Pension Reform in Taiwan: the Path to Long-Run Sustainability

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Abstract

This paper quantifies the costs of different pension reforms in Taiwan that achieve long-run sustainability. We build a general equilibrium life-cycle model with endogenous labor supply in both intensive and extensive margins, consumption, saving, and benefit claiming. We consider several options to make pensions sustainable under current demographic changes. Furthermore, we evaluate changes in welfare costs, as measured by reductions in tax burden, when the retirement age increases.

Keywords: Pension Reform, Aging Demographics, Long-Run Sustainability, Welfare Analysis

JEL Classification: E2, E6, H5, J2

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1 Introduction

In Taiwan, the fear of the fiscal consequences caused by aging demographics and generous pension programs has attracted a lot of public attention and motivated policymakers to consider different possible reforms. In fact, the predicted future deficits associated with the pension programs are substantial. If no reform is implemented, most of the pension programs will go bankrupt within 10 years. Numerous discussions and analyses on different reform options have taken place. However, existing studies have considered reform by making the labor supply responses exogenous, and therefore are not capable of answering questions about the solvency of the system in the long run. Instead, a model with endogenous labor supply and benefit claiming in the general equilibrium is needed to measure the cost of different proposed reforms.

This paper attempts to analyze the fiscal cost of different pension reform options by considering a general equilibrium life-cycle model with endogenous labor supply in both intensive and extensive margins, consumption, saving, and benefit claiming. Taking into account the specific features of pension systems in Taiwan, we are able to answer the general equilibrium effects of different reform options by considering an individual's responses to the changes. In the model, an agent enters an economy with an aging population and a generous pension program. Facing both idiosyncratic and aggregate shocks, the agent will make decisions about labor supply, consumption, and retirement. Hence, any reforms to the pension program effect the agents' actions endogenously.

Taiwan's pension system is unique as there are various options available to agents in relation to benefit claiming and the timing of their retirement. There is also a relatively higher replacement ratio in Taiwan. We will focus our analysis on one of the largest pension programs for blue-color workers, the labor insurance annuity, for these following reasons. First, the labor insurance annuity shares similar properties as other pension programs, such as the public service pension system and the national pension system. Second, the labor insurance annuity is the largest pension program but faces the highest potential deficit under the current pay-as-you-go system. Tackling the issues of the largest system will give us a clear picture as to the consequences of the reforms.

This paper will analyze the fiscal costs of the reforms that achieve long-run sustainability, as is often discussed for the pay-as-you-go system with an aging population. This paper especially considers the following policy option that makes the pension system self-financed and the budget balanced every year: increasing the income tax. Results show that an additional 6.21% income tax has to be considered in order to make the budget balanced. However, options differ significantly in terms of labor supply responses over the life-cycle. We compare the welfare costs for possible alleviations of tax burden by adding options such as deferring retirement. Increasing the early retirement age and normal retirement age both by 5 years helps the sustainability of the pension system the most; under this change, the additional income tax now becomes 1.93%.

Similar issues have been addressed in the literature. For example, Kitao (2014) studies the four options that make the social security system in the United States sustainable by considering the general equilibrium effects. Imrohoroglu and Kitao (2012) considers the solvency of the security system with flexibility on benefit claiming. Imrohoroglu et al. (2016) apples a similar approach but considers the reform in Japan. Hsu and Liao (2015) is one of the few papers to study the labor supply responses to the reforms in Taiwan, but they consider the national health insurance program. Ours is the first analysis of the Taiwanese pension program using a general equilibrium framework. The economy environment is tailored to the specific pension system in Taiwan, and we focus on the general equilibrium effects under the solvency of the system.

The rest of the paper proceeds as follows. Section 2 describes the labor insurance pension program in Taiwan. Section 3 lays out the model. Section 4 outlines the calibration strategy. Section 5 presents the results. Section 6 concludes.

2 Pension Systems in Taiwan

In this section, we describe the labor insurance pension system in Taiwan. Although there are four major pension systems, labor insurance, labor pension, public service pension, and national pension, they share similarities. By focusing on the biggest pension system with similar properties to the others, the labor insurance pension system, we are able to understand the main driving forces behind all of the other pension programs. Descriptions of the other pension systems are presented in Appendix A.

2.1 Labor Insurance

The Labor Insurance Program was established in 1950. It was the first compulsory social insurance program in Taiwan. In 2015, the program covered approximately 10 million laborers (the population in Taiwan is 23.4 million). The labor insurance program offers payments including old-age benefits, survivor benefits, occupational accident medical benefits, disability benefits, and maternity benefits. The program is supported by a pay-as-you-go system. The premium equals the insured salary of each insured worker times the premium rate. The current premium rate is 9%. For each insured worker, 70 percent of the premium is paid by the employer, 20 percent is paid by the insured worker, and 10 percent is paid by the government.

