International Journal of Humanities
and Social Sciences (IJHSS)
ISSN(P): 2319-393X; ISSN(E): 2319-3948
Vol. 6, Issue 3, Apr - May 2017; 9-28

International Academy of Science,
Engineering and Technology
Connecting Researchers; Nurturing Innovations

SOCIAL SECURITY REFORMS IN AGING ECONOMY

NAI-WEN CHANG & YUAN-HO HSU

Department of Economics, National Cheng Kung University, Tainan, Taiwan

ABSTRACT

It has been a fervently discussed that the government may not be able to collect enough tax revenue to finance its enlarging welfare expenditure arising from the demand of increasing elders in an aging economy and the current pay-as-you-go pension system may also encounter deficiency problem in the future. This paper investigates the impacts of population aging in Taiwan and analyzes the effects of social security reforms with multi-period overlapping generation (OLG) model. The simulation results indicate that population aging may not necessarily leads to a reduction in GDP, as long as the economy maintains a constant stream of technological progress. Three social security reform programs proposed in this paper, two on national health insurance (NHI) and one joint reform on pension and NHI, indicate that proper reforms improve financial soundness of the social security system. Moreover, the joint reform program has a more prominent effect on the improvement of the sustainability of the NHI program and government budget stance.

KEYWORDS: National Health Insurance, Overlapping Generation Model, Population Aging, Social Security Reforms

1. INTRODUCTION

The global economic development in the past century has resulted in higher living standard, better physical health, and longevity of peoples. However, along with the pace of economic development, there is a gradual demographic transition characterized by a declining in fertility rate and crude death rate. Decreasing fertility and lengthening of life expectancy are the two major forces that contribute to current aging phenomena in most industrial economies and some newly developed economies like Taiwan.

Population aging is "the process by which older individuals become a proportionally larger share of the total population."[1] It is a predominant demographic issue for the developed economies, newly developed economies, and some developing economies as well. The demographic dynamics of population aging challenge the existing socio-economic institutions, lead to future labor shortage, increase future health care demands, and change the composition of goods market.[2] Furthermore, declining working-age population would not only alter the labor market composition but also affect the decisions of households on wealth allocation. This on-going demographic transition is an unavoidable and irreversible phenomenon of the human society in the 21st Century. The increasing elderly dependency ratio resulting from population aging implies that there would be an increasing portion of people claiming pension benefit, whereas at the same time there would be a relatively smaller portion of working people paying income taxes and making contribution to the pension fund. Given the current pay-as-you-go (PAYG) pension system, this demographic transition raises concern on the sustainability of future pension system. Furthermore, with shrinking size of tax payers due to population aging, the government may

[1] United Nations, *World Population Ageing: 1950-2050*, p.1. Available at http://www.un.org/esa/population/publications/worldageing19502050/.
[2] For example, resources used in producing baby cradles could turn to the production of walking stick.

have to raise tax rate in order to keep its budget balanced. One may expect that tax payment and pension contribution for the future generations would increase as the result of demographic aging. In order to maintain the sustainability of pension system and government budgetary stance, it would be necessary to call for system reforms.

This paper aims to analyze the impact of population aging on the social security systems, especially the NHI system in Taiwan. In order to accomplish this goal, this paper incorporates the universal, compulsory national health insurance system into the model. Figure 1 illustrates a comprehensive structure of the model in this study. In the model there are four sectors (household, firms, government, and social security system) interact in two markets (good market and factor market). Households supply capital and labor to the factor market whereas firms hire factor to produce goods for sale in the goods market. Households earn incomes from factors sold in the factor market and use it to buy goods and services in the goods market. Government collects taxes, pension premium and NHI premium from both households and firms (the employers) and makes transfer payments to both sectors. In addition, the government as social security provider also provides commensurate shares to the pension fund and NHI fund.

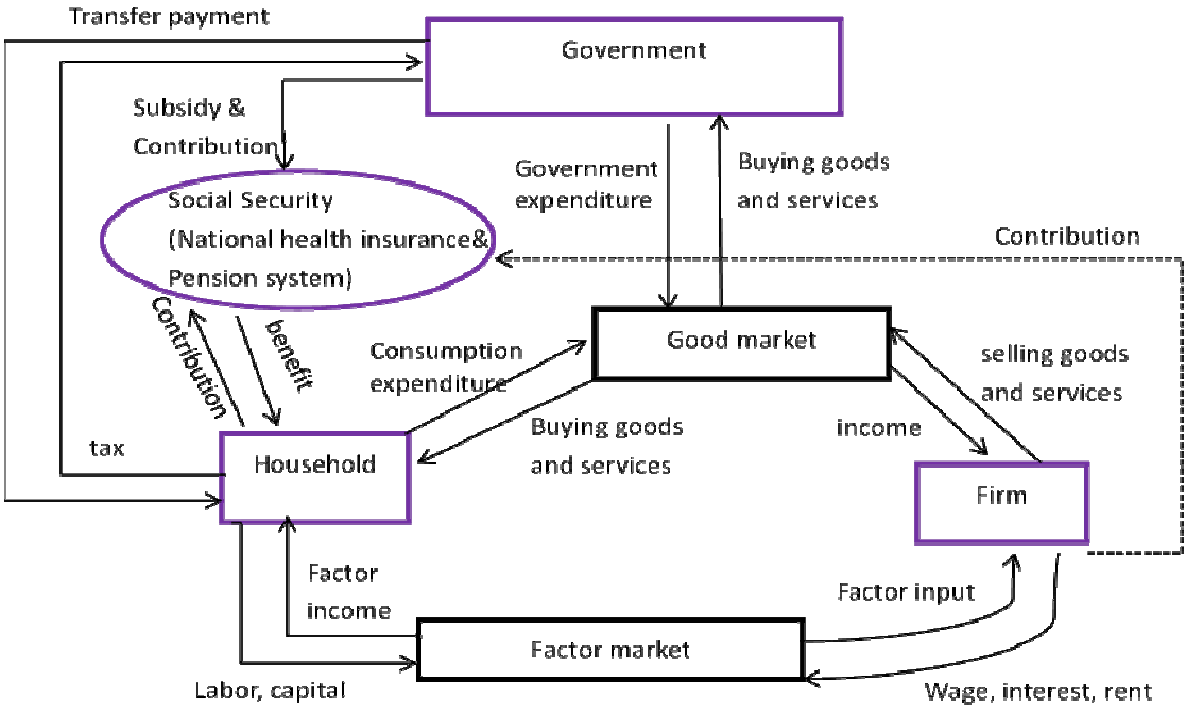


Figure 1: Model Structure and Economic Circular Flow Diagram

This paper employs overlapping generation model (OLG) to analyze the effect of population aging on private saving and consumption, national health insurance system, and the pension system. A major contribution of current paper is the incorporation of NHI in the OLG model and uses it to explore the long-term impacts of population aging on the macro economy. Though most existing papers focus on the investigation of impacts of population aging on pension system, this paper extends existing literature by introducing NHI system to the social security system and investigates its correlation with population aging. The dynamic general equilibrium OLG model will be calibrated and solved with historical data from Taiwan. The results then serve as baseline scenarios with which scenarios from various counterfactual policy reforms are compared. The counterfactual policy simulations would focus on measures of pension system reforms and NHI reforms which will be discussed in Section 4.

The reminder of this paper is as followings: Section 2 surveys related literatures on demographic aging and its macroeconomic impacts. Section 3 illustrates the model used for this paper. Section 4 presents and discusses simulation results of this study. Section 5 sums up major findings and discusses policy implications drawing from the simulation experiments in this study.

2. LITERATURE REVIEWS

The World Health Organization (WHO) states that "health is a cumulative state, to be promoted throughout life in order to ensure that the full benefits are enjoyed in later years. Good health is vital to maintain an acceptable quality of life in older individuals and to ensure the continued contributions of older persons to society."[3] This definition illustrates the relationship between aging and health. It stresses that good health status is the key to maintain good quality of life. Physical health is the most important asset for people and good health is a pre-requisite for happy life. Health insurance coverage provides economic security to accidental health expenditures, especially for the elders who have become frail as age increased. Various studies explores the role of Medicare and other health insurances on saving and retirement behaviors of the elders, whereas some others investigate the effects of pension system on the elders' life and the economy. This section reviews related studies on these two aspects.

