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Macroeconomic and Welfare Effects of Parametric Pension Reform in Iran

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The aim of this paper is to analyze the macroeconomic effects of parametric reforms. An adjusted Auerbach-Kotlikoff model is used to study the effects of decreasing replacement and contribution rates of the pension system. The first part concentrates on the macroeconomic effect of reforms. Our results indicate that reducing the replacement and contribution rates increase the capital stock and decrease the interest rates so the economy moves closer towards the golden rule. Under these parametric reforms, there is a long-run increase in capital stock, wages, labor supply, consumption and income of the future generations. We then measure the welfare effects of different generations and finally show how to use a Lump-Sum Redistribution Authority to calculate an aggregate efficiency measure of policy reforms. Our findings suggest an aggregate efficiency gain of 32.14 % (for replacement rate) and 4.04 % (for contribution rate) compared to the initial equilibrium.

Keywords: Stochastic OLG Model, Pension Reforms, Welfare
JEL Classification: H55, H75, I38, J26

1 Introduction

Population aging is one of the major economic challenges for today's societies. An increasing life expectancy in conjunction with declining birth rates tends to reduce the part of the population in working age and raises the part of the economically dependent old. To meet this challenge it is necessary to understand the economic consequences of such a demographic change. Due to the demographic transition, the pension system is under severe pressure. Therefore, studying different aspects of stabilizing pension fund is crucial.

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In this paper, we investigate the economics of pension reforms and its implications for the welfare of different cohorts. We utilize a general equilibrium model with overlapping generations in order to quantify the macroeconomic, welfare and efficiency consequences of this specific reform. The impact of change in pension system parameters in households behavior can only be measured using a general equilibrium model of the economy, one that takes into account the interaction of decision of households, producers, and the government. Moreover, to measure the impacts of a demographic transition on the behavior and welfare of different generations, it is necessary for a dynamic model to be disaggregated (by age cohorts), describing the experience of each age cohort over time as economic conditions change. Typically we use behavioral reactions and market clearing price adjustments after a reform.

We also exclude micro-simulation models which analyze life-cycle consumption and savings decisions in a partial equilibrium framework. Starting out from the pre-reform benchmark equilibrium of Iran’s economy, we change the parameters of the pension system and compute the transition path, the new long-run equilibrium as well as the welfare consequences for different cohorts. The parameters of the pension system are replacement rate which defined as the ratio of an individual's (or average of a given population's) pension in a given time period and the (average) income in a given time period and also contribution rate which means the amount (typically expressed as a percentage of the contribution base) that is needed to be paid into the pension fund. Finally, we incorporate lump-sum compensations in order to quantify the aggregate efficiency impact of a specific reform scenario.

The study of public finance shocks (implying intergenerational considerations) has been explored incomputable, Overlapping Generations (OLG) model initiated by Auerbach and Kotlikof (1987) and extending the basic framework of Allais– Samuelson–Diamond. These two setups build on the neo-classical one-sector growth model but emphasize the microeconomic structure of the household’s decision.

Our research also builds on and contributes to the seminal framework of Auerbach and Kotlikoff (1987) to analyze the economic consequences of pension reforms in different settings. Pension reforms can be grouped into at least two different categories: systemic and/or parametric. The former consists of replacing the defined benefit system financed typically on a pay-as-you-go basis (PAYG-DB) with a defined contribution (DC), partially or fully funded. The latter boils down to adjusting selected parameters of the existing defined benefit systems: eligibility conditions (e.g. retirement age, contribution rate or replacement rate).

Various numerical studies have already analyzed issues of pension reforms. For example, Boersch-Supan et al. (1999) compute the changes in tax burdens for different generations if the current unfunded system would be completely replaced by a funded system within the next 50 years. Börsch-Supan et al. (2006) also study pension reforms in Germany and in EU in a context of global finance with three zones (Germany, other EU countries and other OECD countries) and notably find the decrease in the German interest rate resulting from aging (due to the reduction of the working population and pension reforms) is "substantially" moderated when capital is invested abroad (Börsch-Supan, Ludwig et al. 2006).

İmrohoroğlu et al. (2018) investigate the impact of social security reform in China in a model with two-sided altruism as well as a pure life-cycle model. They consider three reforms: An increase in the social security replacement, an increase in the retirement age and increases in both the retirement age and the social security replacement rate. They show that the quantitative implications of social security reform, in particular for capital accumulation and output, are very different across the two models. Li and Lin (2016) considered various reforms on China's social security including adjusting the replacement rate while keeping the contribution rate constant, increasing the contribution rate and the retirement age, increasing the retirement age with the replacement rate being unchanged, and switching to a fully-funded system by using government assets to pay the implicit social security debt. The effects of these reforms on capital accumulation, the output, and the welfare for each generation are simulated and compared.

Two recent works in parametric reforms (Cabo and García-González 2014, Chen, Beetsma et al. 2016), that studies a parametric reform of the pension system in a dynamic game between the government and the representative consumer, and the calibrated study in continuous time by Chen and Lau (2014). Okamoto (2004) and Nishiyama and Smetters (2007), use a lump-sum tax, Auerbach and Kotlikoff (1987) adjust the contribution rates, whereas Fehr et al. (2008), Ludwig and Vogel (2010), Fehr and Kindermann (2010) interchangeably employ tax and contribution rate adjustments, just to mention a few. Nishiyama and Smetters (2005) focus on consumption taxation and Conesa and Kruege (2006) study capital income taxation.

There are several papers that study the transition associated with social security reforms and find substantial efficiency and welfare gains in the long run. New models also conceptualize the welfare effects of the reform in addition to the changes in macroeconomic aggregates. The analysis comprises a change in utility observed across cohorts along the entire transition path, as pioneered by Breyer (1989) and Feldstein (2002).