Since 2009, there are three types of payment for old-age benefits: Old-age Pension Benefit, Old-age Lump Sum Benefit, and One Time Old-age Benefit. After resigning from work and withdrawing from insurance coverage, an insured person can claim one of the three types of benefits if he/she meets the conditions required. The primary conditions for each type of benefit are as follows.

- Old-age Pension Benefit: An insured person who is at least 60 years of age with at least 15 years of insurance coverage.
- Old-age Lump Sum Benefit: An insured person who is at least 60 years of age with less than 15 years of insurance coverage.
- One Time Old-age Benefit: An insured person who has insurance coverage before the enforcement of Labor Insurance Act on January 1, 2009, and meets one of the following conditions:
  - At least 60 years of age with at least 1 year of insurance coverage.
  - At least 55 years of age with at least 15 years of insurance coverage.
  - At least 50 years of age with at least 25 years of insurance coverage.
  - Insured in the same insured unit for over 25 years.

The payment standards of the three types of benefits are as follows:

- Old-age Pension benefit: The insured person can select the better option from the following two methods.
  - Average Monthly Insurance Salary[1] × Coverage Years × 0.775% + 3,000
  - Average Monthly Insurance Salary × Coverage Years × 1.55%
- Old-age Lump Sum Benefit: For every one full year of insurance coverage, one month of average monthly Insurance Salary[2] will be issued. For insurance coverage after 60 years of age, five years is the maximum to be included in the insurance coverage.
- One Time Old-age Benefit: For every one full year of insurance coverage, one month of average monthly Insurance Salary[3] will be issued; should the total insurance coverage be more than 15 years, then for the term of coverage exceeding 15 years, 2 months of average monthly insurance will be issued for every one extra year of insurance coverage with the highest limit of 45 months. If the insured person is more than 60 years of age and continues to work, then the insurance coverage after 60 years would be counted as five years for the maximum.

[1] The Average Monthly Insurance Salary is calculated by averaging the highest 60 months of Insurance Salary during the insurance coverage years.

[2] The Average Monthly Insurance Salary is calculated by averaging the highest 60 months of Insurance Salary during the insurance coverage years.

[3] The Average Monthly Insurance Salary is calculated by averaging the actual months of Insurance Salary starting from 3 years before the month the insured person withdraws from insurance coverage.

As described in Appendix A, an annuity-based system with relatively higher replacement ratio and low tax rates presents the common problems among all the systems in Taiwan. In addition, individuals are eligible to claim pension benefits at a relatively early age, 55, and individuals can continue to work afterwards. Since most of the pension systems in Taiwan share these similarities, we will focus on one of the largest systems, the labor insurance system, and study the effects of different policy reforms.

3 Model

3.1 Demographics

The economy is populated by overlapping generations of individuals of age $j = 1, 2, ..., J$, where J is the maximum possible age. The lifespan is stochastic, where an individual of age j at time t survives until the next period t+1 with probability $s_{j,t}$. n_t is the rate of new cohorts entering the economy.

3.2 Individual Preference, Productivity

An individual enters the economy with no assets. For each time t, each individual is endowed with one unit of time, which can be used for market work or leisure. Assuming the individual allocates l unit of time to work, the wage is given by $wz\eta_j l$, where w is the market wage, z is the idiosyncratic labor productivity which follows the first order Markov process, η_j is the age-specific productivity, and l is the labor hours.

In addition, an individual values consumption and leisure over the life cycle, which utility function is denoted as $u(c, l)$. We assume “warm-glow" utility from leaving bequests, denoted as $u^B(.)$. For simplicity, the government collects bequests and distributes them to the individuals as a lump-sum transfer q to the entire population. The discount factor is denoted as β. We further assume that individuals cannot borrow from their future earnings.

3.3 Technology

Production is operated by a representative firm following the constant return to scale technology

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha},$$

where K_t and L_t are the aggregate capital and labor inputs at time t and α is the capital share. A denotes the total factor productivity, and capital depreciates at the rate $\delta \in (0, 1)$. We follow the usual competitive market assumption, where firms rents capital and labor units from individuals in a competitive market, denoting r and w as the factor prices that are equated to marginal productivities.

3.4 Social Security

As described in the introduction, we focus especially on the labor pension system in Taiwan, as other systems follow a similar payment schedule but differ mostly in replacement ratio. The government operates a pay-as-you-go pension system. A proportional payroll tax τ^s is imposed on the earnings of working individuals up to the maximum amount of y^s. The normal retirement age is j^N. Individuals can begin to receive social security benefit ss once they reach the earliest claiming age j^E. The benefit is adjusted downward if it is claimed before the normal retirement age of j^N, and upward if the claim is postponed until after the normal retirement age.

In Taiwan, the pension amount depends on the maximum 5 years of wages; together it is adjusted to reflect how many years an individual has been working. Since it is computationally difficult to have a pension claim dependent on work history, we adopt another formula to simplify the computations. We will discuss these detailed adjustments in the calibration section.