The aging demographic dynamic causes huge increase in pension payments, affects intergenerational wealth distribution and resources allocation. The sustainability of fiscal budget and pension system in an aging society with pay-as-you-go system would face difficult time given that the working age population, the contributors of tax and pension fund, has been shrinking due to population aging. Demographic aging transition has raised the concern on fiscal sustainability and pension system vulnerability in a aging economy.

Horioka *et al*. (2010) analyze the impacts of population aging on saving in East Asia, especially for Japan and China. The main conclusion of this paper is that, population aging will cause decline in national saving, yet may not leads to disastrous outcomes because not all countries get aged simultaneously. Though many literatures claim that population aging would have an adverse effect on saving in the long term, some others would held an opposite view. Kinugasa and Mason (2006) argues that population aging may not necessarily lowers saving rate if life expectancy prolonged. Kulish *et al*. (2010) analyze aging, retirement, and saving using general equilibrium overlapping generation model. The study introduces endogenous retirement decision to the OLG model and concludes that the economy converges to a new equilibrium with higher capital intensity as life expectancy prolonged. However, in the transition periods, capital intensity falls in short run whenever there is improved physical health state associated with rising longevity.

Regarding pension system reform in the aging economy, various studies focus on the vulnerability of pension system and welfare effect of pension reform. Kotlikoff *et al*. (1999) analyze the distributional effects of social security in a computable general equilibrium model with overlapping generation structure. The study concludes that privatization of social security could improve long-run living standard; however, it takes time for the economy to achieve this gain and, in the transition process, there is welfare loss for the transition generation. Vogel *et al.* (2013) investigate the effect of pension reform on human capital formation and welfare of the households. This study indicates that openness has only relative mild effect whereas endogenous human capital formation combined with extension of the retirement age has strong effect.

[3] WHO (1999). "Men Ageing and Health: Achieving Health across the Life Span." p. 10. Available at http://whqlibdoc.who.int/hq/2001/WHO_NMH_NPH_01.2.pdf?ua=1.

With respect to population aging and health care expenditure, the life-cycle medical expenditure predicts that medical expenditure increases with ages. In a universal national health insurance system, population aging results in an increasing number of elders whose health expenditure is expected to be enlarged as times go on. Like that in the pension system, sooner or later the NHI program would encounter financial deficiency problem.

Therefore, NHI reform is another imperative issue in an aging economy.

Breyer *et al.* (2010) investigate the influence of aging on health care and health expenditure. The authors conclude that the rise in longevity leads to further demand for medical care, which demands further expansion of social and medical components care for the elderly. Wen *et al.* (2012) examine the effects population transition and volume-intensity to the growth of health care cost in Taiwan. The authors conclude that an annual 4.49% increase in nominal medical expenditure can be ascribed to contribution of health care inflation (2.43%) and population aging (1.68%).

It is well recognized that aging is one of the major factors that contribute to the increase in medical expenditure. Ensuring sufficient income for the old age is important to the elders' life quality and health condition. Kotlikoff (1986) explores the correlation between health expenditures and precautionary savings in America. The study concludes that, assuming that individuals are self-insured, uncertain health expenditures would lead to 1/3 increase in saving. Chou *et al*. (2003) investigate the association of national health insurance and saving behavior in Taiwan and conclude that comprehensive health insurance can reduce uncertainty on future out-of-pocket medical expenditures and hence the precautionary motive of saving. The empirical results from this study indicate that the compulsory national health insurance program in Taiwan results in a reduction of saving by an average of 8.6-13.7%, with the largest reduction comes from the least saving households. Nardi *et al*. (2009) investigates saving for the retired single people and conclude that out-of-pocket medical expenses rise quickly with both age and permanent income, so that the motive to save is driven by expected expensive medical expenditure in the latter age of life. Rogowski and Karoly (2000) investigates the role of health insurance in the retirement decisions of older workers and find that access to post-retirement health insurance has a large effect on retirement. French and Jones (2011) makes empirical analysis of the effects of employer-provided health insurance, Medicare, and Social Security on retirement behavior. The empirical results suggests that Medicare is important for understanding retirement behavior and that uncertainty and saving are both important for understanding the labor supply responses to Medicare.

Recent rising trend in medical costs has casted the doubt on the efficiency of the NHI program in promoting health of the people. Chen *et al*. (2006) evaluate the effect of Taiwan's NHI program on improving the elders' health care and health status. They use longitudinal survey data to analyze the causality and conclude that Taiwan's NHI has significantly increased the utilization of out-patient and in-patient care for the elderly and low-income. Population aging together with rapid rising in medical cost also cast doubt on the sustainability of the NHI, Medicare, or other comprehensive health insurance programs. Many studies also call for reforms on the health insurance programs. Hsu and Yamada (2013) investigate the impact of population aging on the universal health insurance (UHI) program in Japan and discuss the effects of potential reform policies. They construct a general equilibrium life-cycle model in which the effect of aging on microeconomic and macroeconomic behaviors, tax burden and welfare effect are incorporated. The research concludes that, given the current demographic projection, it would be indispensable for the Japanese government to levy higher labor income tax to finance enlarging future insurance benefit. A reform which increases labor income tax is undesirable because it discourages labor supply; an UHI reform by increasing copayment and tax reform via increasing

consumption tax, or both, would be more desirable. Moreover, the insurance benefits reform and tax reform would improve the welfare of future generation. Other similar studies with Japanese economy as research object, such as Muto *et al*. (2012), and Ihori *et al*. (2011), have proposed reform in social security and/or tax system.

3. THE MODEL

Samuelson (1958) and Diamond (1965) presented the pioneer work on OLG model. Since then OLG model is widely applied in demographic transition issue. Combined with demographic transition, an OLG model can be used to analyze business cycle fluctuation, policy application, public debt, and so on. With the assumption that the households live for finite time, OLG can be used to investigate the dynamic effect of demographic transition. This paper uses OLG model in the analysis of the impacts of population aging on macroeconomic performance of Taiwan. The model in this paper is built on a multi-period OLG with structure as that of Auerbach and Kotlikoff (1987) on demographic transition, social security, and economic activities.

Since young students in Taiwan graduate from college at age 22 and start working thereafter, this paper assumes that new generation enter the economy at biological age of 22, which corresponds to generation j=1 in the OLG model. Everyone retires at physical age 65, corresponding to generation j=44 and dies at age 80, corresponding to j=59. The economy consists of 59 generations that are denoted by j=1, 2,….., 59 and at any point of time there are 59 generations coexist. It is further assumed that there is no intergenerational borrowing and lending. All households make best allocation of their lifetime wealth, given that life expectancy is known to every individual. There is no bequest motive in the model. Each individual is rational and perfectly foresight. It is closed-economy model.

The model consists of four sectors: households, firms, the government, and social security system. There are two markets, factor market and good market, in which households, firms, and the government interact. It assumes no private insurance markets; people choose only health insurance provided by the government as insurance instrument for accidental health events. The government is responsible for administering the public pension and NHI systems. In addition, the government, as a social security provider, also makes fund contribution to these two social welfare systems.

3.1 Demographics

The economy is populated by overlapping generation of individuals. A generation is represented by a specific age. The economy consists of 59 generations of different ages at any point of time. The growth rate of new cohort is $n_{1,t}$, which is also the population growth rate of the economy (n_t). Let P_t denotes number of people living in time t, so the aggregate number of people at time t is given as:

$$\mathrm{P}_t = (1+n_t)P_{t-1}, \tag{3.1}$$

One can also obtain aggregate population by summing up all generations at time t. That is:

$$\sum_{j=1}^{59} P_{j,t} = P_t \ , \tag{3.2}$$

where j is the index of individual generation.

