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Pension Reform in an OLG Model with Multiple Social Security Systems

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Abstract

Primarily due to financial sustainability problems, social security reforms have been on the policy agenda of both developed and developing countries for the last decade. Research literature on the subject tends to use overlapping generations (OLG) models with single representative household and presents reforms as shock to the constructed model. This study presents an OLG model with three separate social security institutions where the heterogeneity is through different benefit payments and contribution rates. Convergence across various institutions is enabled by a replacement ratio shock and model dynamics are discussed.

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1 Introduction

Last decade has seen a considerable wave of social security system reforms in both developed and developing countries. This wave has been triggered mainly by the concerns on financial sustainability of social security systems in both the short and the long run (Holzmann & Hinz, 2005, p. 23-34). The question of whether proposed reforms would contribute to the solution of financial sustainability problems and uncertainties regarding the effects of proposed and performed reforms on macroeconomic dynamics of reforming countries have led to a rich research literature.

In order to asses the impact of these reforms, economists take the path of constructing general equilibrium models and introduce reforms as policy shocks to the constructed models. Given the intergenerational transfer mechanism created by social security systems, the models constructed for such analysis need to take into account two major modeling concerns.

Firstly, since social security systems introduce an intergenerational transfer system to the economy, constructed models have to include a time dimension; that is, they need to be dynamic models. Such dynamism is introduced by focusing on the intertemporal optimizing behavior of agents. Modeling intertemporal behavior is possible through formulation of infinite lifetime agents, as in the case of well-known Solow and Ramsey models, or through finite lifetime agents, as in the case of overlapping generations (OLG) type models.

Second modeling concern is related to agent homogeneity. Analysis of social security systems need to take into account the fact that at a given time there are workers that provide financial resources for the system and retired people that receive benefits from the system. This implies that a study of social security system needs to take into account the fact that at any point in time there exist various types of individuals; that is, agents are heterogeneous rather than homogeneous. The minimum level of heterogeneity required by social security system analysis is the differences in ages. The model must be able to generate behavior of various age groups that coexist at any point in time. Such concerns exclude Solow or Ramsey type models that assume infinite lifetime horizon for homogenous agents and bring forward OLG type models as major tools of analysis.

A leading work on application of OLG models to fiscal policy problems is Auerbach and Kotlikoff (1987). After presenting the basics of OLG models through a simple example, Auerbach and Kotlikoff (1987) proceeds to set up an OLG model that has 55 generations of consumers, single sector production side, a government that uses taxes and debt to finance consumption and a self-financing social security system. The consumers are assumed to come into being at the age of 21 and die at the age of 75. Thus every time period in the model corresponds to a year. The model takes labor supply endogenous and retirement takes place when labor supply is chosen by the consumer to be zero; i.e. retirement age is an endogenous variable. This model has been used by Auerbach and Kotlikoff (1987) to analyze tax reforms, government consumption shocks with different financing strategies, investment incentives and social security systems. It has also formed the basis of a considerable literature on social security research and has been improved by inclusion of voting over social security (Gonzales-Eiras & Niepelt, 2007), open economy dimension (Borsch-Supan, Ludwig, & Winter, 2006), enterpreneur behavior (Eren, 2008) and uncertainty regarding, among others, productivity (Greco, 2008) and lifetime (Huggett, 1996).

Models put forward by the existing literature generally include a single social security system and thus a single pension scheme for all individuals. One such model has been formulated by Heer and Maussner (2005). The model includes 6 cohorts, endogenous labor supply, single sector production and a pay-as-you-go (PAYG) social security system that pays benefits when a consumer becomes of age 5. Following Heer and Maussner (2005), this study aims to develop an OLG model that includes 6 cohorts and analyzes effects of replacement ratio shocks. Taking the labor supply exogenous, the model to be presented below contributes by introducing 3 different social security systems and thus enhancing agent heterogeneity. With the stated aim in mind, the next section proceeds to explain the formulated OLG model. Section 3 details steady state results and responses to replacement ratio shocks in the model. Last section presents conclusions.