3.5 Government Budget Constraint

The government raises revenue from taxation on income; social security taxes on earnings; consumption tax at rate τ^c; taxation on income $T(.), \tau^y, \tau^s$; and issuance of risk-less debt D_t. The revenue finances the payment of the social security benefit expenditure of government transfer, an exogenous given level of expenditure G_t, and the repayment of the debt from the previous period. The government also spends an exogenous amount of G_t on public purchase of goods and service. The government transfer program follows exactly as in Taiwan, which guarantees any individual with minimum consumption level $\underline{c}$.

As for the notations, let us explain in detail. D_t is the government debt issued in the previous period, which pays risk-less interest r_t, and D_{t+1} is the newly issued debt, ($T(.)$, τ^y) and τ^c represent the tax rates of labor income and consumption respectively. The labor income tax τ^y is determined in equilibrium so that the following consolidated government budget constraint is satisfied every period.

$$\begin{aligned} &G_t + (1+r_t)D_t + \sum_x ss_t(x)\mu_t(x) + \sum_x tr(x)\mu_t(x) = \sum_x [T(y_t(x) + r_t(k_t(x)+b_t))) \\ &+\tau^y(y_t(x) + r_t(k_t(x)+b_t) + \tau_t^s \min\{y_t(x), y^s\} + \tau_t^c c_t(x)]\mu_t(x) + D_{t+1} \end{aligned} \tag{1}$$

3.6 Individual Problem

Individuals are heterogeneous in five dimensions summarized by a state vector $x = \{j, z, a, e, i\}$. j denotes age, z is idiosyncratic labor productivity, a are the assets carried over from the previous period, e represents the amount of pension benefits for each individual. i is an indicator that takes 1 if an individual has already applied for social security benefits and 0 otherwise. An individual enters the next period with a new state vector $x' = \{j+1, z', a', e', i'\}$. The value function is given by

$$V(x) = max_{c,l,i'}\{u(c,l) + \beta E[s_j V(x') + (1-s_j)u^b(a')]\},$$

subject to

$$\begin{aligned}
tr &= \max\{0, (1+\tau^c)\underline{c} - a\} \\
k &= a + tr - c(1+\tau^c) \\
a' &= (1+r)k + z\eta_j lw - T(rk + z\eta_j lw) - \tau^y(rk + z\eta_j lw) - \mathbb{1}_{i=0} \cdot \tau^s \min\{z\eta_j lw, y^s\} + ss(x) + b \\
a' &\geq 0, \text{ and} \\
e' &= f(e, y).
\end{aligned}$$

The evolution of e (function f) will be described in detail in the calibration section.

3.7 Competitive Stationary Equilibrium

In this paper, we focus on the long-run sustainability of different pension reforms. We will first define the competitive stationary equilibrium below. Details of the parameterization will be discussed in the calibration section.

Given a set of demographic parameters $\{s_{j,t}\}_{j=1}^{J}$, $\{n_t\}$, and government policy variables $\{G_t, D_t, ss_t, y^s, \tau_t^s, T(.), \tau_t^c\}$, a competitive equilibrium consisting of individuals' decision rules $\{c_t(x), l_t(x), i'_t(x)\}$ for each state vector x, factor prices $\{r_t^k, w_t\}$, proportional income tax $\{\tau^y\}$, bequest transfer $\{b_t\}$, and the density over state space $\{\mu_t(x)\}$ such that:

1. Individuals' decision rules solve the recursive optimization problem.

2. Factor prices are determined competitively:

$$r_t^k = \alpha A_t(\frac{L_t}{K_t})^{1-\alpha} - \delta,$$
$$w_t = (1-\alpha)A_t(\frac{K_t}{L_t})^{\alpha}.$$

3. Lump-sum bequest transfers equal the amount of assets left by deceased:

$$b_t = \sum_x a_t(x)(1 - s_{j,t-1})\mu_{t-1}(x).$$

4. Labor and capital markets clear:

$$K_t = \sum_x (a_t(x) + b_t)\mu_t(x) - D_t,$$
$$L_t = \sum_x z\eta_j l_t(x)\mu_t(x).$$

5. Goods market clears:

$$\sum_x c_t(x)\mu_t(x) + G_t + K_{t+1} = Y_t + (1-\delta)K_t.$$

6. Labor income tax $\{\tau_t^l\}$ satisfies the government budget constraint.

7. The distribution $\mu(x)$ is stationary.

We calculate the additional income taxes that need to be collected to make the government budget balanced. This formulation helps us to evaluate the costs to achieve long-run sustainability under the current pension system as well as different pension reforms.

4 Calibration

In this section, we will describe the parameterization of the model. One period corresponds to a year. Since we focus on the steady state outcomes, we match the moments from the Taiwanese economy prior to 2010. To be specific, we match the selected moments with those from the model. Table 1 summarizes the calibrated parameters, and more details will be discussed below.

