Means-testing retirement benefits in the UK: Is it efficient?

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Abstract

The literature has widely argued in favor of means-testing pension benefits as an efficient way to trade off distortions of labor supply and savings against distributional objectives. Using recent reforms of the taper regime in the UK as an example, we show that the optimality of means-testing strongly depends on what resources benefits are tested for.

We construct a dynamic stochastic general equilibrium model with overlapping generations calibrated to the UK economy. In contrast to previous studies, we do not only look at the long-run welfare effects of policy reforms, but compute full transition paths and separate aggregate efficiency from intergenerational redistribution effects by means of compensating transfers. Our findings reveal that strictly means-testing benefits against pension income is optimal while testing for private wealth heavily deteriorates efficiency. We show that recent cuts in the withdrawal rate of UK first pillar benefits were efficiency deteriorating. However, aggregate efficiency could be increased in the UK system by further lowering the taper rate on wealth while keeping benefits strictly means-tested against second pillar pension income.

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1 Introduction

Means-testing pension benefits allows governments to accurately target poor pensioners while at the same time keeping the system small and pension outlays under control. This in turn results in low distortive contribution rates. For these reasons, means-testing plays an important role in the pay-as-you-go financed social security systems of many OECD countries, especially in the light of sustainability problems due to population dynamics. However, means-testing benefits against private resources such as savings or income has been criticized extensively by the literature for the negative incentives on individual behavior. In particular, means-tested benefits may induce households not to provide privately for retirement via savings as well as to retire early. Contrary to the policy intention of the means-test, these heavy distortions of individual behavior in turn contribute to higher pension outlays.

In order to reduce these disincentive effects, the UK state pension system effectively lowered the taper rate on private resources from 100 to 40% at a fixed benefit level with the introduction of the so-called Pension Credit (PC) in 2003. As over one third of British households were already eligible for means-tested benefits in 2003 before the reform came into force,[1] this major reform in fact traded off high distortions for a small number of pensioners against smaller distortions for a larger number of agents. The present paper quantifies the macroeconomic, welfare and efficiency consequences of this reform as well as alternative taper regimes. We calibrate a dynamic stochastic general equilibrium model with overlapping generations to the UK economy of 2003 before the reform was introduced. Households in our model are liquidity constrained and face both longevity and productivity risk during their life cycle. Starting out from the pre-reform benchmark equilibrium of the UK economy, we change the taper regime of the pension system and compute the transition path, the new long run equilibrium as well as the welfare consequences for different cohorts. Finally we incorporate lump-sum compensations in order to quantify the aggregate efficiency effect of a specific reform scenario.

Our simulations highlight several major results. First, lowering the taper rate on private resources at a fixed benefit level results in a more generous pension system. This always presents a trade off of three different effects which we try to isolate in our study. Positive effects from increased insurance provision as well as reduced distortions of savings counteract negative effects from higher labor supply distortions due to rising contribution rates. The optimal taper rate therefore always depends on which of these counteracting effects dominates.

Second, we show that long-run welfare effects of reforms in means-testing regimes employed by most previous studies give misleading policy recommendations. In particular, abstracting from the earnings-related second pension pillar, it is optimal to strictly means-test retirement benefits from a long-run welfare perspective which is in line with previous studies. However, taking transitional cohorts into account through compensating transfers, we show that aggregate efficiency rises with lower taper rates on private wealth as increased insurance provision as well as lower savings distortions increasingly dominate losses from higher labor supply distortions. In contrast to all previous studies, aggregate efficiency peaks in a system that does away with testing for private wealth altogether.

Finally, starting from the benchmark model that includes the earnings-related second pillar in the analysis, we show that lowering the taper rate on pension and private wealth results in very different

[1] See Brewer and Emmerson (2003) for an extensive review.

effects. Aggregate efficiency is enhanced when testing retirement benefits against second tier pension income in the UK. The aggregate efficiency effect of lowering the taper rate on both pension and investment income therefore depends on which of the counteracting effects dominates. We show that for large taper rates, losses from a lower test on pension income dominate while for small taper rates gains from reduced savings distortions are predominant.

This paper heavily builds on various previous studies which have been concerned with the 2003 replacement of the Minimum Income Guarantee (MIG) by the Pension Credit (PC) in the UK as well as the effects of means-testing pensions in general. Sefton, van de Ven and Weale (2008) analyze the long run behavioral responses of agents to the introduction of the PC using a large scale partial equilibrium life-cycle model calibrated to the UK. Their results indicate that in the absence of second tier pensions, the PC-reform induced the poorest third of household to hold a higher amount of assets for retirement as well as to work longer, but had the opposite effect on richer households, resulting in a small gain in long run welfare. They also show that further lowering the taper rate, effectively making retirement benefits universal, deteriorates long run welfare. In a similar model, Sefton and van de Ven (2009) analyze the long run quantitative implications of various policy reforms for the UK's means-tested retirement benefit program with respect to the benefit level and the taper rate for different financing schemes. Their results indicate a positive role for means-testing of benefits as long as the withdrawal rate is around 50%.

Kumru and Piggott (2010) extend this approach using a large scale general equilibrium stochastic overlapping generations model calibrated to UK data that includes second tier pensions in the analysis. They largely confirm the behavioral findings of Sefton et al (2008) to the PC-reform but find that a 100% taper rate for means-testing is optimal from a long run welfare perspective. Kudrna and Woodland (2011) analyze the abolition of the means-test within the Australian pension system. In contrast to all previous studies their approach does not focus on long-run welfare consequences only. Instead they also consider transitional cohorts and compute compensating transfers which neutralize intergenerational income redistribution effects. However, they abstract from income uncertainty so that they do not take the insurance provision properties of the Australian pension scheme adequately into account. In contrast, Fehr and Uhde (2013) find a positive role of means-testing basic pension benefits against second pillar pension income within multi-pillar systems in a model with uncertain income while considering both long-run and transitional cohorts. After compensating for intergenerational redistribution, the resulting aggregate efficiency consequences are used to identify the optimal benefit design.