Huang et al. (1997) show that complete or partial privatization implies large short-run welfare losses, which cannot be compensated with the long-run gains. Lachowska and Myck (2018) examine the degree of substitution between public pension wealth and private saving by studying Poland's 1999 pension reform. The analysis identifies the effect of pension wealth on private saving using cohort-by-time variation in pension wealth induced by the reform. It shows that pension wealth and private saving appear to be close substitutes. Conesa and Kruege (2006) show that in the presence of uninsurable labor income uncertainty the welfare losses of the initial cohorts are even larger because the unfunded social security system provides partial insurance. Kotlikoff et al. (1999) analyzes different types of transitions and find that transition generations experience a 1% to 3% welfare decline, whereas future generation experience gains that are close to 20%. Using a different approach, Feldstein and Samwick (1998) find smaller but still positive transition costs. Conesa and Garriga (2008) show that eliminating compulsory retirement rules with the privatization can substantially reduce the welfare losses of the initial generations alive, but yet these are still substantial. Finally, McGrattan and Prescott (2005) and Joines (2005) identify a particular policy path such that no cohorts are worse off.

Heterogenous agents OLG models have already been used to assess the impact of policy reforms. For example, İmrohoroğlu et al. (1995) and İmrohoroğlu et al. (1999), Huggett and Ventura (1999), Fehr and Habermann (2008) and Williamson, J. B. et al. (2017) study the effect of pension reforms. Conesa and Krueger (2006) and Erosa and Koreshkova (2007) analyze the effects of progressive taxation.

All studies discussed so far focus on steady states and derive the optimal rate as the one that maximizes long-run welfare. We would like to emphasize that this paper explores the sensitivity of gains from parametric social security reforms.

We employ a stochastic general equilibrium model to study the effects of both parametric and systemic reforms on the macroeconomic variables and the intergenerational welfare of the current and future generations over a life cycle. The model employed has these characteristics: First, the household preferences are represented by a CRRA (Constant Relative Risk-Averse) utility function. Second, there are 10 life-cycle generations in this model. Third, productivity growth is incorporated in the production function. Fourth, the workers retire compulsorily after 30 years of working life. The latter assumption is based on the fact that in the Social Security Organization of Iran an individual receives pension benefit after 30 years working life.

The paper is organized as follows. Section one reviews selected literature that is related to the present analysis. A theoretical model is presented in section 2. Section 3 provides information on the setting of the model parameters and set up initial equilibrium. Section 4 reports the results of some numerical experiments on different policy reforms. Finally, we report some concluding remarks in section 5.

2 The Model

Our model is a simplified version of Fehr and Kindermann (2018). The model consists of four agents; households, firms, government, and the pension system. The household is represented by a set of individual utility functions, each representing a generation living for 75 years. The oldest generation dies at age 75[1] and a new generation enters the labor force at age 25[2]. The individual works for 30 years and from year 31 receives a retirement benefit for 20 years[3]. By perfect foresight, the agent chooses a consumption path and maximizes a time separable constant relative risk aversion (CRRA) utility function. There is no intergenerational transfer (no bequest motive) in this model and the social security system in Iran is an unfunded pay-as-you-go system and financed by the payroll tax on the labor income.

2.1 Demographic

At each point on time, the economy is populated by the J overlapping generation indexed by $j=1, 2,\ldots, J$. Individuals die after J with probability 1. Cohorts grow over time at the constant rate n_p according to

$$N_{1,t+1} = (1 + n_p).N_{1,t+1} \qquad and \qquad N_{j+1,t+1} = N_{j,t} \tag{1}$$

Where $N_{j,t}$ denotes the number of the j-type cohort in period t and n_p is pothe pulation growth rate. As the population size is growing over time at rate n_p on a balanced growth path all, aggregate variables will be growing at a rate n_p.

[1] The life expectancy is 75 in Iran.
[2] The household enters year 25.
[3] Member who works for 30 years has a right to retirement benefits.

Then we normalize all aggregate variables by the size of the youngest cohort alive in a period, which we can do if the production technology is homogeneous of degree 1. This ensures that on a balanced growth path these normalized aggregates will be constant over time. The relative population size to aggregate variables over cohorts is:

$$N_j^r = \frac{N_{j,t}}{N_{1,t}} = (1 + n_p)^{-j} \tag{2}$$

Variables are multiplied by the size of the first cohort.

2.2 Firms

A large number of identical firms use the capital and labor on perfectly competitive factor markets to produce a single good with the Cobb-Douglas production with Y, K, and L denoting aggregate output, capital, and labor. The parameter α marks the share of capital in production while **Ω** represents technology which is adjusted in order to normalize the wage rate of effective labor.

$$Y_t = \Omega_t . K_t^{\alpha} . L_t^{1-\alpha} \tag{3}$$

Capital depreciates over time so that the capital stock is

$$\left(1 + n_p\right) K_{t+1} = (1 - \delta) K_t + I_t \tag{4}$$

Where δ is the depreciation rate. The input demand functions of the firm for capital and labor under the assumption of perfect competition evolve as:

$$r_t = \alpha . \Omega_t . \left[\frac{L_t}{K_t}\right]^{1-\alpha} \quad and \quad w_t = (1 - \alpha) . \Omega_t . \left[\frac{K_t}{L_t}\right]^{\alpha} \tag{5}$$

2.3 Households

We assume an identical preference structure for all agents represented by a time separable, nested CRRA utility function. Individuals have preferences over streams of consumption c_j and leisure l_j.

$$\sum_0^{\infty} \beta^t u(c_j, l_j) \tag{6}$$

Individuals discount future periods with the discount factor β. The utility function then reads

$$E_0\left[\sum_{j=1}^{J}\beta^{j-1}u(c_j,l_j)\right] \qquad with \quad u(c_j,l_j)=\frac{\left[(c_j)^{v}(l_j)^{1-v}\right]^{1-1/\gamma}}{1-1/\gamma} \tag{7}$$

The utility of consumption and leisure takes a Cobb-Douglas form so that their elasticity of substitution is always 1. The intertemporal elasticity of substitution is again constant and equal to γ, where $1/\gamma$ denotes the individual's risk aversion.