4.1 Moments

Demographics.- We assume that individuals enter the economy at age 20 ($j = 1$) and live up to 100 years old ($J = 81$). The growth rate of the population is set to be 1.91, which is the long run birth rate from Ministry of Interior (MOI). The conditional survival probability by age is taken from MOI data as well. The left panel of Figure 1 shows the conditional survival probability that we use in the benchmark model.

Endowment and Preferences.- The idiosyncratic component z is taken from Imrohoroglu and Kitao (2012), in which they approximate the continuous process with a five-state, first-order discrete Markov process. We further assume that period utility takes the form:

$$u(c,l) = \frac{[c^{\gamma}(1-l-\phi)^{1-\gamma}]^{1-\sigma}}{1-\sigma}.$$

γ determines the weight on consumption relative to leisure, ϕ represents the fixed cost of labor force participation. We set the value of σ at 4.0, which implies a coefficient of relative risk aversion

Table 1: Parameters of the model

Parameter	Description	Value/source
Parameter		
n	population growth rate	0.91% (MOI[1])
$\{s_j\}_{j=1}^{J}$	conditional survival probabilities	MOI
J	maximum age	81 (100 years old)
Preference		
β	subjective discount factor	0.992 (Liu et al. (2014))
γ	weight on consumption	0.363
σ	curvature parameter	4 (Imrohoroglu and Kitao (2012))
ψ_1	weight on bequest utility	588.7
ψ_2	curvature of bequest utility	NT $12,800,000
Labor productivity process		
ρ_η	persistence parameter	0.97 (Imrohoroglu and Kitao (2012))
σ_η^2	variance	0.018 (Imrohoroglu and Kitao (2012))
Technology and production		
α	capital share of output	0.34 (DGBAS[2])
δ	depreciation rate of capital	0.0905 (Liao (2011))
X/Y	investment-output ratio	0.21 (DGBAS)
K/Y	capital-output ratio	2.14 (Target at 2.1)
A	scale parameter	1.66
Government		
τ^c	consumption tax rate	5%
$\{\lambda_0, \lambda_1, \lambda_2\}$	personal income tax	{0.258, 0.726, 6.158}
G	government purchases	0.18 (DGBAS)
D	government dabt	0.33 (CBT[3])
τ^{ss}	Social Security tax rate	8.1%
τ^y	Additional Proportion Income Tax	6.21%
j^N	normal retirement age	41 (60 years old)
j^E	earliest retirement age	36 (55 years old)
y^{ss}	Social Security maximum taxable earnings	NT$549,600
$\underline{c}$	consumption floor	NT$150,000

1: Ministry of Interior. 2: Directorate-General of Budget, Accounting and Statistics. 3: Central Bank of Taiwan.

at 2.17. Utility from leaving a bequest a' is defined as

$$u^B(a') = \phi_1 \frac{(\phi_2 + a')^{\gamma(1-\sigma)}}{1-\sigma},$$

where ϕ_1 and ϕ_2 are calibrated such that the average saving of individuals at age 75 and above

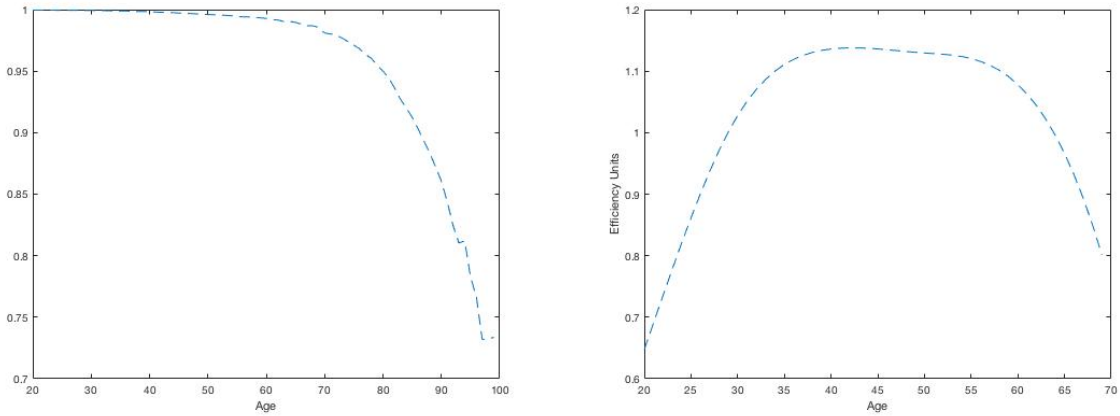

Figure 1: Conditional Survival Probability and Age-Specific Labor Efficiency Profile from Hansen (1993)

is 1.8 times of all individuals. The subjective discount factor β is set as 0.991, taken from Kitao (2010). The deterministic, age-dependent labor productivity η_j is taken from Hansen (1993). We further assume that $\eta_j = 0$ for $j \geq 51$ (70 years old). That is, no one works after age 70. The age-dependent labor productivity from Hansen (1993) is shown in the right panel of Figure 1.

