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Capital income taxation and reforming social security in an OLG economy ☆

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ABSTRACT

Reforming social security can improve efficiency and reduce future fiscal strain, emerging with the rising old-age longevity. However, it generates transitory fiscal cost and reduces insurance against income risk, which is embedded in current US social security. We show that if that transitory fiscal cost is financed through increased capital income taxation, the efficiency gains can be amplified sufficiently to outweigh the costs of the reform. Our result stems from the Ramsey rule: rising old-age longevity makes capital less responsive to tax hikes. We reconcile our results with the existing literature. Our results are of policy relevance for many advanced economies which currently feature redistributive and increasingly unbalanced social security due to rising old-age longevity.

1. Introduction and motivation

We study using the capital income tax as a way to finance social security reform in the context of rising longevity. Longer life expectancy after retirement generates deficits in the current social security in the US, which under status quo is expected to reach 24% of its scheduled payouts by 2034 (SSA, 2021). These demographic developments trigger policy debates about replacing the current defined benefit system (redistributive and financed on a pay-as-you-go basis) with a defined contribution system, partially

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or fully funded (referred to as social security privatization, see Diamond, 1993; Diamond et al., 2016).[1] A transitory fiscal gap and reduced social insurance are two key challenges to such a reform. The fiscal gap emerges because contributions (partly) go into the funded pillar rather than to finance current pension benefits. With rising old-age longevity, the reform avoids a permanent future tax increase under the status quo but at the expense of a transitory tax hike. Reduced social insurance arises because the reformed system no longer redistributes: it links benefits directly to individual contributions. Reduced insurance lowers welfare.

This particular variant of the equity-efficiency trade-off has been studied extensively in the literature with three solid findings. First, the reform improves labor supply incentives. By strengthening the links between pension system benefits and contributions, it reduces the effective tax on labor income (e.g., Nishiyama and Smetters, 2007; Harenberg and Ludwig, 2019). Second, the funded pillar further improves labor supply incentives (e.g., Caliendo et al., 2014; McGrattan and Prescott, 2017; Shourideh and Hosseini, 2019). Giving up contemporaneous consumption in the form of social security contributions to the funded pillar earns an interest rate r rather than the indexation rate of payroll growth g in the PAYG pillar; typically $r > g$. Third, insurance against idiosyncratic income shocks is reduced because with privatized pension benefits, the shocks from the working period propagate directly into the old ages without redistribution embedded in the current US social security. Therefore, there is less insurance against low-income (e.g., Nishiyama and Smetters, 2007; Harenberg and Ludwig, 2019). The current consensus in the literature is that the gains due to improved labor supply incentives do not outweigh the insurance loss (e.g. Davidoff et al., 2005; Nishiyama and Smetters, 2007; Fehr et al., 2008; Harenberg and Ludwig, 2019).[2]

Against these well-established results, we observe that while rising old-age longevity puts an obvious strain on social security balance, it comes with a silver lining: it motivates individuals to raise savings. First, expecting to live longer after retirement, individuals need to accumulate higher private wealth to smooth consumption over the life-cycle. This mechanism is permanent. Likewise, replacing defined benefit pensions with defined contribution pensions reduces the benefits received in every period of retirement, thus amplifying the need to raise retirement savings. This mechanism too is permanent. Furthermore, reducing insurance in social security motivates individuals to raise precautionary savings, also permanently. Thus, several mechanisms explain why individuals save more with reformed social security relative to the status quo. This lowers their responsiveness to transitory hikes in capital income tax, ushering room for the inverse elasticity rule (Ramsey, 1927). In the long run, the reform lowers fiscal strain: relative to the status quo, taxes can be reduced if social security is reformed. Summarizing, old-age longevity and features of the reformed social security make household saving decisions less responsive to transitory capital income tax hikes, whereas lower taxes amplify savings in the long run.

We take these observations to an overlapping generations model and study novel trade-offs between labor supply incentives, taxation, and insurance. Our model is calibrated to the US economy, and has the three key features of the earlier literature: two channels for improved labor incentives and reduced insurance against idiosyncratic income shocks. The current US system redistributes through progressive replacement rates, depending on AIME (Average Indexed Monthly Earnings): the replacement rate is high for low incomes (90%), and it declines step-wise (to 15%) for high incomes. This redistribution embedded in social security provides partial insurance against idiosyncratic income shocks.

We model a rise in longevity consistent with the data and the demographic projections for the US. If the US economy continues with current social security, the necessary fiscal adjustment is indeed large: to balance, an increase in contribution rates by roughly 20% (Braun and Joines, 2015) or an approx. 40% reduction in replacement rates (Fehr, 2000) will be needed. Such a substantial increase in taxes would have immediate welfare effects (e.g. Kotlikoff et al., 1999; Huggett and Ventura, 1999; Genakoplos et al., 2000).

In the initial steady state, the economy has a defined benefit system financed on a pay-as-you-go basis, reflecting the features of the US social security. We introduce an unanticipated social security reform consisting of three major changes: (i) benefits depend fully on individual contributions and redistribution within a birth cohort is removed; (ii) in addition to individual contributions benefits depend also on life expectancy at retirement, common within a birth cohort and rising for subsequent birth cohorts; (iii) part of the contributions goes into a funded pillar of the social security. This last feature generates a transitory gap in social security. We introduce capital income taxation as a fiscal closure for this economy.[3] We formalize the strength of capital reaction to changes in the taxation of capital income by analyzing the elasticity of capital in response to taxation. To pin down quantitatively the specific features, over a wide range of demographic and macroeconomic scenarios. We also consider variants of the reform without funding and without a rise in longevity. Across all those counterfactual simulations, we compare the taxing capital income to alternative fiscal closures.

The main result of our study is that with rising longevity, the privatization of social security with partial funding may yield aggregate welfare improvements. This result stems from both the way to finance the reform and the features of the reform. For the standard reform in the spirit of Nishiyama and Smetters (2007) we show that capital income taxation yields results superior to the previously used consumption taxation. Generally, capital income taxation amplifies the long-term efficiency gains of the reform. In contrast, previously used consumption taxation attenuates them. This result proves robust to many sensitivity checks. We isolate the role of reduced insurance from the aggregate welfare effect and show that in fact, it is relatively small.

[1] Partial funding signifies a system where part of the contributions are directed towards a funded pillar, and part of the contributions remain in the PAYG pillar. Some studies use this term to denote that the PAYG part is mandatory social security, and the rest becomes private voluntary savings (e.g. McGrattan and Prescott, 2017; Shourideh and Hosseini, 2019).

[2] McGrattan and Prescott (2017); Shourideh and Hosseini (2019) show that it is possible to remove social security in a Pareto-improving way.

[3] To the best of our knowledge, only Keuschnigg et al. (2012) consider capital income taxation. This is a policy report for The World Bank an capital income tax is a measure accompanying the reform rather than a way to fiscally close the economy.

We reconcile our results with the earlier literature by quantifying in a coherent framework the welfare implications of employing a variety of fiscal closures. Due to rising longevity, both the status quo of the current US social security and the policy reforms necessitate fiscal adjustments: change in tax rates, contribution rates, or pension benefits (Feldstein et al., 2016; Diamond et al., 2016) We take fiscal closures studied in the past, which include adjustments within social security (parametric adjustments in the contribution and replacement rates) and outside social security (consumption tax). Indeed, choosing a particular fiscal instrument generates welfare effects on its own. This observation did not receive much attention in the earlier literature, though studies differ substantially in how the reforms are financed on the fiscal side. For example, Auerbach and Kotlikoff (1987) adjust the contribution rates, whereas Fehr et al. (2008); Keuschnigg et al. (2012); Fehr and Kindermann (2010); Ludwig and Vogel (2010) interchangeably employ labor tax and contribution rate adjustments. By contrast, Nishiyama and Smetters (2007) use a consumption tax and Okamoto (2005) uses a lump-sum tax.[4]

The significance of the Ramsey (1927) rule in the context of overlapping generations has been recognized in the literature, though not in the context of social security reform. Rich literature shows that optimal capital income taxes ought to be positive in an economy, where individuals have intrinsic motives to save, such as an overlapping generations economy (e.g. Imrohoroglu, 1998; Garriga, 2001; Conesa et al., 2009; Fehr and Kindermann, 2015; Krueger et al., 2021). While this was not explicitly studied before, the key feature of the OLG models is that individuals have to save in order to sustain their consumption during retirement. Thus, intuitively, longevity amplifies some of the mechanisms proposed in the literature, hinting that the optimal capital income tax may be increasing in longevity. Diamond and Spinnewijn (2011); Golosov et al. (2013), as well as Straub and Werning (2020), show that taxing capital income can be particularly advantageous, as capital is a state variable (a stock) and thus over shorter horizons its response to unanticipated tax hikes is negligible.

The literature also provides reasons why taxing capital income can help mitigate the adverse welfare effects of reduced insurance, even absent retirement motives. Domeij and Heathcote (2004) point out that linear capital income taxation combined with non-taxed capital pillar introduces progression. It is especially relevant when capital income taxation is compared with, e.g., consumption tax, which is typically regressive. Conesa et al. (2009) study optimal labor income and capital income tax in an economy similar to ours. They find relatively high optimal capital income tax to complement redistribution in labor income taxation. Findeisen and Sachs (2017) show that if labor income tax depends on contemporaneous labor income (rather than lifetime income), positive capital income tax serves to complement the system, making it possible to reach optimal levels of redistribution. Krueger et al. (2021) show that positive capital income taxation can mitigate excessive precautionary savings in response to idiosyncratic income shocks. While in this study we do not seek the optimal level of taxation, the transitory hike in the capital income tax rate implied endogenously in our model do not exceed far the levels implied by this literature. Notably, the transitory hikes in the reform are lower than the long run permanent increases in the *status quo*.

Our paper is structured as follows. The model is presented in section 2. Since the crux of the mechanisms studied in this paper relates to changes along the transition path, we move directly to a full general equilibrium setup. Section 3 describes the calibration and the simulation scenarios in detail. We present the results in section 5, together with sensitivity checks. The final section concludes, emphasizing the contribution to the literature and the policy recommendations emerging from this study.

2. The model

We build a general equilibrium overlapping generations model with idiosyncratic income shocks (*ex-post* within cohort heterogeneity). In the baseline scenario, an economy follows the current US social security (pay-as-you-go defined benefit with redistribution through AIME and OADSI). We denote this system interchangeably as the baseline or status quo. In such an economy, rising longevity deteriorates fiscal balance in social security.