In our model individuals exogenously differ along with age and labor productivity. Labor productivity has two components. First, when they enter the economy, households draw a permanent labor productivity shock θ from some distribution that we call π_θ and will stay constant over the life cycle. Second, the transitionary shock component η_j follows a first autoregressive process. Labor productivity falls to 0 at some exogenous retirement age j_r so that agents are forced to retire.

$$\eta^{+}=\rho\eta+\varepsilon^{+} \qquad with \quad \varepsilon \sim N(0,\sigma_\varepsilon^2) \tag{8}$$

The household's wage rate does not only depend on labor productivity, but also there is an age earning a profile. It depends on the household's job experience in different ages. Auerbach and Kotlikof (1987) have parameterized age-earning e_j as an exponential function of years of experience. The wage rate then reads

$$w_{j,t}=\begin{cases} w_t.\ e_j.exp\left[\theta+\eta_j\right] & if \quad j<j_r \quad and \\ 0 & if \quad j\geq j_r \end{cases} \tag{9}$$

Recall that as a result of an inelastic labor supply assumption, the labor supply is set equal to one. The parameter e_i is the human capital profile, which grows exponentially by age. It is defined by

$$e_i=\exp(a+bi+ci^2), b>0\,, c<0\,,\ i\in\{1,2,\dots,50\} \tag{10}$$

where *i* is years of experience. The human capital profile builds up as age increases. The following equation shows the household `s budget constraint:

$$S_{j+1}+p_t.c_j=(1+r_t^n)S_t+w_{j,t}^n.\left(1-l_j\right)+pen_j \tag{11}$$

where the households decide about their level of consumption c_j, their leisure l_j as well as savings S_{j+1}. When the individual enters the labor market has no asset ($S_t, 1$=*0*), and when he dies no asset is left behind ($S_{t,10}$=*0*). Note that the household has to pay income taxes $\tau_{w,t}$ and pension contributions $\tau_{p,t}$ from her labor earnings, so the net wage rate equals $w_{j,t}.(1-\tau_w-\tau_p)$.

In reward for the contributions to the pension system, the household receives a pension payment from the age of retirement. The pension payment is a lump-sum payment for all retirees living at a certain point in time *t*.

$$pen_j = \begin{cases} \overline{pen_t} & if \;\; j \geq j_r \quad and \\ 0 & if \;\; j < j_r \end{cases} \tag{12}$$

Due to the additive separability over time, we can again write the household optimization problem as a dynamic program. To do so we have to define the state space for the household. Obviously, we need individual wealth *S* as well as the current labor productivity shocks θ and η to be part of the state space. Since households are not only heterogeneous with respect to savings and labor productivity, but also with respect to their age, *j* needs to be part of the state space as well. The dynamic programming problem of the household then reads

$$\begin{aligned} &V_t(j,S,\theta,\eta) = max_{c,l,s}\, u(c,l) + \beta E_j[V_{t+1}(j+1,S^+,\theta,\eta^+|\eta)] \\ &s.t \quad S^+ + p_t c = (1+r_t^n)S + w^n.(1-l) + pen \;\;,\; S^+ \geq 0 \quad .l \leq 1 \\ &\quad and \qquad \eta^+ = \rho\eta + \varepsilon^+ \quad with \quad \varepsilon \sim N(0,\sigma_\varepsilon^2) \end{aligned} \tag{13}$$

2.4 The Government

We assume that government expenditure and the public debt level should be kept constant in relation to GDP. The tax system is balanced if

$$\tau_{c,t}.c + \tau_{w,t}.w_t + \tau_{r,t}.r_t.S_t + \left(1+n_p\right)B_{t+1} = G_t + (1+r_t)B_t \tag{14}$$

The government-financed expenditure from issuing new debt is $\left(1+n_p\right)B_{t+1}$. However, it has to repay the current debt so that on the expenditure side we add $(1+r_t)B_t$ to government consumption.

2.5 The Pension System

The pension system operates on a pay-as-you-go pension scheme based on defined contribution, i.e., they receive a lump-sum pension when old and it is constant for any cohort. The social security authority collects contribution from the workers to finance its pension payments to the retired agents. There is no capital accumulation process involved. The pension system's budget balance is

$$\tau_{p,t}.w_t.L_t^s = \overline{pen_t}.\sum_{j=j_r}^{J}\left(1+n_p\right)^{1-j}$$
$$\overline{pen_t} = \kappa_t.\frac{w_{t-1}.L_{t-1}^s}{\sum_{j=1}^{j_r-1}(1+n_p)^{1-j}} \tag{15}$$

where κ_t is the replacement rate of the pension system, $\sum_{j=1}^{j_r-1}(1+n_p)^{1-j}$ is the size of the working age cohorts in the previous period, so that total labor earnings divided by this size is average earnings. Every worker pays a social security payroll tax for 30 years and then compulsorily retired. The workers who retire receive a benefit over 20 years i.e., from age 31 to age 50. In the above equations the parameter n_p is the population growth and $\tau_{p,t}$ is the contribution rate.

2.6 Welfare and Aggregate Efficiency

To measure the welfare effects of some policy reform, we use the concept of Hicksian equivalent variation. This concept reveals to what extent additional consumption and leisure should be paid to an individual in the initial equilibrium so that makes her well off, and must be equal when compared to the same individual in the reform scenario. In order to calculate these welfare effects use the value function of an individual. To make these numbers comparable across different generations, we measure them as a fraction of remaining lifetime consumption and leisure.