Technology.- The income share of capital is set at 0.34, which is the value taken from the Directorate-General of Budget, Accounting and Statistics (DGBAS). In addition, we target the investment output ratio (X/Y) at 0.21, and capital output ratio (K/Y) at 2.1, where these values are also taken from DGBAS. The depreciation rate of capital is taken from Liao (2011). A is used such that the aggregate output in the benchmark economy is normalized to 1.

Government: Social Security.- The social security amount is calculated as a concave function of an individual's past earnings. As described in Section 2, the Taiwanese labor insurance formula is complicated. First, the government records each individual with a maximum of five years of earnings, with a lower bound and upper bound. Then the individual is able to choose one of the two formulas that are used to calculate the benefits, both of which relate to the individual's work history. Since it is computationally difficult to keep track of the entire work history of an individual, we use a concave function to calculate the pension benefits. This function maintains the main feature of labor insurance in Taiwan: (1) averaged past earnings are adjusted faster because in reality only 5 years of earnings are taken into account, and (2) we use age to adjust the average work history. The detailed formula is calculated as

$$e' = \frac{\alpha_1(j-1) * e + (2-\alpha_1)w}{N}.$$

We choose N to be 60 such that it reflects the increasing amount of work history, and *alpha* is adjusted such that it reflects the 5 year updating rule. For this version, we set $\alpha_1 = 1$ for simplicity.

Government: Transfer.- The minimum consumption floor $\underline{c}$ is set at NT$150,000. This number is taken directly from reality. However, we could adjust this number such that it reflects all the benefits that the government provides to an individual, such as the discount on public transportation and the subsidy on health care.

Government: Taxes, Expenditures, and Public Debt.- The government spending G is set at 20 percent of the output. The consumption tax is set at 5%, which is the consumption tax rate implemented in Taiwan. For income taxation, we employ a tax schedule of the form

$$T(y) = \lambda_0\{y - (y^{-\lambda_1+\lambda_2})^{-1/\lambda_1}\},$$

where the formula is proposed and estimated by Gouveia and Strauss (1994). Right now, we use the number from Gouveia and Strauss (1994) but we will estimate the number using Taiwanese data in the future. In addition, when we simulate the economy, we add a proportional term $\tau^y y$ such that the government budget is balanced. We can interpret the τ^y as the additional taxes that have to be collected in order to achieve long-run sustainability.

5 Numerical Results

In this section, we present the life-cycle policy functions of individuals that we modeled and calibrated to the Taiwanese economy, in which the government operates a pay-as-you-go system. The model we calibrated is denoted as the benchmark model, where we also evaluate alternative reforms such as deferring retirement age in order to access the long-run effects.

5.1 Benchmark Model

In Figure 2, we plot the percentage by age for those who claim retirement. We find that most people claim the benefits once they reach retirement. This captures most of the effects happening in Taiwan now, where there are not many restrictions on whether a worker can work after retirement. In addition, this reflects the case where incentives are not provided to encourage workers stay in the labor force longer.

The main purpose of this paper is to study the path to long-run sustainability. We find that, under the current tax system, the steady state deficit resulting from the current social security system is around 3.36% GDP, which implies that all individuals would have to pay an additional 6.21% income tax to make the government budget balanced. This number might seem small, but we focus on the labor insurance system where the replacement ratio is relatively small compared to other pension systems in Taiwan. We leave the issue of a joint analysis analysis of all the pension systems in Taiwan for future studies.