3.2 The Households

Assume that the household maximizes its expected lifetime utility. There is no uncertainty regarding life-length. While working, each household supplies a fixed amount of labor inelastically for which she earns the market wage to finance current consumption, saving and tax payments. This paper introduces medical expenditure into the model and treats it as part of household consumption. That is, the household has two forms of consumption: consumption for general consumer goods (*c*) and consumption of medical services (*m*). A minimum level of medical expenditure is necessity to each individual so that one keeps good 'health' to work and consume. The NHI program in Taiwan requires that each household to pay a constant copayment on each visit of clinics. This paper takes this copayment as the necessary minimum medical consumption for each household. The expected lifetime utility of a representative household is given by

$$E(U_j) = \sum_{t=j}^{j+58} \beta^{j-1} v(c_{j,t}, m_{j,t}), \tag{3.3}$$

where β denotes subjective discount factor; $c_{j,t}$ is the consumption of generation *j* at time t and $m_{j,t}$ is the minimum level of medical expenditure of generation *j* at time t.

Because it's difficult to measure medical expenditure for people across ages, this paper uses published age-specified per-capita medical expenditure data from NHI report to represent the medical expenditure of a typical person at a specific age. Let $m_{j,t}$ denote the medical expenditures of j^{th} generation at time t, Ψ denote copayment ratio of medical expenditure, and $\Psi m_{j,t}$ is the amount of copayment for generation j at time t. Instantaneous utility of the household, $v(c_{j,t}, m_{j,t})$, is a function of total consumption $c_{j,t}$ of households, which can be written as

$$v(c_{j,t}, m_{j,t}) = \frac{[c_{j,t} + \Psi m_{j,t}]^{1-\theta}}{1-\theta}, \tag{3.4}$$

where θ denotes intertemporal elasticity of substitution for consumption.

There are two cohorts in the economy: the working age generation and the retired. An individual in his working ages supplies inelastically his labor to obtain wage income. The working generations have to pay various taxes, including interest income tax, consumption tax, and income tax; they also made premium contribution to the government pension system and national health insurance. The tax rates for interest income, consumption, and wage income are τ_r, τ_c, and τ_w, respectively. People make premium contribution to the pension system at rate τ_s, and to the NHI at τ_m.

In the compulsory NHI system each individual is required to contribute a premium which is a portion, υ_m ($0 < \upsilon_m < 1$), of the individual's income. The insurance premium for a working-age generation is shared by the worker, employer, and the government together at the shares of τ_m, ω, and κ_m, respectively; where $\tau_m + \omega + \kappa_m = 1$. For the retired, the insurance premium is collected based on the amount of pension benefit one received.

Each household works until physical age 65, corresponding to generation 44 in the OLG model. A retiree of generation *j* is eligible to receive pension benefit $p_{j,t}$ at time t. The discounted intertemporal budget constraints for the household is given by

$$\sum_{j=1}^{44}[\prod_{t=1}^{j}[1+r_t(1-\tau_r)]^{-1}](1-\tau_w-\tau_s-\tau_m\upsilon_m)w_{j,t}e_j(1+g)$$
$$+\sum_{j=45}^{59}[\prod_{t=1}^{j}[1+r_t(1-\tau_r)]^{-1}](1-\tau_m\upsilon_m)b_{j,t}+\sum_{j=1}^{59}[\prod_{t=1}^{j}[1+r_t(1-\tau_r)]^{-1}]tr_{j,t} \quad \textbf{(3.5)}$$
$$=\sum_{j=1}^{59}[\prod_{t=1}^{j}[1+r_t(1-\tau_r)]^{-1}](1+\tau_c)c_{j,t}+\sum_{j=1}^{59}[\prod_{t=1}^{j}[1+r_t(1-\tau_r)]^{-1}]\Psi m_{j,t},$$

where $w_{j,t}$ denotes the wage rate per effective labor of generation j at time t; r_t denotes interest rate at time t; e_j is the efficiency index of working-age labor at j[th] generation; g is the rate of technology progress and $e_j(1+g)$ represents technology augmented labor efficiency which illustrates human capital formation implicitly. $tr_{j,t}$ is the lump sum transfer from the government to household. Equation (3.5) represents the household's lifetime budget constraint; that is, total lifetime income equals to total lifetime expenditure.

The household's saving is assumed to held in government bonds or lending to the firms for investment. Household's saving which is not held in bonds is the source of injection to national capital stock. For the j[th] generation during its working time, its asset which is used in capital formation can be written as:

$$k_{j,t}=(1-\tau_w-\tau_s-\tau_m\upsilon_m)w_{j,t}e_j(1+g)-\Psi m_{j,t}$$
$$-(1+\tau_c)c_{j,t}-d_{j,t} \qquad for\ j=1, \qquad (3.6)$$
$$k_{j,t}=[1+(1-\tau_r)r_t]k_{j,t-1}+(1-\tau_w-\tau_s-\tau_m\upsilon_m)w_{j,t}e_j(1+g)$$
$$-\Psi m_{j,t}-(1+\tau_c)c_{j,t}+[1+(1-\tau_r)r_t]d_{j,t-1}-d_{j,t}$$
$$for\ 2\le j\le 44, \qquad (3.7)$$
$$k_{j,t}=[1+(1-\tau_r)r_t]k_{j,t-1}+(1-\tau_m\upsilon_m)b_{j,t}-\Psi m_{j,t}-(1+\tau_c)c_{j,t}$$
$$+[1+(1-\tau_r)r_t]d_{j,t-1}-d_{j,t} \qquad for\ 45\le j<59, \qquad (3.8)$$
$$k_{j,t}=0 \qquad for\ j=59 \qquad (3.9)$$

where $k_{j,t}$ is physical asset of generation j at the end of period t ; $d_{j,t}$ is bonds held by this generation at time t. This paper assumes that all bonds mature in one year for each period. The amount of bonds held by each household is the average of bonds held; that is, $d_{j,t}=\overline{d_t}=D_t/P_t$. Working generations accumulate assets by saving. When j=1, the new born generation accumulates asset only by its net wage income and receives no interest income from bond holding (equation 3.6). Equation (3.7) is the assets determination for working-age generations whereas (3.8) is for the retired generations that are still alive. Since this paper assumes that people doesn't have bequest motive, so that in the last period of lifetime the net asset would equal to zero (equation 3.9).

The problem of the household is to maximize lifetime utility subject to the inter-temporal budget constraint. The first-order necessary condition for this problem can be shown in the following inter-temporal Euler equation:

$$(c_{j,t}+\Psi m_{j,t})^{-\theta}=\frac{[1+r_t(1-\tau_r)]}{\beta}(c_{j,t-1}+\Psi m_{j,t-1})^{-\theta}, \qquad \textbf{(3.10)}$$

The Euler equation determines optimal consumption choice over time, so that one derives optimal consumption path of the households from equation (3.10).

3.3 Firms

The production is assumed to use a Cobb-Douglas type, constant return to scale technology. At any point of time, firm employs labor N_t and capital K_t in the perfectly competitive factor markets and puts both factors into production. The production function is:

$$F(K_t, N_t) = A_t K_t^{\alpha} N_t^{1-\alpha}, \tag{3.11}$$

Where A_t is total factor productivity; α denotes capital's share of output; N_t is the aggregate number of labors employed by firm; K_t is the aggregate capital stock. This paper assumes that total factor productivity, A_t, grows at rate of g which is also the rate of technical progress in the economy.

In the production sector, firm is assumed to be a profit maximizer. Firm's profit function is given as: $F(K_t,N_t)$ - $w_t(1+\omega\upsilon_m)N_t$ - $r_t(1-\tau_r)K_t$, where $\omega\nu_m$ is the portion of national health insurance premium that the employer is responsible for each dollar of wage bill paid.