$$V_t(j,S,\theta,\eta) = E\left[\sum_{s=j}^{j}\frac{\left[(c_j)^{\upsilon}(l_j)^{1-\upsilon}\right]^{1-1/\gamma}}{1-1/\gamma}\right] \tag{16}$$

where assume a household at age *j* have some level of wealth *S* and is experiencing some labor productivity shocks *θ* and *η*. According to its definition, this household's value function is an expected discounted sum of utilities from instantaneous flows of consumption and leisure with respect to the individual budget constraint and the laws of motion of the transitory shocks. We now ask how the value functions changes when we increase consumption and leisure at each remaining age *s=j,…,J* and in each state of the world by a factor ϕ. The answer to this problem is

$$E\left[\sum_{s=j}^{j}\frac{\left[\left((1+\varphi)c_j\right)^{\upsilon}.\left((1+\varphi)l_j\right)^{1-\upsilon}\right]^{1-1/\gamma}}{1-1/\gamma}\right] = (1+\varphi)^{1-1/\gamma}.E\left[\sum_{s=j}^{j}\frac{\left[(c_j)^{\upsilon}.(l_j)^{1-\upsilon}\right]^{1-1/\gamma}}{1-1/\gamma}\right] = (1+\varphi)^{1-1/\gamma}.V_t(j,S,\theta,\eta) \qquad (17)$$

To understand how much additional consumption and leisure would have to be given to a household at state *(j, S, θ, η)* to make her equally well off as in the reform path, the following equation is used:

$$\left(1+\varphi(j,S,\theta,\eta)\right)^{1-1/\gamma}.V_0(j,S,\theta,\eta) = V_t(j,S,\theta,\eta)$$

$$\Rightarrow \qquad \varphi(j,S,\theta,\eta) = \left[\frac{V_t(j,S,\theta,\eta)}{V_0(j,S,\theta,\eta)}\right]^{\frac{1}{1-1/\gamma}} - 1 \qquad (18)$$

Due to the existence of many different generations affected by the reform, the welfare effects might not be of the identical sign, due to the fact that from one reform some generations might win, some might lose. When we want to judge whether a reform proposal is a good or bad thing, we ideally have to subsume all the different welfare effects of different generations and individuals under one number. This number should summarize the pure efficiency effect of the reform.

To isolate the pure efficiency effects of the reform, we apply the hypothetical concept of a Lump-Sum Redistribution Authority (LSRA) used by Auerbach and Kotlikoff (1987) in a separate simulation. This concept was first fully adapted to the stochastic OLG model by Nishiyama and Smetters (2005). LSRA contains a hypothetical governmental agency that can use lump-sum taxes and transfers to redistribute among generations alive at a point in time as well as those who will be born in the future. It is a useful tool to separate the effect of pure intragenerational and intergenerational distribution from efficiency.

The LSRA thereby proceeds as follows: to all generations already being economically active in year t it pays a lump-sum transfers or levies lump-sum taxes in order to make them as well off in the reform path than in the baseline path. Consequently, their compensating variation amounts to zero. Having done that, the LSRA might have run into debt or build up some assets. It now redistributes this debt or assets across all future generations in a way that they all face the same compensating variation. This variation is interpreted as a measure of efficiency. Consequently, if the variation is greater than zero, the reform is Pareto improving after compensation and vice versa (Fehr, 2011).

3 Parameterizing the Model

The economic environment described above allows us to simulate the transitory and steady-state growth and macroeconomic effects of pension reforms. To map the model into the data there are mainly two types of model parameters: Those that can be directly observed in the data, e.g. life expectancy, individual wages or government consumption. Other parameters of the model need to be pinned down by calibration, as it is very popular in the literature, see e.g. Conesa et al. (2009).

Table 1

Direct parameter choices in the OLG model

Parameter		Value	Source
Maximum age	J	10	Statistical Centre of Iran
Retirement age	j_r	7	Statutory Retirement Age
Population growth rate	n_p	0.012	Statistical Centre of Iran
Age productivity profile	e_j	1	Hansen (1993)
Capital share	α	0.42	Jalali-Naini (2003)
Government spending to GDP	G/Y	0.18	Central Bank Database
Government debt to GDP	B/Y	0.15	Central Bank Database
Consumption tax rate	$\tau_{c,t}$	0.09	Iranian National Tax Administration (INTA)
Contribution rate	τ_p	0.33	Iran Social Security Organization

According to the Statistical Centre of Iran, life expectancy at birth, currently, amounts to 75 years. We assume one model period to cover a 5-year intervals and households start their working life by the age of 25 (j = 1). To map this into the model, we let individuals retire at age 55.

Consequently, when each period covers 5 years, they reach the age of 75 after period JJ= 10. Since lifetime is deterministic, we let all agents exit from the model after period 10.

The contribution rate is 33%, which Individuals have to pay 7%, agent 23%, and government 3%. Note that the government share of contribution rate, which is about 3% is estimated in government expenditure as G_t in Equation 11. Also, the consumption taxes are set equal to 9 percent.

Other parameters, however, just influence some outcomes, but do not have a direct counterpart in reality so they are hard to pin down directly in a dataset.

We borrow a lot from the calibration strategy of Dashtban Faroji et.al (2011), who calibrate a similar model setup to Iran's economy. There is no estimation for the intratemporal elasticity of substitution for Iran, hence, an intertemporal elasticity of substitution (ρ) of 0.6 is chosen. The value is chosen by running the simulations such that Majidi (2005) found the actual macroeconomic data imitates the simulated data. The earning profile is set to a range of values for $e_i = \exp(a + bi + ci^2)$ such that the best choice matches the initial steady state. The values found for a, b, and c are -0.003233, 0.03233, and -0.00067, respectively (Majidi, 2005). The aggregate technology is the parameter that needs to be calibrated for the firm sector. There are mainly two ways to specify the aggregate technology level. One is to just normalize it to a value of 1. The route we are choosing is that we set the technology level such that the wage rate for effective labor is equal to w = 1. This requires Ω_t to be:

$$\Omega_t = \frac{1}{1-\alpha} \cdot \left[\frac{L_t}{K_t}\right]^{\alpha} \tag{19}$$

In our calibration with a capital share of α=0.42 the technology level leads to Ω_t=1.4.