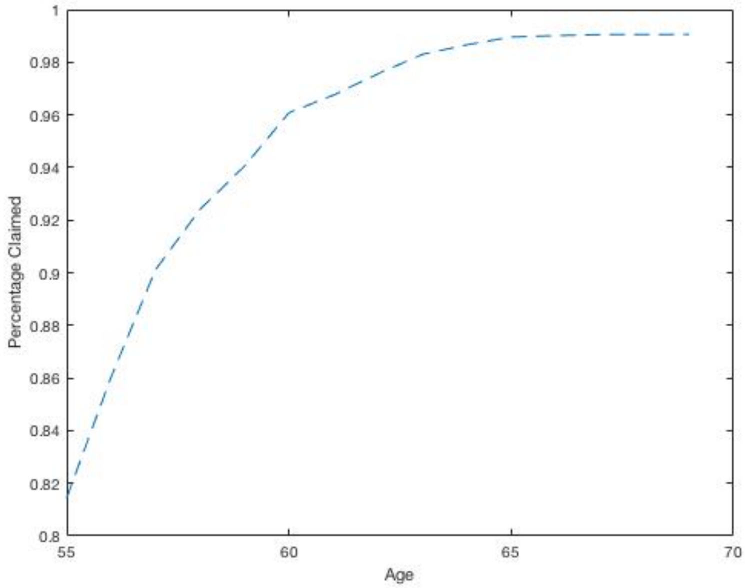

Figure 2: Social Security Benefit Entitlement

For the robustness check, we compare labor force participation, work hours, and accumulated assets. In Figure 3, we plot the labor force participation by age and work hours. We observe that in the benchmark model, participation increases relatively slowly until an individual reaches 35. In addition, an individual spends the most time working around age 35, where the productivity is the highest in the life-cycle. We can observe that although 80% of workers claim retirement at age 55, which is the earliest retirement age, the work hours do not decline substantially accordingly. This is because under the current system, people can work after claiming retirement. At the same time, the punishment is not harsh enough for workers who choose early retirement. Hence, many workers claim retirement at age 55 but continue to work, mostly as part time workers.

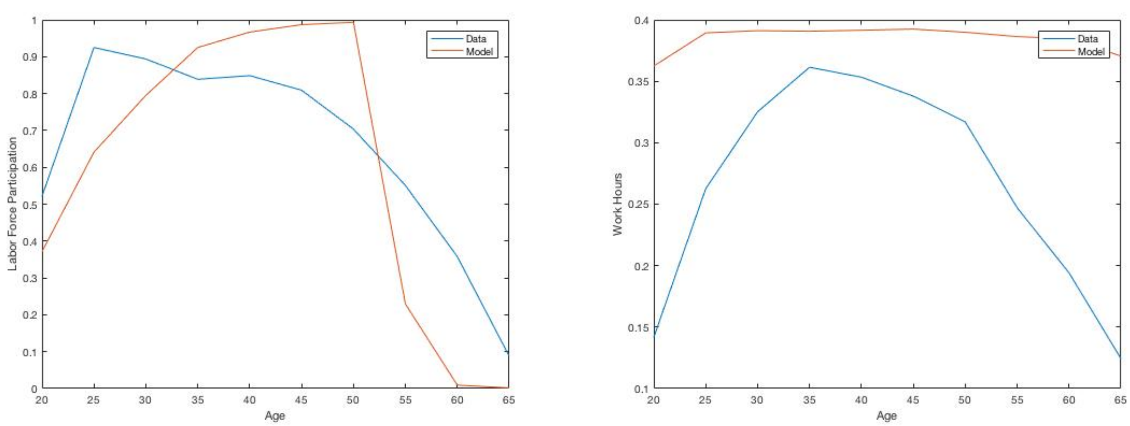

Figure 3: Labor Force Participation and Work Hours

In Figure 4, we plot the average asset holding over the life-cycle. However, we find that an individual continues to hold the asset even after retirement. This partially reflects the generosity of the labor insurance pension system.

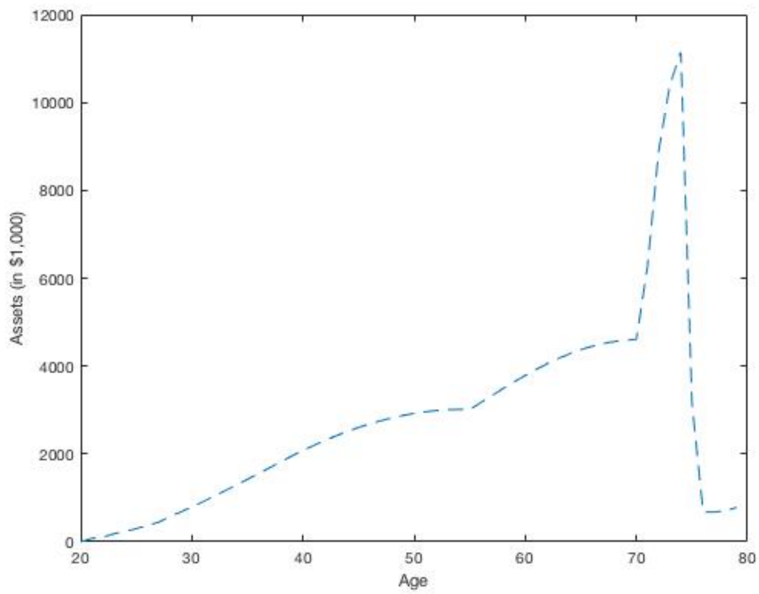

Figure 4: Assets (Model, in $1,000)

5.2 Policy Experiments

In this section, we study the effects of the policy experiments of raising the earliest and normal retirement ages. We focus mainly on the additional taxes an individual would have to pay in order to make the system sustainable. That is, we focus on the additional proportional income tax $\tau^y y$ that satisfies the government budget equation.

