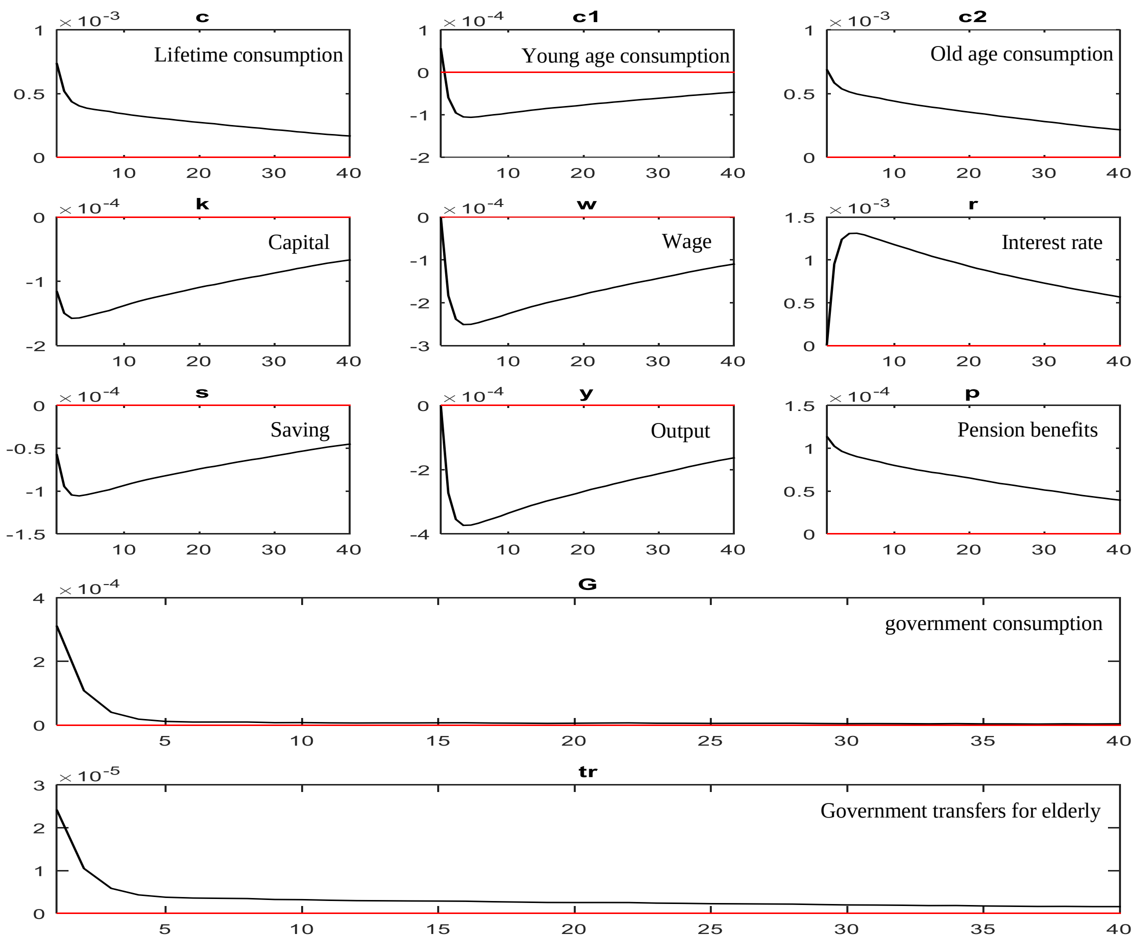

Figure 1 Responses to retirement age policy shock
Source: Author's illustration

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