2 The Model

The foundation of OLG models goes back to Samuelson (1958) and Diamond (1965). Aimed to explore the role of money in financial markets and effects of national debt, these models included two generations alive at any given time represented by one working and one retired individual.Even though they carry the same rationales, modern versions, including the ones cited in the introduction, are by far more complicated.

The model presented in this study is a relatively simple version designed to study the existence of multiple social security systems. It includes a single production sector and a slightly more detailed household behavior represented through 6 cohorts. Along with the production and household sectors, a simple public sector with three social security systems is also depicted in the model. Lack of a medium of exchange implies that all variables in the model are real. The model is built around a single good that can be used for consumption or production. Therefore any saving done is actually a contribution to the capital stock and has a rate of return equal to the return on capital.

2.1 *Household*

Households are assumed to live for 6 periods. Out of these 6 periods, 4 are assumed to represent working periods in exchange for wage and 2 are spent in retirement, during which social security benefits are received. Thus a member of the new born generation can be assumed to enter the economy at age 21, retire at age 61 and die at age 80. Since there are three different social security systems, at any given time, the model includes 18 representative households belonging to either one of these three systems. Every year, a generation of equal measure to be included in each of these social security systems is born. There is no uncertainty regarding life length and all demographic dynamics are excluded. All households are modeled without children or a detailed family structure. The heterogeneity across households is introduced through differences in ages and membership in different social security systems. Since households will have different saving levels at different stages of their lives, members of the same social security systems differ due to available material resources. The existence of a multiple social security system contributes to heterogeneity of households through differences in tax payments and benefit receipts.

The representative household of any social security system s is assumed to have the instantaneous preferences represented by the following version of the constant relative risk aversion (CRRA) utility function:

$$\frac{(c^a_{s,t+a-1})^{1-\eta_s}-1}{1-\eta_s} \tag{2.1}$$

The index t stands for time periods, a = 1, ..., 6 stands for the age of the household and s=A, B, C stands for different social security systems. The parameter η of the function represents Arrow-Pratt measure of relative risk aversion and would be interpreted as the inverse of intertemporal elasticity of substitution for this specific case. Since η is regarded as a measure of curvature of the utility function, a higher η implies a more curved function or a lower intertemporal substitutability. Hence, higher risk aversion as represented by a higher η would imply a smoother consumption through time.

In a lifetime of 6 periods, a representative household belonging to the social security system s has the lifetime utility represented as:

$$\sum_{a=1}^{6} \beta_s^{a-1} \frac{(c^a_{s,t+a-1})^{1-\eta_s}-1}{1-\eta_s} \tag{2.2}$$

where β is the discount factor.t should be noted that there is no restriction on the value of β other than that it be positive.

Households are assumed to receive no inheritance and leave no bequests. 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, implying the budget constraint to be:

$$c^a_{s,t} + k^{a+1}_{s,t+1} \leq (1+r_t)k^a_{s,t} + (1-\tau_{s,t})w_t \tag{2.3}$$

for a=1,...,4. In the equation above, $k^a_{s,t}$ represents saving of a household of age a belonging to social security system s at the beginning of time t. Under such specification, household savings become the basic tool for intertemporal re-allocation of resources. Interest rate is denoted r_t, w_t is the market wage rate and $\tau_{s,t}$ is the tax paid out of wage earnings by a household belonging to social security system s. Note that the interest and wage rates are same for all household types but tax rates differ according to membership in different social security systems.Tax payments out of wage income are to be takenas social security contributions.