2.1. Producers and consumers

Production Using capital K and labor L, the economy produces a composite consumption good. Production function takes a standard Cobb-Douglas form $Y_t = K_t^{\alpha}(z_t L_t)^{1-\alpha}$ with labor augmenting exogenous technological progress, $z_{t+1}/z_t = 1 + \gamma_t$. Capital depreciates at the rate of d. Standard maximization problem of the firm yields the return on capital r_t and real wage per unit of labor w_t

$$r_t = \alpha K_t^{\alpha-1}(z_t L_t)^{1-\alpha} - d \quad \text{and} \quad w_t = (1-\alpha)K_t^{\alpha} z_t^{1-\alpha} L_t^{-\alpha}, \tag{1}$$

Population dynamics Agents live for $j = 1, 2..., J$ periods and are heterogeneous with respect to age j, one period corresponds to five years. Agents are born at the age of $j = 1$. Consumers face age- and time-specific survival rates $\pi_{j,t,t+i}$, which is a conditional probability in period t of surviving to age $j + i$. At all points in time, consumers who survive until the age of $J = 16$ die with certitude. The share of the population surviving until older age is increasing to reflect rising longevity. We denote the size of the age cohort j in time t as $N_{j,t}$.

[4] Table A summarizes examples of the studies devoted to parametric and systemic social security reforms, synthesizing the diversity in the fiscal closures used. Reportedly, this literature focuses on fundamental questions – e.g., fiscal stability of the social security, welfare, political support – leaving aside "technicalities" such as fiscal closures (Lindbeck and Persson, 2003; Fehr, 2009).

Intra-cohort heterogeneity Each agent is born with identical labor productivity $\omega_{1,t} = 1$, for all t. However, productivity evolves over lifetime according to $\omega_{j,t} = e^{\eta_{j,t}}$, where a random component $\eta_{j,t}$ follows an AR(1) process with persistence parameter ϱ and $\varepsilon_{j,t} \sim \mathbf{N}(0, \sigma^2)$.

$$\eta_{j,t} = \varrho\eta_{j-1,t-1} + \varepsilon_{j,t} \tag{2}$$

We approximate this process above by a first-order Markov chain with a transition matrix $\Pi(\eta_{j,t}|\eta_{j-1,t-1})$.

Budget constraint Working age agents earn gross labor income $\omega_{j,t}w_t l_{j,t}$, where w_t is the real wage per unit of labor, $l_{j,t}$ denotes labor supply and $\omega_{j,t}$ is an idiosyncratic component of labor productivity. Labor income is subject to social security contribution τ_t and progressive labor income tax with the elasticity of post-tax to pre-tax income equal $1 - \lambda$ and average tax rates determined by τ_l. Note that social security contributions are exempt from labor taxation. Labor income tax base $y_{j,t}$ of agent at age j at the time t is given by: $y_{j,t} = (1 - \tau_t)w_t\omega_{j,t}l_{j,t}$. Labor income taxes are given by $\mathcal{T}_t(y_{j,t}) = y_{j,t} - (1 - \tau_l)(y_{j,t}/\bar{y}_t)^{1-\lambda}\bar{y}_t$ (see Benabou, 2002), where $\bar{y}_t$ denotes the average labor income in period t. This formulation gives rise to the following disposable labor income formula $\tilde{y}_{j,t} = (1 - \tau_l)y_{j,t}^{1-\lambda}\bar{y}_t^{\lambda}$.

The retirement age, $\bar{J}_t$, is exogenously given, possibly time-varying. Individuals past the retirement age receive pension benefits $b_{j,t}$.[5] Moreover, they receive the after-tax capital gains $(1 - \tau_{k,t})r_t a_{j,t}$ (with $\tau_{k,t}$ denoting capital income tax rate, r_t the interest rate and $a_{j,t}$ denoting assets held at age j). For brevity, denote $\tilde{r}_t = (1 - \tau_{k,t})r_t$. Agents have no bequest motive, but since survival rates $\pi_{j,t,t+i}$ are lower than one, in each period t certain fraction of cohort j leaves unintended bequests, which are distributed within the birth cohort, $\Gamma_{j,t}$.[6] Income is used to purchase consumption goods $\tilde{c}_{j,t} = (1 + \tau_{c,t})c_{j,t}$ (with $\tau_{c,t}$ denoting tax on consumption) and to accumulate assets $a_{j+1,t+1}$.

Assets markets are incomplete; only assets with risk-free interest rate r_t are available, and asset holdings cannot be negative. Hence, the budget constraint is given by the following formula:

$$a_{j+1,t+1} + \tilde{c}_{j,t} = y_{j,t} - \mathcal{T}_t(y_{j,t}) + b_{j,t} + (1 + \tilde{r}_t)a_{j,t} + \Gamma_{j,t}, \text{ with } a_{j,t} \geqslant 0. \tag{3}$$

Status quo pensions In the baseline, we replicate the main features of the current U.S. social security design: average index of monthly wages accumulation (AIME) and cap imposed by Old-Age, Survivors, and Disability Insurance (OASDI).[7] For convenience denote payroll growth by $\gamma_t = \frac{w_t L_t}{w_{t-1}L_{t-1}} - 1$. Since the production function has the Cobb-Douglas form, the payroll growth rate equals the exogenous technological progress growth rate. We denote AIME accumulation by $f_{j,t}^A$. AIME is implemented as follows:

$$f_{j+1,t+1}^A = \frac{1}{j}\left((j-1)\cdot f_{j,t}^A \cdot (1+\gamma_t) + \min\{\omega_{j,t}w_t l_{j,t}, cap_t\}\right), \tag{4}$$

where cap_t denotes the OASDI cap. To replicate the progressive nature of the replacement rate, we rely on bend points $(F_{1,t}, F_{2,t})$ expressed as a ratio to average earnings. We then define the replacement rate $\rho_{\bar{J}_t,t}$ to be consistent with:

$$\rho_{\bar{J}_t,t} = 0.9\cdot\min\{1, \frac{F_{1,t}}{f_{\bar{J}_t,t}^A}\} + 0.32\cdot\min\{1 - \frac{F_{1,t}}{f_{\bar{J}_t,t}^A}, \frac{F_{2,t}}{f_{\bar{J}_t,t}^A}\} + 0.15\max\cdot(1 - \frac{F_{2,t}}{f_{\bar{J}_t,t}^A}, 0). \tag{5}$$

The actual value of the old age pension benefit for a cohort retiring in period t is given by

$$b_{\bar{J}_t,t}^A = \rho_m\rho_{\bar{J}_t,t}\cdot f_{\bar{J}_t,t}^A \quad \text{and} \quad b_{j,t}^A = (1+\gamma_t)b_{j-1,t-1}^A \qquad \forall j > \bar{J}_t, \tag{6}$$

where ρ_m is a scaling factor to be defined later.

Consumer problem An individual state of each agent $s_{j,t} = (a_{j,t}, \eta_{j,t}, f_{j,t}^A) \in \Omega_t$ consists of the level of private assets $a_{j,t}$, individual productivity determined by $\eta_{j,t}$, and pension wealth $f_{j,t}^A$. Let $\mathbb{P}_{j,t}$ denote the probability measure over the state space consistent with transition probabilities $\Pi(\eta_{j,t}|\eta_{j-1,t-1})$ and policy functions. An agent enters the economy with no assets ($a_{1,t} = 0$), and the agent at the state $s_{j,t}$ maximizes the expected value of the lifetime utility. The discount factor is denoted by δ. We define the optimization problem of the consumer in a recursive form:

$$V_{j,t}(s_{j,t}) = \max_{c_{j,t}, l_{j,t}, a_{j+1,t+1}} u(c_{j,t}, l_{j,t}) + \delta\pi_{j,t,t+1}\mathbf{E}\big(V(s_{j+1,t+1}) \mid s_{j,t}\big) \tag{7}$$

[5] Note that later in text $b_{j,t}$ is characterized by superscripts. In the baseline social security has $b_{j,t} = b_{j,t}^A$, whereas in the reform scenarios it is $b_{j,t} = b_{j,t}^I + b_{j,t}^{II}$. Analogously, the following notation applies two pension wealth: $f_{j,t} = f_{j,t}^A$ in baseline scenario, $f_{j,t} = f_{j,t}^I$ in reform scenario without funding, and $f_{j,t} = f_{j,t}^I + f_{j,t}^{II}$ in reform scenario with funding. Without loss of generality, there is no income tax on pension benefits.

[6] Bequests further increase the motivation to accumulate assets (De Nardi and Yang, 2014), which would amplify the mechanisms described in our paper.

[7] We compute AIME based on the whole working period rather than 35 years with the highest earnings, as it would be redundant in a setup with 5-year periods. Our implementation of the contemporaneous U.S. social security is in line with the earlier literature (e.g. Nishiyama and Smetters, 2007; McGrattan and Prescott, 2017).

subject to the budget constraint given by equation (3), the evolution of the productivity process given by equation (2), and pension wealth accumulation given by (4)-(6). The total time endowment is normalized to one. The instantaneous utility is given by:

$$u(c_{j,t}, l_{j,t}) = \frac{1}{1-\theta}\left(c_{j,t}^{\phi}(1-l_{j,t})^{1-\phi}\right)^{1-\theta}, \tag{8}$$

with ϕ and θ determining leisure and risk preferences, respectively.

Social security The social security system uses contributions to finance old-age pensions. The deficit of social security is denoted as X_t (negative in the case of surplus) and is financed by the general government.

The budget constraint of social security is given by

$$\sum_{j=\bar{J}_t}^{J} N_{j,t} \int_{\Omega} b_{j,t}^{A}(s_{j,t}) d\mathbb{P}_{j,t} = \tau_t w_t L_t + X_t. \tag{9}$$

Note that while this system is redistributive (the effective pensions are disproportionally high for low-income individuals and disproportionally low for high-income individuals), it is not the maximal insurance, which would be achieved with equal benefits to all agents within a cohort.

The general government There are three types of taxes: labor income tax, capital income tax, and consumption tax. There are no lump sum taxes, therefore they are distortionary. The labor income tax is progressive.

Tax revenue or change in public debt D_t is used to finance spending on public goods and services G_t, balance social security, and service debt $r_t D_t$, with $\Delta D_{t+1} \equiv D_{t+1} - D_t$. The general government budget constraint follows

$$G_t + X_t + r_t D_t = T_t + \Delta D_{t+1}, \tag{10}$$

$$\text{where } T_t = \sum_{j=1}^{\bar{J}_t - 1} N_{j,t} \int_{\Omega} \mathcal{T}_t\big(y_{j,t}(s_{j,t})\big) d\mathbb{P}_{j,t} + \tau_{k,t} r_t A_t + \tau_{c,t} C_t,$$

and C_t and A_t denote aggregate consumption and aggregate assets, respectively.