The first-order condition for profit maximization yields equations for factor prices:

$$(1+\omega\,\upsilon_m)w_t = (1-\alpha)\,A_t K_t^{\alpha} N_t^{-\alpha}, \tag{3.12}$$

$$(1-\tau_r)r_t = \alpha A_t K_t^{\alpha-1} N_t^{1-\alpha} - \delta_k, \tag{3.13}$$

where ω denotes portion of national health insurance premium that employers are responsible to share based on wages paid to the worker ($\upsilon_m w_t$); δ_k is depreciation rate for K_t. According to Taiwan's NHI system, employers have to share certain portion of social security premium. This shared amount is an extra to wage and is regarded as extra costs for employers.

3.4 The Government

The government sector consists of two parts: a general government sector, and a social security system. In the general sector, the government provides services to the public and collects taxes to finance its expenditure. In national income accounting, government expenditure includes government consumption, investment, and transfer payment. This paper uses G_t to denote government consumption and investment expenditure on infrastructure, and tr_t denotes lump sum transfer to the household. Such lump sum transfer includes unemployment insurance, low-income housing allowance, etc.

The social security system consists of the pension system and universal health insurance program. In the pension system, $b_{j,t}$ denotes per capita pension benefits received by retirees of generation j at time t, which is defined as:

$$b_{j,t} = \rho(\frac{1}{44}\sum_{j=1}^{44} w_{j,t}e_j(1+g)), \tag{3.14}$$

where ρ is income replacement ratio. Equation (3.14) states the amount of pension benefits is income replacement ratio multiplied by the individual's mean effective wages during working periods. This paper assumes that the amount of pension benefit is fixed in each period after retirement. Since only the retirees are eligible to draw pension benefit, so that pension income for the j[th] generation is:

$$b_{j,t} = \begin{cases} 0 & for\ j = 1,2,...44 \\ b_{45,t+45-j} & for\ j = 45,46,...59 \end{cases} \tag{3.15}$$

This paper doesn't consider moral hazard and adverse problem in the national health insurance (NHI) program. Define Ψ as the copayment rate, then $(1-\Psi)m_{j,t}$ is per capita medical costs covered by NHI across generations. Intuitively, the aggregate medical coverage by NHI (ME_t) is

$$ME_t = (1-\Psi)\sum_{1}^{59} P_{j,t}m_{j,t}(1+g), \tag{3.16}$$

The government finances its expenditures through taxes. There are three types of taxes: capital income tax, wage income tax, and consumption tax, with tax rates τ_r, τ_w, and τ_c, respectively. There are two sources of contributions to the social security system, the pension contribution and the health insurance premiums. In the pension system, all working generations are required to contribute to the public pension at rate τ_s with respect to wage incomes. This paper assumes that, once pension system becomes deficiency, the government is responsible to offset the imbalance (ε_t). The budget for the pension system is:

$$\tau_s\sum_{j=1}^{44} P_{j,t}w_t e_j(1+g) + \kappa_s\sum_{j=1}^{44} P_{j,t}w_t e_j(1+g) + \varepsilon_t = \sum_{45}^{59} P_{j,t}b_{j,t}, \tag{3.17}$$

The first term on the left-hand-side of (3.17) is the pension premium drawn from wage earners and the second term represents corresponding contribution from the government, with κ_s the ratio that the government is responsible for and $\tau_s + \kappa_s = 1$.

In the compulsory NHI program, both workers and employers are required to make mandatory premium contribution based on workers' wage at rates τ_m and ω respectively. In addition, the government has to make a corresponding share (κ_m) of contribution to the insurance premium. Whenever the system is imbalance, the government is responsible to make an offset, η_t, to balance it. The budget constraint for the NHI is:

$$ME_t = (\omega + \tau_m + \kappa_m)\upsilon_m\sum_{j=1}^{44} P_{j,t}w_t e_j(1+g) + \eta_t, \tag{3.18}$$

The budget constraint for the government is:

$$
\begin{aligned}
&G_t + \kappa_s \sum_{45}^{59} P_{j,t} b_{j,t} + \kappa_m \upsilon_m \sum_{1}^{44} P_{j,t} w_{j,t} e_j (1+g) + \sum_{1}^{59} P_{j,t} tr_t + \varepsilon_t + \eta_t + (1+r) D_{t-1} \\
&= \tau_w \sum_{1}^{44} P_{j,t} w_{j,t} e_j (1+g) + \tau_k \sum_{1}^{59} P_{j,t} r_t k_t + \tau_c C_t + D_t \\
&= \tau_w w_t N_t + \tau_k K_t + \tau_c C_t + D_t \,,
\end{aligned}
\tag{3.19}
$$

where κ_s and κ_m denote government coverage ratio for the public pension and health insurance respectively. This paper assumes that the government finances the deficiencies in social security by issuing one-period debt. D_t is government bonds outstanding at time t, which is issued to cover the deficiency in the social security system.

3.5 The Equilibrium Condition

The aggregate consumption C_t in the economy can be presented by

$$\sum c_{j,t} P_{j,t} = C_t \,, \tag{3.20}$$

The sum of labor supply is equal to aggregate demand for labor. Labor market equilibrium is given by

$$\sum e_{j,t} P_{j,t} = N_t, \tag{3.21}$$

The capital market equilibrium in time t is:

$$\sum k_{j,t} P_{j,t} = K_t \tag{3.22}$$

$$\sum d_{j,t} P_{j,t} = D_t \tag{3.23}$$

$$S_t = K_t + D_t \tag{3.24}$$

where S_t in (3.24) is aggregate saving in the economy. Equation (3.22) and (3.23) illustrates aggregate capital and aggregate bonds outstanding in the economy respectively.

The equilibrium condition in economy is:

$$
\begin{aligned}
Y_t &= A_t K_t^{\alpha} N_t^{1-\alpha} \\
&= C_t + [\mathrm{K}_{t+1} - (1-\delta) K_t] + G_t \\
&= C_t + \mathrm{S}_t + T_t \,,
\end{aligned}
\tag{3.25}
$$

where Y_t is the aggregate output.

4. MODEL CALIBRATION AND SIMULATIONS

Given the model discussed in Section 3, this paper first performs model calibration to mimic steady state economy for Taiwan based on data in 2012. Figure 4-1 illustrates parameters used in this study. This paper conducts dynamic simulations for years 2012 to 2112, given the official medium variant population projection made by the National Development Council of Taiwan. The effects of various counterfactual policy reforms will be discussed and the resulting effects on the economy will be compared to the scenarios of baseline simulation. This paper uses Matlab in model estimation and simulations.

4.1 Data and Parameterization

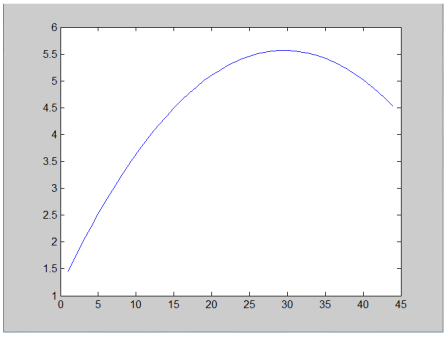
This paper assumes that the economy is at its initial steady-state at year2012 and allows a 100-year-period for the transition to the new steady-state. Each agent in the model has a prototype life-cycle age-earning profile and life-cycle age-specified per capita medical expenditure. The life-cycle age-earning profile has been estimated with personal income tax data[4] in 2012 and a similar health expenditure profile been estimated based on the NHI data.

