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# SOCIAL SECURITY: UNIVERSAL VS. EARNINGS-DEPENDENT BENEFITS

By

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# Social Security: Universal vs. Earnings-Dependent Benefits

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**Abstract**

I compare the welfare implications of implementing Bismarckian and Beveridgean social security systems.

In an overlapping generations environment with intragenerational homogeneity, agents can be better off with a system with universal benefits than with a comparable system with earnings-dependent benefits because the latter generates a stronger decrease in net wages. Once I allow for intragenerational skill heterogeneity, agents are on average better off with the more redistributive universal benefits system.

I then let agents vote for the replacement rates in a democratic process. In the absence of intragenerational heterogeneity, a larger social security system is implemented when benefits are earnings-dependent than when they are universal resulting in a larger decrease in net wages; this makes young agents worse off with earnings-dependent benefits. In the presence of intragenerational skill heterogeneity, the reverse occurs and agents fare on average better in the long-run when benefits are earnings-dependent. However, because of its redistributional effects, agents born at the time of implementation are on average better off with an universal benefits system.

JEL Classification: E62, H55.

Keywords: social security, universal benefits, earnings-dependent benefits, Bismarckian social security system, Beveridgean social security system, voting, welfare.

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# 1 Introduction

Social security systems are generally financed on a pay-as-you-go basis with taxes levied on the labor income of workers financing the benefits to retirees. These benefits are typically of two types: in a Beveridgean social security system benefits are universal, in the sense that all retirees from the same cohort are entitled to the same level of benefits; in a Bismarckian system retirees' benefits depend on their earnings history.

The two systems have distinct redistributional features and (in)efficiency implications. In a Beveridgean system retirees receive the same level of benefits independently of their earnings history. This implies some intragenerational redistribution from high to low income earners, as high earners contribute significantly more than low earners and receive the same benefits. In opposition, a Bismarckian system where benefits are proportional to earnings does not imply any direct intragenerational redistribution. Moreover, by making benefits dependent on earnings a Bismarckian system can reduce the distortionary effect of social security taxation on the supply of labor. This lays ground to the common perception that absent intragenerational inequities, on average, agents are better off with a social security system with earnings-dependent benefits, a Bismarckian system, than with one with universal benefits, a Beveridgean system. In fact, in their seminal work, and, to my knowledge, the only work that presents a welfare comparison of the two systems, Auerbach and Kotlikoff (1987) find efficiency gains from establishing a link between an agent's contributions and benefits in a standard overlapping generations model calibrated to match the U.S. economy.

In this paper, I revisit the effectiveness of Bismarckian social security systems and Beveridgean social security systems in redistributing resources across generations. I start by abstracting from their intragenerational distributive features and study their welfare implications firstly when the parameters of the systems are given and then when agents choose the corresponding policy parameters. I then introduce intragenerational heterogeneity and re-evaluate the two systems.

I evaluate social security systems using an overlapping generations economy where a large number of agents are "born" each period and live for a maximum of four periods. The population in this economy grows at a constant rate and individuals supply labor endogenously for the first three periods of their lives and retire during the last period before dying. With a pay-as-you-go social security system, the government levies a tax on labor income and uses the revenue to fund the benefits of the retirees. I let benefits either be proportional to the economy's labor income, in a Beveridgean system, or proportional to the recipient's lifetime earnings, in a Bismarckian system. I quantify the findings by calibrating the parameters of the economy and solving numerically for the equilibrium paths for the economy under different social security systems.

I first compare a social security system with universal benefits to one with earnings-dependent benefits that provides the same level of benefits. Surprisingly, when I abstract from the intragenerational distributional features of the systems[1], I find that the current young and future generations are better off in the economy with universal benefits. If benefits are earnings-dependent the link between agents' contributions and benefits they receive upon retirement implies that the tax distortion is lower for any given level of social security benefits. However, the reduction in the tax distortion implies a much lower decrease in labor supply. The increase in the supply of labor with the earnings-dependent benefits system relatively to the supply of labor in a comparable universal benefits system rises with age. Consequently, the lifetime income profile is relatively steeper and young and middle-aged agents smooth their lifetime consumption profiles by saving less. Although the oldest generation of workers saves relatively more with the earnings-dependent system in order to consume more upon retirement, the resulting increase in their savings is smaller than the decrease in the younger generations savings and the earnings-dependent benefits system has a higher negative impact on aggregate savings than the universal benefits system. So an earnings-dependent benefits system generates a higher supply of labor and lower accumulation of capital along the equilibrium path than a comparable universal benefits system. In general equilibrium, the disparity in the impact on the supply of labor and on capital accumulation implies that net wages are significantly lower and, therefore, agents are worse off with an earnings-dependent benefits system than with a comparable universal benefits system.

Once I allow for agents to differ within each cohort according to their skill levels, the intragenerational redistributive features of the Beveridgean system dominate and on average agents fare better with an universal benefits system than with a comparable earnings-dependent benefits system. While this is true both in partial and in general equilibrium, in the latter case the resulting decrease in wages diminishes the redistributive features of the universal benefits system and

[1] An overlapping generations environment without intragenerational heterogeneity precludes the redistributive feature of universal benefits social security systems and predisposes the model to deliver results favorable to an earnings-dependent benefits system relatively to a comparable universal benefits system.

consequently its relative welfare advantage.

As I increase the exogenous social security tax rate, the reduction in tax distortions achieved through earnings-dependency increases exponentially, and ends up offsetting the other effects, leading to welfare gains of the system with earnings dependent benefits relatively to a comparable system with universal benefits.

I then construct a political economy model of social security, where agents vote for the parameters that determine the level of social security benefits, to study the welfare implications of implementing either a Bismarckian or a Beveridgean social security system. I find that, in the absence of intragenerational heterogeneity, when voters choose social security parameters, the median voter prefers a significantly larger social security system when benefits are earnings-dependent. As in Cooley and Soares (1999), the general equilibrium effects are determinant. An earnings-dependent benefits system generates a higher supply of labor and lower accumulation of capital along the equilibrium path than a comparable universal benefits system. While the impact on the initial period factor prices is very similar across systems, thereafter the interest rate increases and the wage rate decreases significantly more with an earnings-dependent benefits system. The augmented impact on the interest rate generates the extra support for social security by the older agents, that have accumulated capital, and the median voter is enticed to vote for a bigger social security system when she is choosing over levels of earnings-dependent benefits. As a result young agents are worse off, in the short-run and in the long-run, when benefits are earnings-dependent than when they are universal.

Finally, in an economy with intragenerational heterogeneity, the median voter prefers a larger social security system when benefits are universal. In the short-run less skilled agents who benefit from the intragenerational redistribution generated by this system and some older more skilled agents who gain from the larger intergenerational redistribution associated with a larger system are better off than with an earnings-dependent system. On average all cohorts are better off in the short-run with an universal benefits system. However, in the long-run the larger size of the system generates a stronger decrease in wages and results in increased welfare losses. Consequently, most agents are worse off with an universal benefits system in the long-run.

There is an extensive literature that studies the introduction of social security in the context of majority voting in general equilibrium overlapping generations models. Previous work on the political economy of social security has focused on explaining the size of social security systems, looking at the determination of the level of benefits which, in general, have been assumed to be universal (see Browning (1975), Boadway and Wildasin (1989), Cooley and Soares (1999), Tabellini (2000) and Boldrin and Rustichini (2000) among others). Zhang and Zhang (2003) study the optimality of earnings-dependent benefits in an endogenous fertility model where they have a positive impact on human capital accumulation and growth. Casamatta et al (2000a) study the choice of the size of social security systems given the fraction of benefits related to contributions, which is chosen optimally in Casamatta et al (2000b). However, they assume that agents differ in their labor productivity but supply labor exogenously, therefore abstracting from one of the main points of this paper. Cremer and Pestieau (1998) and Conde-Ruiz and Profeta (2007) focus on the composition of the social security system; their objective is not to compare the welfare implications of the two systems but to generate an equilibrium where both systems coexist. Koethenbuerger et al. (2008), develop an analytical political economic model, where voters choose the size of the social security system given the exogenous composition of the benefits and show that as the relative size of the earnings-dependent component increases, the size of the system increases. This paper is different from theirs in many dimensions. In the first place, Koethenbuerger et al (2008) do not pursue a welfare analysis of the different social security systems. Moreover, in sharp contrast with the results of this paper, as they do not allow factor prices to change, they find that earnings-dependent benefits systems are more attractive for the median voter because of lower distortion in labor supply and less intragenerational redistribution.

This paper is organized as follows. Section 2 introduces the economic environment. Section 3 presents the economic equilibria, describes the political decision process and the resulting politico-economic equilibria. Section 4 calibrates the model while section 5 presents the findings. Section 6 provides a summary of the findings and section 7 concludes.

## 2 The Economic Environment

I study an economy where, in each period, a large number of heterogeneous agents with a lifetime of four periods are born. The population size in period $t$ is given by $N_t$ and grows at the rate $n$. The share of age $i$ individuals in the population, given by the measure $\mu_i$, $i = 1, ..., 4$ is constant over time and $\mu_{i+1} = \frac{1}{1+n}\mu_i$, with $\sum_{i=1}^{4} \mu_i = 1$. Within each generation there are $J$ types of agents that differ according to their labor productivity, the share of type $j$ agents in the population, $\nu_j$, is constant.

Agents in each generation maximize their discounted lifetime utility: for a type $j$ agent born in period $t$ the lifetime utility is given by

$$\sum_{i=1}^{4} \beta^{i-1} U(c_{i,j,t+i-1}, l_{i,j,t+i-1}) \tag{1}$$

where $\beta$ is the discount factor, $c_{i,j,t+i-1}$ is consumption and $l_{i,j,t+i-1}$ is leisure of an age $i$, type $j$ individual in period $t+i-1$.

The "momentary" utility function is assumed to take the constant relative risk aversion form of a Cobb-Douglas consumption-leisure index,

$$U(c,l) = \frac{\left(c^{\sigma} l^{1-\sigma}\right)^{1-\rho}}{1-\rho}, \tag{2}$$

where $\rho > 0$, is the inverse of the intertemporal elasticity of substitution, and $\sigma \in (0,1)$ is the coefficient of consumption on the Cobb-Douglas index.

The budget constraint facing an individual of age $i$ and type $j$ can be written as

$$a_{i+1,j,t+1} = (1+r_t)a_{i,j,t} + y_{i,j,t} - c_{i,j,t}, \tag{3}$$

where $a_{i,j,t}$ denotes the asset holdings at the beginning of period $t$ and $r_t$ denotes the rate of return on these assets; $y_{i,j,t}$ is the real net labor income plus social security transfers of an age $i$, type $j$ individual in period $t$.

I assume that agents may work the first three periods of their lives, but must retire afterwards. Before their mandatory retirement, age $i$, type $j$ workers supply endogenously $h_{i,j}$ hours of labor and have different productivity levels represented by $\varepsilon_{i,j}$, an efficiency index that quantifies the productivity of an unit of work supplied by an agent of age $i$ and type $j$. After retirement, workers receive social security benefits, $b_{j,t}$. The level of benefits can either be proportional to the average labor income of the retiree, in a Bismarckian system, or independent of her past earnings and proportional to the income of currently employed agents, in a Beveridgean system.

$$b_{j,t} = \begin{cases} \theta_t e_{4,j,t}, & \text{in a Bismarckian system,} \\ \phi_t \overline{wh\varepsilon}_t, & \text{in a Beveridgean system.} \end{cases} \tag{4}$$

where

$$e_{i,j,t} = \frac{\sum_{l=1}^{i-1} w_{t-i+l} h_{l,j,t-i+l} \varepsilon_{l,j}}{3} \tag{5}$$

is the average lifetime earnings of an age $i$, type $j$ agent at time $t$ and $\overline{wh\varepsilon}_t$ is the weighted average earnings of the current working generations. The parameters $\theta_t$ and $\phi_t$ are the replacement rate that determine the level of social security benefits in each period for the Bismarckian and the Beveridgean systems respectively.

Under these assumptions, the net labor income of an individual is given by

$$y_{i,j,t} = \begin{cases} (1-\tau_{ss,t}) w_t h_{i,j,t} \varepsilon_{i,j}, & \text{for } i = 1,2,3, \\ b_{j,t}, & \text{for } i = 4. \end{cases} \tag{6}$$

where $\tau_{ss,t}$ is the social security tax rate on labor income.

The production technology of the economy is described by a constant-returns-to-scale function,

$$Y_t = F(K_t, L_t) = K_t^{1-\alpha} L_t^{\alpha}, \tag{7}$$

where $\alpha \in (0,1)$ is the labor share of output, $Y_t$, and $K_t$ and $L_t$ are the capital and labor inputs. The capital stock is equal to the aggregate asset holdings of agents in the economy. It depreciates at a constant rate $\delta$ and evolves according to the law of motion,

$$K_{t+1} = (1-\delta) K_t + I_t. \tag{8}$$

There is a government in this economy that implements the pay-as-you-go social insurance system. The government must impose taxes on labor income so that its budget is balanced each period.

$$\tau_{ss,t} w_t L_t = B_t \tag{9}$$

where $B_t$ is the level of total benefits paid to retirees in period $t$.

# 3 Equilibrium

I first describe the individual economic problem faced by agents for a given sequence of political parameters. I then describe how these parameters are determined and define a politico-economic equilibrium for this economy.

## 3.1 Economic Decisions

Given a sequence of social security replacement rates and the corresponding tax rate, the economic problem of an age $i$, type $j$ individual is to choose a sequence of consumption, leisure and asset holdings that maximize the discounted lifetime utility subject to her budget constraints. Define $X$ and $x_{i,j}$ as vectors describing respectively the aggregate state of the economy and the individual state of an agent. $X = (A, E)$, where $A$ and $E$ represent the distributions of assets and of past lifetime earnings across agents. $x_{i,j} = (a_{i,j}, e_{i,j})$, where $a_{i,j}$ and $e_{i,j}$ represent the level of assets and average labor earnings of an age $i$, type $j$ agent. I write this as:

$$V_{i,j}(x_{i,j}, X; \Theta) = \max_{c_{i,j}, h_{i,j}, a'_{i+1,j}, e'_{i+1,j}} \left\{ U(c_{i,j}, 1 - h_{i,j}) + \beta V_{i+1,j}(x'_{i+1,j}, X'; \Theta) \right\}$$

s.t.

$$\begin{aligned}
& a'_{i+1,j} = (1 + R(X;\Theta))a_{i,j} + y_{i,j} - c_{i,j}, \\
& y_{i,j} = \begin{cases} (1 - \tau(X;\Theta))W(X;\Theta)h_{i,j}\varepsilon_{i,j}, & \text{for } i = 1, 2, 3, \\ b_j, & \text{for } i = 4. \end{cases} \\
& e'_{i+1,j} = e_{i,j} + \frac{W(X;\Theta)h_{i,j}\varepsilon_{i,j}}{3}, \\
& X' = P(X;\Theta), \\
& V_{5,j} = 0, \\
& \text{given } \Theta.
\end{aligned} \tag{10}$$

Here, $P(X;\Theta)$ is the law of motion of the distribution of capital and lifetime earnings, $W(X;\Theta)$ and $R(X;\Theta)$ are the relative factor price functions and $\tau(X;\Theta)$ is the social security tax rate function. $\Theta$ is a given sequence of replacement rates that describe the social security policy in each period from the current period on, $\Theta = \{\theta_l, \phi_l\}_{l=t}^{\infty}$.