Sources of income during retirement are retirement benefits received from the social security system and savings accumulated during working periods. Denoting the retirement benefits from social security institution s by $b_{s,t}$, the budget constraint during retirement is written as:

$$c^a_{s,t} + k^{a+1}_{s,t+1} \leq (1 + r_t)k^a_{s,t} + b_{s,t} \tag{2.4}$$

where a takes the values of 5 and 6. Since new generations receive no bequest, it can be assumed that $k^1_{s,t} = 0$ for all household types. That is, at any time period t, a household of age 1 has no wealth at the beginning of the life-time. One additional constraint that can be considered at this point is that consumption for each household in each period should be non-negative. However, since lifetime utility is strictly increasing in consumption, this constraint would not be binding.

Due to similarity in preference structures, it is safe to assume that a single household's optimization problem would be representative of all households in the economy despite the heterogeneities introduced. Given above formulations, the optimization problem of a representative agent of social security system s can be summarized as the maximization of lifetime utility (2.2) subject to budget constraints (2.3) and (2.4) and the conditions that i) wealth, at the beginning of life-time is zero, and ii) consumption and saving each period is non-negative. The first order necessary conditions of this optimization problem would yield:

$$\frac{c^{a+1}_{s,t+1}}{c^a_{s,t}} = [\beta_s(1 + r_{t+1})]^{\frac{1}{\eta_s}} \tag{2.5}$$

which is the well known consumption Euler equation relating consecutive consumption choices through time. Should the right hand side of this equation be greater than one, an increasing consumption profile would be observed for the consumer being analyzed.

2.2 *Firm Behavior*

Production side of the economy is represented by a single sector that includes firms engaged in perfect competition. The inputs used are labor, N_t and capital, K_t. Production is assumed to take place in accordance with a Cobb-Douglas production function that displays constant returns to scale:

$$Y_t = K^\alpha_t N^{1-\alpha}_t \tag{2.6}$$

Capital is assumed to depreciate at the constant rate δ. Firm behavior is based on profit maximization. Therefore, construction of a profit function yields the first order necessary conditions

$$w_t = (1 - \alpha)K^\alpha_t N^{-\alpha}_t \tag{2.7}$$

$$r_t = \alpha K^{\alpha-1}_t N^{1-\alpha}_t - \delta \tag{2.8}$$

which are nothing but factor prices.

2.3 *Government and Social Security System*

The government in the model is assumed to be consisting of three social security institutions denoted A, B and C. These institutions are financed by the taxes levied on wage income and collected by the government. Government is assumed to have no spending other than benefit payments to the retired households. Taxes collected at any time period t are distributed to the beneficiaries of the social security systems; thus the social security structure is presumed as a pay-as-you-go (PAYG) system.

For practical purposes, government and the social security institutions can be regarded as a single entity that only collects taxes out of wage incomes of workers and pays benefits to current retirees. Collected taxes and benefit payments differ according to membership in social security systems. Hence, for any person belonging to social security system s, the benefit payments are:

$$b_{s,t} = rep_s(1 - \tau_{s,t})w_t \tag{2.9}$$

where rep_s is the replacement ratio adopted by system s. A further simplifying assumption is that every social security system has a separately balanced budget, so that collected contributions (or taxes) are equal to made benefit payments. Then for any time period t, the budget for any social security system s can be written as:

$$4w_t\tau_{s,t} = 2b_{s,t} \tag{2.10}$$

On the left hand side of Equation (2.10)is the total income of social security system s. Given that individuals spend 4 periods working, there are 4 workers that are contributing members of social security system s at any point in time. Similarly, since people are assumed to spend 2 periods in retirement, a total of 2 benefit payments are made by any social security system to the retirees at any point in time. Making use of the balanced budget as in (2.10) and the benefit payments equation (2.9), tax rate for each social security system would be calculated as:

$$\tau_{s,t} = \frac{rep_s}{\frac{4}{2} + rep_s} \tag{2.11}$$

Deceptively simple, this last equation has strong implications for the policy experiments available in the model. Since tax rate set by any social security system is a function of the replacement rate, which is an exogenously provided parameter for the model, a tax or contribution rate shock is not independent of replacement rate. More clearly, what the government decides on in this model is the replacement ratio. Given wage, this determines benefit payments made by any social security system. What falls on social security systems is to pick the tax rate so that their respective budgets remain balanced.