In the OLG model, households start lifetime career at age 1 (j=1), corresponding to physical age of 22. All households retire at mandatory retirement age 65 (j=44) and survive up to age 80 (j=59). An individual's wage income is assumed to correspond to his productivity, whereas productivity is subject to knowledge and experience accumulated in working life. The representative household's lifetime labor income is a hump-shaped curve. That is, an individual's income is low at the early stage of career and then increases gradually at the early middle-age as experience accumulated; his labor income, commensurate with his productivity, reaches the summit around the late middle-age and then starts to decline as mandatory retirement is approaching. This papers normalizes the representative household's lifetime income with the income Figure at age 22 (generation j=1), so that earnings at various ages is indexed with that of the beginning year. A similar transformation has also been made to age-specified medical expenditure. The life-cycle labor efficiency profile (i.e., the synonym for age-earning profile) and per capita medical expenditures profile are estimated as followings:

$$e_j=1.1671+0.2973j-0.005023j^2 \quad \textbf{(4.1)}$$

$$m_j=1.461192-0.0523317j+0.0030394j^2 \quad \textbf{(4.2)}$$

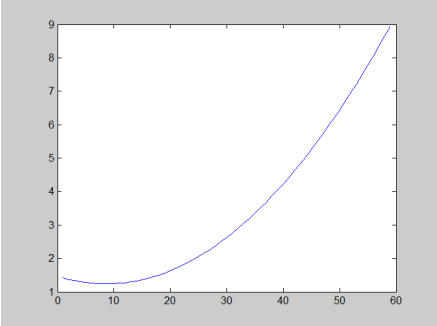
where *j* denotes generation *j*. Figure 2 shows that the hump-shaped life-cycle age-earning profile peaks around j=30 (physical age 52). The age-medical-expenditure profile is a hyperbola, which indicates that health expenditure accelerates at the latter years (Figure 3).



Data source: Authors' Estimation

Figure 2: Labor Efficiency Profile

[4] Available at http://www.fia.gov.tw/public/Attachment/34191135771.xls



Data Source: Authors' Estimation

Figure 3: Per Capita Medical Expenditure Profile

Household's intertemporal elasticity of substitution for consumption (θ) is set at 0.25 as in Auerbach (1987). Following Chang *et al.* (2005), this paper sets time discount factor (β) at 0.97. The depreciation rate is set to 0.04 that are nearly in line with empirical data in Taiwan. All taxes rates are assumed to be fixed at the 2012 levels. Table 1 reports the parameters values used in model estimation.

Table 1: Parameter Values Setting

Parameter	Description	Value
α	Capital's share of output	0.33
β	Time discount factor	0.97
δ	Depreciate rate	0.04
d	Technical progress rate	0.017
ρ	Pension-income replacement ratio	0.465
θ	Inter-temporal elasticity of substitution for consumption	0.25
τ_r	Tax rate for capital tax	0.14
τ_c	Consumption tax rate	0.05
τ_w	Income tax rate	0.135
τ_s	Worker's public pension contribution rate	0.12
τ_m	Worker's NHI premium contribution rate	0.3
ω	Firm's share of health insurance premium	0.6
k_s	Government's share of public pension premium	0.6
k_m	Government's share of health insurance premium	0.1
υ_m	Ratio of labor income that is subject to NHI premium charge	0.0491

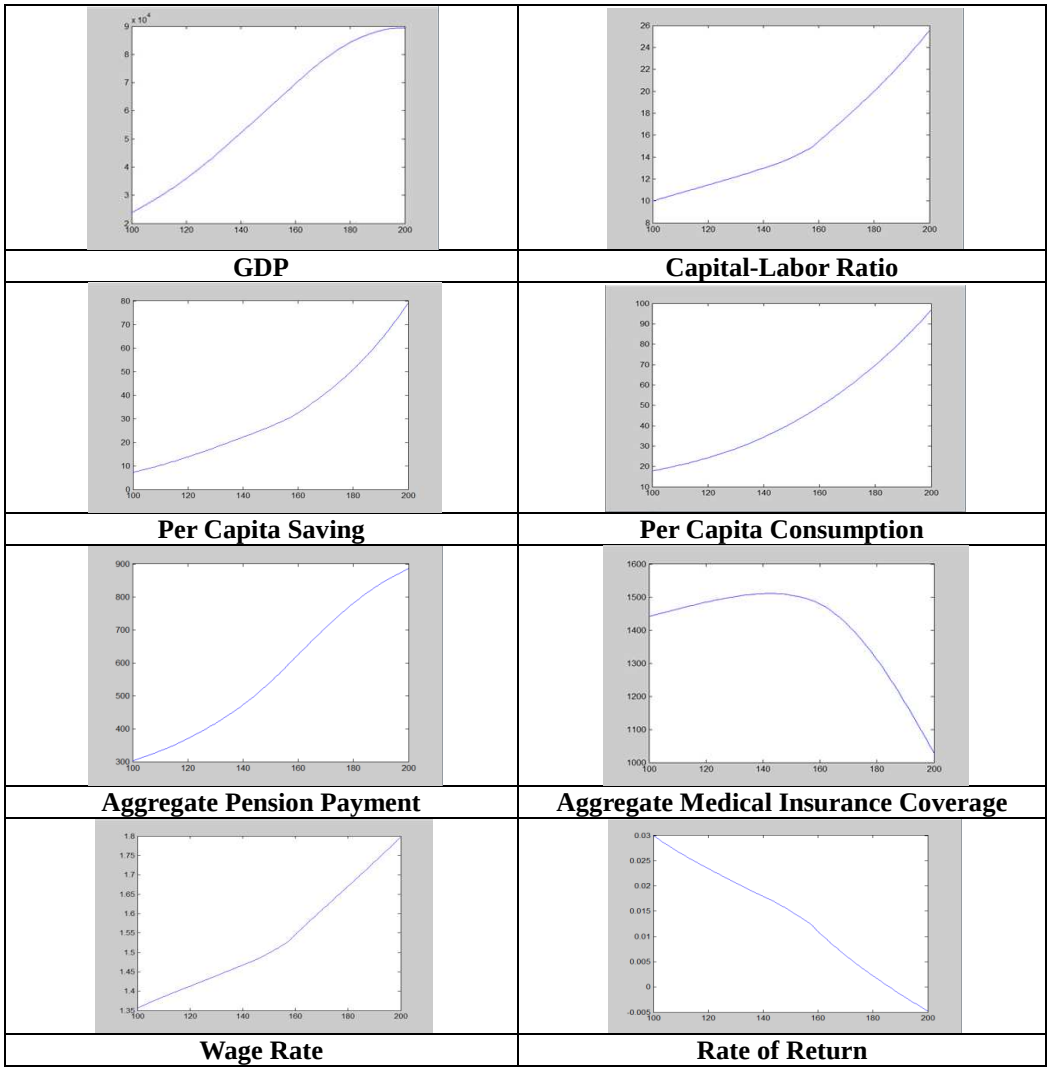
4.2 SIMULATION ANALYSIS

4.2.1 Baseline Scenarios

This paper uses parameters listed in Table 1 of model solution and calibration. The solution of the model serves as baseline and the baseline scenarios will be compared with that of other policy simulation outcomes. The policy experiments in this study include medical health insurance reform and a joint reform of pension and medical insurance. Figure 4 illustrates the scenarios of eight key macroeconomic variables of the baseline results. That is, GDP, per capita consumption, per capita saving, capital-labor ratio, pension payment, NHI coverage, wage rate, and rate of return on capital.

Productivity growth due to technological progress can offset part of the adverse effect of shrinking labor force on output and income resulting from population aging. With the assumed 0.017 annual technologic growth rate, the baseline simulation indicates that aggregate output (GDP) can still keep growing for a certain periods of time. However, due to shrinking working-age population, the growth in GDP would gradually stagnate in the long run. Per capita saving and consumption show increasing trend as GDP increased. In the factor markets, wage rate shows an increasing trend as labor becomes scarce, whereas rate of return on capital declines as savings increased in the aging economy. With demographic aging, aggregate labor decreases faster than capital stock does, so that capital-labor ratio shows an increasing trend. Capital-labor ratio correlates negatively with rate of return of capital and positively with wage rate.

Aggregate pension payments increases as population aging evolves. Aggregate medical health insurance coverage increases at the first instance and then falls with the declined total population. From the perspective of the households, aging leads to higher personal medical expenditure; however, on the macro aspect, population aging leads to a decline in aggregate medical expenditure once total population starts to decline. The scenario of aggregate NHI coverage is the interactive outcome of individual aging and aggregate demographic transition.