This problem generates a set of decision functions $c_{i,j}(x_{i,j}, X;\Theta)$, $h_{i,j}(x_{i,j}, X;\Theta)$, $a_{i,j}(x_{i,j}, X;\Theta)$, a law of motion $P(X;\Theta)$, and value functions $V_{i,j}(x_{i,j}, X;\Theta)$.

In this economy, competitive firms maximize profits taking the wage rate and interest rate as given. The first-order conditions for the firm's problem determine the following functions for the net real return to capital and the real wage rate:

$$\begin{aligned}
R(X;\Theta) &= (1-\alpha)\left(\tfrac{K}{L}\right)^{-\alpha} - \delta, \\
W(X;\Theta) &= \alpha\left(\tfrac{K}{L}\right)^{1-\alpha}.
\end{aligned} \tag{11}$$

The government levies taxes on labor income to balance its budget each period.

## 3.2 Political Decisions

In the political economy model of social security, I implement either a Bismarckian or a Beveridgean social security system in an initial period. The corresponding replacement rate, $\theta$ or $\phi$, is chosen by agents through a democratic voting process and it determines the level of social security benefits as described by equation (4). As in Cooley and Soares (1999), I restrict the set of possible sequences of policy functions to be sequences of a constant policy parameter. Therefore agents in the implementation period choose a social security system described by this constant parameter.

To abbreviate the analysis and focus on the choice of the social security parameters, I assume that a social security system is chosen and implemented in an initial period and is maintained henceforth[2].

### 3.2.1 The political choice

In the initial period, period 1, agents choose the level of the policy parameter, $\Theta = \theta$ or $\Theta = \phi$, that will be implemented.

The solution to an agent's political problems involves evaluating the utility obtained under all possible values for the policy parameter. This requires that the agent predicts the competitive equilibrium path from the implementation period on for all alternative choices.

The political problem of the age $i$, type $j$ agent in the period when social security is implemented is:

$$\max_{\mathbf{\Theta}} V_{i,j}(x_{i,j,1}, X_1; \Theta) \tag{12}$$

where $X_1$ and $x_{i,j,1}$ describe, respectively, the aggregate state of the economy and the individual state of age $i$, type $j$ agent in the implementation period.

In this setting, if the preferences over the possible parameters are single-peaked, there exists a policy function, defined by the choice of the median voter, that resists every set of proposals to change, and thus constitutes a voting equilibrium.

**Lemma 1:** Let $m$ denote the age and type of the median voter in the initial period of the

[2] This assumption could be rationalized by assuming that a social security is implemented together with a reputational mechanism as in Cooley and Soares (1999). The reputational mechanism would imply that if workers vote against paying social security benefits, then agents next period loose confidence in the sustainability of the system. This loss of credibility means the cost of defecting today involves the collapse of the system tomorrow.

voting process, then the aggregate choice will be determined according to:

$$\Theta(X_1) = \arg\max_{\Theta} V_m(x_{m,1}, X_1, \Theta). \tag{13}$$

### 3.3 Equilibrium

**Definition:** A *politico-economic equilibrium* is a set of value functions, $V_{i,j}(x, X; \Theta)$, decision rules for consumption, individual labor supply and asset holding $c_{i,j}(x, X; \Theta)$, $h_{i,j}(x, X; \Theta)$, $a_{i,j}(x, X; \Theta)$, $\forall\ i, j$, a law of motion for the distribution of capital and lifetime earnings $P(X; \Theta)$, the relative factor price functions $W(X; \Theta)$ and $R(X; \Theta)$, the tax rate function $\tau(X; \Theta)$, functions for the level of capital $K(X; \Theta)$ and for the effective labor supply $L(X; \Theta)$ and a political outcome function $\Theta(X)$ such that these functions satisfy:

1. The individual's dynamic program (10).

2. The first-order conditions of the firm's problem (11).

3. Factor markets clear:

$$\begin{aligned} K &= K(X;\Theta) = N_t \textstyle\sum_{i=1}^{4} \mu_i \sum_{j=1}^{J} \nu_j a_{i+1,j}, \\ L &= L(X;\Theta) = N_t \textstyle\sum_{i=1}^{3} \mu_i \sum_{j=1}^{J} \nu_j h_{i,j}(x, X; \Theta) \varepsilon_{i,j}. \end{aligned} \tag{14}$$

4. The commodity market clears:

$$N_t \sum_{i=1}^{4} \mu_i \sum_{j=1}^{J} \nu_j \left[ c_{i,j}(x, X; \Theta) + a_{i,j}(x, X; \Theta) \right] = F(K, L) + (1 - \delta) K. \tag{15}$$

5. The law of motion for the distribution of capital and earnings is generated by the decision rules of agents:

$$P(X; \Theta) = \left[ a_{i,j}(x, X; \Theta),\ \ e_{i,j} + \frac{w h_{i,j}(x, X; \Theta) \varepsilon_{i,j}}{3} \right]_{i,j}. \tag{16}$$

6. The government budget is balanced.

7. The political outcome function is generated by the aggregation of the choices of agents following lemma 1.

## 4 Calibration

To solve this model numerically, I calibrate the parameters of the model so that the politico-economic steady-state equilibrium of the economy with universal benefits matches some long run features of the U.S. economy. I assume that a period in the model corresponds to 15 years. Agents in this model are assumed to be born at the age of 21 when they become full-time workers, working 3 periods (45 years) and then retiring for the last period of their lives (15 years).

**Population Growth Rate:**

I match the annual population growth rate for the model to the average population growth rate in the US economy in the last decades, 0.0124 (Citibase Data, 1946-1993). For the four generation model this translates to a growth rate of $n = 0.203$.

**Preferences**

I choose the coefficient of risk aversion $\rho$ and the value for the discount factor, $\beta$, so that the equilibrium annual interest rate is approximately 6% and the equilibrium social security tax rate is about 9.4%. I calibrate the coefficient of consumption in the utility function, $\sigma$, to 0.358 so that on average agents in the labor force allocate around 31% of their time to market activities.

**Technology**

The share of labor in the production function and the annual depreciation rate are set to be 0.64 and 8% respectively, standard values in the literature.

**Labor efficiency units:**

The age specific endowments of efficiency units are taken from Altig et al (2001). Using their estimates, I differentiate agents according to their efficiency levels, $\varepsilon_{i,j}$ ordering twelve different agent types from the less efficient and poorer (type 1) to the more efficient and richer (type 12). Types 1 and 12 consist of 2 percent of the cohort each, types 2 and 11 include 8 percent apiece, while each other type constitutes 10 percent of the cohort.

In order to allow a straightforward comparison of the results across economies and keep the experiment simple, I assume that the age specific endowments of efficiency units for an agent in the economy with intragenerational homogeneity correspond to the average endowment of his cohort in the economy with intragenerational heterogeneity.

The parameter choices are summarized in Table 1[3].

# 5 Findings

I first compare a social security system with universal benefits to one with earnings-dependent benefits while keeping the level of social security benefits the same across systems. I start by maintaining factor prices fixed and focus on partial equilibrium differences between the systems. I then let prices adjust and study the contrast between the systems when general equilibrium effects are allowed to play a role.

Finally, I compute the politico-economic equilibria where agents vote for the replacement rate given one system or the other, and compare the welfare implications of implementing either a universal benefits or an earnings-dependent benefits social security system.

## 5.1 Economic Equilibria

In this section I evaluate the welfare impacts of introducing comparable social security systems with either earnings-dependent benefits or universal benefits.

I set the replacement rate of the social security system with universal benefits (hereafter referred to as the UB system) so that it delivers a tax rate of 9.4%, and choose the sequence of replacement rates for the system with earnings-dependent benefits (hereafter referred to as the EDB system) such that social security benefits are the same as with the UB system along the equilibrium path.[4]

[3] For the benchmark calibration the interest rate is 1.0196 per period while the population grows at a rate of 0.203 per period implying that the economy is dynamically efficient.

[4] While there are many alternative criteria to compare social security systems, I chose to compare systems that provide the same level of benefits because an earnings-dependent benefit system is perceived as more efficient. This

In order to abstract from all pecuniary effects of social security, I first look at the partial equilibrium effect of implementing social security. For this purpose, I set the wage and interest rates to their equilibrium levels in the steady-state of the economy without social security. I then take into account the pecuniary effect of social security by studying the general equilibrium where factor prices are endogenous.

#### 5.1.1 Intragenerational Homogeneity

**Partial Equilibria:** In the EDB system, the level of benefits is proportional to an agent's lifetime labor income and workers account for the impact on their social security benefits of an increase in their labor income. The optimality condition for the labor supply decision is then:

$$h_{i,j,t} : u_l \left(c_{i,j,t}, l_{i,j,t}\right) = w_t \ \varepsilon_{i,j} \left[(1-\tau_t) + \xi_{i,j,t}\right] u_c \left(c_{i,j,t}, l_{i,j,t}\right), \tag{17}$$

where

$$\xi_{i,j,t} = \sum_{l=3+1}^{4} \frac{\theta_{t+l-i}}{3} \prod_{n=1}^{l-i} \frac{1}{1+r_{t+n}} \tag{18}$$

is the impact of current labor supply on retirement benefits in terms of current units of consumption. This link between benefits and earnings reduces the effective level of social security taxation. For the same wage rate and social security tax rate, the relative cost of leisure in terms of consumption is higher because of the impact of labor income on social security benefits. Hence agents increase consumption, and decrease leisure. This results in an increase in the supply of labor relatively to the UB case. Moreover, because of the increase in labor supply the tax needed to finance the same level of benefits is lower in the EDB system which further decreases the tax distortion. As can be seen in figure (1 panel c), a lower social security tax rate is needed to finance the same level of social security benefits when benefits are earnings-dependent. In figure (1 panel b) it is clear that the supply of labor is less negatively affected by social security when benefits are earnings-dependent. Notice also that, when benefits are earnings-dependent, we observe a long-run increase in the aggregate supply of labor relatively to the equilibrium without social security.

To some extent savings decreases by more in the earnings-dependent case (see figure 1 panel

implies that it should provide the same level of benefits at a lower cost, therefore generating lower welfare losses, than an universal benefits system. An alternative would be to compare systems with the same tax rate, however this would imply different levels of benefits as well as different contributions, making it more difficult to compare the two systems.

a). The impact of an increase in labor on social security benefits, $\xi_{i,j,t}$, is higher as agents get closer to their retirement. Therefore, the reduction in the effective level of social security taxation and the corresponding raise in the cost of opportunity of leisure augment with an individual's age. Hence, the increase of the supply of labor relatively to the UB case rises with age (see figure 2 panels a-c) and so does the increase in after tax labor income. As a result, the lifetime income profile becomes steeper and the young and the middle-aged reduce their savings to smooth their lifetime consumption profiles (see figure 2 panels d and e). Notice however that retirees' assets are higher in the EDB case (see figure 2 panel f). In order to smooth the consumption-leisure bundle, and although their leisure automatically goes up upon retirement, retirees want to consume more than in the UB system because their lifetime resources are higher. Given that, by construction, social security benefits are identical across systems, agents want more assets upon retirement in the EDB case. However, the resulting relative increase in retirees' asset accumulation is smaller than the decrease in younger agents' savings and the EDB system has a stronger negative impact on aggregate savings than the UB system.

More importantly, not only the present value of net benefits and the after-tax wage rate are higher under the EDB system because of the decrease in the tax rate, but the reduction in the tax distortion reduces the corresponding deadweight loss. Consequently, the welfare of current and future young is higher under the EDB system (see figure 3).

I measure the welfare loss of an agent in a given equilibrium relatively to a reference equilibrium as the fixed percentage increase in the lifetime consumption of the individual needed to equate the level of welfare she would achieve in the reference equilibrium. I refer to this measure as the compensating variation. Formally, if $V^R$ and $V^T$ denote the welfare levels in the reference equilibrium and in the equilibrium under analysis respectively. The compensating variation is calculated as

$$\left[\frac{V^R}{V^T}\right]^{\frac{1}{(1-\rho)(1-\sigma)}} - 1. \tag{19}$$

The compensating variation is positive (negative) if there is a welfare loss (gain) relatively to the reference equilibrium. Table 2 presents the values of this measure for the different experiments.

In the present analysis, for a young agent born at the time of implementation of social security, we would have to decrease her lifetime consumption in the economy with the EDB system by 0.14% for her to be as well off as with the implementation of the UB system. In the long-run, to make a young agent born in the steady-state of the economy with the EDB system as well off as if she was born in the steady-state of the economy with the UB system, we would have to decrease her lifetime consumption by 0.14%. As a reference, note that for the initial young to be as well off with the implementation of the UB system as in the steady-state without social security we would need to increase her consumption by 3.96%.

**General Equilibria:** I now compare the impact of implementing the different types of social security systems in general equilibrium, choosing the sequence of replacement rates for the EDB system so that social security benefits are the same along the equilibrium paths.

The difference between the general equilibrium and the partial equilibrium paths stems from the adjustment of factor prices and its feedback into agents' decisions. As we observed in the partial equilibrium analysis, the supply of labor is significantly higher and savings are slightly lower with the EDB system. As a result of its impact on savings, the EDB system generates slightly lower levels of capital (see figure 4 panel a). Once we allow factor prices to respond, the decrease in capital and increase in labor supply (see figure 4 panel b) relatively to the UB equilibrium results in a lower wages (see figure 4 panel c). Even though the tax rate is lower with the EDB system (see figure 4 panel e), the response of the wage rate implies a lower after tax wage rate (see figure 4 panel f). The decrease in after-tax wages makes the current young and future agents worse off with the EDB system than with the UB system (see figure 5).

In this case, we would have to increase the lifetime consumption of a young agent at the time of implementation of the EDB system by 0.14% for her to be as well off as with the implementation of the UB system. To make a young agent as well off in the steady-state of the economy with the EDB system as in the steady-state of the economy with the UB system, we would have to increase her lifetime consumption by 0.3%. As a reference note that for the initial young to be as well off with the implementation of the UB system as in the steady-state without social security we would need to increase her lifetime consumption by 3%, while the compensation that would make young agents as well off in the long-run would be 7.82%. Although, these welfare costs of adopting an EDB system instead of an UB system are small they correspond to a relevant share, about 4.7% and 3.84%, of the cost of adopting an UB social security system. More importantly they are bigger than the welfare gains associated with the reduction in tax distortions obtained in partial equilibrium. The welfare losses due to the general equilibrium effects of the EDB system relatively to the UB system are about twice the size of the gains associated with the reduction in tax distortions measured in section 5.1.1 in the short-run, and about three times the size of those gains in the long-run.

Furthermore, while the impact on after-tax wages is more negative with the EDB system, the impact on the rate of return is more positive (see figure 4 panel d). Consequently, in the short-run, agents that have accumulated a significant amount of assets benefit more from an EDB system. In fact, while young agents are worse off with the EDB system because of the higher decrease in after-tax wages it generates, we can see in figure (5) that all remaining initial generations are better off with the EDB system (this will be crucial when we endogenize the size of the systems).

So, relatively to an UB system, the EDB system reduces the distortionary effect of social security taxation, but it can also increase the negative impact that social security has on wage rates. In the benchmark economy, the latter effect is present and is stronger than the first; consequently the EDB system makes current young and future agents worse off than with the comparable UB system.[5]

As we increase the social security tax rate, its distortionary effect increases exponentially and gains a relatively higher importance in the comparison between the two systems. For the benchmark calibration, current young and future agents are worse off with an UB system corresponding to a tax superior to 27% than with the comparable EDB system. Therefore, a considerable tax rate is necessary for the EDB system to generate a reduction in the tax distortion large enough to offset its general equilibrium effects.