2.2. Determining endogenous tax rates: fiscal closures

In this paper, we allow **capital income taxation** to adjust as aging gives rise to the deficit in social security. It is our main fiscal closure. The tax rate adjusts immediately in each period to balance the government budget constraint system (including the social security system). The following formula gives it

$$\tau_{k,t} = \frac{G_t + X_t + r_t D_t - \tau_{c,1} C_t - \sum_{j=1}^{\bar{J}_t-1} N_{j,t} \int_{\Omega} \mathcal{T}\big(y_{j,t}(s_{j,t})\big) d\mathbb{P}_{j,t} - \Delta D_{t+1}}{r_t A_t}. \tag{11}$$

Alternatively, we use **consumption tax** to balance the government budget. In such a case, equation (11) is replaced with the following one

$$\tau_{c,t} = \frac{G_t + X_t + r_t D_t - \tau_{k,1} r_t A_t - \sum_{j=1}^{\bar{J}_t-1} N_{j,t} \int_{\Omega} \mathcal{T}\big(y_{j,t}(s_{j,t})\big) d\mathbb{P}_{j,t} - \Delta D_{t+1}}{C_t}. \tag{12}$$

2.3. Market clearing and equilibrium

In our economy, there are several market clearing conditions. Good market clearing requires

$$Y_t = C_t + K_{t+1} - (1-d)K_t + G_t; \tag{13}$$

where the following formula gives aggregate consumption

$$C_t = \textstyle\sum_{j=1}^{J} N_{j,t} \int_{\Omega} c_{j,t}(s_{j,t}) d\mathbb{P}_{j,t} \tag{14}$$

Recall that the state of an agent is denoted by $s_{j,t} = (a_{j,t}, \eta_{j,t}, f_{j,t}^{A}) \in \Omega$ and the probability measure describing the distribution of agents of age j in period t over the state space Ω as $\mathbb{P}_{j,t}$.

Labor market clearing implies

$$L_t = \textstyle\sum_{j=1}^{\bar{J}_t} N_{j,t} \int_{\Omega} \omega_{j,t}(s_{j,t}) l_{j,t}(s_{j,t}) d\mathbb{P}_{j,t} \tag{15}$$

and finally, asset market clearing is given by

$$K_{t+1} = A_{t+1} + D_{t+1} \tag{16}$$

Table 1
Calibrated parameters for the initial steady state.

Macroeconomic parameters		Calibration	Target	Value (source)	Model outcome
ϕ	preference for consumption	0.37	average hours	31% BEA(NIPA)	31%
θ	risk preference	2	literature		
δ	discounting rate	1.002^5	capital to output ratio	2.7	2.7
d	annual year depreciation rate	$1\text{-}(1\text{-}0.06)^5$	investment rate	20% BEA(NIPA)	20%
λ	labor tax progression	0.15	earnings distributions	Holter et al. (2019)	-
τ_l	labor tax	0.127*	revenue as % of GDP	9.2% OECD	9.2%
τ_c	consumption tax	0.041	revenue as % of GDP	2.8% OECD	2.8%
τ_k	capital tax	0.207	revenue as % of GDP	5.4% OECD	5.4%
ρ_m	pension scaling factor	1.003	benefits as % of GDP	5.2% BEA(NIPA)	5.2%
τ	social security contr.	0.078	pensions deficit as % GDP	0.00%	0.00%
ς	government expenditure	0.125**	.		12%
income shocks					
ρ_η	shock persistence	0.859	Borella et al. (2018)		
σ_η	shock variance	0.093	Borella et al. (2018)		

* Average labor tax is equal to 13%.
** Used as a closure in initial steady state, then kept constant in per capita terms.
Notes: Holter et al. (2019), who use the change in government distribution pre- and post-taxes and transfers to calibrate the extent of tax progression. Tax rates calibrations following Mendoza et al. (1994), see Table F.1.

where the following formula gives aggregate asset holding

$$A_{t+1} = \sum_{j=1}^{J} N_{j,t} \int_{\Omega} a_{j+1,t+1}(s_{j,t}) d\mathbb{P}_{j,t} \tag{17}$$

Definition 1. ***Competitive equilibrium.*** *A competitive equilibrium is a sequence of value functions* $\{(V_{j,t}(s_{j,t}))_{j=1}^{J}\}_{t=1}^{\infty}$, *policy functions* $\{(c_{j,t}(s_{j,t}), l_{j,t}(s_{j,t}), a_{j+1,t+1}(s_{j,t}))_{j=1}^{J}\}_{t=1}^{\infty}$, *prices* $\{r_t, w_t\}_{t=1}^{\infty}$, *government policies* $\{\tau_{c,t}, \mathcal{T}(y_{j,t}), \tau_{k,t}, D_{t+1}\}_{t=1}^{\infty}$, *social security system* $\{\tau, X_t, \rho\}_{t=1}^{\infty}$, *aggregate quantities* $\{L_t, A_t, K_t, C_t, Y_t\}_{t=1}^{\infty}$, *and a measure of households* $\mathbb{P}_{j,t}$ *such that:*

- ***consumer problem:*** *for each* j *and* t *the value function* $V_{j,t}(s_{j,t})$ *and the policy functions* $(c_{j,t}(s_{j,t}), l_{j,t}(s_{j,t}), a_{j+1,t+1}(s_{j,t}), f_{j+1,t+1}(s_{j,t}))$ *solve the Bellman equation (7) given prices and policies;*
- ***firm problem:*** *for each* t, *prices* (r_t, w_t) *satisfy equation (1);*
- ***government sector:*** *the government budget and the PAYG social security are balanced, i.e., equations (9) and (10) are satisfied;*
- ***markets clear****, i.e., equations (13)- (17)*
- ***probability measure:*** *for all* t *and for all* j, $\mathbb{P}_{j,t}$ *is consistent with the transition probabilities* $\Pi(\eta_{j,t}|\eta_{j-1,t-1})$ *and policy functions.*

3. Calibration and *status quo*

The model is calibrated to match the features of the U.S. economy. We use recent work by McGrattan and Prescott (2017) to guide the calibration of the macroeconomy, as our study shares many features of their approach. The model period corresponds to five years. Using microeconomic evidence and the general characteristics of the U.S. economy, we established reference values for preferences, life-cycle productivity patterns, taxes, technology growth rates, etc. Given these, the discount factor δ is set to match the initial steady state capital to output ratio 2.7, given the assumed $\alpha = 0.3$. Depreciation rate d is set to 5.6% per annum (25.8% for five-year periods). The implied aggregate investment rate is equal to 19.6%, and the interest rate of 6.2%. The calibration of the model parameters is summarized in Table 1.

Demographics The age $j = 1$ corresponds to 20 years of age in the data. Population evolution is based on the projection by The United Nations 2019 projection and the US Census. We use the number of 20-year-olds born at each period in time and mortality rates as input data. The projection period is 50 years for the population and 90 years for mortality rates. After periods covered by projection, we assume that mortality stabilizes and the annual population growth rate converges to 1.002, see Figure F.1 in Appendix F. In scenarios without longevity increase, we keep $\pi_{j,t}$ constant $\forall t$, but allow for population increase due to a larger size of subsequent birth cohorts.

Productivity growth (γ_t) The model specifies labor augmenting growth of technological progress γ.[8] The debate about the future of the US growth is ongoing (e.g. Fernald and Jones, 2014; Gordon, 2014). We assume steady technological progress at the current rate of 2% per annum, constant over the whole transition path. Note that although the technological progress is the same in baseline and reform scenarios, higher values of γ are beneficial for the PAYG systems. With stable technological progress, the main secular driver

8 In the steady state the per capita output growth rate overlaps with the technological progress.

of the changes in the interest rate is demographics. We introduce specifications with gradually declining technological progress as a robustness check.

Idiosyncratic productivity shock (η) The idiosyncratic component is specified as a first-order autoregressive process with autoregression $\bar{\varrho}_\eta = 0.97$ and variance $\bar{\sigma}_\eta = 0.021$, as it replicates the income dynamics observed in the US (Borella et al., 2018). In our model, each period corresponds to 5 years. Hence we recalculate input variables according to $\varrho_\eta = \bar{\varrho}_\eta{}^5 \approx 0.859$ and $\sigma^2_\eta = \bar{\sigma}^2_\eta \frac{1-\bar{\varrho}_\eta{}^{10}}{1-\bar{\varrho}^2_\eta} \approx 0.093$. The shocks are drawn from the same distribution as the agents' age. It is consistent with extensive evidence that, once birth cohort effects are accounted for, the age profiles remain flat for the productive ages between 30 years old and retirement (Skirbekk, 2004, 2008; Strittmatter et al., 2020).

Preferences We calibrate the preference for consumption parameter ϕ to match the observed share of hours worked in the economy, which is 33% on average. Given the utility function, Frisch elasticity in our setup depends effectively on $\hat{s}_{j,t} \in \hat{\Omega}$ and scenario. Hence the model features a distribution of Frisch elasticities. The discount factor δ was set at 1.007^5 to match the capital-output ratio equal to 2.7. With mortality, the effective discount rate is lower and varies with age and between subsequent birth cohorts. The risk preference parameter is set to $\theta = 2$. While this parametrization is standard in the macroeconomic literature, the precautionary motive plays a role in savings decisions. Section 6 presents the sensitivity analysis of our results to this parametrization.

Social security parameters Given the replacement rate defined in formula (5), we set the scaling factor (ρ_m) to match the 5.2% ratio of pensions to GDP in the initial steady state. The effective contribution rate τ is set so the social security deficit in the original baseline steady state equals 0. Retirement age eligibility in the U.S. occurs at 66, equivalent to $\bar{J} = 10$. Retirement age eligibility is increased in 2035 to $\bar{J} = 11$. This rise is commensurate with the rise in life expectancy and is fully anticipated during the transition. Gradual increase in the eligibility age is a topic of open policy debate in the US, with the rise to 67 for those born in 1960 and later already passed into legislation. In scenarios without the rise in longevity, retirement age is kept constant. For convenience, we also provide results for the constant retirement age in our main scenarios of rising longevity.

Taxes and public debt Taxes are calibrated using Mendoza et al. (1994) approach. The capital income tax is set to 18.5% to match the 5.4% ratio of the capital income tax revenues to GDP. The marginal tax rate consumption was set to 4.6% to match 2.8% radio of consumption income tax revenues to GDP. Progressive labor income tax function parameters $\lambda = 0.15$ and $\tau_l = 0.127$ are set to match the elasticity of post-tax to pretax income and the 9.2% ratio of the labor income tax revenues to GDP. This elasticity is based on Heathcote et al. (2017). The data on ratios between tax revenues and GPD come from the OECD data, see Table F.1.

We set the initial debt D_t at par with the data to 110% of GDP.[9] We assume that in the baseline and the reform scenarios, public spending is constant as a share of GDP: $G_t = \varsigma Y_t$. This way, we avoid welfare effects stemming from permanent changes in the public debt ratio.