Table 2
Calibrated parameters in the OLG model

Parameter		Value	Source
Technology level	Ωt	1.4	Based on the author's calculation utilizing Fehr at al (2018) formula.
Intertemp. Elast. of Subst	γ	0.6	Majidi, G (2005)
Depreciation rate	δ	0.042	Amini et al. (2005)
Intertemporal discount factor	β	0.98	Adibnia (2012)
Consumption share in utility	ν	0.3	Docquier and Leigeois (2004)
Replacement rate	κ_t	0.84	Iran Social Security Organization

3.1 Initial Steady State

The first part shows the outcomes of the model on the macroeconomic level, the second part summarizes the average life cycle profiles of individual variables.

Table 3 summarizes the macroeconomic data generated by our calibrated OLG model. The parametrization outlined and the demographic and the social security parameters generate an initial long-run equilibrium with a capital-output ratio of 1.3% and a consumption-output ratio of 4.11 %. Note that the model generates an interest rate of 13.76 % per year. In this case, we have r>n and therefore the economy is not in the golden rule.

Table 3
The initial equilibrium of OLG model

	Variable	Value (%)
Capital Market	Private Assets	30.69
	Capital	22.69
	Public Debt	75
	Interest Rate	13.76
Goods Market	Private Consumption	70.41
	Public Consumption	18
	Investment	11.59
Labor Market	Average Hours Worked (in % of time endowment)	28.25
	Wage Rate(absolute)	1

Figure 1 shows the life cycle profiles of households as a fraction of the average working household labor income. Several observations are drawn from the figures below. First, labor hours start from its maximum value due to high labor productivity in the initial years. Second, labor earnings are hump-shaped over the life cycle. It first increases in the initial years as labor productivity increases. However, in the same way, as households demand an increasing consumption path, they will also want leisure consumption to increase. Therefore hours worked decrease again successively with age. Third, the combination of an increasing consumption path and a hump-shaped labor-related income profile leads households to save quite a substantial amount. These savings are meant to finance consumption in the retirement period, where labor-related income is especially low. The household wealth profile increases over the life cycle. On the other hand, households receive a pension at age 55 so their wealth increases again.

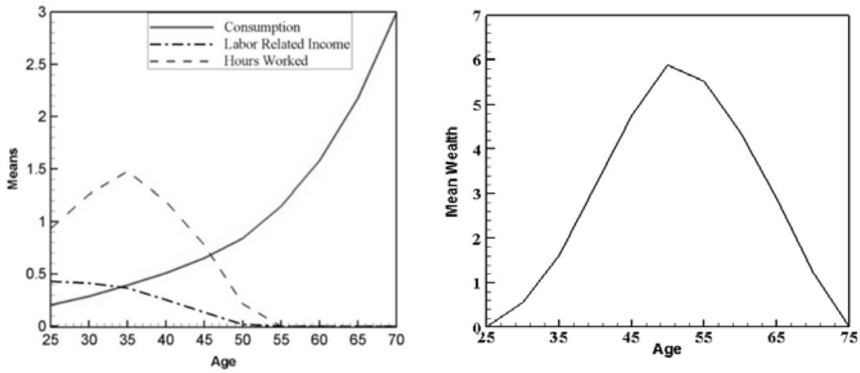

Figure 1. Average Life Cycle Profiles

Note that there is also a precautionary savings motive in this model. Households will build up a buffer stock of assets in order to insure against transitory fluctuations in labor productivity. Also, adjust their labor supply freely; they can start working more hours in times with low labor productivity to generate more income.

4 Simulation Results and Policy Reform

This section describes the policies which have been experimented to study the macroeconomic effects and intergenerational distribution (welfare effect) of parametric reform[1].

We now want to use this model to analyze several parametric pension reforms. We first make one reform and study its effects on the macroeconomic, household behavior, the decision of individual consumption and leisure as well as on the welfare of different generations and aggregate efficiency. In the next step, we then determine the optimal policy that maximizes aggregate efficiency.

For the term "parametric" reforms, the impact of the two options is analyzed: (i) a reduction in the generosity of the PAYG pension system brought about through changes in the system's replacement ratio and (ii) decreasing the contribution rate of the pension system.

[1] A FORTRAN program is used for simulation purpose.

4.1 Replacement Rate

Table 4 reports some important effects of decreasing the replacement rate of the pension system to zero on macroeconomic variables: First, by this reform, the pension contribution rate falls in period 1 of the transition and distorted labor supply in the initial equilibrium. This distortion causes aggregate labor supply to increase quite substantially by 35.96 % and it rises even more.

Second, pension payment immediately drops down to zero, so individuals have to prepare for retirement by building up adequate private wealth. This causes a significant increase in private wealth as well as the capital stock. Note that capital needs time to be built so in the first period of transition that labor supply increases and capital stock being fixed the wage rate drops to -1.24. While the capital stock increases over time, the capital to labor ratio in the economy starts to rise and the interest rate falls and wage rate again rises.

Finally, with increasing labor income and capital stock, consumption increases significantly in the long-run. Not surprisingly, with increasing capital stock and labor supply, the GDP of the economy increases in the long-run by roughly 18 %.

Table 4

The macroeconomic implication of reduction in the replacement rate[1]

t	1	2	3	4	5	…	∞
A	0.00	2.69	5.69	8.81	12.87	…	**31.22**
C	1.04	1.76	3.10	5.63	7.77	…	**17.09**
Y	1.60	3.48	5.89	7.00	9.47	…	**17.91**
K	0.00	3.82	7.71	11.39	16.65	…	**42.03**
L	35.96	34.14	35.35	38.00	40.77	…	**40.32**
I	13.88	19.14	26.38	32.81	34.58	…	**42.03**
w	-1.24	-0.49	1.96	2.09	3.15	…	**9.06**

Figure 2 compares the life cycle effects before and after the reform. Looking at the left panel of Figure 2, it comes out that retirement saving increases when the pension system shutting down and households save most of their labor earning. As we mentioned above when there is a pension system, individuals do not need to save more to insure against transitory fluctuations. But when there is no pension system, it is not surprising that private wealth mostly rises in working life, and while they enter the retirement age at 55 the private wealth decreases because of lack of productivity and losing all pension

[1] Changes are reported in percentage over initial equilibrium.

claims at retirement. As the public pension system is made less (more) generous, households save and accumulate more (less) in order to compensate for the effect of lower pension on consumption in retirement.