[5] In the only other work, to my knowledge, that presents a welfare comparison of the two systems, Auerbach and Kotlikoff (1987) find efficiency gains from establishing a link between an agent's contributions and benefits in a standard overlapping generations model calibrated to match the U.S. economy. In their model, the level of capital is higher in the long-run under the EDB system and outweighs the effect of the increase in labor supply on wages. Their 60 overlapping generations model is a finer representation of the demographic structure of the economy, but the experiments are not similar. Auerbach and Kotlikoff (1987) compare systems where the present value of the flow of benefits paid over 15 retirement periods is a fixed percentage of the average lifetime labor income, while I compare systems that deliver the same level of benefits. More importantly, the point of this section is to show, in a realistic economic environment, that the welfare impact of linking benefits to earnings might not be positive as it is commonly perceived. The choice of a simpler generational structure is made to reduce the burden of computing the politico-economic equilibrium, the main focus of the paper.

### 5.1.2 Intragenerational Heterogeneity

I now compare the systems in an environment where agents within each generation can differ in their labor efficiency levels. I set the replacement rate of the UB system so that it delivers a tax rate of 9.4%, and choose the sequence of replacement rates for the EDB system such that average social security benefits are the same as with the UB system along the equilibrium path.

**Partial Equilibria:** In the presence of intragenerational heterogeneity an UB system implies some redistribution from high to low earners, with high earners contributing significantly more than low earners and receiving the same benefits, while the EDB does not imply any direct intragenerational redistribution. Although the EDB system reduces the distortionary effect of the tax on labor, agents with lower labor efficiency are better off with the UB system than with the EDB system and agents with higher labor efficiency are better off with the EDB system than with the UB system (see figure 6). As in the economy with intragenerational homogeneity, the EDB results in lower tax rates and in a higher supply of labor as well as a slightly lower accumulation of physical capital. Notice however that, in contrast with the previous case, the average lifetime utility level is higher with the UB system than with the EDB system (see figure 7). The gains from redistributing resources in the UB system from high productivity agents to low productivity agents, that enjoy less consumption and hence have higher marginal utilities of consumption, outweighs the efficiency gains associated with the EDB system.

We would have to increase the "lifetime consumption of the average young" at the time of implementation of the EDB system by 1.88% for her to be as well off as with the implementation of the UB system[6]. As a reference note that for the "average initial young" to be as well off with the implementation of the UB system as in the steady-state without social security we would need to increase her "lifetime consumption" by 1.9%. The values are the same for the comparisons across steady-states.

Finally, all but the least efficient current and future young are worse off with both systems (see figure 6). Current old are better off with both systems while the middle-aged are worse off with both systems with the exception of some of the low skilled middle-aged that can be better off with

[6] The values are computed by applying the compensating variation formula described in equation (19) to the average lifetime utilities of the young. The resulting variation is not relatively to the average consumption of the young but to a consumption stream that would generate the average level of lifetime utility. This measure captures the relative impact of the social security systems on the average levels of utility.

the UB system.

**General Equilibria:** Once we allow prices to adjust, the aggregate response of the economy is identical to the case with intragenerational homogeneity. Because of the relatively higher labor supply and lower capital accumulation the wages are lower in the equilibrium with the EDB system. As a result net wages are lower which makes agents worse off. However, in contrast with the previous case, in the presence of intragenerational heterogeneity the general equilibrium effects seem to diminish the negative impact of the EDB system relatively to the UB system(see figure 9).

We would have to increase the "lifetime consumption of the average young" at the time of implementation of the EDB system by 1.52% for her to be as well off as with the implementation of the UB system. To make the average young as well off in the steady-state of the economy with the EDB system as in the steady-state of the economy with the UB system, we would have to increase her "lifetime consumption" by 1.6%. When compared to the corresponding values from the partial equilibrium analysis, these results indicate that the general equilibrium effects reduce the welfare losses of the EDB system relatively to the UB system.

As in the economy with intragenerational homogeneity, the higher decrease in wages with the EDB system increases the negative impact of the EDB system relatively to the UB system. Only the three wealthiest types of current and future young are better off with the EDB than with the UB system (see figure 8). However, the decrease in the wage rate not only reduces the value of an individual's human capital but also implies that, for given levels of labor supplied, relatively less is distributed from more skilled workers to less skilled workers with the UB system. Moreover, while the aggregate effective labor supply decreases, the decrease in the effective labor supplied by more skilled workers is higher. Therefore, the redistributive features of the UB system are weaker than in partial equilibrium which decreases the welfare benefits of the UB system relatively to the EDB system.

An additional consequence of the decrease in the intragenerational redistribution associated with the UB system is that, in general equilibrium even the least efficient young agents are worse off with both systems in the long-run.

As we increase the social security tax rate, its distortionary effect increases exponentially and gains a relatively higher importance in the comparison between the two systems. For the benchmark calibration, agents are worse off in the long-run with an UB system corresponding to a tax superior to 37.7% than with the comparable EDB system.

## 5.2 Politico-economic Equilibria

In this section, I study the welfare impact of implementing a social security system when agents choose the corresponding replacement rate given that benefits are either earnings-dependent or universal.

I start by showing that voters' preferences over the policy parameters are single-peaked. I then locate the median voter and determine the equilibrium levels of the replacement rates.

### 5.2.1 Intragenerational Homogeneity

In figure 10, we can see the lifetime utility of agents alive in the period when social security is implemented over the policy parameters $\theta$ (EDB) and $\phi$ (UB). In this economy, preferences are clearly single peaked over the policy parameters. Older agents prefer higher levels of the replacement rate, and the utilities of the two oldest generations are strictly increasing over the depicted levels of the replacement rates. On the other hand, young agents prefer that no social security system be implemented and their utility is strictly decreasing with the replacement rates. Hence, the median voter is an age-2 agent which has interior peaks for the policy parameters.

The equilibrium levels of the policy parameters are those that maximize the lifetime utility of the median voter: $\theta^* = 0.2892$ and $\phi^* = 0.1902$. In steady-state these replacement rates correspond respectively to a tax rate on labor income of $\tau^* = 0.0638$ and $\tau^* = 0.0433$. Therefore the economy with an EDB social security system has a higher contribution rate than the one with an UB system.

Figure 11 shows the levels of several aggregate variables for the equilibrium paths with the chosen replacement rates ($\theta = \theta^*$, $\phi = 0$ and $\phi = \phi^*$, $\theta = 0$).

We observe that tax rates are significantly higher for the social security system with EDB than for the one with UB (see figure 11 panel e); when voters choose social security benefits, the median voter prefers a significantly larger social security system when benefits are earnings-dependent. Additionally, while both systems decrease welfare, current young and future agents are worse off in the equilibrium with EDB (see figure 12).

Although the present value of net benefits for the median voter is lower with an earnings-dependent system than with a comparable UB system, its general equilibrium effects are more favorable to the median voter and older agents[7]. As we saw in section 5.1.1, the EDB system generates a higher supply of labor and lower accumulation of capital along the equilibrium path than a comparable UB system. Because of the response of the labor supply, in the initial period the wage rate increases by slightly less in the EDB system. Thereafter the interest rate increases and the wage rate decreases considerably more in the EDB equilibrium. The augmented impact on the interest rate generates an increased support for social security by agents that have accumulated capital, and the median voter is enticed to vote for a bigger social security system when she is choosing over levels of earnings-dependent benefits.

Moreover, in an universal system the social security benefits the median voter will receive upon retirement are linked to the future supply of labor, which decreases with the replacement rate, while in the EDB system, her benefits are proportional to her lifetime earnings, which are much less responsive to changes in the replacement rate. This effect increases the incentive to choose higher replacement rates in the latter case.

Finally, as we saw in the previous section, an EDB system can lead to higher welfare losses than a comparable UB system for the initial young and all future generations. As the median voter chooses a relatively bigger EDB system, those agents are much worse off with an EDB system when we allow the size of the systems to be chosen in a democratic voting process. We would have to increase the lifetime consumption of a young agent at the time of implementation of the EDB system by 0.84% for her to be as well off as with the implementation of the UB system. To make a young agent as well off in the steady-state of the economy with the EDB system as in the steady-state of the economy with the UB system, we would have to increase her lifetime consumption by 1.93%. So once we endogenize the size of the social security system, the welfare cost of opting for an EDB system is very significant. Note that the welfare cost for the young of an UB system relatively to the steady-state without social security is 1.24% in the short-run and 3.41% in the long-run.

In figures 12 and 10 it is clear that the three oldest initial generations are better off in the politico-equilibrium achieved with an EDB system ($\theta = \theta^*$, $\phi = 0$), than in the equilibrium achieved

[7] The results in this environment are similar to Cooley and Soares (1999) where, although the present value of net benefits of social security are negative for the median voter, the general equilibrium effects of social security on the utility of agents, through its impact on factor prices, are important and generate support for positive levels of social security.

with an UB system ($\phi = \phi^*$, $\theta = 0$). So, if we allowed for the choice of systems before agents would vote on the corresponding parameters, an EDB system would be chosen over an UB system which would make agents worse off in the long-run.

### 5.2.2 Intragenerational Heterogeneity

In figures 13-16, we can see that the preferences of agents alive in the period when social security is implemented are single peaked over the policy parameters $\theta$ (EDB) and $\phi$ (UB).

The preferences of nearly all agents in the two oldest generations are strictly increasing over the depicted range of the replacement rates as their contributions are low and benefits are large (see figures 15 and 16). However, in the UB system individual's contributions increase with their skills while their benefits remain constant. Therefore while the level of the UB replacement rate preferred by the middle-aged is positive it decreases with their skill level. We observe a peak in the preferences of the more skilled middle-aged over the UB replacement rate, as they pay a relative high level of taxes for the benefits received, with the most skilled middle-aged preferring very low levels of social security in the UB system.

On the other hand, the preferences of nearly every young are strictly decreasing with the replacement rates (see figure 13) and they prefer that no social security system be implemented. The exception are the less skilled young who benefit enough from the redistribution associated with the UB system and consequently support a non-trivial level of the corresponding replacement rate. The less skilled age-2 agents together with the older generations prefer higher levels of the UB system parameter, Hence, the median voter is a type-6 age-2 agent which has interior peaks for the policy parameter.

Finally, within any given cohort, while more skilled agents prefer a smaller UB system than less skilled agents, the ranking of preferences over the size of the EDB system is independent of the skill level.

As we saw in section 5.1.2, the intragenerational distribution features of the UB system are dominant and favor the median voter, increasing her incentive to choose higher replacement rates in an UB system than in an EDB system. As a result, the median voter prefers a significantly larger social security system when benefits are universal. The equilibrium levels of the policy parameters are $\theta^* = 0.3005$ and $\phi^* = 0.4147$. In steady-state these replacement rates correspond respectively to a tax rate on labor income of $\tau^* = 0.0663$ and $\tau^* = 0.0944$. Therefore the economy with an UB social security system has a higher contribution rate than one with an EDB system.

Figure 17 shows the levels of the main aggregate variables for the equilibrium paths with the chosen replacement rates ($\theta = \theta^*$, $\phi = 0$ and $\phi = \phi^*$, $\theta = 0$). It is clear that the larger equilibrium UB system has a stronger impact on the aggregate variables. The levels of capital and labor are lower in the equilibrium with the UB system and the wage rate increases by more in the short-run and then sinks deeper in the long-run, with the interest rate following the opposite pattern. Given that tax rates are significantly higher in the equilibrium with UB than in the equilibrium with EDB, the decrease of the net wage rate is much higher with the UB system. Consequently, in the long-run agents are on average worse off when the system is UB (see figure 19). To make the average young agent as well off in the steady-state of the economy with the EDB system as in the steady-state of the economy with the UB system, we would have to decrease her "lifetime consumption" by 0.79%. So when we endogenize the size of the social security system, the welfare cost of opting for an UB system is very significant. Notice that the welfare cost for the "average young" of an UB system relatively to the steady-state without social security is 6.47% in the long-run. Moreover, in the long-run, all agents except the ones in the two lowest skill groups are worse off with the UB system (see figure 18); the lowest skilled agents still benefit from the redistribution associated with this system.

However, on average the current young are better off in the equilibrium with UB (see figure 19). We would have to increase the "lifetime consumption of the average young agent" at the time of implementation of the EDB system by 0.57% for her to be as well off as with the implementation of the UB system. The welfare cost for the "average young" at the time of implementation of an UB system relatively to the steady-state without social security is 1.61%.

Because the system is bigger and implies more intergenerational redistribution all initial old and middle-aged, except the more skilled ones, are better off with the UB system, non-withstanding its highest initial negative impact on the interest rate (see figure 18). On the other hand, age-2 agents preferences are equally distributed across systems with the less skilled half preferring the UB system and the most skilled half faring better with the EDB system. Finally most initially living younger generations prefer the smaller EDB system. Given the resulting larger decrease of wage rates after the implementation period with the UB system, only the three lowest skill groups among the young gain enough from its intragenerational distributional features to prefer the UB system over the EDB system. Consequently, if we allowed for the choice of systems before agents would vote on the corresponding parameters, an UB system would be chosen over an EDB system which would make most agents worse off in the long-run.

# 6 Summary of findings

## 6.1 Economic Equilibria

### 6.1.1 Intragenerational Homogeneity

**Partial Equilibria** In an environment where factor prices remain unchanged, an EDB social security system that delivers the same benefits as the benchmark UB system results in a decrease of the deadweight loss associated with the tax on labor income, and also in a lower tax rate. Consequently, the welfare of current and future young is higher under the EDB system.

**General Equilibria** In general equilibrium, as the labor supply is larger and savings are lower under the EDB system than under the UB system, the after tax wage rate is lower. Consequently, the welfare of current and future young is higher under the UB system.

### 6.1.2 Intragenerational Heterogeneity

**Partial Equilibria:** In the presence of intragenerational skill heterogeneity, when factor prices remain unchanged, although the EDB system results in less distortion and lower tax rates, the redistributional features of the UB system imply that agents with lower skills are better off with the UB system than with the EDB system, and agents with higher skills are better off with the EDB system than with the UB system. On average current and future young are better off with the UB system than with the EDB system.

**General Equilibria** In the presence of intragenerational heterogeneity the general equilibrium effects diminish the negative impact of the EDB system relatively to the UB system. The higher decrease in wages with the EDB system increases the negative impact of the EDB system relatively to the UB system. However the decrease in the wage rate and the higher reduction in the effective labor supplied by more skilled workers implies that an UB system redistributes less from more skilled workers to less skilled workers. Therefore, the redistributive features of the UB system are weaker than in partial equilibrium which decreases the welfare benefits of the UB system relatively to the EDB system.

### 6.2 Politico-economic Equilibria

#### 6.2.1 Intragenerational Homogeneity

When we let agents choose the size of the social security systems in an environment with intragenerational homogeneity, the median voter, an age-2 agent, prefers a significantly larger system under an EDB system than under an UB system. While both systems decrease welfare, current and future young are worse off in the politico-economic equilibrium with an EDB system.

If we allow for the choice of systems before agents vote on the corresponding parameters, the EDB system is chosen over the UB system which would make agents worse off in the long-run..

#### 6.2.2 Intragenerational Heterogeneity

When agents choose the size of the social security systems in an environment with intragenerational skill heterogeneity, the median voter, a type-6 age-2 agent, prefers a larger social security system when benefits are universal. In the long-run, agents are on average worse off when the system is UB, with all agents except the ones in the two lowest skill groups being worse off with the UB system. However, on average the current young are better off when the equilibrium UB system is implemented.