The government expenditure in our model reflects only government consumption. The cost of servicing public debt and social security are dealt with separately. Hence, we calibrate the government expenditure in the initial steady state to match the debt/GDP ratio of 110%. The implied $\varsigma = \frac{G}{Y} = 0.125$ is about two-three percentage points lower than the levels reported in NIPA. In the baseline and reform scenarios, we keep debt as a constant share of GDP.

Wealth distribution Measurement of wealth inequality is troublesome in both data and in calibrated models, although for different reasons. The former struggle with adequately capturing the top of the wealth distribution. The latter impose restrictions on the bottom of wealth distribution (e.g., non-negativity constraint in simulated models) and cannot plausibly generate the top of the wealth distribution without self-employed individuals (see De Nardi and Fella, 2017, for an extensive review). With the calibration in place, our model matches wealth inequality reasonably when compared to Survey of Consumer Finance data, see Figure F.2 and Table F.2 in the Appendices.[10] Note that wealth distribution was not a target in our calibration.

4. The social security reform

Our model economy adopts an unanticipated systemic change in social security: we replace the status quo social security with a partially funded defined contribution system (DC).[11] In the reformed system, the contribution rate remains unchanged. The contributions are split between a Pay-As-You-Go (PAYG) and a funded pillar. In both pillars, contributions are proportional to individual earnings in each point in life cycle, thus they accrue with individual earnings histories. The reformed system has no redistribution within birth cohort.

[9] Due to fiscal developments in the U.S., the debt/GDP ratio is higher in our study than in the earlier literature.

[10] While the model understates the level of wealth inequality, it accurately captures the relative importance of both components. Our findings underscore that the majority of wealth inequality can be attributed to differences between birth cohorts, closely mirroring established stylized facts.

[11] This type of reform was recommended as means to address fiscal vulnerability resulting from a rise in longevity; it has been implemented as of the 1990s in many countries around the world (e.g., Sweden, Central Europe, Mexico, and Chile, among others, see Holzmann, 2013) and is invariably under consideration in the US (Feldstein, 2005; Diamond et al., 2016).

Table 2
The comparison of baseline and reform scenarios.

Topic	Status quo	privatization	privatization w/o funding
Contribution rates	τ_t	$\tau_t^I = 0.5\tau_t, \tau_t^{II} = 0.5\tau_t$	$\tau_t^I = \tau_t, \tau_t^{II} = 0$
Pension benefits	$b_{j,t}^A$	$b_{j,t}^I + b_{j,t}^{II}$	$b_{j,t}^I$
Balanced with longevity	No	Yes (with a transitory gap)	Yes
Redistribution	Some (AIME)	None	None
Distortion in labor supply	High	Low	Medium

The reform scenario is implemented gradually as of 2020. Individuals who were active before the reform continue to receive their pensions from the status quo social security. They live in a reformed economy, though. Individuals born in or after the year of the reform are enrolled in the new, partially funded two-pillar defined contribution social security.

Reformed social security The reform establishes two pillars of social security. The first pillar is financed on a PAYG basis, using contributions to fund current benefits. The second pillar is a funded scheme. The reform does not change the overall contribution rate relative to the baseline scenario: $\tau_t = \tau_t^I + \tau_t^{II}$, where we denote by τ_t^I the mandatory contributions that go into the DC PAYG pillar and, by τ_t^{II} the mandatory contributions that go into the DC funded pillar.

Contributions in the PAYG pillar, indexed by payroll growth rate γ_t adjusted for cohort-specific mortality $\pi_{j-1,t-1,t}$, evolve according to the following formula

$$f_{j,t}^I = (1+\gamma_t)\pi_{j-1,t-1,t}^{-1} \cdot f_{j-1,t-1}^I + \tau_t^I \omega_{j,t} w_t l_{j,t} \tag{18}$$

for $j < \bar{J}_t$. This formula replaces the baseline system's formula (4). Once an agent reaches retirement age, their pensions from the PAYG pillar, denoted as $b_{j,t}^I$, are calculated using the formula (19). This involves dividing the value of accumulated assets, $f_{\bar{J}t,t}^I$, by the life expectancy at retirement age, represented by $\sum_{i=0}^{J-\bar{J}t} \pi_{\bar{J}_t,t,t+i}$. Upon retirement, pensions are indexed by the payroll growth rate, consistent with the indexing of contributions during the working period.

$$b_{j,t}^I = \begin{cases} f_{j,t}^I \cdot \left(\sum_{i=0}^{J-j} \pi_{j,t,t+i} \right)^{-1}, & \text{for} \quad j = \bar{J}_t \\ (1+\gamma_t) b_{j-1,t-1}^I, & \text{for} \quad j > \bar{J}_t. \end{cases} \tag{19}$$

This formula differs from equation (6) in two important ways. First, $b_{j,t}^A$ in the baseline defined benefit (DB) social security does not account for life expectancy. Second, in baseline social security equation (5) describes the extent of redistribution within a birth cohort, whereas in equation (19) there is no redistribution.

The funded pillar is analogous to the PAYG pillar, with the main difference that the former invests the funds. Hence, the return is given by the market interest rate r_t rather than indexation with payroll growth rate. Pension wealth accumulation and pension benefits follow:

$$f_{j,t}^{II} = (1+r_t)\pi_{j-1,t-1,t}^{-1} \cdot f_{j-1,t-1}^{II} + \tau_t^{II} \omega_{j,t} w_t l_{j,t} \tag{20}$$

$$b_{\bar{J}_t,t}^{II} = \begin{cases} f_{j,t}^{II} \cdot \left(\sum_{i=0}^{J-j} \pi_{j,t,t+i} \right)^{-1} & \text{for} \quad j = \bar{J}_t \\ (1+r_t) b_{j-1,t-1}^{II} & \text{for} \quad j > \bar{J}_t. \end{cases} \tag{21}$$

Note that, unlike private savings, contributions in the funded pillar are exempt from capital gains tax. This exemption introduces the quasi-progressive nature of capital income taxation after the reform in the sense that individuals who do not accumulate pension wealth in excess of the mandatory social security effectively pay no τ_k. In contrast, individuals who accumulate also private voluntary savings, pay τ_k on returns to these assets.

Scenarios We consider two possible reform scenarios. Our main reform scenario, which we call **privatization**, assumes that the social security contributions are split evenly between two pillars, i.e., $\tau_t^I = \tau_t^{II} = 0.5\tau_t$. We also analyze scenario with no funded pillar for robustness, i.e., $\tau_t^I = \tau_t$ and $\tau_t^{II} = 0$. We call it **privatization without funding**. Table 2 summarizes the differences between the status quo and the reform scenarios.

The trade-offs involved in our reform are as follows. First, the transition to DC system with partial funding incurs transitory fiscal costs, necessitating tax increases during the transition period. However, it also offers long-term fiscal benefits that allow for tax reductions in the future. Second, the reform eliminates the partial insurance against idiosyncratic income shocks during working years provided by the current social security system through AIME. Third, the reform reduces the effective taxation of labor income, thereby improving work incentives, see Appendix B for a formal derivation. Contributions to the PAYG and funded pillars directly affect future pensions, thus reducing distortions to labor supply relative to the baseline system. Since future benefits in the PAYG pillar grow with the payroll growth rate γ_t, and future incomes are discounted at a rate $r_t > \gamma_t$, the effective tax reduction is more significant in the funded pillar than in the PAYG pillar.

We propose the **capital income tax** as a fiscal closure of social security reform. It distinguishes this paper from the previous literature. We report a systematic overview of the fiscal closures used in earlier studies in Table A. As is clear from this table, the most common fiscal adjustments employed in the literature are either consumption taxation or adjustments within the social security (the contribution or replacement rates). We relate to this literature: we compare our results to analogous simulation with **consumption tax** as fiscal closure. Capital income tax as fiscal closure is given by equation (11) and consumption tax by equation (12).

Social security deficit If we designate the initiation date of the reform as t, individuals who remain within the original social security system are denoted by $j \geqslant t$, whereas individuals covered by the reformed social security system are indicated by $j < t$. The budget constraint of the PAYG pillar of social security is expressed as:

$$\sum_{j=\bar{J}_t}^{J} N_{j,t} \left[\mathbb{1}_{\{j\geqslant t\}} \int_{\Omega} b^A_{j,t}(s_{j,t}) d\mathbb{P}_{j,t} + \mathbb{1}_{\{j<t\}} \int_{\Omega^R} b^I_{j,t}(s^R_{j,t}) d\mathbb{P}^R_{j,t} \right] = \tau^I_t w_t L_t + X_t, \tag{22}$$

where $\mathbb{1}$ represents the indicator function. The term $b^A_{j,t}$ refers to the pensions of individuals born before the reform, calculated according to the baseline formulas (4)-(6), while $b^I_{j,t}$ pertains to pensions under the reformed system for individuals born after the reform. $\mathbb{P}^R_{j,t}$ denotes the probability measure over the state space consistent with the transition probabilities $\Pi(\eta_{j,t}|\eta_{j-1,t-1})$ and policy functions.

It is important to note that the pension obligations from the baseline system are fulfilled. Concurrently, on the revenue side of the PAYG pillar, τ^I_t replaces τ_t, necessitating the subsidization of the pension system during the transition period due to the slow adjustment of the expenditure side to the revenue side. Following the transition period, the reformed social security system is designed to be balanced, with longevity pension benefits decreasing for subsequent birth cohorts.

The gradual implementation of the reform delays fiscal benefits. Indeed, most of the rise in social security imbalance due to increased longevity occurs before the reform has been fully implemented. On the one hand, slower transition moderates the transition costs (the contributions are diverted from the PAYG pillar at the rate of one birth cohort in each period). This reduces the pace of the rise in the transitory gap in social security. On the other hand, the benefits of the reform – including the improved economic efficiency – materialize later in time. Our sensitivity analysis examines how varying speeds of reform implementation impact our results.

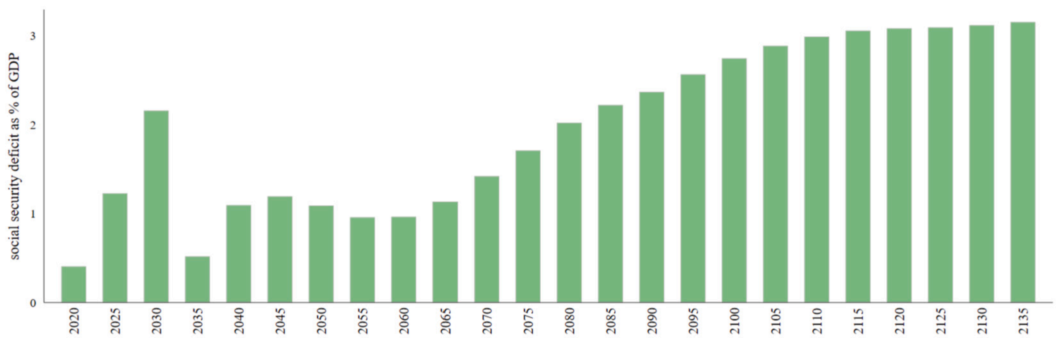
Appendix B describes in detail the changes to the consumer problem induced by the reform. Specifically, we derive the extent of labor supply distortion, and formalize alternative fiscal closures. We also discuss the necessary modifications to the definition of the equilibrium.