The right panel of Figure 2 reports the changes in hours over the life cycle. Labor hours increase at almost all ages, both in the short and the long run. The reaction of generations shortly before retiring because of losing all pension claims is strongest. These are due to compensating the loss in income.

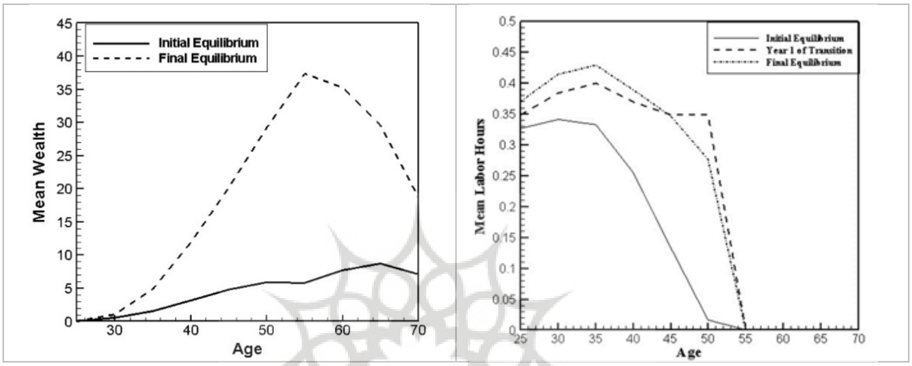

Figure 2. Life Cycle Profiles Before and After Reform

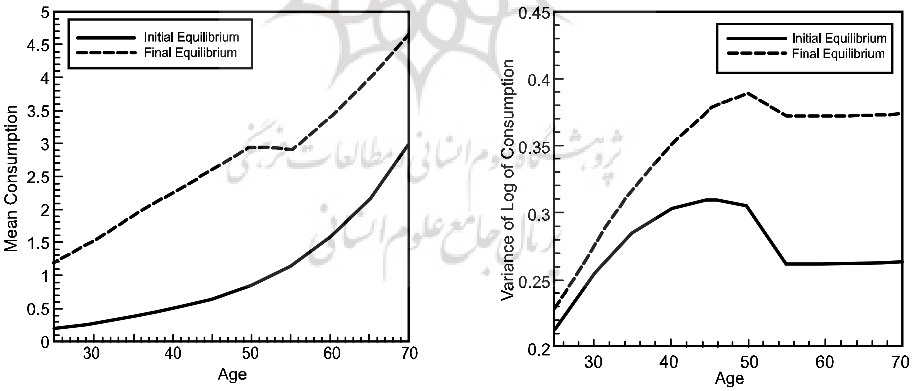

Figure 3. Life Cycle Profiles of Consumption

The life cycle profiles for both mean consumption and the variance of its log are provided in Figure 3. Obviously, by increasing capital and labor hours, consumption increases substantially. The right panel of Figure. 3 shows the variance of log consumption before and after the reform. Throughout the working years, the increase in consumption inequality from the reform is induced by the decline in the pension contribution rate. Also, we can see that at retirement age the variance of consumption decreases. Note that leisure and consumption are substituted in the utility function and while individuals are forced to retire, both leisure and consumption increase.

Table 5
The macroeconomic implication of reduction in the contribution rate

t	1	2	3	4	5	…	∞
A	0.00	1.24	2.89	4.16	5.16	…	**7.54**
C	0.21	1.52	2.25	2.88	3.46	…	**4.75**
Y	0.15	1.47	1.99	2.52	2.96	…	**3.85**
K	-3.38	-2.10	-0.32	0.90	1.93	…	**4.38**
L	3.81	5.18	4.34	4.17	4.00	…	**3.33**
I	-0.08	2.51	2.83	3.56	3.93	…	**4.39**
w	-5.06	-5.06	-3.82	-3.15	-2.58	…	**-1.09**

Figure 4 shows the implications of the reform experiment for the life cycle profiles of wealth and labor hours.

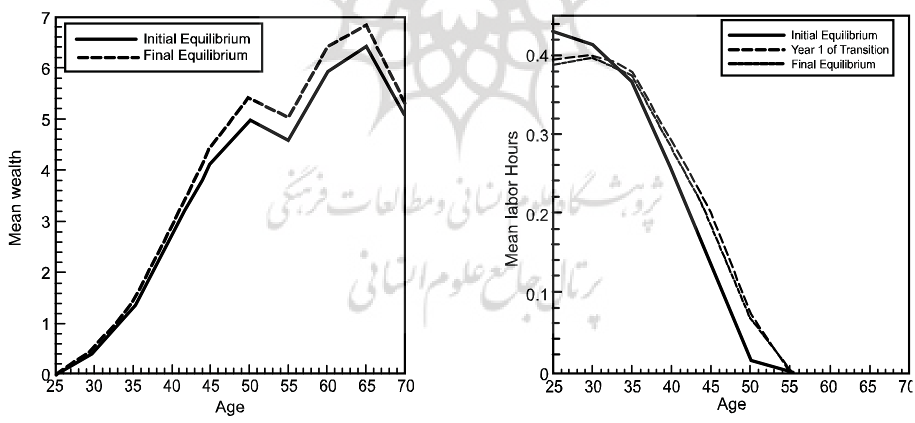

Figure 4. Life Cycle Profiles Before and After Reform

4.2 Contribution Rate

In order to compensate for this reduction and to finance old-age consumption, they have to increase labor supply. The link between labor supply and pension benefits, implicit in the defined contribution pension system, appears to provide very strong reaction by the households. While working more is not welcome in principle, immediate reductions in taxation due to the reform are sufficient to cause a substantial increase in taxable labor supply, thus financing the introduction of the funded pillar. Table 5 again summarizes our macroeconomic implication of the decreasing contribution rate.