If we allow for the choice of systems before agents vote on the corresponding parameters, the UB system would be chosen over the EDB system which would make most agents worse off in the long-run.

# 7 Concluding Remarks

A pure earnings-dependent benefits system is commonly perceived as being more efficient than an universal benefits system because it reduces the distortions inherent to a tax on labor income and the corresponding deadweight losses. In this paper, I build an overlapping generations environment with intragenerational homogeneity which underscores the positive features of earnings-dependent benefits systems, and therefore predisposes the model to deliver results favorable to this system relatively to a comparable universal benefits system. I find that the current young and future generations can be better off in an economy with an universal benefits system than in an economy with a comparable earnings-dependent benefits system. The earnings-dependent benefit system generates a much lower decrease in labor supply and a somewhat higher decrease in savings. In general equilibrium, the disparity in the impact on the supply of labor and on capital accumulation implies that net wages can be significantly lower and, therefore, agents can be worse off with an earnings-dependent system than with a comparable universal system. Once I introduce intragenerational heterogeneity, as expected, the results are mostly driven by the intragenerational distribution features of the UB system that increase average levels of utility by redistributing resources from wealthier agents with lower marginal utility of consumption to less skilled and poorer agents with higher marginal benefits of consumption. Moreover, the general equilibrium effects are such that, only the most skilled groups are better off with the EDB system than with a comparable UB system.

If we allow agents to choose social security benefits in a majority voting process, in the economy with intragenerational homogeneity, the median voter prefers a significantly larger social security system when benefits are earnings-dependent. Consequently, agents are considerably worse off, in the short-run and in the long-run, when benefits are earnings-dependent than when they are universal. As in Cooley and Soares (1999), the general equilibrium effects are determinant. An earnings-dependent benefits system generates a higher supply of labor and lower accumulation of capital along the equilibrium path than a comparable universal benefits system. The consequent bigger impact on interest rates increases the support for social security by the median voter who benefits from the increase in future labor income. In the economy with intragenerational heterogeneity, the median voter is the top of the bottom half of the skill distribution among her cohort and prefers a larger social security system when benefits are universal. The larger size of this system, leads to a bigger decrease of the wage rate in the long-run which makes all but the two least skilled groups of agents worse off than with an earnings-dependent system. However, agents are on average better off in the short-run when benefits are universal.

Interestingly, if we would allow for the choice of systems before agents would vote on the corresponding parameters, the system that would be chosen would be the one that makes most agents worse off in the long-run.

This paper does not take into account some features that might relevant for the comparison of these two social security systems. In particular, I do not allow for idiosyncratic nor aggregate shocks which are important in the analysis of a social security program. For instance, the introduction of uninsurable idiosyncratic individual shocks might reinforce the impact of an universal benefits system and the presence of cohort specific shocks might possibly improve the welfare impact of an earnings-dependent benefits system.

Despite these limitations, this paper stresses the importance of considering the general equilibrium effects and specially the politico-economic equilibrium impact of introducing changes to the structure of the social security system.

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# A Tables and Graphs

| Table 1 - Calibration | | | | | |
|---|---|---|---|---|---|
| $\boldsymbol{\beta}$ | $\boldsymbol{\rho}$ | $\boldsymbol{\sigma}$ | $\boldsymbol{\alpha}$ | $\boldsymbol{\delta}$ | **n** |
| 0.881 | 5.1 | 0.358 | 0.64 | 0.7137 | 0.203 |

| Table 2 - Welfare Measures | | | | |
|---|---|---|---|---|
| | Short-run | | Long-run | |
| | Universal Benefits | Earnings-Dependent Benefits | Universal Benefits | Earnings-Dependent Benefits |
| Economic Equilibria - Comparable systems | | | | |
| Intragenerational Homogeneity | | | | |
| Compensating variation partial equilibrium | 3.96%[8] | 3.81%[9] | 3.96%[10] | 3.81%[11] |
| | −0.14%[12] | | −0.14%[13] | |
| Compensating variation general equilibrium | 3% | 3.15% | 7.82% | 8.14% |
| | 0.14% | | 0.3% | |
| Intragenerational Heterogeneity[14] | | | | |
| Compensating variation partial equilibrium | 1.9% | 3.82% | 1.9% | 3.82% |
| | 1.88% | | 1.88% | |
| Compensating variation general equilibrium | 1.6% | 3.15% | 6.43% | 8.14% |
| | 1.52% | | 1.6% | |
| Politico-economic equilibria | | | | |
| Intragenerational Homogeneity | | | | |
| Replacement rate | 0.1902 | 0.2892 | 0.1902 | 0.2892 |
| Tax rate | 0.0433 | 0.0648 | 0.0433 | 0.0638 |
| Compensating variation | 1.24% | 2.1% | 3.41% | 5.41% |
| | 0.84% | | 1.93% | |
| Intragenerational Heterogeneity | | | | |
| Replacement rate | 0.4147 | 0.3005 | 0.4147 | 0.3005 |
| Tax rate | 0.0944 | 0.0674 | 0.0944 | 0.0663 |
| Compensating variation | 1.61% | 2.19% | 6.47% | 5.63% |
| | 0.57% | | −0.79% | |

[8] Percentual increase in the lifetime consumption of a young agent born at the time of implementation of the UB social security system necessary for her to be as well off as in the economy without social security.

[9] Percentual increase in the lifetime consumption of a young agent born at the time of implementation of the EDB social security system necessary for her to be as well off as in the economy without social security.

[10] Percentual increase in the lifetime consumption of a young agent born in the steady-state of the economy with the UB system necessary for her to be as well off as if she was born in the steady-state of the economy without social security.

[11] Percentual increase in the lifetime consumption of a young agent born in the steady-state of the economy with the EDB system necessary for her to be as well off as if she was born in the steady-state of the economy without social security.

[12] Percentual increase in the lifetime consumption of a young agent born at the time of implementation of the EDB social security system necessary for her to be as well off as with the implementation of a cimparable UB system.

[13] Percentual increase in the lifetime consumption of a young agent born in the steady-state of the economy with the EDB system necessary for her to be as well off as if she was born in the steady-state of the economy with a comparable UB system.

[14] See footnote 6.

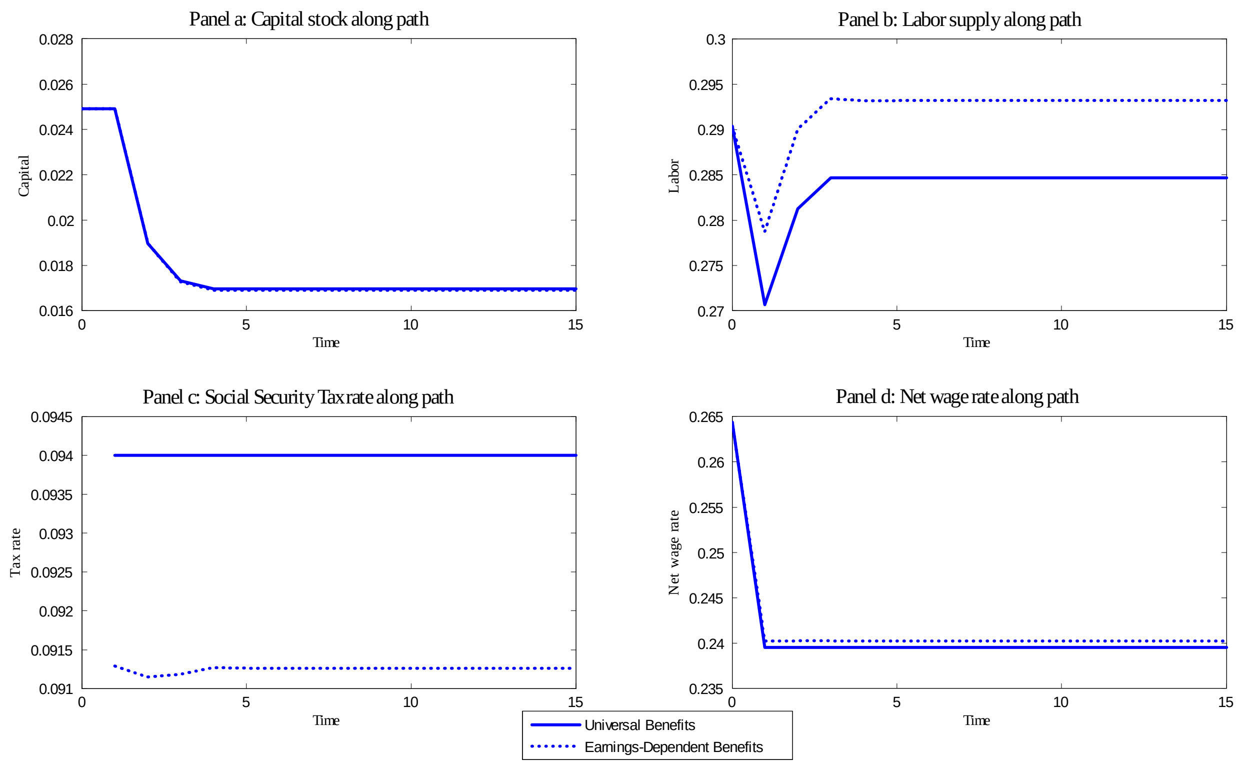


Figure 1: Variables along partial equilibrium path for comparable social security systems

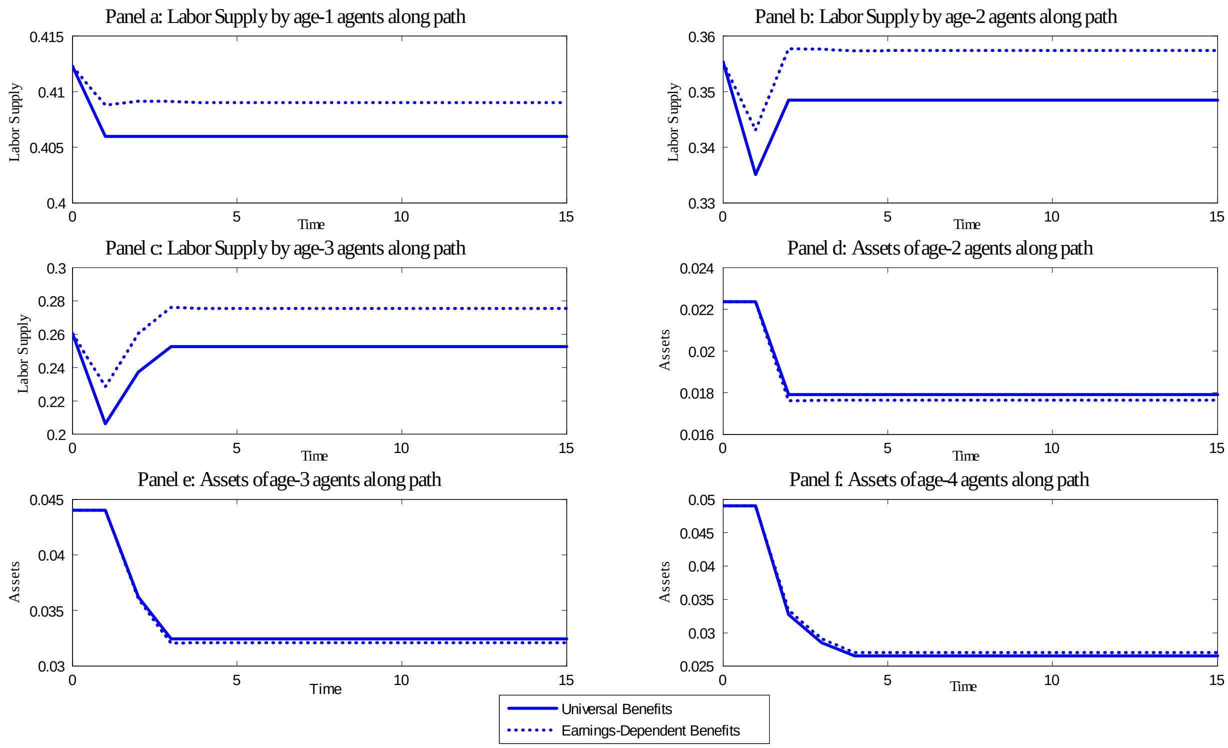


Figure 2: Labor supply and assets along partial equilibrium path for comparable social security systems

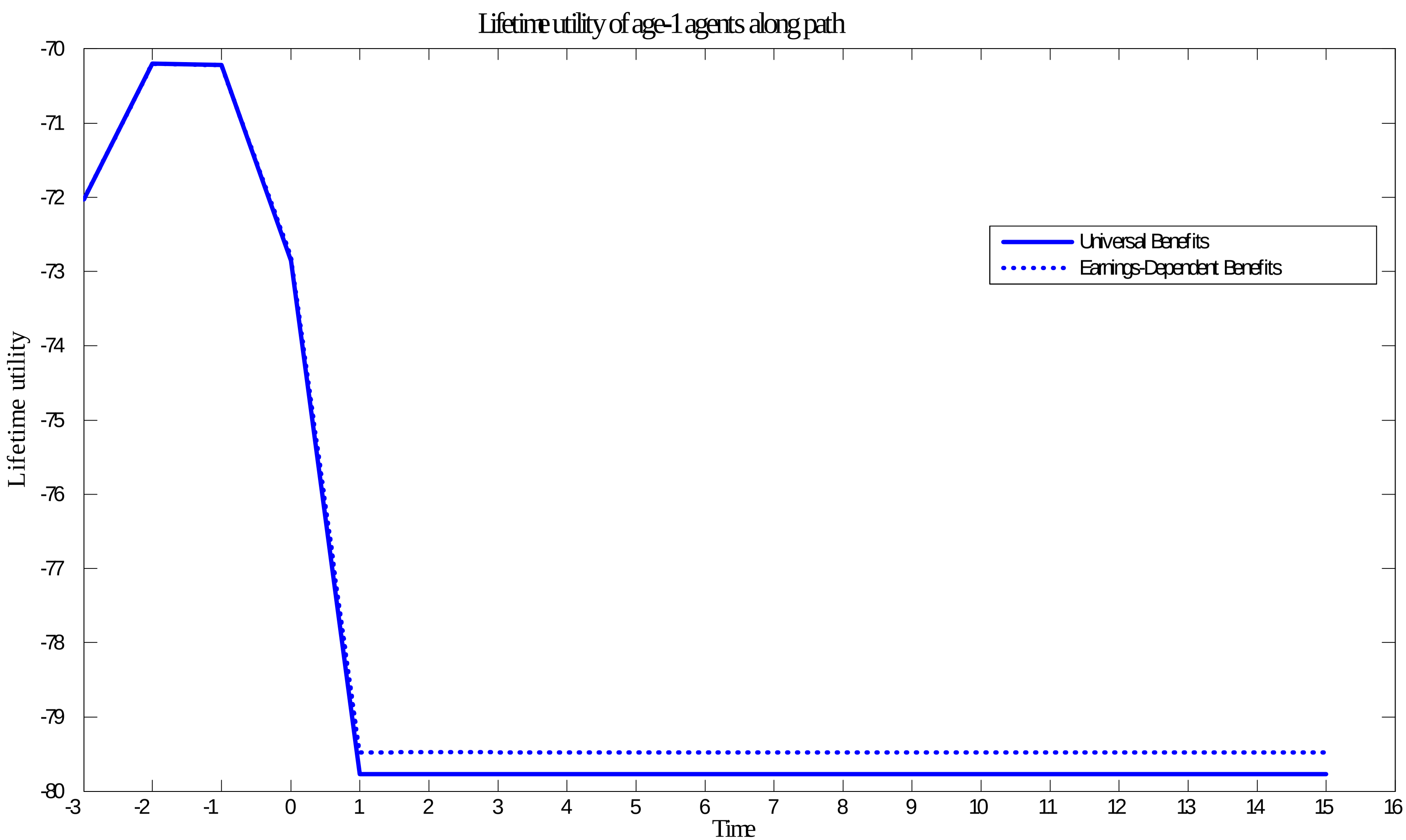


Figure 3: Lifetime utility along partial equilibrium path for comparable social security systems