If one desires to analyze the effects of social security tax shocks in this model, one has to start with corresponding replacement ratio shocks. Given desired tax rate shock, corresponding replacement ratio can be calculated through equation (2.11). A comparative static analysis on equation (2.11) would reveal that the tax rate and the associated replacement ratio are positively related. It is also possible to obtain an exact numerical relationship between desired tax rate change and necessary replacement ratio change through the same comparative static analysis.

2.4 *Equilibrium*

The definition of the equilibrium in this model is as follows:

> *Given policy on replacement ratios, an equilibrium for the model consists of sequences of consumption choices* $\{c^a_{s,t}\}^6_{a=1}$*, saving decisions* $\{k^a_{s,t}\}^6_{a=1}$*, factor demands* $\{K_t\}$*,* $\{N_t\}$*, prices* $\{w_t\}$*,* $\{r_t\}$*, benefit payments* $\{b_{s,t}\}$ *and tax rates* $\{\tau_{s,t}\}$ *such that*
>
> *i) Given wage rate* w_t*, interest rate* r_t *and tax rate* $\tau_{s,t}$ *household belonging to any social security system s chooses consumption sequence* $\{c^a_{s,t}\}^6_{a=1}$ *and saving sequence* $\{k^a_{s,t}\}^6_{a=1}$ *so that lifetime utility (2.2) is maximised subject to budget constraints (2.3) and (2.4).*
> *ii) Given factor prices* w_t *and* r_t *capital demand* K_t *and labor demand* N_t *maximize profits of the firm.*
> *iii) The benefit payments* $b_{s,t}$ *and tax rates* $\tau_{s,t}$ *are such that social security system budgets as in (2.10) are balanced.*
> *iv) The good market clears.*
> *v) Individual and aggregate behavior are consistent.*

Some of the items require further explanation. Firstly, note in (v) that individual and aggregate behaviors are stated to be consistent. This will be taken to mean that aggregate labor supply is equal to the labor supply of each cohort weighted by the cohort's mass. Under the assumptions of equal cohort mass and lack of demographic dynamics, this will simply mean $N_t = 12$ for one unit of labor is supplied inelastically by every household belonging to any social security system in the model. Similarly,

$$K_t = \sum_{s=A,B,C} \sum_{a=1}^{6} k^a_{s,t} \tag{2.12}$$

will represent the aggregate capital stock of the economy at any given time period.

Secondly, goods market equilibrium in (iv) implies:

$$K_t^{\alpha} N_t^{1-\alpha} = \sum_{s=A,B,C} \sum_{a=1}^{6} c^a_{s,t} + K_{t+1} - (1-\delta)K_t \tag{2.13}$$

That is, production on the left hand side is absorbed by aggregate consumption and investment where investment includes additions to the capital stock and depreciation expenditures. In this equation, the only term not related to the capital stock is consumption. But note from budget constraints that consumption is actually a function of saving, which eventually is tied to the capital stock, and factor prices that are functions of the capital stock as can be seen in equations (2.7) and (2.8). Therefore, given inelastic labor supply and household budgets relating consumption and saving, the whole characterization procedure of the model can be taken to consist of calculating the saving path of the representative household.

Numerical solution of the proposed model makes use of the consumption Eulers (2.5), budget constraints (2.3) and (2.4), first order conditions of the firm as presented in equations (2.7) and (2.8), social security related equations (2.9) and (2.11) which define benefit payments and tax rate, respectively and Equation (2.12) that defines the capital stock. The method proposed by Heer and Maussner (2005) to obtain a numerical solution of the steady state for such a model starts with a guess on the capital stock. Factor prices are calculated for the guessed capital supply. Given these factor prices, consumption and saving sequences for the household are obtained. Saving sequences are then used to recalculate the capital stock of the economy. The algorithm stops if the obtained capital stock figures are in the nighborhood of the initial capital stock guesses. If results do not match the initial guess, guesses are updated and the whole algorithm is repeated. Such solution approach has also been adopted by this study for the calculation of the steady state.