5. Results

We study the effects of the social security reform described above in general equilibrium framework. First, we discuss fiscal adjustments necessary to facilitate longevity and the reform. Second, we provide the overall welfare effect. Next, we isolate the insurance effect from the overall welfare effects to explain our result. Finally, we highlight the role of capital income taxation in our result.

5.1. Implications of longevity for social security balance in status quo

Maintaining *status quo* social security necessitates considerable fiscal adjustments. Within the horizon of our analysis, the deficit in social security increases up to 2% of GDP in 2030, as presented in Fig. 1. This deficit is only temporarily mitigated by raising the



Note: The figure portrays the social security deficit X_t in time as a percentage of GDP. A positive number signifies that social security has a deficit. A negative number signifies a surplus. The figure portrays results for scenarios with longevity and capital income tax as closures. Figure H.1 in the Appendices compares capital income tax closure with consumption closure.

Fig. 1. Social security deficit in the baseline scenario, as % of GDP.

Note: Social security deficit X_t is expressed in percent of GDP. The figure portrays the difference between reform and baseline in percentage points. A positive number signifies that the deficit is higher in the reform scenario than in the baseline scenario. A negative number signifies that the deficit is higher in the baseline scenario. The figure portrays results for scenarios with longevity. Other specifications are available upon request.

Fig. 2. The difference in social security deficit between reform and baseline.

retirement age.[12] In the long run, despite the increase in retirement age, social security deficit increases up to 3% of GDP. To give context to this number, the scale of the adjustment in the social security parameters necessary to prevent these imbalances amounts to a 30% rise in the contribution rate or a 40% decline in the replacement rate (our results are consistent with Fehr, 2000; Braun and Joines, 2015).

The powerful effects of the rise in longevity are displayed through economic adjustments. Figure H.2 reports the adjustments in capital stock and labor supply with and without a rise in longevity in the economy with the *status quo* social security.

5.2. Implications of reform on social security balance

The reform of social security has twofold implications on its balance. First, the outflow of half of the social security contributions to the capital pillar generates a deficit which necessitates an increase in taxation in the medium term. The second effect relates to the change in the pension benefit formula: unlike in the case of the status quo, the formula guarantees that social security is balanced. As a result, taxes can be lowered in the long run relative to the status quo. Fig. 2 portrays the total of these two effects. The lighter bars portray the privatization of social security without funding, thus only the second effect, whereas the darker bars present the total of the two effects.

5.3. Welfare effects of the reform

The current US social security is characterized by progressive defined benefit pensions (due to the regressive character of accumulation in AIME and cap from OASDI). This system provides insurance against income shocks. The proposed non-redistributive defined contribution system propagates income shocks from the working period to the retirement period, hence reducing the scope of redistribution embedded in social security. Thus, the reform induces **insurance loss**. Meanwhile, three channels boost efficiency. First, linking contributions with future pension benefits eliminates distortions to the labor supply associated with contributions to redistributive social security proportional to wages. Second, since $r > g$, partial funding reduces implicit taxation of labor associated with the contribution rates (i.e. implicit tax). It further improves labor supply incentives. Third, with longevity, baseline social security experiences a deficit, and the reformed system does not. Hence, taxes can be lowered in the long run compared to the status quo. Jointly, we term these effects as **tax & general equilibrium** effects.

The reform generates a transition cost associated with shifting contributions from the PAYG pillar to the funded one. Thus, taxes in the medium term have to increase. Recall that the extent of necessary fiscal adjustment accompanying the reform is presented in Fig. 2. The medium-term fiscal costs amount up to 2%, and the long-term fiscal benefits amount to approximately 3% of GDP. Note that, to some extent, we overstretch the term efficiency gains for ease of exposition. While the first two effects mentioned above clearly boost efficiency, the third one, which is adjustments to the tax rates, does so only in the long run.

The welfare effects of social security reform are presented in Table 3. In each column of Table 3, we show the welfare effect for the main variants of social security reform:

- replacing a redistributive DB social security, described by equations (4)-(6) by a non-redistributive partially funded social security, defined by equations (18)-(21) with $\tau^I = \tau^{II} = \tau/2$; these results are reported in columns (1) and (1*);

[12] To raise retirement age at par with rising longevity, $\bar{J}$ goes up by one model period, that is, five years, in 2035. Retirement age increase limits the imbalance of social security and thus long run gain due to social security reform, compare Table 3.

Table 3
Welfare effects of social security reform.

	Reform scenario			
Social security	Privatization		Privatization w/o funding	
Retirement age	rising	constant	rising	constant
	(1)	(1*)	(2)	(2*)
Fiscal closure τ_k	0.92	2.35	1.55	3.11
Fiscal closure τ_c	0.69	0.80	1.15	1.08

Notes: Results report aggregate welfare (consumption equivalent) effects for all cohorts in % of lifetime consumption in status quo, following equation (42). Consumption tax closure is described by equation (12), and capital income taxation closure by equation (11). The same fiscal closure is used in both the baseline *status quo* and the reform scenarios. * denotes scenarios with a constant retirement age (unchanged relative to the initial steady state in both the baseline and the reform scenarios) for comparison.

- the same, only without capital pillar, thus $\tau^I = \tau/2$ and benefits given solely by equations (18)-(19) in columns (2) and (2*).

The first row of Table 3 presents results for capital income taxation and the second for consumption taxation. Which tax base is selected as fiscal closure has an important bearing on the welfare effects of reform since they affect capital accumulation and labor supply differently. Raising consumption tax increases distortions in consumption-labor choice, thus affecting labor supply. Taxing capital shrinks the effective rate of return on assets. Therefore, a transitory rise in τ_k reduces savings. In the case of rising longevity, however, this mechanism is weaker because longer life expectancy reduces the reaction of capital accumulation to the rate of return.

The welfare effects of reform, which combines the DC formula and partial funding, are reported in column (1). This reform delivers fully individualized pension benefits. Hence labor supply decision is less distorted. The efficiency gains at the individual level are combined with the loss of insurance at the individual level: redistribution embedded in baseline social security is no longer provided. In addition, in this reform, a part of the contributions is diverted from the pay-as-you-go pillar into the funded pillar, and all prior pension obligations are honored. With $r > g$, (partial) funding delivers a higher retirement wealth accumulation. However, a transitory additional financial gap emerges in social security to honor prior pension obligations despite diverting a share of contributions to the funded pillar.

In column (2), we show the results without the funded pillar: social security benefits are individualized (reduced distortion in labor supply decision), but there is no room for dynamic efficiency gains. Thus, this reform reduces insurance and reduces distortions in the labor market. There is also a decline in taxation due to the social security reform: the funded pillar is not created, so there is no medium-term increase in taxation.

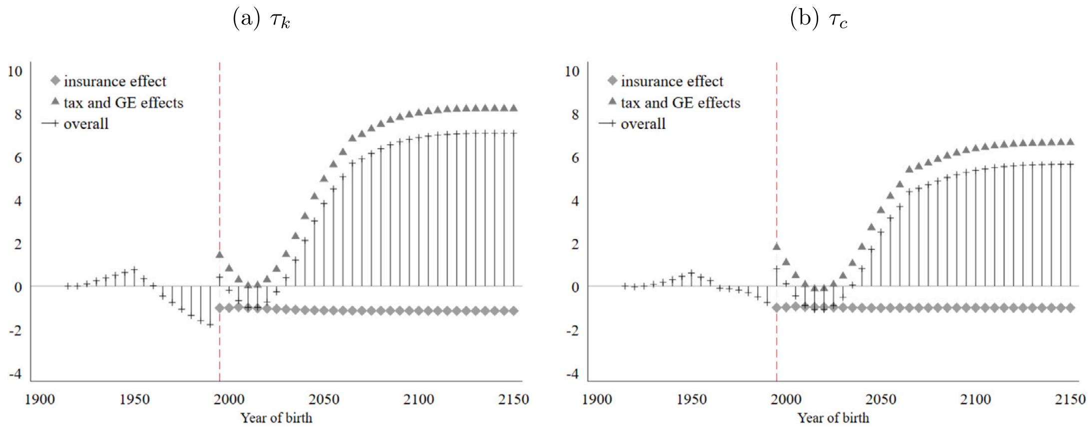
For comparison, in columns (1*) and (2*), we report the welfare effects of the two reform scenarios with constant retirement age. With constant retirement age, longevity implies a growing social security deficit in the baseline and an even stronger decline in pension benefits in the reform scenarios. Thus, with constant retirement age, the scope of fiscal adjustment in the baseline scenario is more pronounced: the taxes have to rise more to cover the deficit in social security due to longevity. The relative decline in taxes due to the reform is likewise larger. Note that the extent to which capital income tax closure outperforms consumption tax is larger than when the eligibility age for retirement rises in line with longevity. It is because the relative reduction in distortion is larger with capital income taxation and constant retirement age, whereas insurance loss is the same.

To summarize, social security reform is beneficial in all scenarios: general equilibrium gains outweigh the insurance loss. Our main point is that the benefits are larger with capital income tax closure and that this effect is related specifically to which taxes get adjusted in response to social security balance.