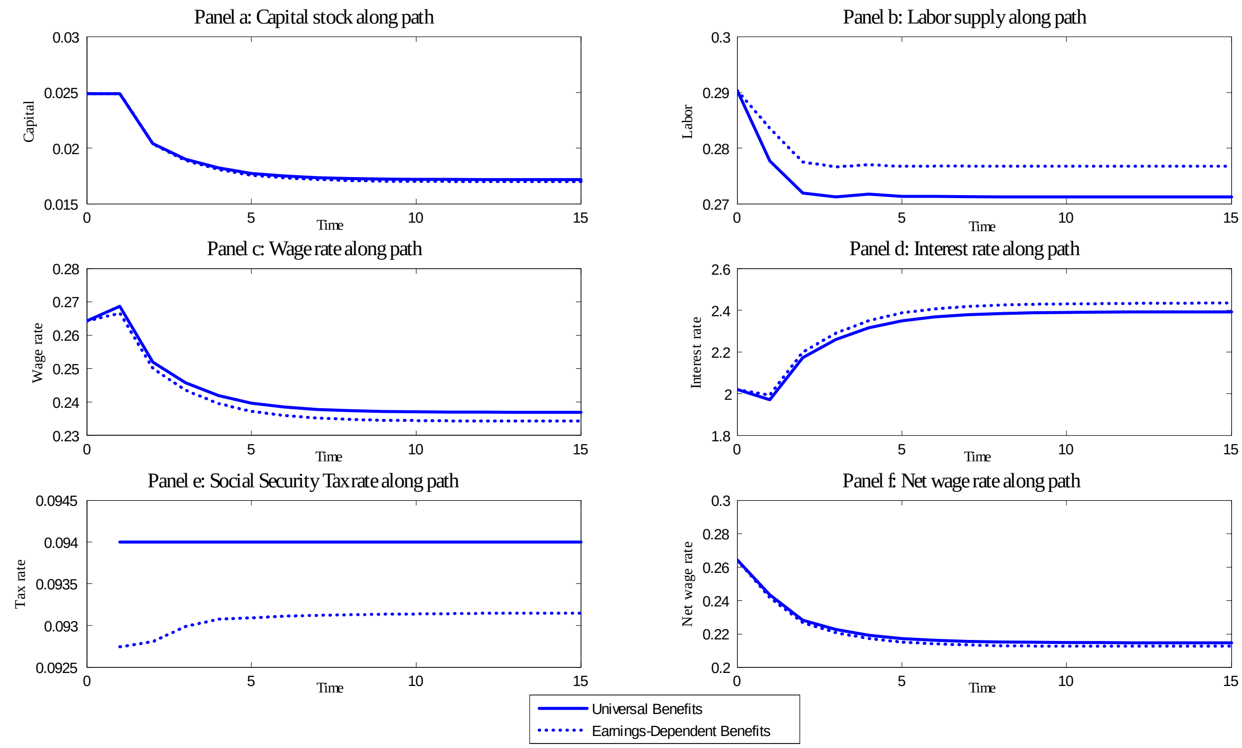


Figure 4: Variables along general equilibrium path for comparable social security systems

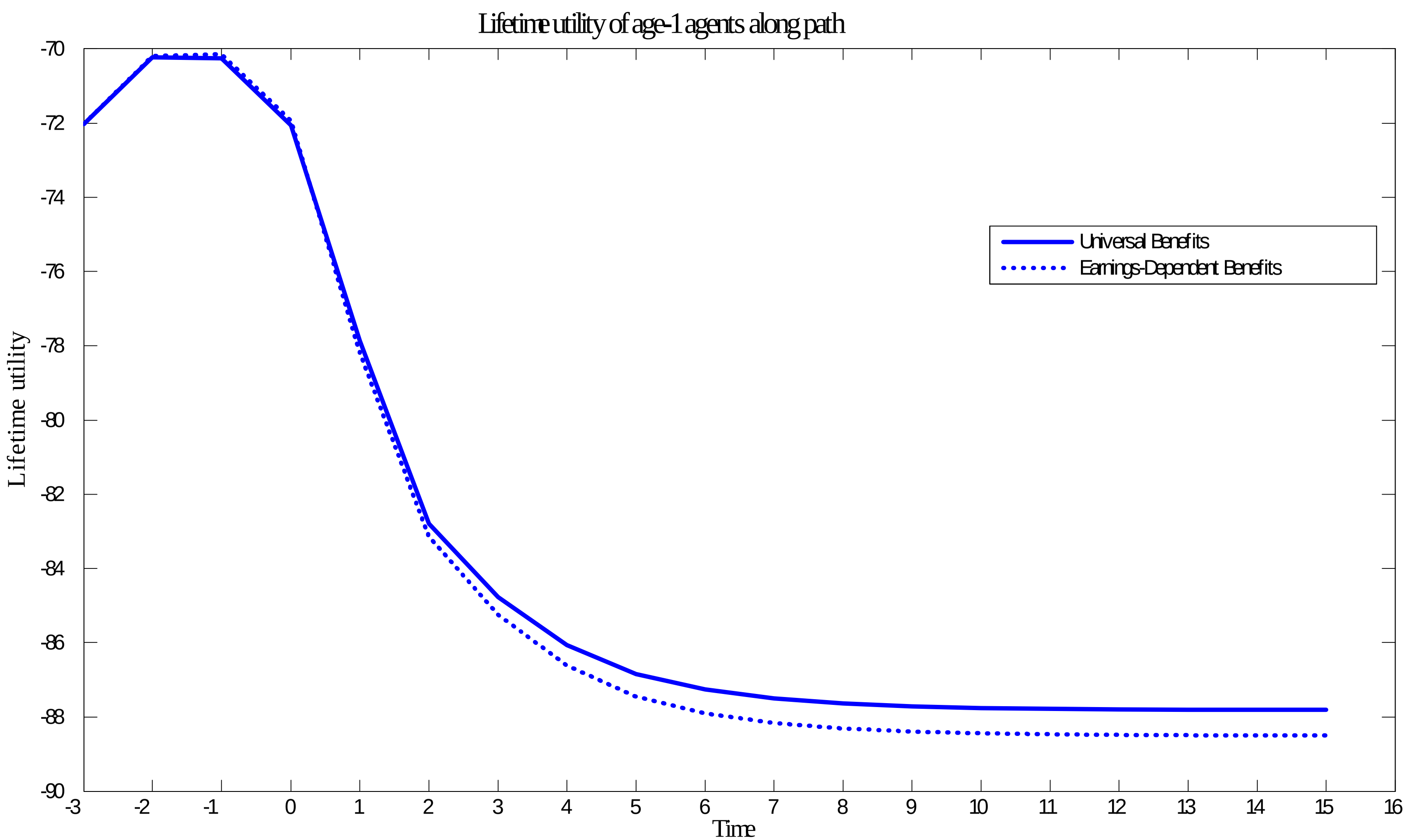


Figure 5: Lifetime utility along general equilibrium path for comparable social security systems

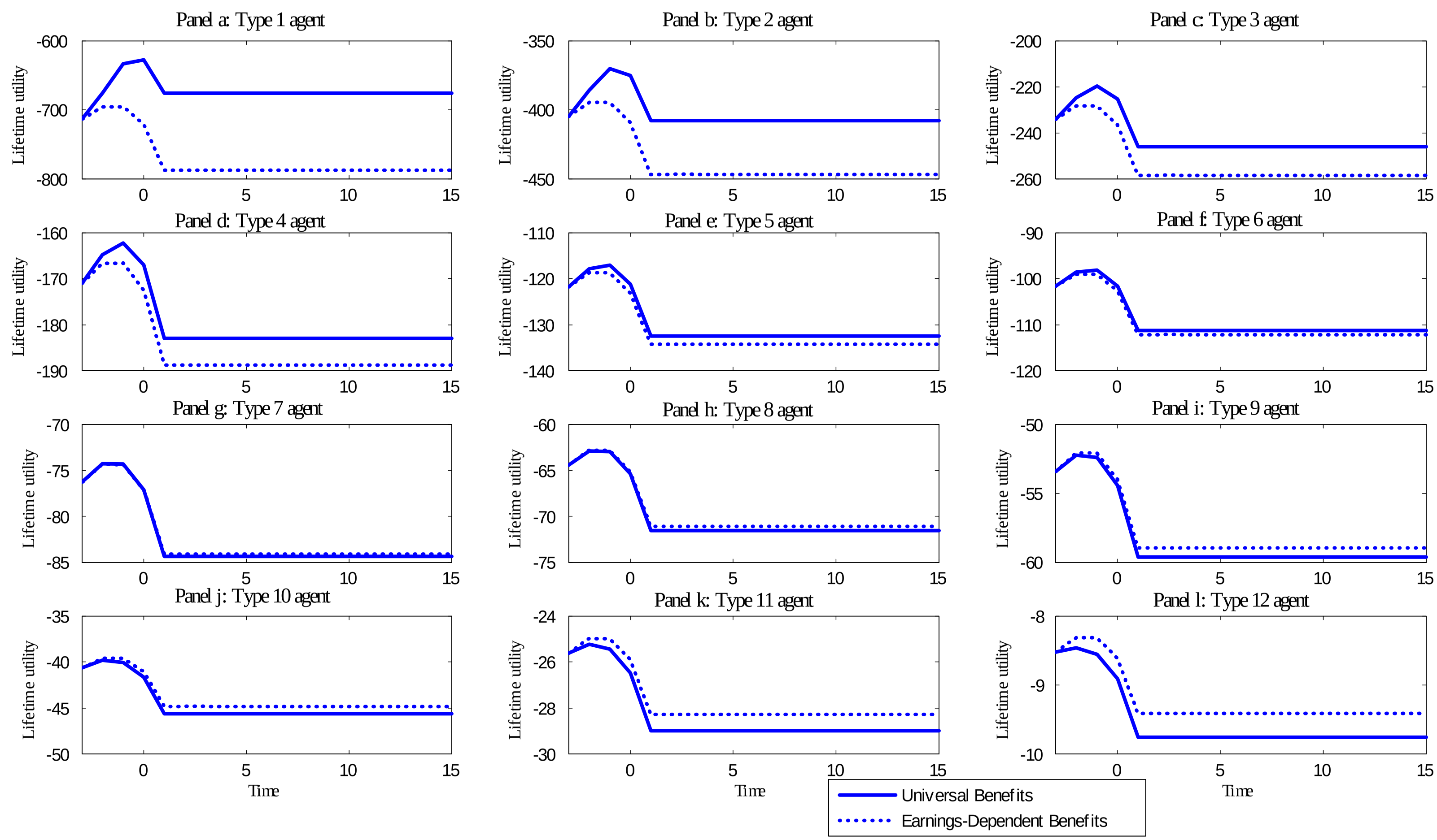


Figure 6: Lifetime utility of different agent types along partial equilibrium path for comparable social security systems

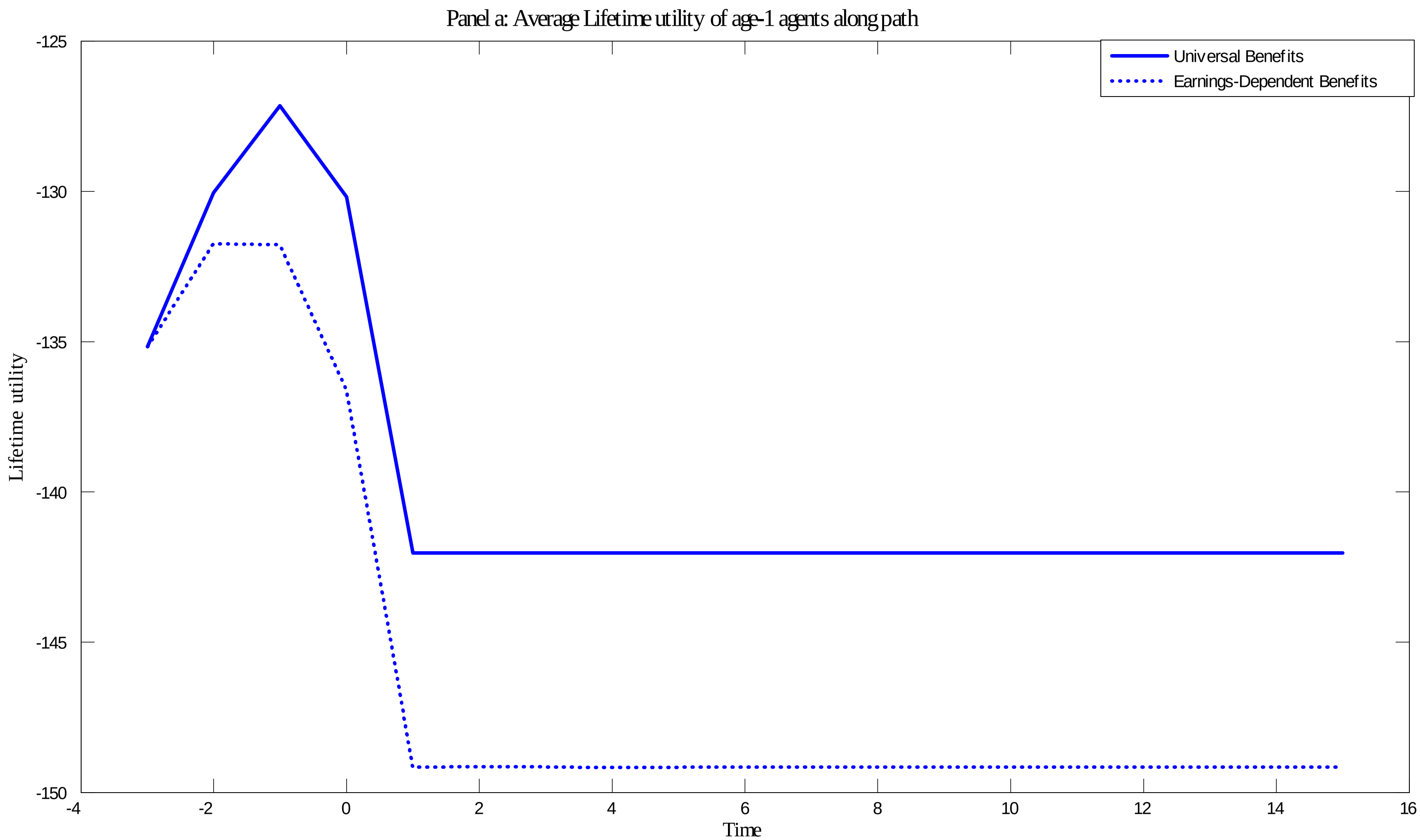


Figure 7: Average Lifetime utility along partial equilibrium path for comparable social security systems