Data source: Prepared by the Authors

Figure 4: Scenarios of Baseline Simulation

4.2.2 National Health Insurance Reforms

This section discusses the effects of national health insurance reform in an aging economy. This paper conducts two alternate reforms and investigates its effects on the economy. The reforms schemas are: (1) an increase in the copayment rate, and (2) an increase in the insurance premium contribution by the private sector.

We first discuss the change in the copayment rate. According to National Health Insurance Act in Taiwan, each beneficiary of the NHI is responsible for a small portion of the medical cost for each use of the insurance. Current effective copayment rate is 0.364.[5] Suppose that the insurance authority demands a raise of the copayment rate by 15%, from 0.364 to 0.4. Figure 5 illustrates the effects of this policy reform.

Raising copayment ratio has the effects of increasing per capita saving and decreasing per capita consumption. As per capita saving increases, so does capital stock. Other things being equal, increasing capital stock leads to increase in GDP. This effect can be understood by examination of the households' optimization behavior. The optimal consumption in households' utility function is the sum of consumption on medical services plus consumption on goods and non-medical services (Equation 3.10). Consumption of medical service is specified as a necessary minimum expenditure that is required to maintain "good" health of the individual. The amount of copayment is that "minimum" necessity which is deducted from the "optimal" aggregate consumption to obtain the level of consumption on goods and non-medical services. Thus, a rise in the copayment rate implies that, at given level of aggregate consumption, the costs of the "minimum" medical service have been raised so that the consumption on goods and non-medical services has to be lower. On the other hand, the NHI outlay which is the aggregate medical insurance coverage would be lower with the raise in copayment. Other things being equal, the increase in copayment has the effect of improving the financial status of the NHI system. However, given the unchanged NHI premium contribution, a rise in the copayment rate means that the insurers pay the same premium yet receive less benefit. As a result, medical coverage to premium ratio decreased and the insurers' welfare has deteriorated.

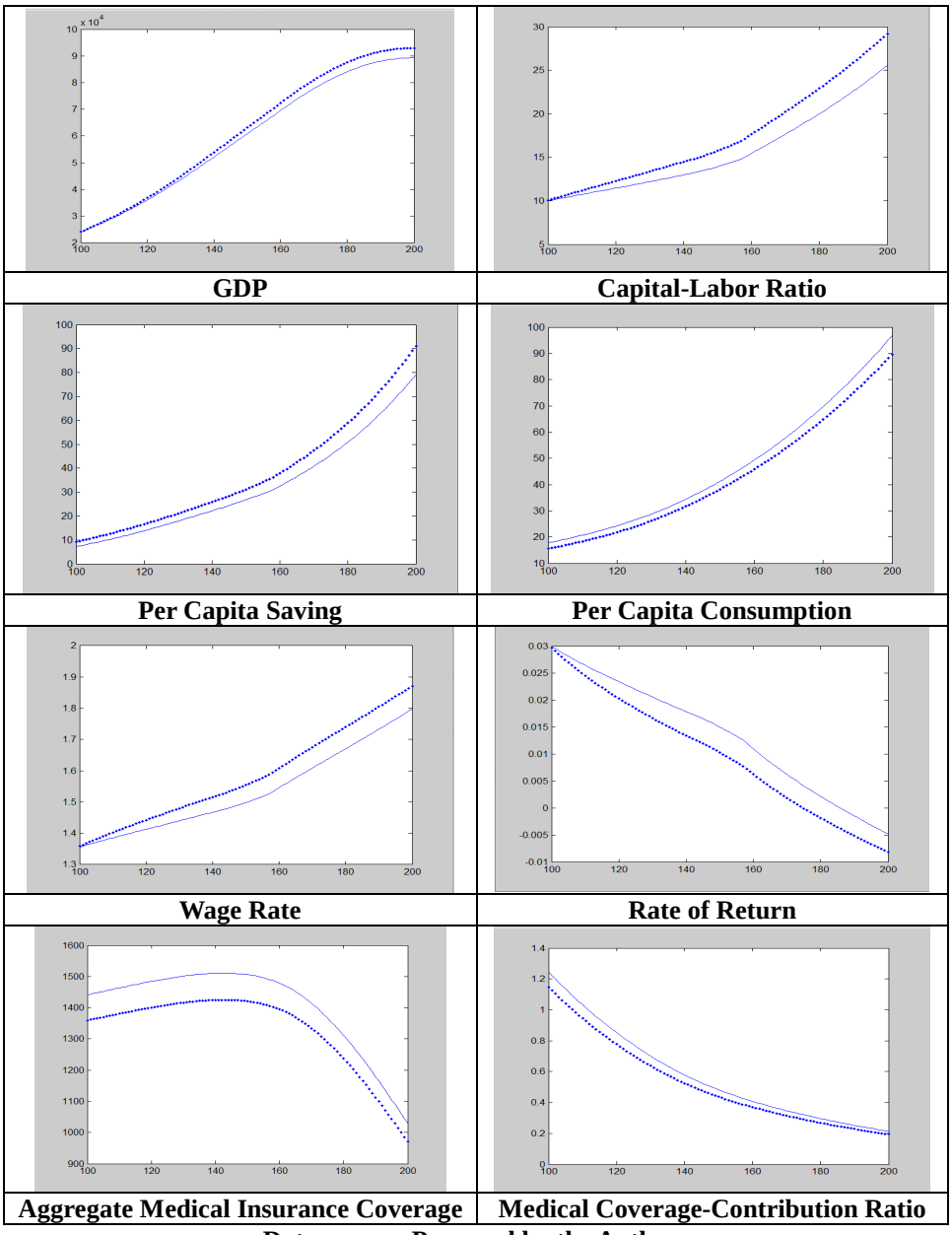
Furthermore, raising copayment rate has the effect of reducing personal in-pocket income and may also promote the incentive for precautionary saving. Rising copayment means that people have to prepare more out-of-pocket money for the medical service in the future, so that people would save more for uncertain medical payment in the future. This provides partial explanation for the rising per capita saving, comparing to that of the baseline scenario. In the factor markets the increase in copayment also has noticeable effects on raising wage rate and discouraging rate of return on capital.

To improve financial soundness of the NHI system, another possible reform proposition would be the increase in the private premium payment. Current NHI premium in Taiwan is shared among household, firm, and the government with the share of 30%, 60%, and 10%, respectively. Since household is the beneficiary of the NHI program, the proposed reform is to increase the share of the beneficiary and reduces the shares of the other two contributors. That is, the premium shares among household, firm, and the government change to 40%, 40% and 20%. Figure 6 illustrates the outcome scenarios of this reform.

The simulation results indicates that aggregate medical insurance coverage doesn't change in this reform, because this reform only changes the sources of funding, not the outlay. This reform reduces the premium share of the firm