As we can see in Figure. 4 mean wealth is not changed the initial years of working life. This is the time that labor productivity is the highest and therefore the household's earning is the highest too. A rising in earning is accompanied by an increase in saving. But the household mostly saves for precautionary reasons. These savings are barely influenced by changes in the contribution rate.

The reaction in consumption is obvious. The reason for rising life cycle consumption in some period of life is that households earn more labor income also it can be seen that after working life, consumption reduces because of the DB system's assumption. In this case with a lower contribution rate, individual's consumption and its variance fall.

Finally, when we compare the result of a reduction in the contribution rate to a reduction in the replacement rate, we find that the overall changes in trends are small, but there are greater fluctuations with a reduction in contribution rate before and after the reforms.

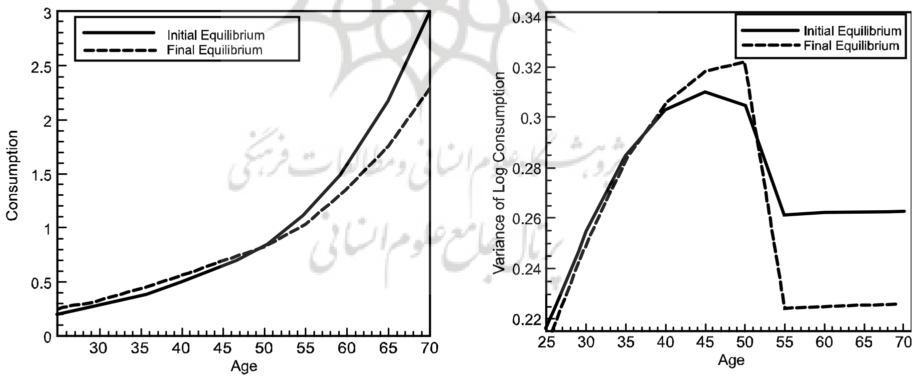

Figure 5. Life Cycle Profiles of Consumption

4.3 Welfare Effects and Aggregate Efficiency

In order to assess the welfare effects of policy reform on different cohorts, we use the concept of Hicksian equivalent variation. We start the aggregate welfare analysis with the overview across cohort: the generations with entry years −8 and −7 that are retired at the date the reform hits in, necessarily lose in terms of welfare from this reform. While in the initial equilibrium these cohorts received pension payments, these payments are taken away from them. In the reform year, it is easier for the younger cohort to make up for the loss in pension benefits by just working more and saving private so the welfare effect ultimately become positive. Future generations profit from this reform as both the capital stock and labor supply increase, which causes the economy to grow heavy[1].

Figures 6 and 7 show the percentage changes in the welfare of individuals born before and after the reform. In Figures 6 and 7, the horizontal axis shows the different cohorts, while the vertical axis reports the welfare changes (typically computed as equivalent variation and measured in percent of remaining lifetime resources) after the reform.

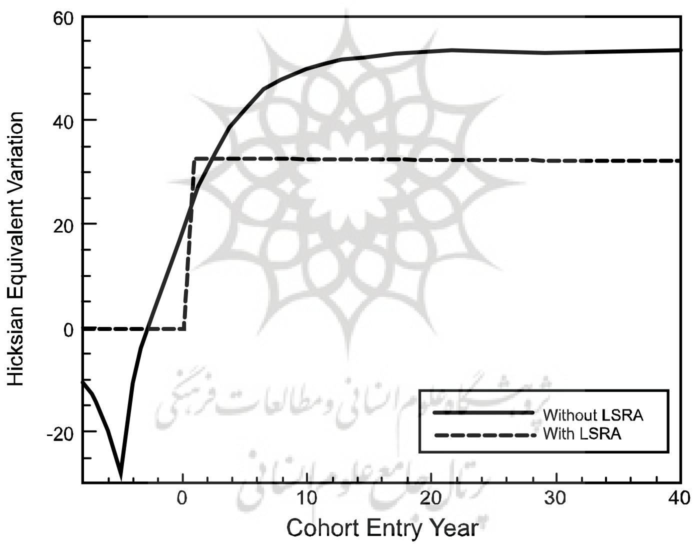

Figure 6. Welfare Effects of Shutting Down the Pension System

[1] The reform of the pension system actually increases the capital stock and lowers the interest rate so that the economy moves closer towards the golden rule.

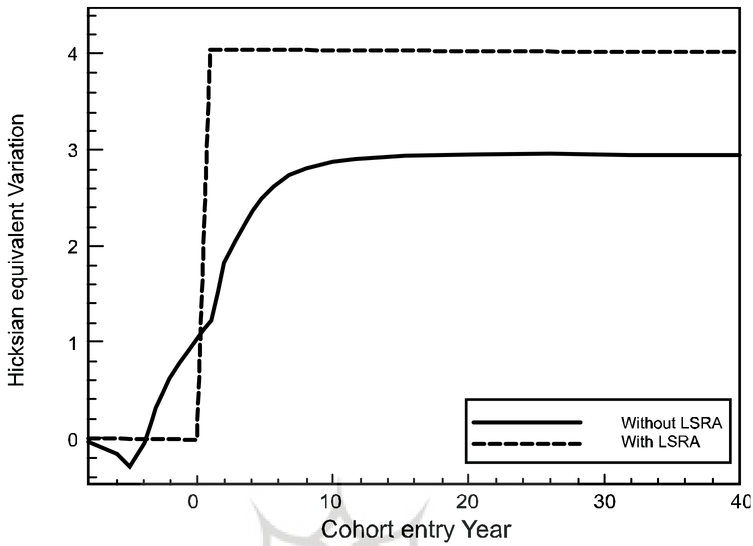

Figure 7. Welfare Effects of Decline the Contribution Rate

Then, let's turn to welfare effects after LSRA compensation payments. As mentioned above, the LSRA makes all existing cohorts as well off as in the benchmark simulation and redistributes resources across future generations to make them all face the same welfare changes. In fact, there are two competing efficiency effects that the reduction of replacement and contribution rates of the pension system comes along with. On the one hand, lower rates alleviate labor supply distortions and therefore improve aggregate efficiency. On the other hand, we have seen that the pension system moves income from individuals with high productivity fixed effect to those with a low productivity fixed effect and it provides insurance against individual fluctuations in labor productivity over the life cycle. As it can be seen from Figures 8 and 9, when we shut down the pension system and reduce contribution rate the positive effect through decreased labor supply distortions clearly dominates the negative efficiency effect caused by a loss in redistribution and insurance. This, in the end, induces a gain in aggregate efficiency of 32.14% (for replacement rate) and 4.04% (for contribution rate) of initial equilibrium.