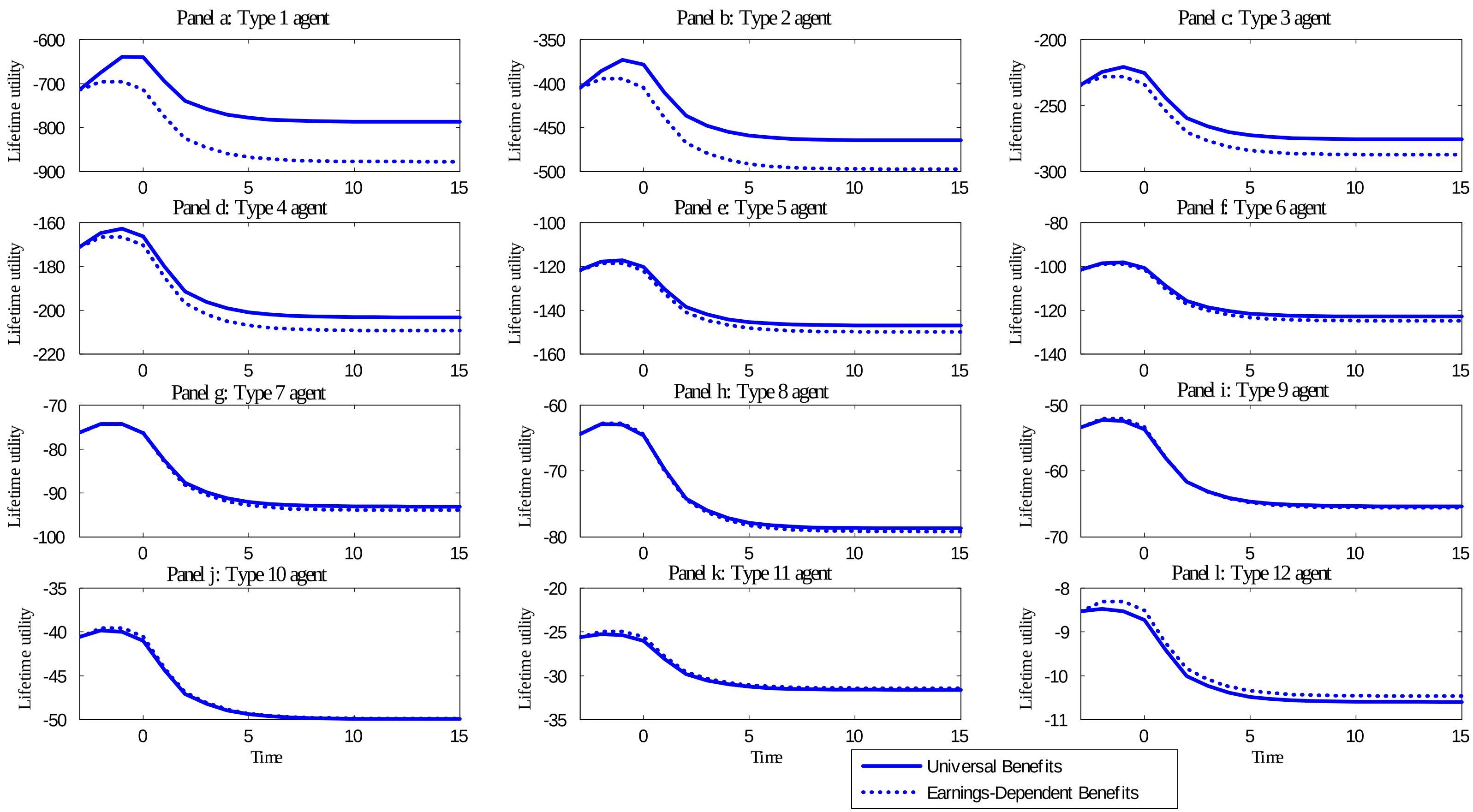


Figure 8: Lifetime utility of different agent types along general equilibrium path for comparable social security systems

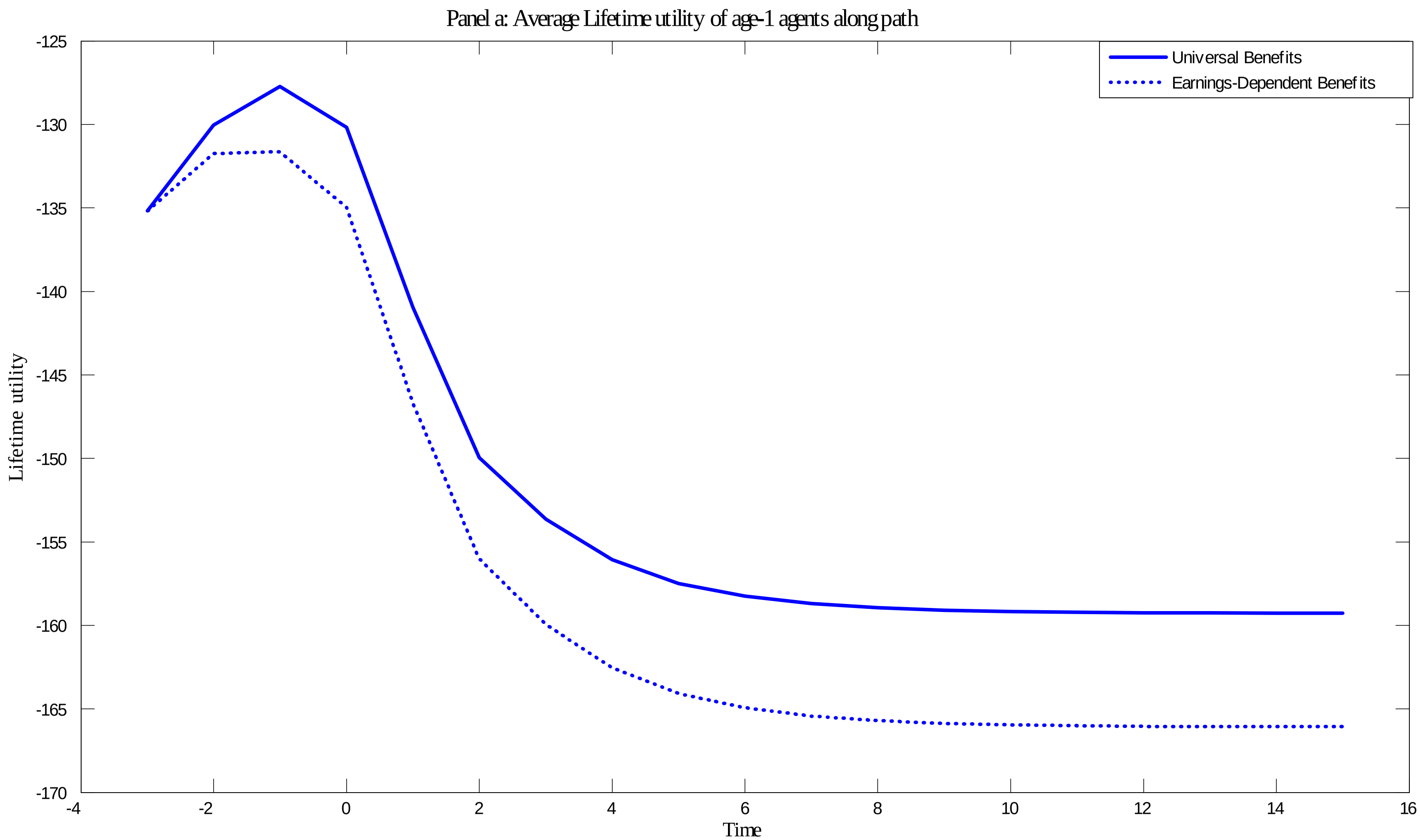


Figure 9: Average Lifetime utility along general equilibrium path for comparable social security systems

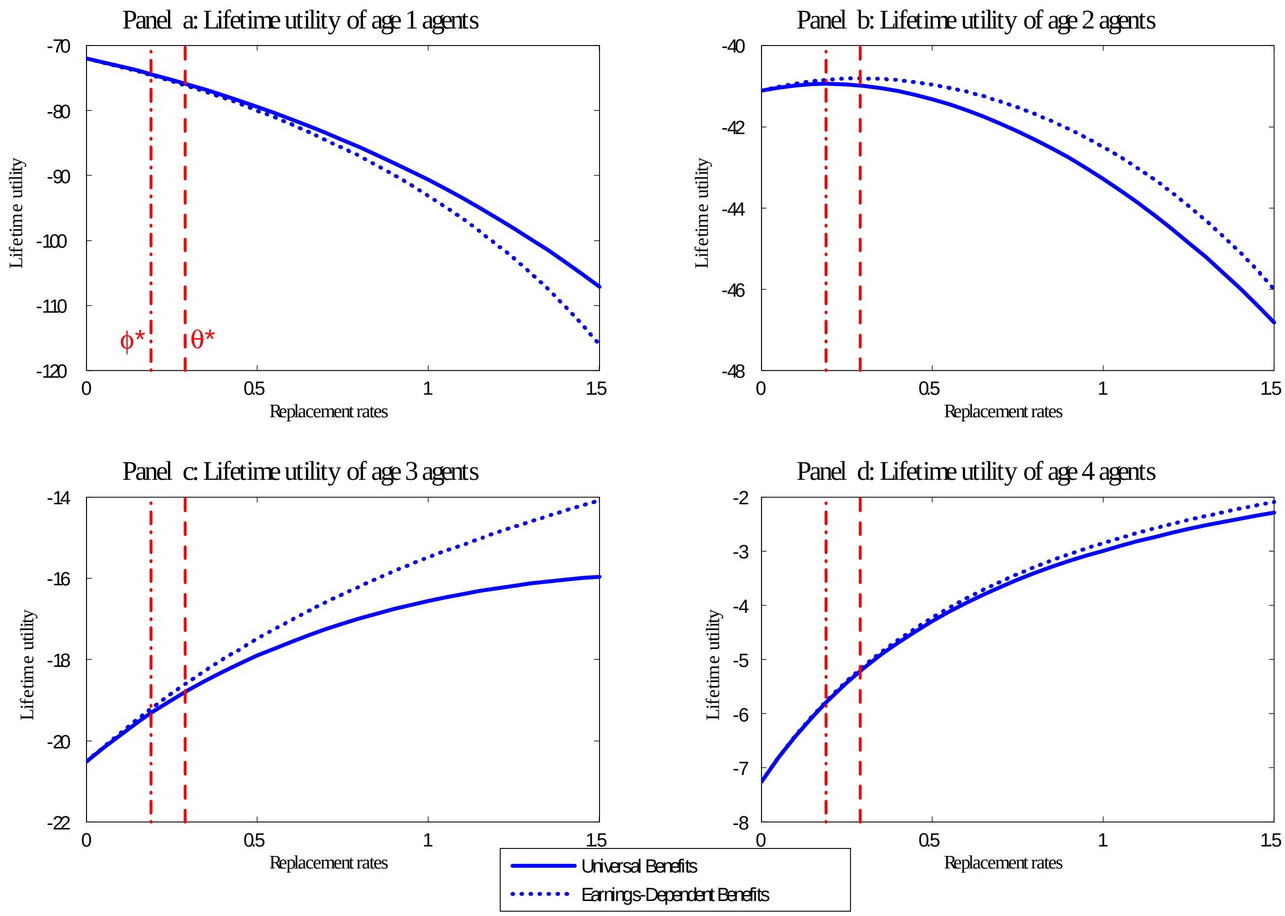


Figure 10: Lifetime utilities of period 1 agents for different values of the replacement rates

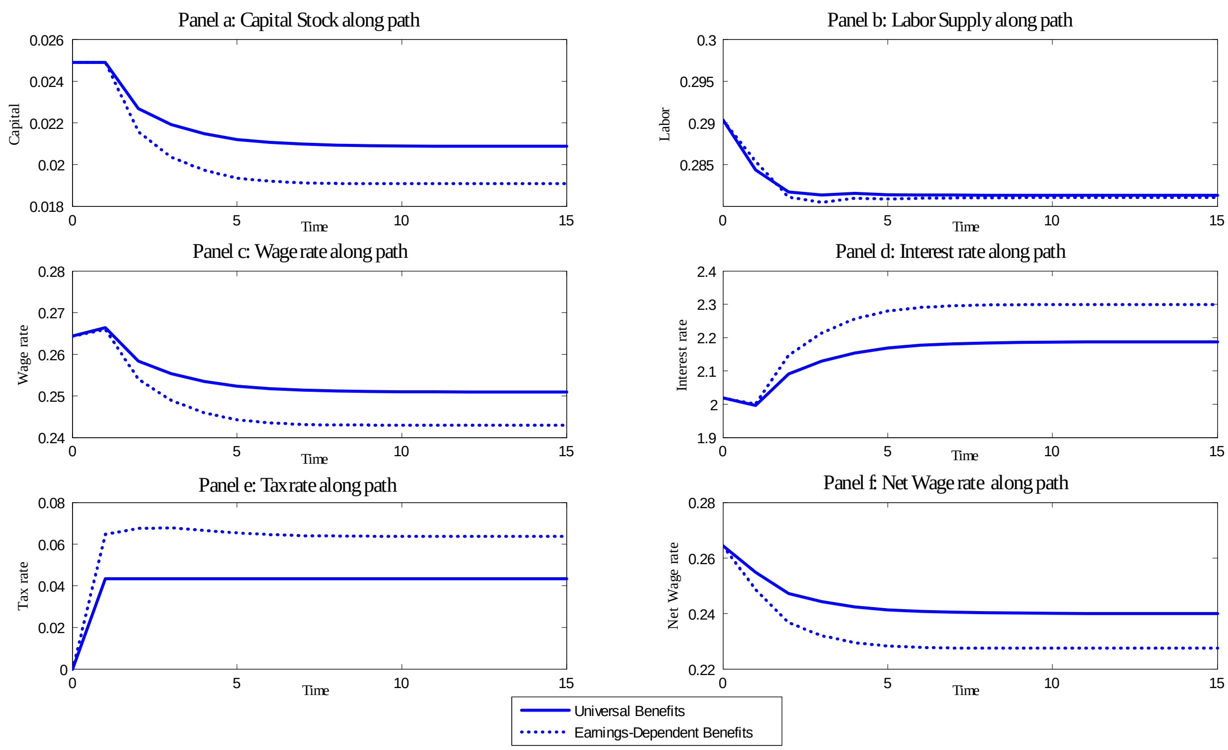


Figure 11: Variables along equilibrium path for equilibrium values of the replacement rates