5.4. *Isolating insurance loss*

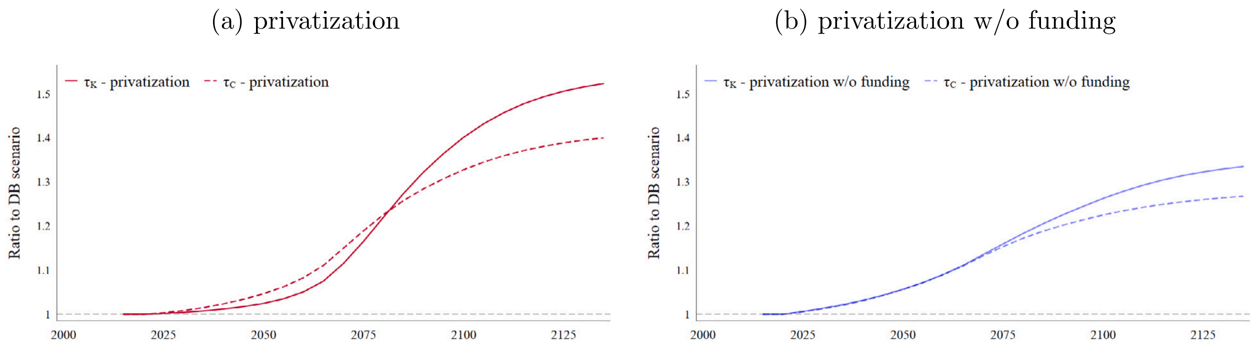
We provide intuition on the mechanisms behind our results in Fig. 3. We decompose the aggregate impact of the pension reform into the insurance loss effect associated with the change of redistribution implicit in social security and the efficiency gains effect for the subsequent cohorts. We obtain the decomposition in the following manner. In the baseline scenario, we have the current social security. To capture insurance loss, we modify the current social security as follows. First, we replace equation (4) with the following formula $f^c_{j+1,t+1} = \frac{1}{j}(\tau \cdot \omega_{j,t} w_t l_{j,t} + (j-1) \cdot f_{j,t} \cdot (1+\gamma_t))$. Thus, we keep track of counterfactual individual pension wealth in social security. Second, instead of the progressive replacement rate in equation (6), we set the counterfactual $b^c_{\bar{J},t} = \rho_m \bar{\rho}_{\bar{J},t} \cdot f^c_{\bar{J},t}$, where $\bar{\rho}_{\bar{J},t}$ is the average replacement rate. Thanks to these two modifications, there are no efficiency gains from linking contributions to future pensions and no redistribution within social security. Using the counterfactual $b^c_{\bar{J},t}$, we compute agents' utility and thus can establish the welfare effect of insurance loss. Welfare effects of efficiency gains are measured as residual to aggregate welfare.

Indeed, the welfare effect of insurance loss is negative, as one would expect. The values are similar for all future cohorts because their problem is solved under the veil of ignorance. There is no insurance loss for cohorts born before the reform because all prior pension obligations are honored. Most importantly, Fig. 3 shows that the welfare effect of efficiency gains depends strongly on fiscal closure. We show capital income taxation in the left panel and compare it to consumption taxation in the right panel. We keep the same scale on the axes in both panels to facilitate comparisons. The benefits for the new birth cohorts are substantially higher in the case of capital income taxation, outweighing the costs to the initially old birth cohorts.



Note: We report welfare by birth cohort for a scenario with partial privatization ($\tau^I = \tau^{II} = 0.5\tau$) and rising longevity. The vertical dashed line denotes the cohort born at the moment of the reform. For the cohorts living at the time of reform ($j - t > 1$), the difference in utilities is computed as averaged for idiosyncratic income shocks within a cohort. We report the consumption equivalents (% of permanent consumption in the reform scenario) from scenarios where the same fiscal closure is assumed for the baseline and reform scenarios. In the partial equilibrium decomposition equation (4) is replaced with $f^c_{j+1,t+1} = \frac{1}{j}(\tau \cdot \omega_{j,t} w_t l_{j,t} + (j-1) \cdot f_{j,t} \cdot (1+\gamma_t))$ and equation (6) is replaced with $b^c_{\bar{J},t} = \rho_m \bar{\rho}_{\bar{J},t} \cdot f^c_{\bar{J},t}$, where $\bar{\rho}_{\bar{J},t}$ is the average replacement rate. Welfare effects of efficiency gains are measured as residual to aggregate welfare.

Fig. 3. Consumption equivalent: reform to DC with partial funding and rising longevity.



Notes: The figures depict adjustment in aggregate capital K_t in case of privatization and privatization w/o funding (right) as an outcome of the reform for our preferred fiscal closure (capital income tax τ_k) and the alternative fiscal closure (τ_c). Appendix H in Figure H.3 reports analogous graphs accounting for results without longevity.

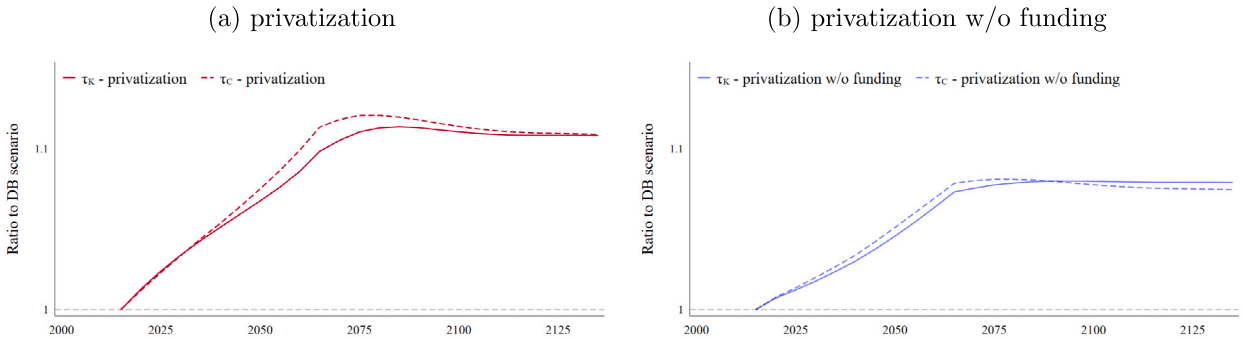
Fig. 4. The effects of pension reforms on capital.

Why is capital income taxation delivering higher efficiency gains? Notably, capital accumulation grows with rising longevity, with the reform and the introduction of the funded pillar to social security. The same holds for labor supply: the reform generally strengthens the link between contributions and future pensions, thus reducing distortions in labor supply decision. Rising longevity and funding amplify this reaction. We report adjustments in labor and capital (relative to the *status quo*) in Figs. 4 and 5. For capital, in panel 4a, the immediate adjustment in τ_k to finance the transition costs of the reform implies that capital accumulation picks up slower. It is because the net returns to capital are lower than with τ_c as fiscal closure. Panel 4b portrays the reform scenario when no transitory gap in the social security and the long-run benefits of τ_k are visible. For labor, as portrayed in Fig. 5, using consumption taxation effectively raises the price of consumption, necessitating the households to raise income to afford the same level of consumption. Note, however, that strengthening the link between labor supply and pension benefits substantially increases the labor supply, which raises the base for labor taxation. Thus, a necessary rise in capital taxation is lower, see Figure H.6. An apparent higher rise in labor supply is the reaction, as portrayed in panel 5a.

The adjustments in capital and labor are coupled with the aggregate fiscal trends: in the baseline scenario, the public pension pillar becomes unbalanced due to a rise in longevity, eventually reaching 0.9% of GDP.[13] Meanwhile, in the reform scenario, a fraction of the contributions to social security is diverted from the pay-as-you-go pillar to the funded pillar.[14] The adjustments in tax rates implied by our fiscal rules described in equations (11) for capital income tax and (12) for consumption taxation are

[13] See Figure H.5 for comparison of baseline and reform.

[14] As we reported with Fig. 2, during the transition to partially funded DC, the social insurance fund deficit grows temporarily to roughly 2.4% of GDP from a calibration of 0% in the initial steady state. It eventually declines back to balance when the transition cohorts finish collecting their benefits. We expressed relative



Notes: The figures depict adjustment in aggregate labor supply L_t in case of privatization and privatization w/o funding (right) as an outcome of the reform for our preferred fiscal closure (capital income tax τ_k) and the alternative fiscal closure (τ_c). We report the results of full privatization and privatization without funding. Each line represents the ratio of labor supply in the reform scenario to its value in the respective baseline scenario. Appendix H in Figure H.3 reports analogous graphs accounting for results without longevity.

Fig. 5. The effects of pension reforms on labor supply.

portrayed in Figure H.6 in the Appendix H. To finance the costs of the reform, the consumption tax has to increase by more than 2 percentage points by 2060. In case capital income taxation is used, the effective rate goes up by as much as nearly 12 percentage points. However, with the progress of longevity, both of these rates may drop substantially, to as low as roughly 5% in the case of capital income taxation and roughly 4% in the case of consumption taxation. These declines are substantial, especially compared to the baseline tax rates (approximately 35% and 9%, respectively). The decline in taxation begins faster for capital income tax due to a rapid rise in the tax base.

The economic literature is consistent in stating that OLG economies are efficient with a positive level of capital income tax (e.g. Imrohoroglu, 1998; Bernheim, 2002; Conesa et al., 2009; Krueger and Ludwig, 2013). Our reform achieves a reduction in capital income taxation and simultaneously efficiency gains in the long run. During the transition period, taxing capital relies on the fact that the capital stock adjusts slowly, which makes it less responsive to tax rate hikes. Facing longevity, households have to raise their old-age savings, especially expecting low social security benefits after retirement. It makes households less responsive to rate hikes in their inter-temporal choices and thus makes capital a suitable tax base (Golosov et al., 2013), as we quantify next.

5.5. *Semi-elasticity of assets to capital income taxation*

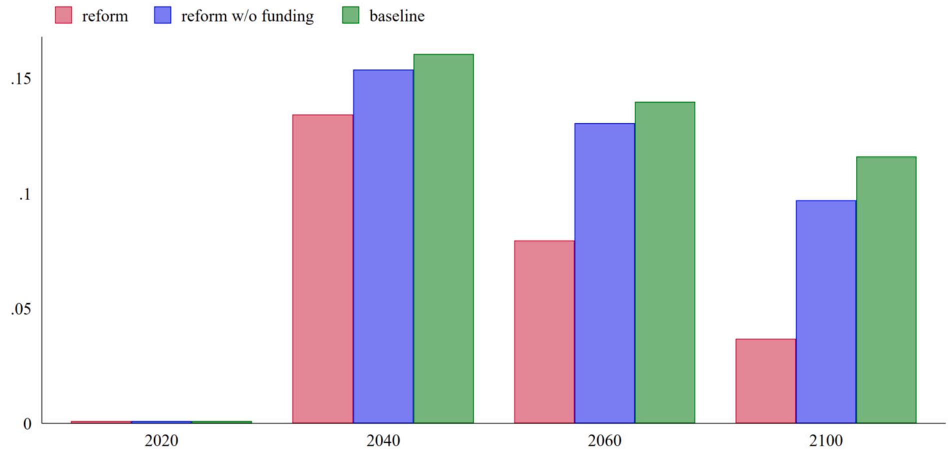
The contribution of this paper is to study the role of capital income taxation. To this end, we quantify the semi-elasticity of assets in reaction to changes in $\tau_{k,t}$. We use a partial equilibrium exercise to obtain the semi-elasticity of capital with respect to $\tau_{k,t}$. We keep taxes, bequests, and the interest rate as in the initial steady state. In such a counterfactual economy, we obtain total assets $\hat{A}_t$ from the household optimization. Next, in partial equilibrium, we increase $\tau_{k,t}$ by 1 percentage point in period t and only in that period. We then obtain total assets $\check{A}_t$ from the household optimization. Semi-elasticity is computed as the absolute value of the following expression $100\% \times \frac{\hat{A}_t - \check{A}_t}{\check{A}_t} \div 1\%$ (in the simulations a rise in $\tau_{k,t}$ reduces assets accumulation). We run a separate counterfactual simulation for each horizon (period t). This way, we obtain measures of semi-elasticity at various points in time.[15]

Fig. 6 portrays jointly the three reasons capital becomes less responsive to hikes in capital income taxation in the reform scenario: rising longevity, declining pensions, and more precautionary savings. The first of the three is associated with rising longevity, generally translating to higher accumulated wealth at lifetime maximum and a higher share of high-wealth individuals in the population, *ceteris paribus*. The second stems from the fact that in the reform scenario, pensions decline as longevity rises, reinforcing the original mechanism associated with rising longevity. Finally, the third channel is related to the insurance motive: less redistributive pensions raise risk exposure and thus make agents accumulate more precautionary savings. As is presented step-wise in Fig. 6, gradually, the response of capital to capital income tax rates declines with: (i) a rise in longevity; (ii) the reform. This decline in responsiveness is what makes capital income tax a suitable candidate for a fiscal closure during the social security reform.