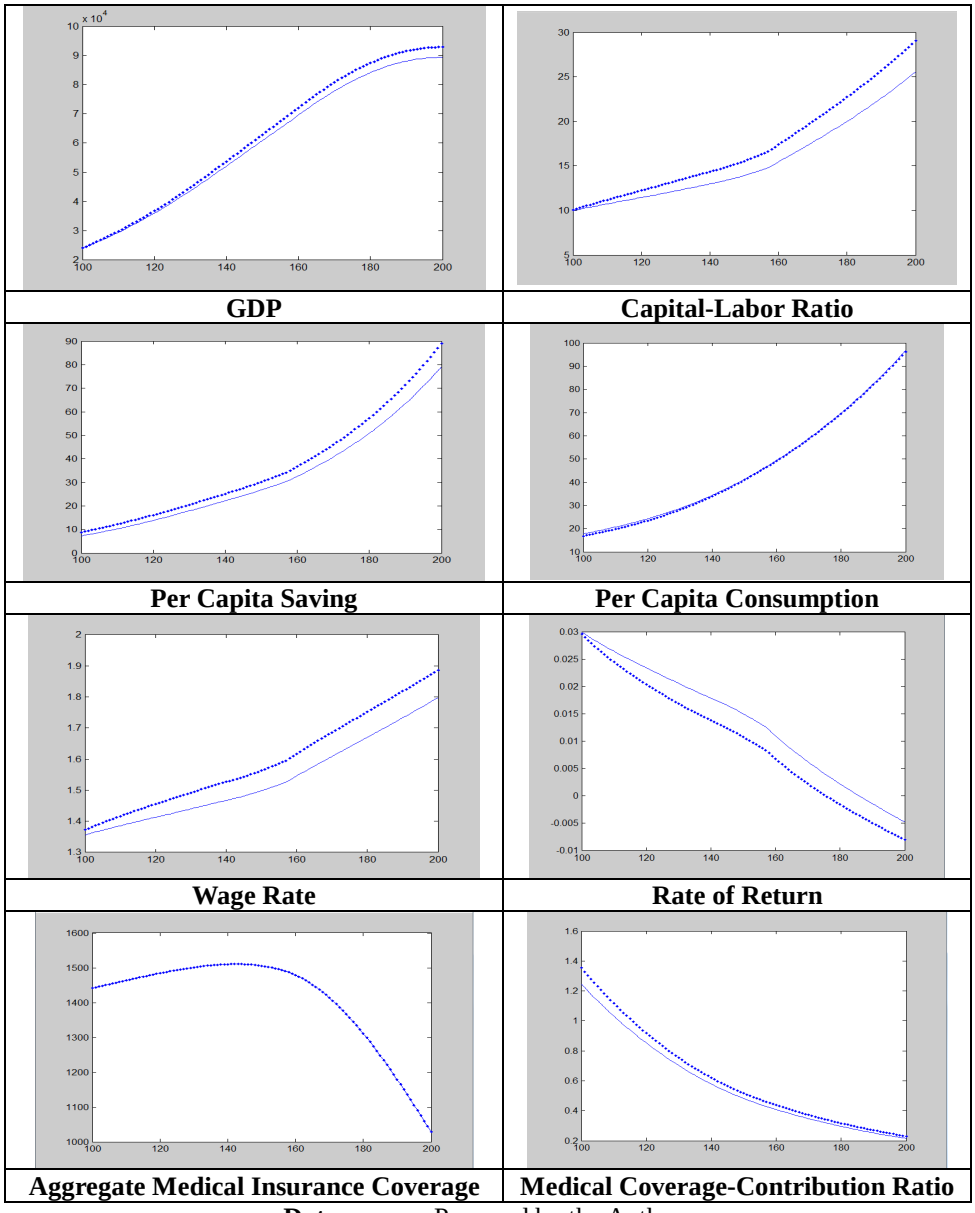
[5] Available at http://www.mohw.gov.tw/cht/DOS/Statistic.aspx?f_list_no=312&fod_list_no=4534.

from 60% to 40%, which has reduced firm's indirect labor costs, so that labor demand increases. Increased labor demand bids up the wage rate. On the labor supply side, increased premium share reduces laborers' net wage income, which stimulates per capita saving. However, this reform yields little effect on per capita consumption. However, this reform improves the medical coverage to contribution ratio, which implies an improvement of the medical health insurance welfare.



Data source: Prepared by the Authors

Figure 5: Increasing Copayment Rate to 0.4



Data source: Prepared by the Authors

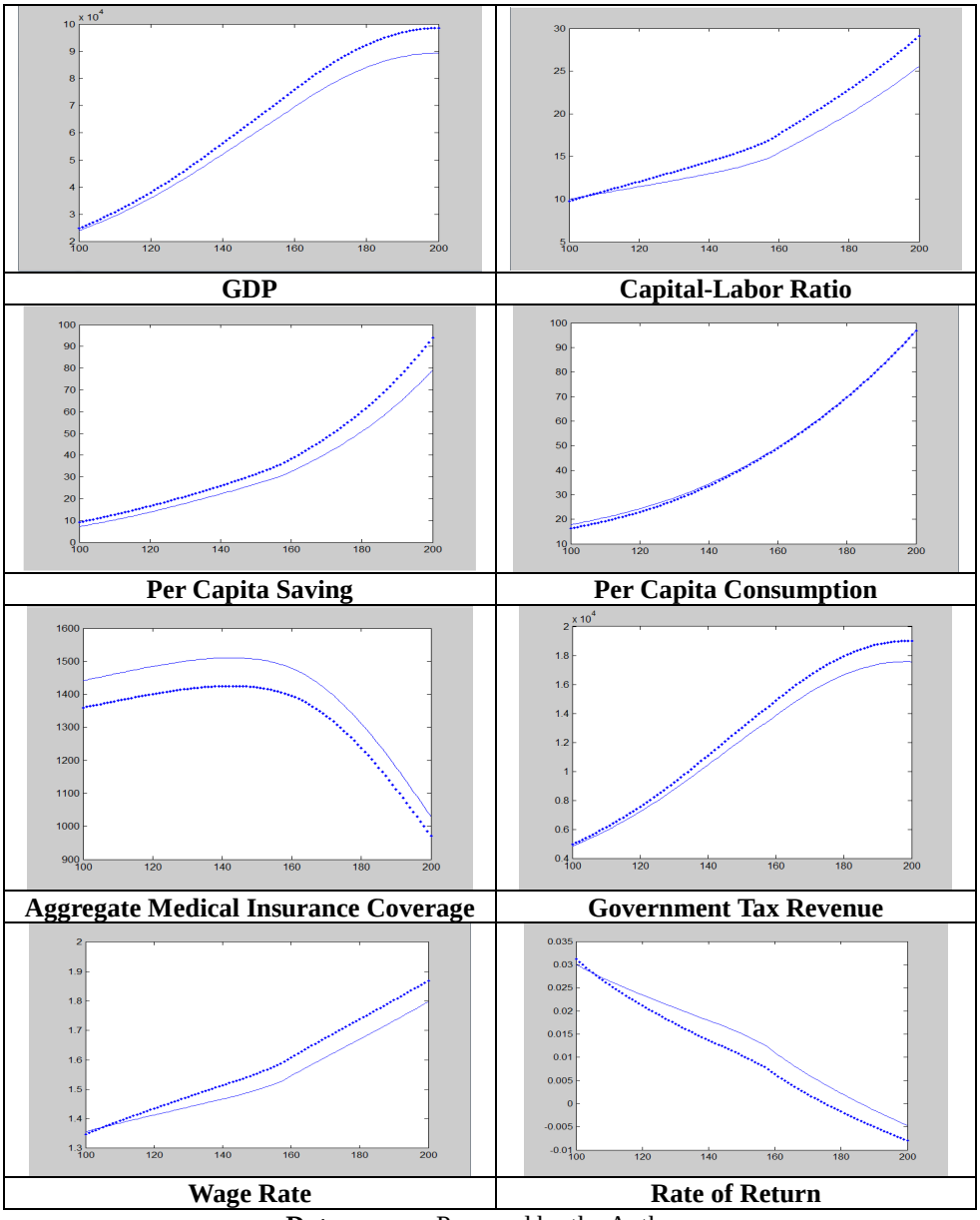
Figure 6: Effect of Contribution Ratio Change in the NHI Premium

4.2.3 Joint Reform of Pension and NHI Systems

So far, this paper has conducted two simulation analyses for the NHI program. In this final simulation, we consider a joint reform in the pension and NHI system Again, this reform aims at increasing financial soundness of the current social security system. The reform experiment proposes a deferment of retirement age by two years, from 65 to 67, and an increase in NHI copayment rate by 15%, from 0.364 to 0.4. Figure 7 shows the effects of this reform.

This joint policy reform increases saving and capital stock, so that scenario of GDP performs better than that without reforms, or that with NHI reform only. In spite that GDP has been increased, per capita consumption has been lower than that in the baseline simulation, though the difference is not much significant. The reform has positive effect in improving wage rate whereas has adverse impact on rate of return on capital. One noticeable outcome of this integrated

reform is that it significantly improves the financial strength of government revenue and reduces aggregate NHI insurance coverage and thus improves financial soundness of the NHI system.