The results are presented in Table 2. In the first column, we present the result of the benchmark economy. As mentioned before, the steady state social security deficit is around 3.36% of the GDP, at which the government can achieve long-run sustainability if all the workers pay an additional income tax of 6.21%. We first analyze the effects of the changes in the early retirement age, which we calculate as a policy experiment by increasing the early retirement age by 2 years and 5 years. We find that the impact of increasing the early retirement age is relatively small. Workers pay less additional income tax to make the government budget balanced, but the additional tax rate only decreases from 6.21% to 4.60%. The capital, labor, and average work hours do not change substantially. This implies that increasing the early retirement age might not solve the problem of long-run sustainability.

Next, we consider the policy experiment of changing the early retirement age and normal

Table 2: Effects of Social Security Reforms

	benchmark	τ^c	(ERA*,NRA**) (57,60)	(ERA,NRA) (60,60)	(ERA,NRA) (57,62)	(ERA,NRA) (60,65)
Capital(per capita)	-	+18.49%	-0.40%	+2.30%	+5.98%	+15.79%
Labor(per capita)	-	+7.61	-0.19%	+0.94%	+2.34%	+6.01%
Average work hours	-	0.70%	+0.27%	+0.82%	+1.00%	+2.02%
wage	-	3.33%	-0.07%	+0.46%	+1.20%	+3.05%
Interest rate	6.812%	5.833%	6.835%	6.672%	6.449%	5.912%
Propotional income tax rate τ^y	6.21%	0%	5.91%	4.60%	4.60%	1.93%
Consumption tax rate τ^c	5%	10.36%	5%	5%	5%	5%
SS budget balance(% of GDP)	-3.36%	-3.36%	-2.96%	-2.00%	-2.23%	-0.55%
Average asset at 55 (NT$1,000)	3008	3504	3123	3404	3369	3879
	-	+16.50%	+3.81%	+13.15%	+12.00%	+28.96%
Retirement percentage						
at 55	81.44%	90.41%	-	-	-	-
by 60	96.08%	98.80%	95.73%	95.95%	95.27%	89.35%
by 69	99.06%	99.80%	99.00%	99.23%	98.51%	91.81%

Note: The percentage changes are expressed as the distance from the benchmark (first-column).
*(ERA):Early retirement age. **(NRA): Normal Retirement Age.

retirement age simultaneously. We find that deferring the normal retirement age to 62 does not have a big impact on individuals' decisions. Individuals still have to pay around 4.6% additional income tax to make the government budget balanced. However, if the government changes the retirement policy by increasing both the early retirement age and the normal retirement age by 5 years, the deficit resulting from the social security would be 0.55% of the GDP, where individuals' additional income tax becomes 1.93%. This result suggests that deferring the retirement age might be a solution to help the current system achieve long-run sustainability.

6 Conclusion

In this paper, we build a quantitative general equilibrium model of overlapping generations of individuals who make decisions on consumption, saving, labor supply on both extensive and intensive margins, and Social Security benefit claims. We focus especially on the long-run sustainability of the pension system.

We show that to make Social Security sustainable, an additional income tax of 6.21% has to be added. In addition, reforms to raise early retirement age and normal retirement ages can have a large impact on the sustainability of the Taiwanese pension system through changes in life-cycle savings and labor supply. An increase of 5 years in the early retirement age and normal retirement age is shown to have a significant positive effect on both saving and labor supply.

Finally, we note that the focus of our study is on the long-run effects of ONE pension system in Taiwan, the labor insurance pension system. Another important contribution would be complete study on all the insurance systems. There are, in principle, a large set of possible fiscal policy options for how to treat current and future generations, and therefore alternative paths to reach the long-run state of the economy, including the ones that we have investigated. We leave this interesting extension to be explored in future research.

Appendix

A Institutional Background

In this appendix, we summarize other pension systems in Taiwan, which we omitted in the main context because we do not calibrate the model to match different pension programs. However, understanding other pension systems helps us to understand why labor insurance is a representative system.

A.1 Labor Pension

The Old Labor Pension Program was established by the Labor Standards Act of 1984. On July 1 2005, the Labor Pension Act was put into practice and the New Labor Pension System was established to replace the old one. Unlike the Labor Insurance Program, the New Labor Pension System is a fully-funded system. Under the new Act, all employers are required to deposit 6% (or more) of a worker's monthly wages into an individual labor pension account managed by the Bureau of Labor Insurance, with ownership going to the worker. Workers adopting the new pension system may begin accumulating their pension accounts as their employers contribute to them. The accounts are portable and will be retained even if workers switch jobs or if business entities shut down or cease operations. According to the Labor Pension Act, the dividends accrued from a worker's pension fund may not be lower than a certain level. In the future, dividends from individual pension accounts may vary due to investment outcomes in the financial markets, but with the guaranteed minimum rate, when a worker eventually receive his/her pension payments, in addition to the principal accumulated from all monthly contributions, they will also collect dividends equivalent to or higher than the guaranteed minimum rate.