The magnitude of capital's response to hikes in capital income taxation cannot be readily compared to the estimates obtained from observational data. Empirical literature typically finds little to no effect of variation of net returns on the aggregate assets (Bernheim, 2002). However, in observational data, one is challenged to observe the long-term evolution of stocks. Typically short-term variation of flows is available instead (Attanasio and Wakefield, 2010; Bernheim, 2002). By contrast, our implied elasticities are obtained for stocks. Furthermore, the empirical studies focus on a well-identified but instantaneous effect (Ramnath, 2013; Seim, 2017), which by design should be close to zero for stocks (Boskin, 1978; Beznoska and Ochmann, 2013). By contrast, our simulations reveal that over the short horizon, indeed, the implied elasticity of capital to changes in interest rates is low, but as changes in flows accumulate, the

adjustments of the social security deficit in percentage points because the deficits are expressed as % of GDP. The baseline and reform adjustments in social security deficit in levels are relegated to Figure H.5 in the Appendix H.

[15] In the interest of clarity, we present the results for the periods when the biggest changes in taxation occur, see Figure H.6.



Note: Semi-elasticity is obtained from a counterfactual increase in $\tau_{k,t}$ in a partial equilibrium exercise. First, we keep taxes, bequests, and interest rate as in the initial steady state, solve the household optimization problem and obtain $\hat{A}_t$, where A_t is defined in equation (17). Subsequently, we increase $\tau_{k,t}$ by 1% and solve the household problem to obtain counterfactual $\check{A}_t$. Semi-elasticity is obtained as the absolute value of the following expression $100\% \times \frac{\check{A}_t - \hat{A}_t}{\hat{A}_t} \div 1\%$. A positive value in the Figure implies that a rise in $\tau_{k,t}$ reduces asset accumulation. This exercise is simulated for periods $t \in \{2020, 2040, 2060, 2100\}$. An analogous Figure quantifying the pure effects of longevity is reported in Appendix H as Figure H.4.

Fig. 6. Semi-elasticity of capital with respect to $\tau_{k,t}$ for $t \in \{2020, 2040, 2060, 2100\}$.

Table 4
Welfare effects of social security reform – a comparison with Nishiyama and Smetters (2007).

	Reform scenario			
Social security	Privatization		Nishiyama and Smetters (2007)	
Retirement age	rising	constant	rising	constant
	(1)	(1*)	(3)	(3*)
Fiscal closure τ_k	0.92	2.35	-0.11	-0.15
Fiscal closure τ_c	0.69	0.80	-0.31	-0.56

Note: Results report aggregate welfare (consumption equivalent) effects for all cohorts in % of lifetime consumption in status quo, following equation (42). The consumption tax closure is described by equation (12), and the capital income taxation closure is described by equation (11). The same fiscal closure is used in both the baseline *status quo* and reform scenarios. Columns denoted as (1) and (1*) replicate columns with the same numbers in Table 3. The columns denoted as (3) and (3*) refer to Nishiyama and Smetters (2007), see Appendix G for details.

compound effects are rather large. Finally, the literature typically estimates compensated elasticities (Bernheim, 2002; Seim, 2017). By contrast, our simulations report elasticities accounting for income effects.

5.6. Reconciling our results with Nishiyama and Smetters (2007)

Recall that Nishiyama and Smetters (2007) obtain the negative overall effect of their reform. We replicate this result. Notably, there are several differences in how the reform is implemented between our study and Nishiyama and Smetters (2007). Overall, our reformed social security is of the same size as in status quo, it is less distortionary than status quo and it provides longevity insurance. By contrast, their reformed social security is smaller, introduces intertemporal choice distortion and has less longevity insurance. For example, the agents are exempt from capital income tax in our funded pillar, whereas voluntary savings in Nishiyama and Smetters (2007) reform are not. This additional boost in efficiency is quantitatively relevant, especially during the transition. Also, funded social security provides longevity insurance, which is absent in the case of voluntary savings. We provide an extensive discussion in and replication of Nishiyama and Smetters (2007) in Appendix G.

With consumption taxation, both our reform and a reform mimicking Nishiyama and Smetters (2007) in our setup prove to reduce welfare. For capital income taxation, the negative welfare effect is substantially smaller even with the original reform as proposed by Nishiyama and Smetters (2007), see we portray in Table 4.

5.7. Capital income taxation versus other fiscal closures

We consider a wide array of fiscal closures discussed in the earlier literature.[16] Accordingly, we attempt to reconcile our results with the existing literature. First, we consider fiscal adjustments which occur within social security. We analyze a change in pension

[16] Table A summarizes the use of these closures in the earlier literature.

benefits and a change in the contribution rate such that social security is balanced ($\forall t \quad X_t = 0$).[17] For each of the analyzed closures, we show aggregate welfare effects. We present cohort-based decomposition into efficiency gains and redistribution loss in Figure H.9 in Appendix H. We report aggregate macroeconomic effects for each fiscal closure, see Table H.1 in Appendix H.

We replicate the findings of the earlier literature (e.g. De Nardi et al., 1999; Davidoff et al., 2005; Nishiyama and Smetters, 2007; Fehr et al., 2008; Harenberg and Ludwig, 2019). Indeed, adverse welfare effects of raising contributions are large, our results are similar to De Nardi et al. (1999). Any positive welfare effects are possible in the long run, but capital income taxation delivers superior welfare gains. An alternative with higher aggregate welfare gains is the decline in pension benefits, which is likely politically unfeasible in aging democracies. Figure H.9 strongly corroborates the intuition that fiscal closures substantially affect which cohorts experience welfare gains and which face welfare losses. For example, closures with contribution rates are neutral to initial retirees and almost neutral to cohorts close to retirement. By contrast, adjustments in consumption tax imply that the welfare of these cohorts increases less.

Each fiscal closure is implemented for the same social security reform, strengthening the link between labor supply and future pension benefits, thus raising the labor supply substantially.[18] Reduced labor distortion results in higher labor supply and raised labor tax revenue despite unchanged labor taxation. Required hike in capital income taxation is thus lower, and a decline in this tax is more pronounced in the long run. Social security eventually becomes balanced in the effect of the reform, so taxation declines across all fiscal closures in reform scenarios. In contrast, it would remain permanently elevated in the baseline scenario (Figures H.6 and H.7-H.8).

In terms of magnitude, the overall effects are similar for the final steady states compared to studies that utilize an OLG model with individual uncertainty. For example, Fehr and Kindermann (2010) find long-run welfare gains of roughly 0.2% for Germany, whereas Kitao (2014) finds 0.7% for the U.S. case. However, his social security has a somewhat different design (benefits increase with earned incomes but do not decline with rising longevity).

6. Sensitivity of the results

Productivity slowdown Our results carry over to a calibration that features the declining rate of exogenous technological progress. We document the complete set of results in Appendix I. It is not surprising because the relatively higher rate of technological progress favors the current social security in the US. If we observe welfare gains from reforming with higher exogenous technological progress in our main results, the lower rate of technological progress can only raise gains from privatizing social security with partial funding under rising longevity.

Speed of phasing in the reform Admittedly, our original timing of the reform is relatively slow; such a lengthy implementation may be viewed as not credible. We thus study also an alternative, faster implementation, in which only cohorts older than 50 at the time of the reform ($j > 6$ at $t = 2$) remain in the status quo social security. For the transition cohorts who worked prior to the implementation of the reform and are shifted to the new scheme, we impute the initial values of $f^I_{j,2}$. This imputation is performed for the cohorts born between 1965-1995. We impute the counter-factual funds using the contribution rate τ from the initial steady state and the formula:

$$\text{if} \quad 2 \leqslant j \leqslant 6 \quad \text{in} \quad t = 2 \quad f^I_{j,2} = \sum_{i=1}^{j} \frac{1}{\pi_{i,1,j}} \tau w_1 \bar{l}_{i,1} (1 + g_1)^{j-i} \tag{23}$$

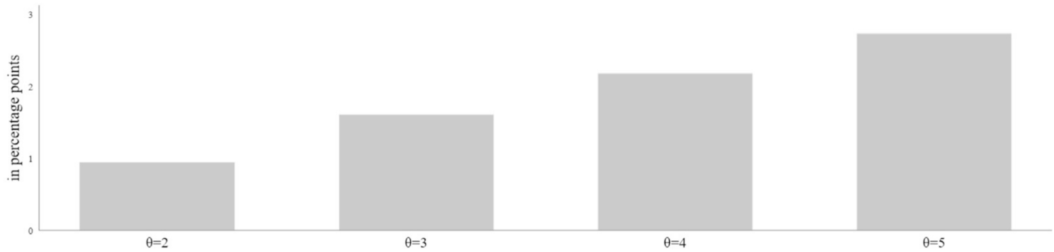
where $j = 6$ corresponds to the maximum age of agents assigned to the DC scheme once the reform is implemented, and $\bar{l}_{i,1}$ is the average labor supply of cohort i at time 1. Note that these imputed incomes are deterministic, as if there was no income uncertainty before the social security reform implementation. Hence, for the transition cohorts, the insurance motive is preserved in the social security. Cohorts born in 1965 and later fully participate in the new, two-pillar DC system. The deficit of the PAYG DC pillar, the X_t in equation (9), is financed by the government. The speed of the reform implementation does not affect the overall results (even if results for specific birth cohorts are naturally different).