3 Calibration and Simulation

Calculation of the steady state for the proposed model requires values for the parameters in relevant equations. As a most obvious example, we need a value for the intertemporal discount factor, β, of the household. The procedure of choosing or calculating the parameter values in a general equilibrium model is commonly referred to as calibration. In a strictly practical sense, a general equilibrium model is simply a system of equations to be solved. The system generally includes both linear and non-linear equations. The common procedure for obtaining a solution to such a system includes providing initial values for the endogenous variables, making use of model equations to calculate required parameters and recalculating the model once more to see if initial values can be reproduced. Under the assumption that model equations are correctly provided to the software, if the initial values can not be reproduced, calculated parameter values need to be updated. Ideally, the initial values represent a steady state or the equilibrium of the model so that divergence from the steady state, dynamics displayed by the model during a return to the steady state or dynamics of convergence to a new steady state can be analyzed.

Assuming initial values of 0.4714 for the wage rate, 0.3548 for the interest rate and making use of purely fictional saving and consumption sequences, parameter values in Table 1 are obtained. By the nature of the Eulers in Equation (2.5) risk aversion parameter and discount factor can not be calibrated from model equations separately. One simply has to assume the value of one to obtain the other. The utility discount factor values have been calculated under the assumption that the relative risk aversion parameter is 2. Parameters related to production are calculated through factor price equations (2.7) and (2.8). Re-

Table 1: Model Parameters

Households		
β_A	Utility discount factors	0.9
β_B		0.9
β_C		0.9
Firms		
η_A	Relative risk aversion parameters	2
η_B		2
η_C		2
α	Capital share in production	0.3
δ	Depreciation rate	0.4
Social Security		
rep_A	Replacement ratios	0.75
rep_B		0.55
rep_C		0.25

placement ratios are provided exogenously as listed in Table 1 and differ across social security institutions, contributing to agent heterogeneity in the model.

The constructed model is used to analyze the effects of a replacement ratio shock on the economy. Initially, replacement ratios for social security systems A, B and C are 0.75, 0.55 and 0.25 respectively. In a sketchy attempt to represent the unification of the three social security systems, the simulation exercise here equates replacement ratios of all social security systems at an exogenous level of 0.45. In order to see this, note that given same replacement ratio and an economy-wide wage, the only factor that would cause benefit payments to differ across social security systems is the tax rate. However, written under the assumption of balanced social security system budgets, Equation (2.11) implies that tax rates would also be the same for all the three systems, leading to the conclusion that the policy experiment can be regarded as a unification of the three social security systems[1].

Table 2 shows the values of key model variables before and after the shock. The old steady state columns refer to variable values before the shock, whereas new steady state values refer to the equilibrium attained after the transition takes place. A couple of points regarding the values in Table 2 should be emphasized, for they provide valuable insights about the workings of the model.

Firstly, saving figures refer to beginning-of-period values. Secondly, note that at both the old and the new steady state, savings increase from age 1 to age 4, reach a peak at age 5 and decrease thereafter. This is most logical, for saving figures refer to stock rather than flow. At any time period t, given prices and available resources, what the household does is actually to choose current consumption, $c^a_{s,t}$, and the stock of saving to be held during the next period, $k^{a+1}_{s,t+1}$. Therefore, as household approaches retirement, stock of savings increases.

[1]But note that such an implication is available only if the social security systems run balanced budgets under the constructed model.