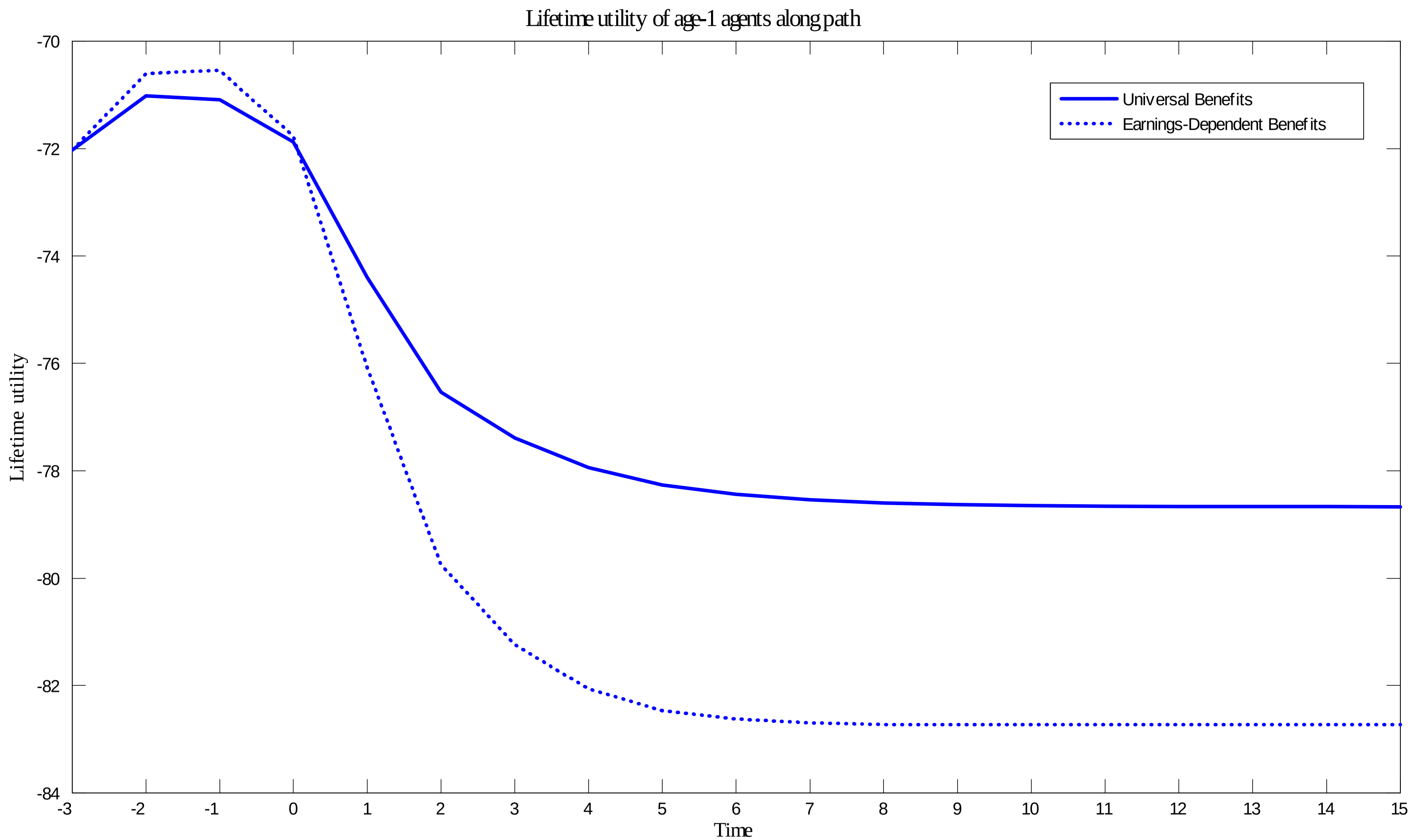


Figure 12: Lifetime utility along equilibrium path for equilibrium values of the replacement rates

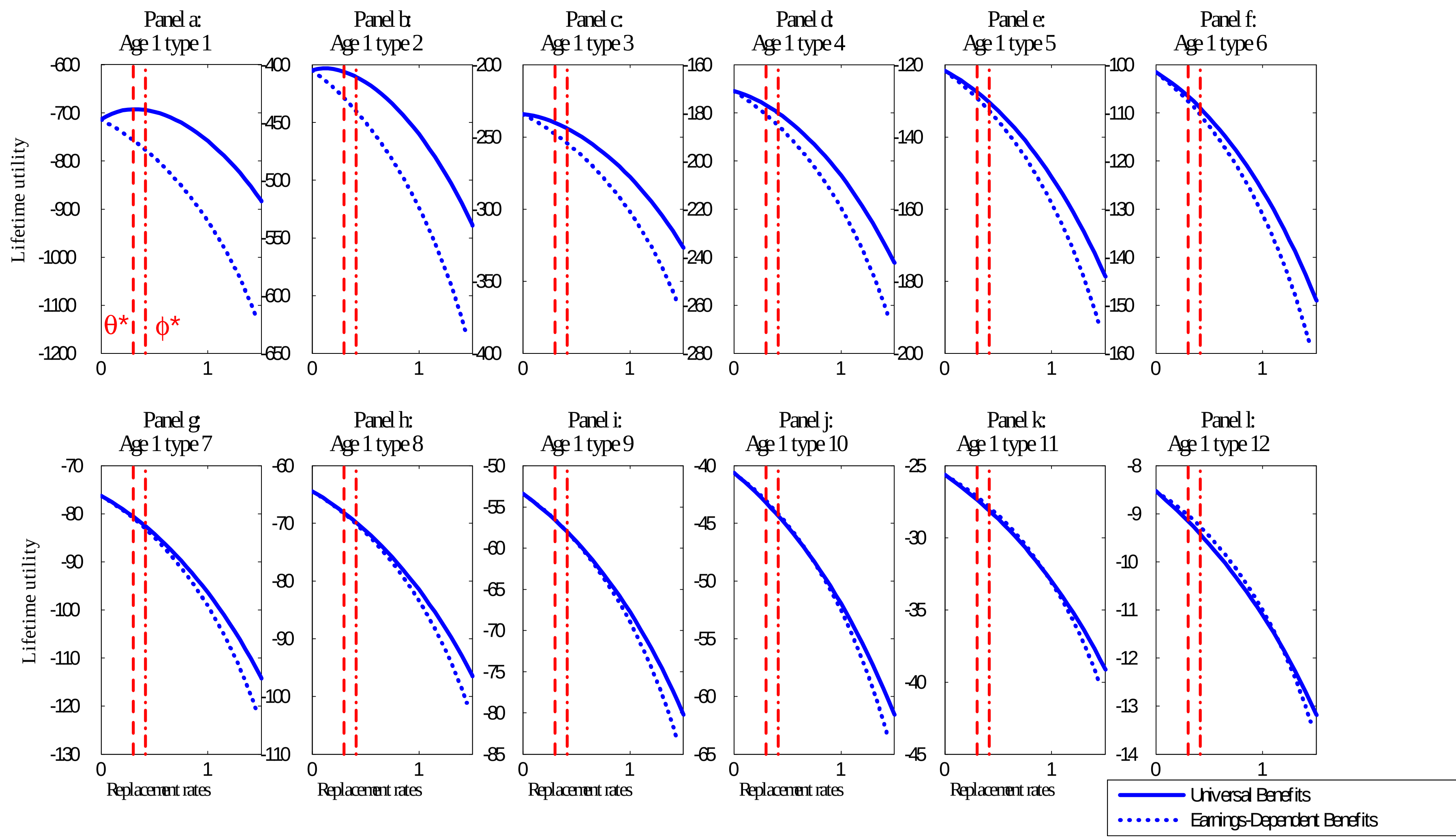


Figure 13: Lifetime utility of age-1 agents along equilibrium path for different values of the replacement rates

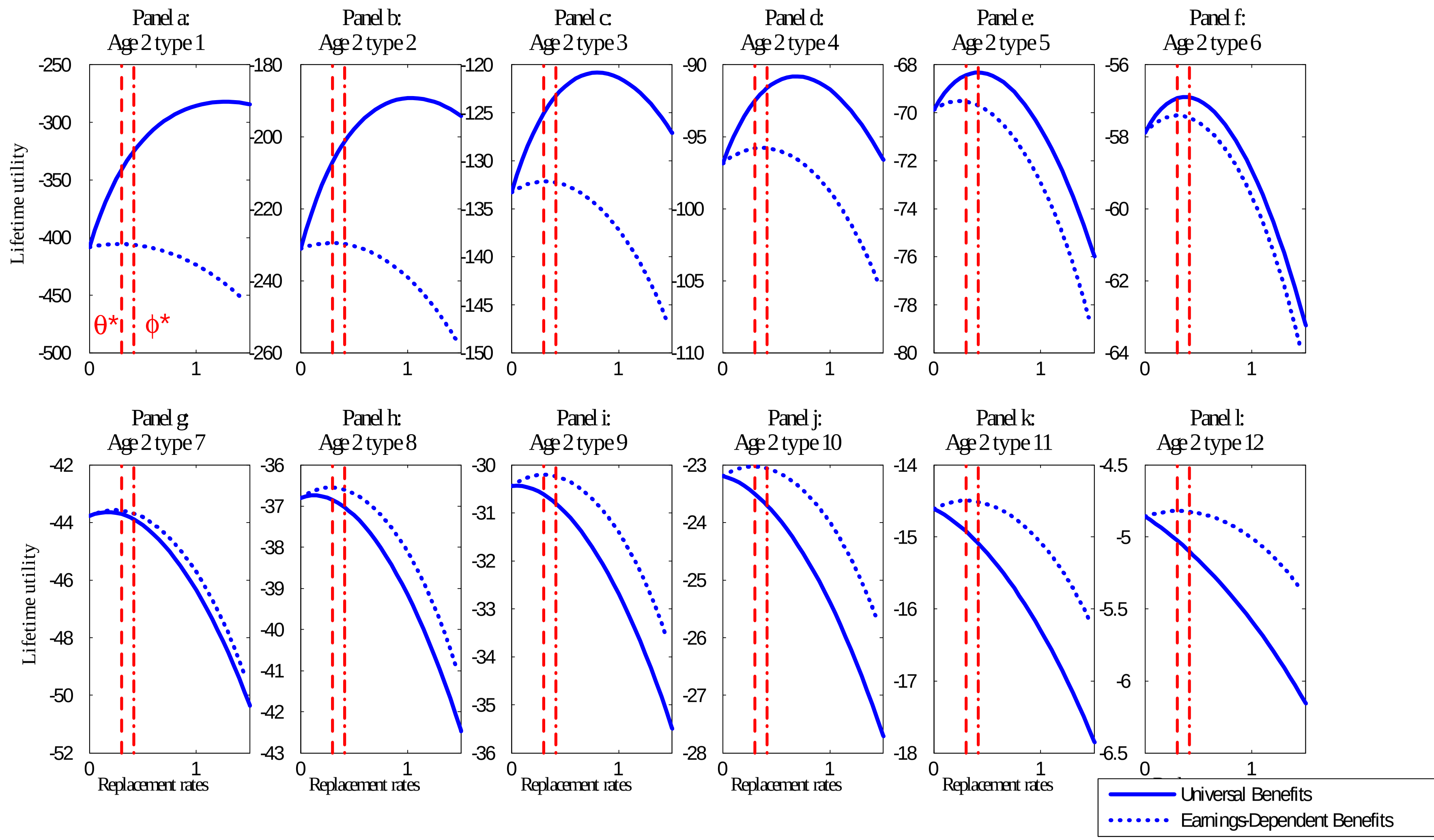


Figure 14: Lifetime utility of age-2 agents along equilibrium path for different values of the replacement rates

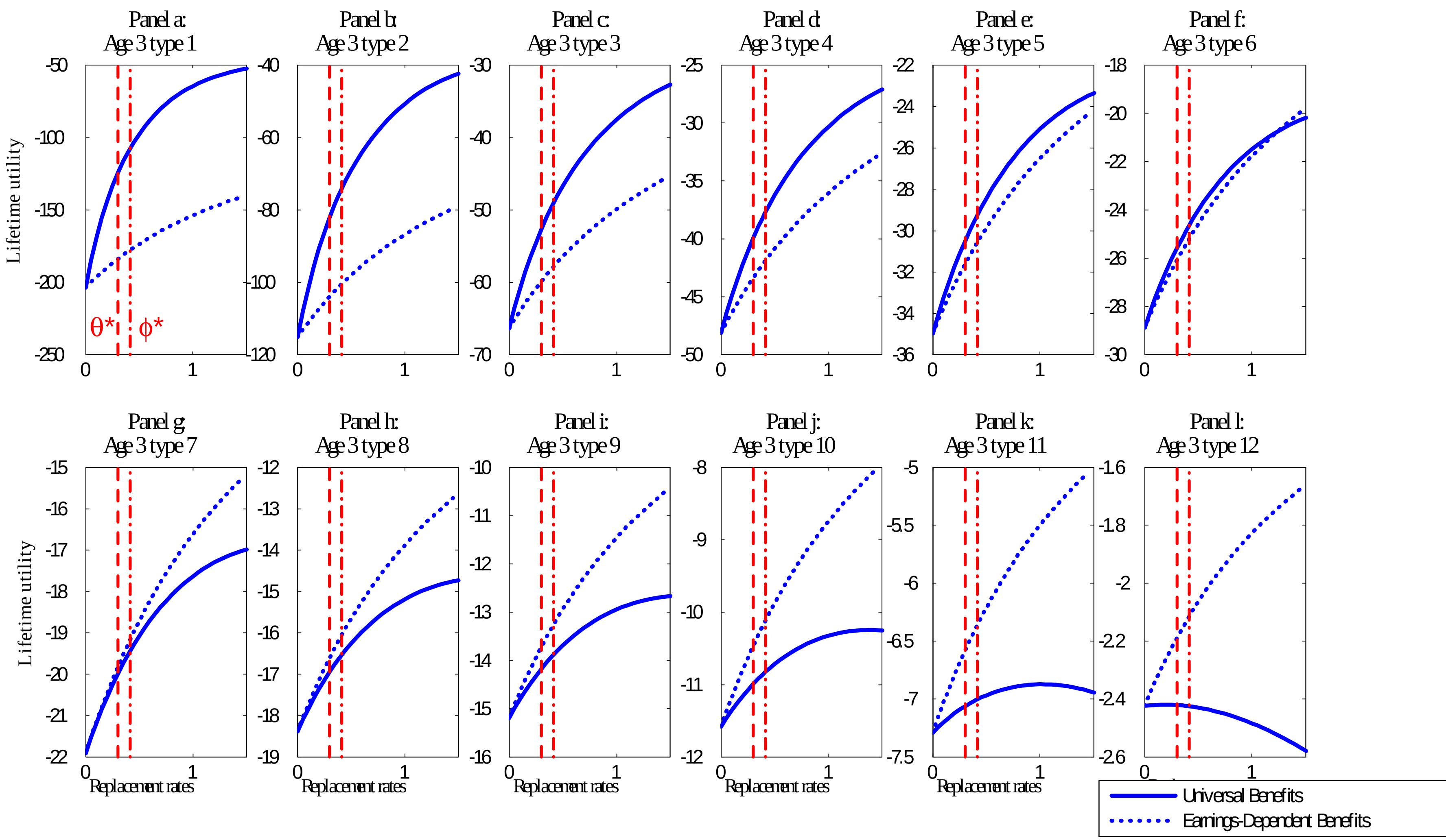


Figure 15: Lifetime utility of age-3 agents along equilibrium path for different values of the replacement rates