The results remain unaffected by how fast the reform is implemented. Recall that the main results in this study assume that only future cohorts are subjected to the new pension rules, which in practical terms would imply uncertainty about whether in the future the gains would actually materialize, i.e., once the losing cohorts start influencing the political process; we do not explicitly model the political process, but we study if a more rapid implementation of the reform delivers different macroeconomic and welfare outcomes. We find that the key results remain the same, which we report in Appendix J.

Risk aversion There is a concern about the quantitative role of redistribution. Our simulations are obtained with CRRA utility function with a risk aversion parameter $\theta = 2$. While such calibration is consistent with the prior literature on social security privatization,

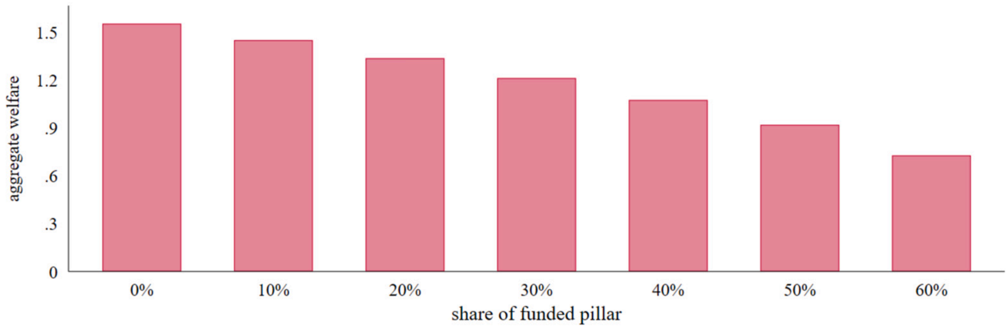
[17] In a setup, where one period is equivalent to five years, experimenting with the retirement age as a way to balance social security is understandably questionable.

[18] The quantitative role of this channel may be gauged by comparing our results to Imrohoroglu et al. (2003). The link between labor supply and future pension benefits is not strengthened in their setup. In addition, the fiscal closure is equivalent to increased labor taxation. It implies that distortion actually rises. Our results provide an intuition for why Imrohoroglu et al. (2003) find large, negative effects in a model with uncertainty: labor taxation as fiscal closure reinforces the negative welfare effects of reducing the insurance motive. However, the negative welfare effects in this study are not as much due to the reform itself as due to the model setup combined with fiscal closure. Unlike in our setup, the increase in labor supply in the Imrohoroglu et al. (2003) one is insufficient to finance the reform, which triggers upward tax adjustment.



Note: We recalibrate the other parameters in the model, see Table K.1. Results report aggregate welfare (consumption equivalent) effects for all cohorts in % of lifetime consumption in status quo, following equation (42). The capital income taxation closure is described by equation (11). The same fiscal closure is used in both the baseline *status quo* and reform scenarios.

Fig. 7. Welfare effects across calibrations of θ parameter, τ_k closure.



Notes: Our main model uses the 50% share in the funded pillar. The vertical axis measures the aggregate welfare effect as in equation (42). The horizontal axis reports the share of τ^{II}. τ^{II} is diverted to the funded pillar in our reform. Results report aggregate welfare (consumption equivalent) effects for all cohorts in % of lifetime consumption in status quo, following equation (42). The capital income taxation closure is described by equation (11). The same fiscal closure is used in both the baseline *status quo* and reform scenarios.

Fig. 8. Welfare effects across the values of $\frac{\tau^{II}}{\tau}$, τ_k closure.

the empirical estimates of the coefficient of relative risk aversion are highly dispersed (e.g. Chetty, 2006; Andersen et al., 2008; Charness et al., 2013; Outreville, 2014). Indeed, for higher levels of risk aversion, welfare loss related to replacing redistributive with non-redistributive social security could be larger.

To study this question quantitatively, we replicate our original simulations for alternative calibrations of θ. We present the results of this exercise in Fig. 7. Admittedly, with high levels of risk aversion, the insurance channel becomes quantitatively more important, and thus our reform could no longer bring welfare gains on balance. Our results do not confirm this, however. Our simulations show that it is the opposite. On the one hand, with high levels of risk aversion, the insurance channel ought to become quantitatively more relevant. On the other hand, adjusting the θ parameter necessitates recalibrating the model, the respective parametrizations are reported in Appendix K. In particular, as θ increases recalibration necessitates the increase of the discount factor. While more risk averse individuals like the reform less, the more patient ones like it more. To identify the pure role of risk aversion, the model would need a class of utility functions separating the intertemporal discounting from risk preference.

The size of the funded pillar Following prior literature, we set the size of the funded pillar to be 50% of the total social security contributions. This parameter indirectly determines two important elements: the size of the fiscal gap to be financed when funding is introduced and the increase in pension benefits because $r > \gamma$. In Fig. 8, we demonstrate that our main result survives regardless of the size of the funded pillar.

To summarize, the welfare effect of privatizing social security with funding consists of three effects. First, labor incentives are improved with privatization, as contributions to social security become less distortionary. The flip side of this mechanism is the second effect: the insurance inherent in the redistributive social security is lost – the second effect. The third effect relates to pension wealth: it accumulates faster in the two-pillar system with funding. The efficiency gains are amplified when the transitory fiscal gap in social security is closed with capital income taxation. Longevity reduces the response of capital to hikes in capital income taxation, which helps to tilt the aggregate welfare effects.

7. Discussion

Given that our results are partially driven by the labor supply response by households to better-aligned incentives, one can ask if the reaction size is plausible. Admittedly, the reform immediately reduces labor distortions by literally the entire social security contribution: agents used to treat the contributions as a tax and suddenly started treating them as postponed revenue streams.

Given the magnitude of the contribution rate, the sizable increase in labor supply – roughly 6.5% to 9% – may be justifiable in a macroeconomic model. A large selection of studies reviewed empirical evidence from numerous labor taxation reforms, yielding the plausible Hicksian labor supply elasticities of roughly 0.3-0.4 for the intensive margin and approximately 0.1 for the extensive margin (e.g. Keane and Rogerson, 2012; Chetty, 2012). Such estimates would be consistent with our outcomes. Also, some empirical studies analyzing the shifts from defined benefit to defined contribution plans worldwide suggest that the labor supply incentives play a substantial role in explaining the rise in labor force participation (Bairoliya, 2019).

Admittedly, most of the studies in the literature concern labor taxation *per se*, not long-term optimization between contributions, benefits, and labor supply, as such studies are rare. A large response here is conditional on workers internalizing the entire adjustment in their decision-making process. Concerning this point, the empirical literature is not as optimistic. For example, using evidence from Denmark, Chetty et al. (2011) show that people tend to respond to nominal taxation (and their changes) and are relatively inattentive to real taxation changes, even if the latter are relatively large. The reform we model would fit the latter type. However, people tend to react to changes in the nature of the social security much stronger than to changes in tax rates per se (Bairoliya, 2019).

Note that our key result does not depend on the labor supply response. Trivially, if labor does not react at all to social security reform (for example: if labor supply is inelastic), then there is no change in labor distortion due to replacing a redistributive defined benefit system with a defined contribution social security. However, as stems from our paper, even in this extreme case, if funding is to be introduced in the context of longevity, it is better to finance this process with capital income than with consumption taxation. Likely, with unresponsive labor, the simulations of such an economy would not produce welfare gains from privatization (no room for efficiency gain due to reduced labor distortion). However, as long as longevity increases, welfare loss will be lower if funding occurs via a tax raised on capital.

A growing body of the literature demonstrates that inter-temporal elasticity of substitution is quantitatively relevant for the magnitude of capital adjustment in response to capital taxation (Diamond and Spinnewijn, 2011; Golosov et al., 2013; Straub and Werning, 2020). It hints that, in reality, the magnitude of the efficiency gain may depend on the calibration of the inter-temporal elasticity of substitution.

Our framework does not feature a bequest motive: if parents are inclined to accumulate capital also for their off-spring, population growth in the US economy raises further incentives to save, which makes capital income tax base even less responsive than in our simulations (De Nardi and Yang, 2014). In such a setup, the optimal capital income tax rate would be higher than in our simulations (and likely higher than in the US economy currently). Accounting for the effects of the bequest motive would result in a lower response of capital to taxation and amplify the positive welfare effects we identify in this study.

Likewise, longevity may translate to changes in the policy preferences in the economy. In our setup, we consider government expenditure as a fixed percentage of GDP in baseline, taken in per capita terms to the reform scenarios. With declining pension benefits, one may expect that public expenditure will have to rise in per capita terms. Modeling these effects is beyond the scope of our paper. However, longevity may introduce important changes to social policy on the expenditure side, with many implicit and explicit mechanisms of between-cohort and within-cohort redistribution. For example, incentives for old-age savings may be reduced if more health care in old age is provided. Likewise, egalitarian access to the health care system in old age attenuates the role of idiosyncratic income shocks, reducing the precautionary motive. Accounting for how these policy-relevant scenarios interact with capital income taxation is a similarly promising research area.

8. Conclusions

Rising longevity marks our future, necessitating adjustments in social security and on the fiscal side. Public finance literature broadly suggests raising taxes on an inelastic tax base. We quantify that rising longevity makes capital particularly unresponsive to tax hikes. We further analyze the privatization of pensions with funding using different fiscal closures. Social security reform from a redistributive pay-as-you-go system to a defined contribution system allows for better alignment in the labor supply incentives between macro- and micro-levels, reducing the scope for labor supply distortions. Furthermore, it enhances pension wealth accumulation due to $r > g$. However, individual productivity risk becomes more afflicting.

Our contribution is to show that financing social security reform with adjustments in capital income taxes delivers superior welfare effects compared to other fiscal closures. We show that in the context of rising longevity, capital income taxation is a particularly suitable candidate: the responsiveness of capital to tax hikes is lower with increasing longevity. We thus contribute to a debate in the literature on social security reform and show that fiscal closures deliver first order rather than minor effects.

Moreover, our decomposition through a partial equilibrium exercise reveals that the insurance loss is indeed sizable, but the overall welfare effect is higher if an adequate fiscal closure amplifies the efficiency gains associated with the social security reform. Our effect is, to some extent, driven by the fact that the semi-elasticity of capital to capital income taxation declines both with longevity and privatization of social security.

The policy implications of our study are pretty optimistic: reforming social security from a redistributive pay-as-you-go system to a privatized and partly funded system may improve welfare, with the efficiency gain sufficient to outweigh the insurance loss. This result is robust to several sensitivity checks and holds even for quite a rapid reform implementation. However, a strong labor supply reaction is imperative for the gains to materialize. Some effort may be necessary to inform citizens about the nature of the reform and thus encourage adequate response to the changing incentives.

Appendix. Supplementary material

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jedc.2024.104878.

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