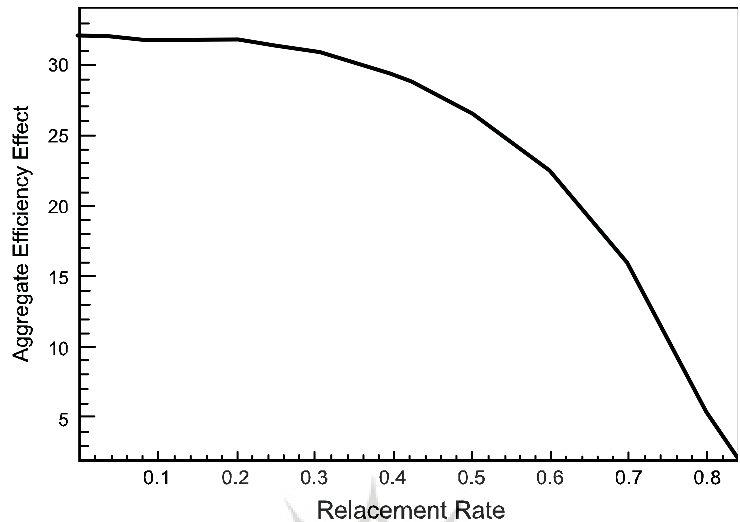

Figure 8. Aggregate Efficiency Effects for Different Value of Replacement Rate

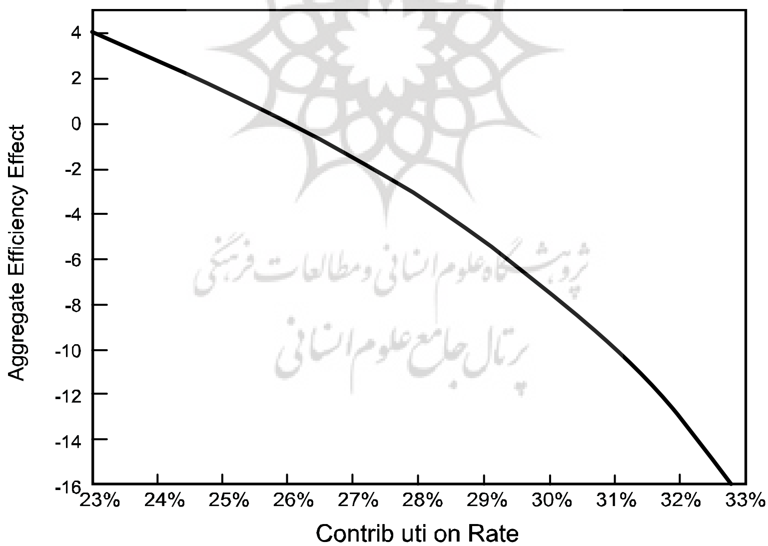

Figure 9. Aggregate Efficiency Effects for Different Value of Contribution Rate

As stated above, the efficiency gains arising from increasing the replacement rate of the pension system are due to positive insurance and negative distortion effects. As we increase the replacement rate, we see that aggregate efficiency improves. The reason is the positive redistribution and the insurance effect weigh larger than labor supply distortions. By reducing the contribution rate, we can see the same results.

5 Conclusion

The purpose of the present paper is to quantify the macroeconomic and welfare effects of the various pension reform policies such as decreasing the replacement and contribution rates of the pension system utilizing a dynamic general equilibrium model.

In order to clarify this problem, we construct a model of overlapping generations which consist of three sectors: firms, households, and government. We calibrate our base year to Iran's economy and consider the pension system and its reforms in our baseline path. In this setup, we solve stochastic OLG models, calibrate it, compute transition paths and measure welfare effects of reforms and calculate the efficiency effect by using a Lump-Sum Redistribution Authority.

We first make one reform and study its effects on the macroeconomy, household behavior, life cycle profiles such as labor hours, consumption and leisure. Then we calculate the welfare effects of different generations and aggregate efficiency.

We consider two types of reforms separately: Reduction in replacement rate and reduction in contribution rate. Summing up, our results indicate the fact that shutting down the pension system by reducing the replacement rate to 0, increases private wealth by 31% as well as capital stock by 42%. As a result of the reforms of the pension system, the capital stock increases and the interest rates decrease so the economy moves closer towards the golden rule.

As a second result, a reduction in the contribution rate from 33% to 23% leads the economy to a higher level of consumption and labor supply. To deal with fluctuations in income, individuals have to work more and grow private wealth and therefore the capital stock increases over time.

Another interesting point to look at is the aggregate efficiency effects analyzed in this paper. Our results indicate a gain in aggregate efficiency of 32.14% (for replacement rate) and 4.04% (for contribution rate) of initial equilibrium. This interesting result of the reduction of replacement and contribution rates of the pension system is due to two things: On the one hand, insurance provision against the labor market risk causes efficiency to rise while, on the other hand, increasing labor market distortions reduce it.

We complement the aggregate welfare analysis with the overview across cohorts by using a mechanism of the Lump Sum Redistribution Authority

(LSRA) for different value of replacement and contribution rates. Our simulations show that both drops in replacement rates from 84% to 0% and in contribution rate from 33% to 23% result in improvements in aggregate efficiency of Iran's economy.

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