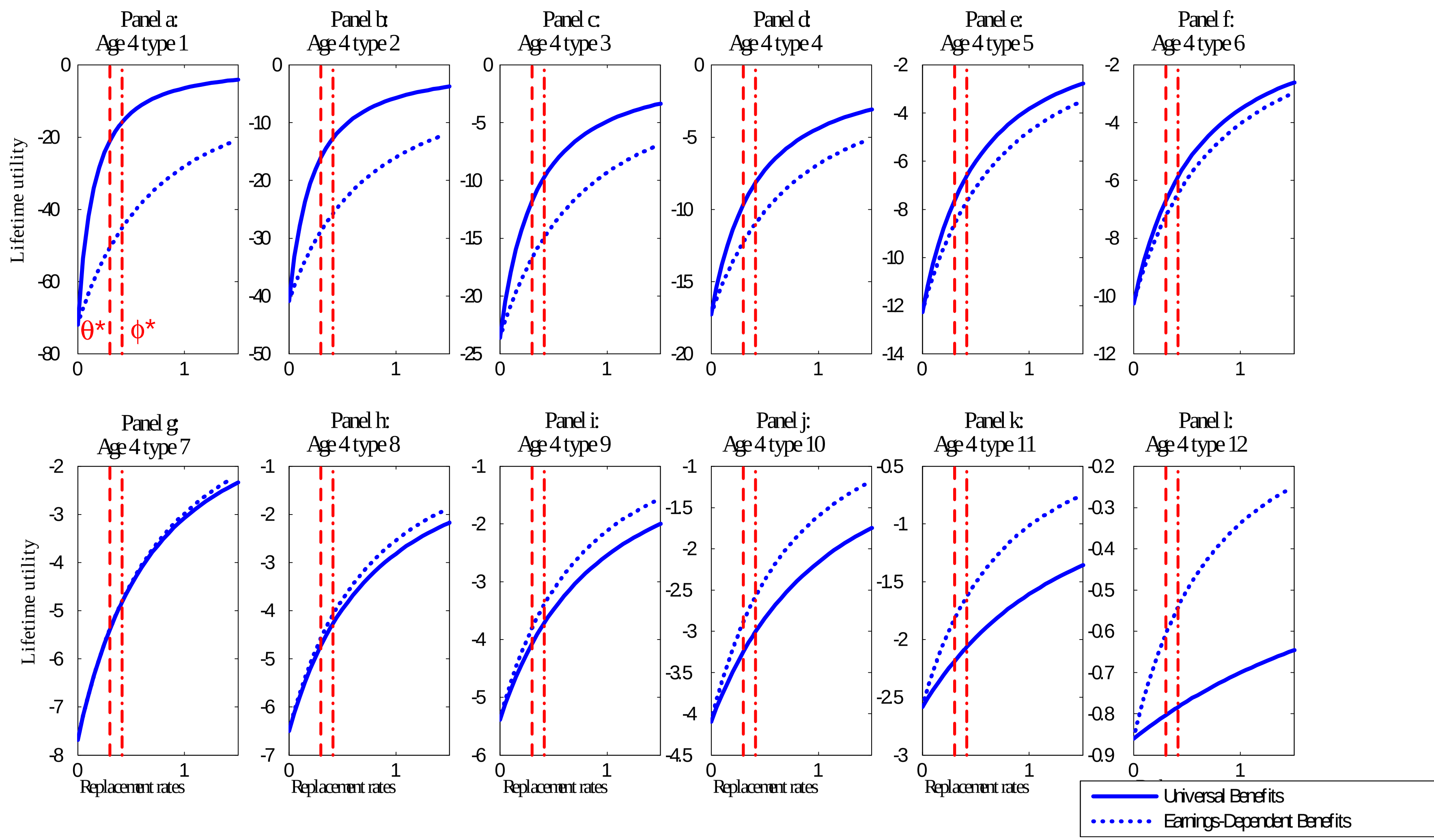


Figure 16: Lifetime utility of age-4 agents along equilibrium path for different values of the replacement rates

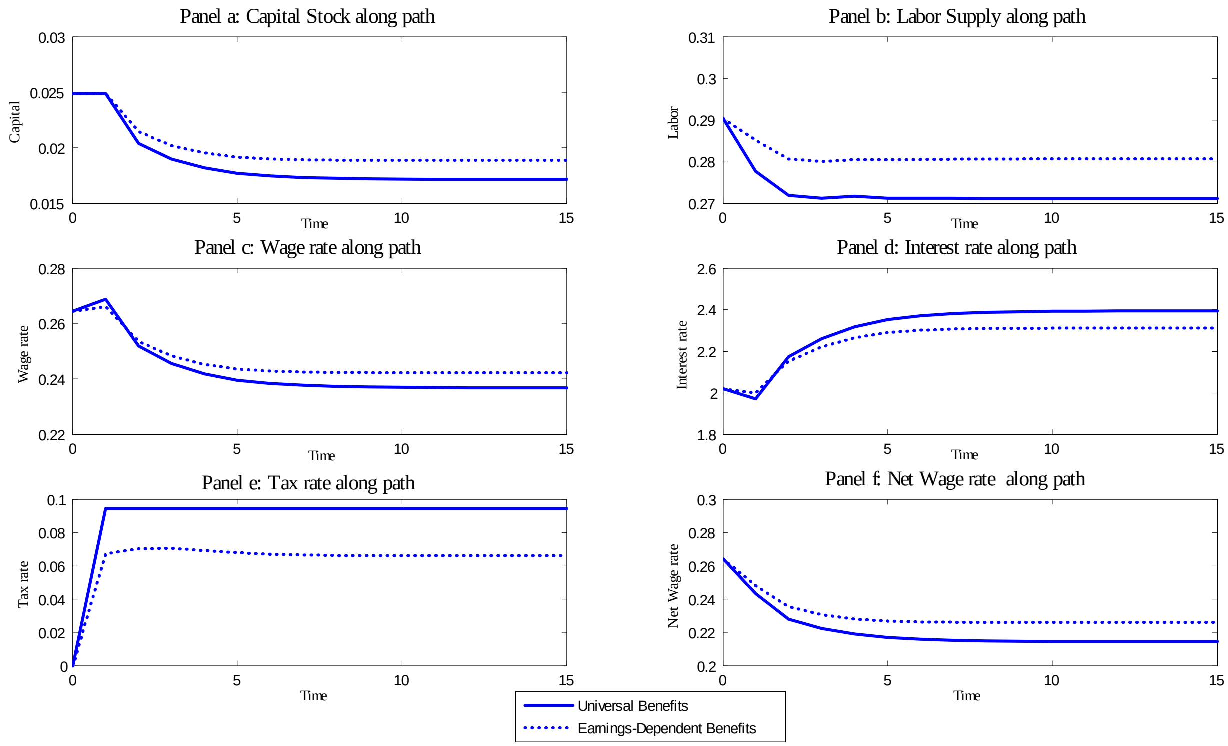


Figure 17: Variables along equilibrium path for equilibrium values of the replacement rates

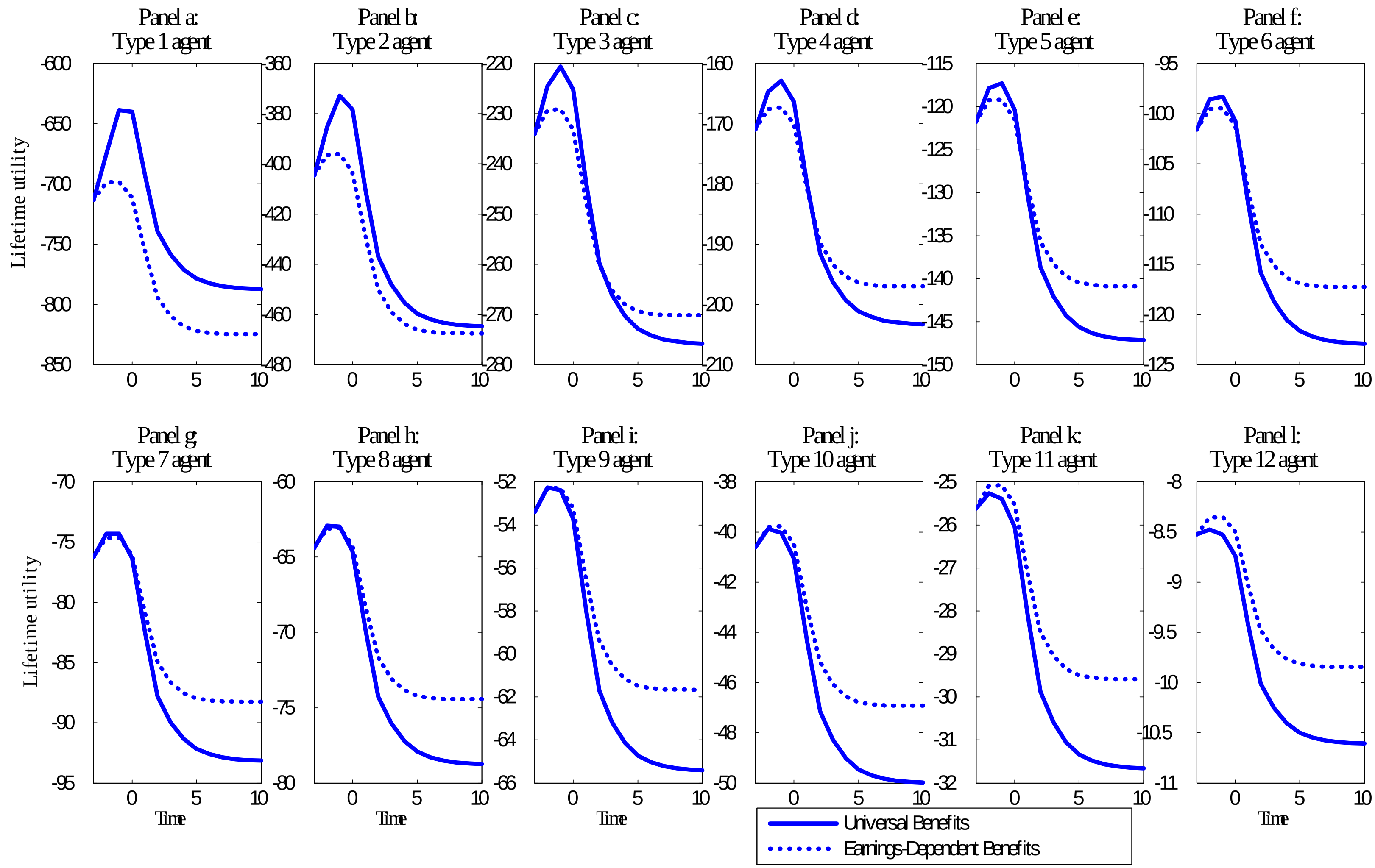


Figure 18: Lifetime utility of different agent types along equilibrium path for equilibrium values of the replacement rates

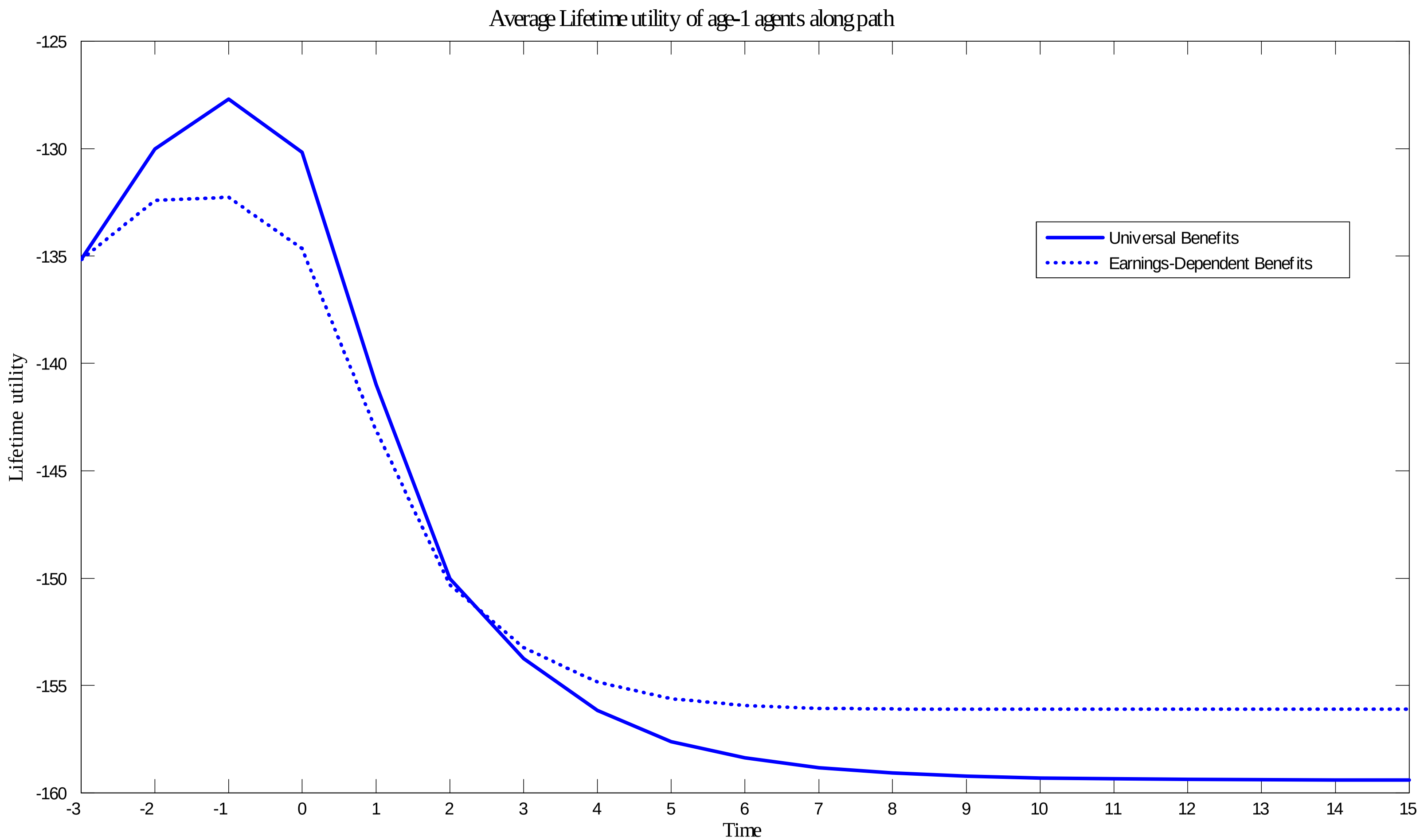


Figure 19: Average lifetime utility along equilibrium path for equilibrium values of the replacement rates

# B Solution Algorithm

This appendix describes the procedure used to compute the equilibria described in the paper.

The procedure involves solving for the competitive equilibrium path for a given level of the policy parameters.

I then evaluate how agents fare under different sequences of the policy parameters and then find the level of the policy parameter that maximizes the utility of the first period median voter.

## B.1 The Competitive Equilibrium Path

The equilibrium paths are computed using the following algorithm:

1. I start by computing the initial state of the economy $(A_0, E_0)$.
2. I then set the set of replacement rates, $\Theta$, which will remain constant along the equilibrium path.
3. I make an initial guess for the equilibrium path for the state of the economy and for the labor supply $\{A, E, L\}^0$. Given this path, the levels of all the remaining endogenous variables along the path can be determined, including aggregate capital stock, $\{K\}^0$, aggregate labor supply, factor prices, social security benefits, taxes, and $\xi_{ijt}$ (see equation 18).
4. I can then use the optimality conditions for problem (10) to calculate the decisions of agents along the path, $c_{i,j}, l_{i,j}, a'_{i+1,j}, e'_{i+1,j}$.
5. Once we get to the individual decisions along the path, we can compute the implied path for state of the economy and for the labor supply $\{A, E, L\}^1$.
6. Finally, we compare the corresponding path for the aggregate capital stock, $\{K\}^1$ to the one obtained from the initial guess, $\{K\}^0$.
7. If the new path is significantly different from the initial path we update the initial guess in step 3 and repeat steps 3-7.
8. Otherwise, an equilibrium path has been found.

## B.2 The Implemented Social Security Tax Rate

We know describe how we use this procedure to determine the level of the replacement rate that will be implemented in the initial period.

1. I start by computing the initial state of the economy $(A_0, E_0)$.
    - I define a grid for the replacement rate that is being voted on.

- Then, I compute the competitive equilibrium path $\{A, E, L\}$ corresponding to each replacement rate (see the previous section of the Appendix).
- I obtain the lifetime utility levels of agents living in the initial period for each level of the replacement rate: $V_i(x_i, X; \Theta)$
- I check for single-peakedness of preferences and locate the median voter.

2. Once the median voter is located I search for the level of the replacement rate that maximizes her lifetime utility, around the peak found in the initial grid.

    - Notice that in order to do this, I need to compute the competitive equilibrium path for each level of the replacement rate.