Table 2: Old and New Steady State

	System A		System B		System C	
	Old S. S.	New S. S.	Old S. S.	New S. S.	Old S. S.	New S. S.
Replacement Ratio	0.7500	0.4500	0.5500	0.4500	0.2500	0.4500
Savings						
Age 1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Age 2	0.0674	0.0901	0.0827	0.0900	0.1107	0.0901
Age 3	0.1300	0.1816	0.1646	0.1815	0.2283	0.1815
Age 4	0.1829	0.2722	0.2426	0.2721	0.3522	0.2721
Age 5	0.2195	0.3589	0.3116	0.3587	0.4806	0.3588
Age 6	0.1445	0.2222	0.1982	0.2221	0.2968	0.2221
Consumption						
Age 1	0.2755	0.3005	0.2872	0.3006	0.3085	0.3006
Age 2	0.3043	0.3288	0.3172	0.3288	0.3407	0.3288
Age 3	0.3361	0.3598	0.3503	0.3598	0.3763	0.3598
Age 4	0.3713	0.3936	0.3869	0.3936	0.4156	0.3936
Age 5	0.4101	0.4306	0.4273	0.4305	0.4590	0.4306
Age 6	0.4529	0.4711	0.4719	0.4710	0.5069	0.4710
Benefit Payments	0.2572	0.1758	0.2034	0.1758	0.1048	0.1758
Lifetime Income[1]	2.1500	2.2844	2.2406	2.2842	2.4069	2.2842
Capital Stock[2]	3.2126	3.3739				
Factor Prices[2]						
Interest Rate	0.3547	0.3292				
Wage	0.4715	0.4785				

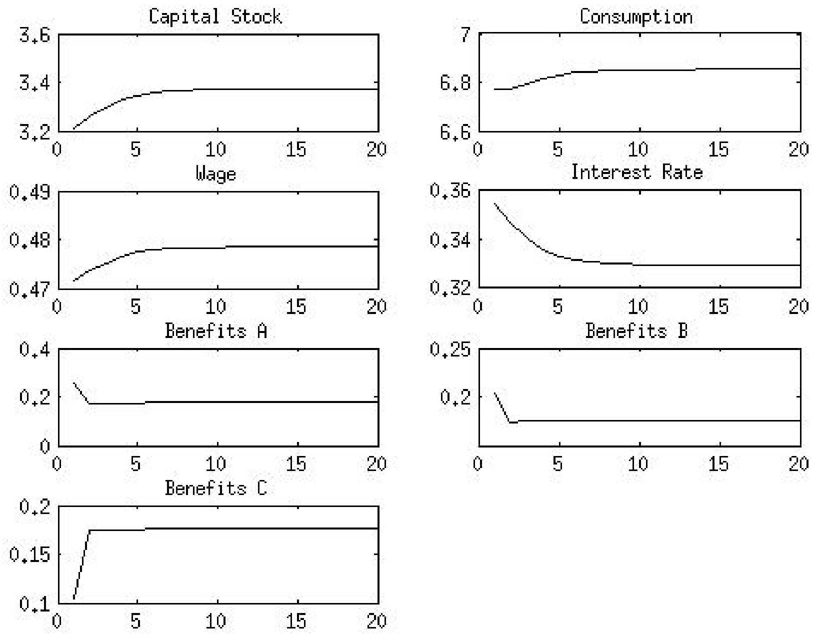
[1] Lifetime income is calculated as the sum of net-of-taxes wage income earned while working, total benefits received during retirement and the sum of interest return from savings through the lifetime.

[2] Capital stock and factor price figures stand for the aggregate economy. There are no distinct values for different social security systems.

At the last period spent working, chosen value of saving stock for the next period, which will be the first period of retirement, would be the highest value of saving during the life-cycle. Therefore the saving figures reach a peak at the 5th period of the household life-time. As saving stock is used to finance consumption after retirement, the saving stock decreases after the first period of retirement.

Thirdly, note that consumption, a flow variable, displays an increase and reaches its maximum for a representative household over her lifetime, at the end of life. In line with the life-cycle consumption theory, such an increasing consumption profile is possible only if the right hand side of the Euler equations (2.5) is greater than unity. This is indeed the case and can be easily confirmed using the parameter values in Table 1 and the interest rate figure from Table 2.