Under the new scheme, a worker may begin collecting his or her pension payments upon reaching the age of 60, regardless of employment status. Workers with 15 years or more work seniority can receive monthly pension payments. Workers with less than 15 years of seniority can only receive a lump sum payment.

A.2 Public Service Pension

The public service pension system of Taiwan was established in 1943. Since then, the framework and principles that define it as a government-financed superannuation system have remained unchanged. However, the growing financial burdens of the government have posed great challenges to the system. This prompted the government to organize a task force to review the system. The public service pension system was changed on 1 July, 1995, from a totally government-financed system to a Contributory Public Service Pension Fund that is supported by funds jointly contributed by the government and the participants.

Upon the adoption of the new system, the Public Service Pension Fund (PSPF) began paying pension benefits based on years of service. The contribution rates to the Pension Fund by the participants ranged from 8% to 15%

of their salary. The Public Service Pension Fund Management Board (PSPFMB) was set up to manage the Fund. Fund participants comprise civil servants, education workers, and military personnel, totaling more than 630,000 persons. The aim of PSPF is to secure and steady the income for these retirees so as to facilitate the recruitment of human forces for public service, boost its morale, take care of the aged and their dependents, and establish a sound and solid retirement system.

A.3 National Pension

The National Pension Program was established by the National Pension Act of 2008. The spirit of the National Pension Program is to safeguard people who do not take part in any social insurance program, no matter if they are unemployed or retired. Citizens who are over 25 years of age and under 65 years of age with their household registered in Taiwan shall take part in National Pension Insurance and become insured persons during the period they do not participate in labor insurance, farmer's health insurance, government employee's insurance, and insurance of military personnel. (For detailed rules check the official website of the Bureau of Labor Insurance). The program offers three types of annuity payments, including the Old-Age Pension, Disability Pension and Survivors Pension, as well as two types of lump sum benefits, including the Maternity Benefit and Funeral Benefit. The National Pension Program is a pay-as-you-go system. The insurance premium equals the monthly insured amount times the premium rate. The current monthly insured amount is NT \$18, 282 and the premium rate is 8%. The premium sharing ratio varies depending on the income of the insured person.

Those who are insured can claim the Old-age Benefit as long as they reach the age of 65, regardless of how long their insurance period is. The insured person can select the better one from the following two methods:

- Monthly Insured Amount $\times$ Insurance coverage year $\times$ 0.65% + 3,628[4]
- Monthly Insured Amount $\times$ Insurance coverage year $\times$ 1.3%

[4]This method does not applicable to some kind of individuals. Please check the website of the Bureau of Labor Insurance.

References

S. R. Aiyagari. Uninsured Idiosyncratic Risk and Aggregate Saving. *The Quarterly Journal of Economics*, 109(3):659–684, 1994.

O. Attanasio, S. Kitao, and G. L. Violante. Global Demographic Trends and Social Security Reform. *Journal of Monetary Economics*, 54(1):144–198, 2007.

M. Gouveia and R. P. Strauss. Effective Federal Individual Income Tax Functions: An Exploratory Empirical Analysis. *National Tax Journal*, 47(2):317–339, 1994.

G. D. Hansen. The cyclical and secular behaviour of the labour input: Comparing efficiency units and hours worked. *Journal of Applied Econometrics*, 8(1):71–80, 1993.

M. Hsu and P.-J. Liao. Financing National Health Insurance: Challenge of Fast Population Aging. *Taiwan Economic Review Special Issue: Macroeconomic-Theory and Empirics*, 43(2):145–182, 2015.

M. Huggett. The Risk-Free Rate in Heterogeneous-Agent Incomplete-Insurance Economies. *Journal of Economic Dynamics and Control*, 17(5-6):953–969, 1993.

S. Imrohoroglu and S. Kitao. Social Security Reforms: Benefit Claiming, Labor Force Participation, and Long-Run Sustainability. *American Economic Journal: Macroeconomics*, 4(3): 096–127, 2012.

S. Imrohoroglu, S. Kitao, and T. Yamada. Achieving Fiscal Balance in Japan. *International Economic Review*, 57(1):117–154, 2016.

S. Kitao. Sustainable Social Security: Four Options. *Review of Economic Dynamics*, 17(4):756–779, 2014.

S. Kitao. Fiscal Cost of Demographic Transition in Japan. *Journal of Economic Dynamics and Control*, 54:37–58, 2015.

P.-J. J. Liao. Does Demographic Change Matter for Growth? *European Economic Review*, 55(5): 659–677, jun 2011.

E. M. Liu, J. Meng, and J. T. yi Wang. Confucianism and Preferences: Evidence from Lab Experiments in Taiwan and China. *Journal of Economic Behavior and Organization*, 104:106–122, 2014.

J. K. Scholz, A. Seshadri, and S. Khitatrakun. Are Americans Saving Optimally for Retirement? *Journal of Political Economy*, 114(4):607–643, 2006.