Data source: Prepared by the Authors

Figure 7: Postponing Retirement Age and Rising in NHI Copayment Rate

5. CONCLUSIONS

This paper investigates the effect of social security reform of the aging society in Taiwan by a multi-period overlapping generation (OLG) model. The model assumes constant growth of technology in the production sector and in medical service industry. In the labor market a worker's income is commensurate with his productivity whereas the productivity is related to his age on the lifetime horizon. As a result, the typical age-earning profile of an agent is hump-shaped. In the medical service market, the empirical data indicates that per capita medical expenditure is also correlated to the patient's age on the lifetime horizon.

The major contribution of current paper is the introduction of age-specified, life-cycle income and medical expenditure profiles of the representative individual to the conventional OLG model framework to analyze the effects of population aging on social security system.

The demographic transition in an aging economy leads to a shrinking portion of economic active population and an increase in the elderly dependency ratio. It has been fervently discussed that, without reforming the current pay-as-you-go (PAYG) pension system and tax system, both government sector and the pension system may go bankruptcy. It is afraid that, given the shrinking working-age population which is the source of taxable income, the government may not be able to collect enough tax revenue to finance its enlarging welfare expenditure arising from the demand of increasing elders. Moreover, given the increasing imbalance between the contributors and beneficiaries of the current PAYG system, it is also argued that the PAYG pension system may also encounter deficiency problem in the future.

Concerning the potential impacts of population aging on Taiwanese economy, this paper first uses the OLG model to investigate the effects of population aging on major macroeconomic economic variables in Taiwan. The baseline simulation results indicate that, although population aging reduces the size of working-age population and the source of labor supply, it may not necessarily leads to a reduction in GDP growth if the economy can maintain a constant stream of technological progress. The increased GDP translates to increase in per capita saving and consumption in the aging economy. It is also noticed that population aging changes the relative prices in the factor market; workers' wage shows an increasing trend with the transition of population aging whereas the rate of return on capital displays an ever decreasing trend. As to the social security system, population aging causes an ever increasing pension payment. However, NHI coverage increases moderately with the demographic dynamic at the first couple decades and then declines as aggregate population decreased.

This paper has conducts three policy reforms and compares the outcomes with the scenarios in the baseline model. The reforms in the NHI program propose an increase in the copayment ratio and a change in the relative shares of premium contribution among household, firm and government. These two reforms stress that the household should bear more financial responsibility for the NHI system, based on the beneficiary-pays principle. Comparing the reform results with that of the baseline scenarios, both policy reform leads to higher level of GDP and per capita saving. It is noticed that change in copayment rate has significant effect in reducing the outlay of the NHI program whereas an increase in individual premium share doesn't yield obvious effect in altering the NHI outlay. However, increase in copayment reduces medical coverage-contribution ratio whereas increase in premium share increase medical coverage-contribution ratio.

The last simulation experiment of this paper proposes a joint reform in the pension system by postponing mandatory retirement age by two years and an increase in the effective copayment rate by 15%. Comparing the simulation results of this experiment with that of previous ones, we notice that all reforms would lead to better performance in GDP, increased per capita saving, and relative change in factor prices in favor of labor income. However, this joint reform has more prominent effect in improving the sustainability of the NHI program and financial soundness of government budget.

REFERENCES

1. Auerbach, A. J., and Kotlikoff, L. J. (1987), *Dynamic Fiscal Policy,* Cambridge University Press.
2. Breyer, F., Costa-Font, J., and Felder, S. (2010), "Ageing, health, and health care." *Oxford Review of Economic Policy*, 26(4), pp. 674~690.

3. Chang, Y., and Guan, D. (2005), "An empirical study on total factor productivity and economic growth in Taiwan." *Socioeconomic Law and Institution Review,* 36, pp.111~154.
4. Chen, L., W., Yip, W., Chang, M., Lin, H., Lee, S., Chiu, Y., and Lin, Y. (2006), "The effects of Taiwan's national health insurance on access and health status of the elderly." *Health Economics*, 16(3), pp.223~242.
5. Chou, S., Liu, J., and Hammitt, J. K. (2003), "National health insurance and precautionary saving: evidence from Taiwan." *Journal of Public Economics,* 87, 1873~1894.
6. French, E., and Jones, J. B. (2011), "The effects of health insurance and self-insurance on retirement behavior." *Journal of the Econometric Society*, 79(3), pp.693~732.
7. Hoel, M. (2007), "What should (public) health insurance cover ? " *Journal of Health Economics*, 26(2), pp.251~262.
8. Horioka, C.,Y. (2009), "Aging and saving in Asia." *Pacific Economic Review*, 15(1), pp.46~55.
9. Hsieh, C., Lin, C., J., and Yu, H. (1998), "The determinants of health care expenditures in Taiwan." Journal of Social Sciences and Philosophy, 10, pp.1~32. (in Chinese.)
10. Hsu, M., and Yamada, T. (2013), "Financing health care in Japan: A rapidly aging population and the dilemma of reforms." *Working paper.*
11. Ihori, T., Kato, R. R., Kawade, M., and Bessho, S. (2011), "Health insurance reform and economic growth: Simulation analysis in Japan." *Japan and the World Economy*, 23(4), 227~239.
12. Keng, S., and Sheu, S. (2013), "The effect of national health insurance on mortality and the SES-Health gradient: evidence from the elderly in Taiwan." *Health Economics*, 22(1), pp.52~72.
13. Kinugasa, T, and Mason, A. (2006), "Why countries become wealthy: the effects of adult longevity on saving." *World develop*, 35(1), pp.1~23.
14. Kotlikoff, L., J. (1986), "Health expenditures and precautionary savings." *NBER Working Paper*, No. 2008.
15. Kotlikoff, L., J., Smetters, K., and Wallister, J. (1999), "Distributional Effects in a General Equilibrium Analysis of Social Security." *NBER*.
16. Kulish, M., Kent, C., and Smith, K. (2010), "Aging, Retirement, and Savings: A General Equilibrium Analysis." *The B. E. Journal of Macroeconomics*, 10(1), pp.1~32.
17. Lee, R., and Mason, A. (2010), "Some macroeconomic aspects of global population aging." *Demography*, vol. 47-supplement, pp.151~172.
18. Lee, R., Mason, A., and Miller, T. (2003), "Saving, wealth and the transition from transfers to individual responsibility: The case of Taiwan and the United States." *The Scandinavian Journal of Economics*, 105(3), pp.339~357.
19. Lee, Y., Huang, Y., Tasi, Y., Huang, S., Kuo, K., N., McKee, M., and Nolte, E. (2010), "The impact of universal national health insurance on population health: the experience of Taiwan." *BMC Health Service Research*, vol. 10, article 225.

20. Li, H., and Mérette, M. (2005), "Population aging and pension system reform in China: A computable reform in China: A computable overlapping-generations general equilibrium model analysis." *Journal of Chinese Economic and Business Studies*, 3(3), pp.263~277.

21. Muto, I., Oda, T., and Sudo, N. (2012), "Macroeconomic impact of population aging in Japan: A perspective from an overlapping generation model." *Bank of Japan Working Paper Series*, No. 12-E-9.

22. Nardi, M., D., French, E., and Jones, J., B. (2009), "Why do the elderly save? The role of medical expenses." *NBER Working Paper*, No.15149.

23. Rogowski, J., and Karoly, L. (2000), "Health insurance and retirement behavior: evidence from the health and retirement survey." *Journal of Health Economics*, 19(4), pp.529~539.

24. Shiu, Y., and Chiu, M. (2008), "Re-estimating the demographic impact on health care expenditure: evidence from Taiwan." *The Geneva Papers*, 33(4), pp.728~743.

25. Vogel, E., Ludwig, A., and Börsch-Supan, A. (2013), "Aging and Pension Reform: Extending the Retirement Age and Human Capital Formation." *NBER* Working Paper, No. 18856.

26. Wen, Y., Huang, S., and Chiang, T. (2012), "An analysis of the growth of healthcare expenditure in Taiwan: healthcare inflation, volume-intensity, and equity." *Taiwan J Public Health,* **31(1),** pp.1-10. (In Chinese.)