Under the assumption that adjustment to the new steady state takes place



in 20 time periods, transition paths of key variables have been calculated and presented in Figure 1. Within the setup of the proposed model, a reduction in the replacement ratio will have two immediate effects. First the associated tax rate will decrease. The fall in the tax rate will lead to a parallel decrease in the revenues of the social security system. Thus the end-result is a derease in the benefit payments to keep a balanced budget for the associated social security system. The fall in tax rate is an instantaneous change for tax rate simply depends on replacement ratio. But benefit payments are functions of wage level as well; thus they are expected to display transition dynamics.

The fall in tax rate implies a higher income level during working years; hence it is possible to simply save more during working years to offset the lifetime income loss caused by falling benefit payments. Higher savings would lead to increased capital stock. Higher capital stock decreases marginal product of capital, the interest rate. Given that labor is supplied inelastically, wage rate is expected to increase.

In the model, while systems A and B have to decrease benefit payments to keep their budgets balanced, system C finds the liberty to increase benefit payments for its retirees, for the new replacement ratio increases tax rate and hence revenues available to the system. Therefore members of system A and B will find the resources available during retirement restricted. But the resources available during working periods will increase, due to reduced taxes. An opposite picture is valid for members of system C with increases in taxes and benefit payments. The natural response for members of systems A and B is to save more while working to finance expenditures during retirement while members of system C devote less resources to saving.

This is indeed the response of households according to the results in Table 2.The unclear point is related to aggregate savings and hence capital stock in the economy. If the increases in savings brought about by households belonging to systems A and B are outweighed by decreases in savings from households of social security system C, then capital stock would decrease. As traced in Table 2 the capital stock at the new steady state has increased, hence the inverse dynamics has taken place. The top left panel of Figure 1 clearly shows the increase and the smooth convergence to the new steady state value.

This is actually a natural result of relative cohort masses of social security systems. The number of members in all systems is the same whereas the replacement ratio changes are not even among systems. The ratio falls by 0.30 and 0.10 for systems A and B respectively whereas it increases by 0.20 for system C. Given same cohort masses, the fall in replacement ratio of systems A and B would dominate the economy, leading to an increase in aggregate saving and hence capital stock.

Given that the net effect of proposed policy shock on the capital stock is positive, marginal product of capital decreases and causes interest rate to decline. On the other hand, given labor supply, wage is positively related to the capital stock; wage rate increases. These dynamics can be observed in Figure 1 as well.

The contradictory effects of factor prices on lifetime income leave the final change in lifetime resources unclear. The figures in Table 2. show that lifetime income increases for individuals from social security systems A and B whereas income falls for those from system C. As expected, when income rises, consumption path shifts up (See Table 2). Since lifetime income falls for the households from social security system C, their consumption falls. The top right panel of Figure 1 displays that the net effect is an increase and aggregate consumption smoothly converges to the new steady state value. The three panels at the bottom of Figure 1 show that benefits increase when replacement ratio increases, as in the case of system C, and fall when replacement ratio falls, as can be observed for systems A and B.

4 Discussion

Comparison of old and new steady state benefit payment values imply that the total pension bill decreases from 1.13 to 1.05 after the shock. It is also observed that the higher capital stock leads to increased production, aggregate income and aggregate consumption. Given that the common problem in social security systems of most countries is financial sustainability, proposed policy would decrease cost of pension system and has the bonus of contributing to growth.

But the replacement ratio shock decreases the benefit payment made to households of social security systems A and B. More broadly speaking, lifetime incomes of households from systems A and B increase while those in system C experience an decrease in lifetime income. These shifts in budget sets cause consumption paths of households from A and B to shift up and path of households from C to shift down. Since utility is strictly increasing in consumption, utility levels of households from systems A and B increase while utility level of households from C decrease. Hence the proposed policy on replacement ratios makes some households better off while leaving some households worse off; therefore, it is not pareto optimum.

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