The remainder of the paper is organized as follows: the next section describes the general equilibrium model we use in our quantitative analysis. Sections 3 discusses the calibration of the initial equilibrium. Our simulation results are presented in Section 4, Section 5 concludes.

2 The model economy

2.1 Demographics and intracohort heterogeneity

Our model economy is populated by overlapping generations of individuals which may live up to a maximum possible lifespan of J periods. At each date t a new generation is born with its size normalized to unity, i.e. we assume zero population growth. Agents are characterized by the state

vector $z_j = (s, a_j, \hat{w}_j, \eta_j)$, with $j \in \mathcal{J} = \{1, \ldots, J\}$ denoting the age of the individual, $s \in \mathcal{S} = \{1, \ldots, S\}$ defining the skill level, $a_j \in \mathcal{A} = [0, \infty)$ representing liquid assets held by the agent at the beginning of age j and $\hat{w}_j \in \mathcal{W} = [0, w^{max}]$ marking the agent's current average earnings for earnings-related public pension claims. Furthermore, $\eta_j \in \mathcal{E}$ is an idiosyncratic shock to individual labor productivity.

At the beginning of life, individuals are assigned a skill level s with an (exogenous) probability $N_{1,s}$. Since individuals face lifespan uncertainty, cohort sizes decrease over time, i.e. $N_{j,s} = \psi_j N_{j-1,s}$, with $\psi_j < 1$ denoting the time-invariant conditional survival probability of an individual at the age of $j-1$ and $\psi_{J+1} = 0$. At a given point in time t, the cohort of j-old agents is fragmented into subgroups $\xi_t(z_j)$ determined by the initial distribution at birth, the income process, mortality and the respective optimal decisions of its individuals over their life cycle. We define $X_t(z_j)$ as the corresponding cumulated measure of $\xi_t(z_j)$. As $\xi_t(z_j)$ only gives densities within cohorts and is not affected by cohort sizes,

$$\int_{\mathcal{A}\times\mathcal{W}\times\mathcal{E}} \mathrm{d}X_t(z_j) = N_{j,s} \quad \text{and} \quad \sum_{j\in\mathcal{J}} \sum_{s\in\mathcal{S}} N_{j,s} = \sum_{j\in\mathcal{J}} \int_{\mathcal{Z}} \mathrm{d}X_t(z_j) \quad \text{with} \quad \mathcal{Z} = \mathcal{S} \times \mathcal{A} \times \mathcal{W} \times \mathcal{E}$$

Our model abstracts from annuity markets. Individuals that die before the maximum age of J may leave accidental bequests that will be collected by the government. All agents retire at age J_R and start to receive pension benefits. In the following, we will, for the sake of simplicity, omit the time index t, the skill level s and the state index z_j whenever possible. Agents are then only distinguished according to their age j.

2.2 The household decision problem

All agents value streams of consumption c_j and leisure ℓ_j according to the standard expected utility function

$$E\left[\sum_{j=1}^{J} \beta^{j-1} u(c_j, \ell_j)\right],$$

where β is a time discount factor. Expectations are taken with respect to the stochastic processes governing idiosyncratic labor productivity and mortality. Due to additive separability, we can formulate the decision problem recursively:

$$V(z_j) = \max_{c_j, \ell_j} \quad \left\{u(c_j, \ell_j) + \beta\psi_{j+1} E\big[V(z_{j+1})\big].\right\} \tag{1}$$

Since lifespan is uncertain, expected future utility is weighted with the survival probability ψ_{j+1}. Future utility is computed over the distribution of future states of productivity η_{j+1}. Agents maximize (1) subject to the budget constraint

$$a_{j+1} = a_j(1+r) + w_j(1-\tau^m-\tau^e) - T(\cdot) + b_j^m + b_j^e - (1+\tau^c)c_j + \nu_j. \tag{2}$$

where we additionally assume that an individual does not hold any assets at birth and does not leave any intentional bequests, i.e. $a_1 = a_{J+1} = 0$. Furthermore, agents face credit market constraints, i.e. $a_j \geq 0 \quad \forall \; j$. Households receive interest payments from liquid assets held in period j as well

as gross labor income $w_j = \omega(1-\ell_j)\epsilon_j\eta_j$, where ϵ_j defines the skill-dependent deterministic age-productivity profile. The wage rate for effective labor and the gross interest rate are denoted by ω and r, respectively. Households pay progressive income taxes $T(\cdot)$ from taxable income, where $T(\cdot)$ defines the progressive tax function computing the individual income tax burden of an agent. Consumption expenditures are given by c_j, the price of which include consumption taxes levied at the rate τ^c.

After retiring from the labor force at the mandatory retirement age of J_R, agents may claim means-tested retirement benefits b_j^m financed by contributions levied on gross labor income with the rate τ^m. In addition, they receive earnings-related State Second Pension (S2P) benefits b_j^e, financed by the contribution rate τ^e. Earnings-related pension claims depend on average labor income during working phase which evolves according to

$$\hat{w}_{j+1} = \hat{w}_j + (J_R - 1)^{-1} w_j, \tag{3}$$

where $\hat{w}_1 = 0$.

Finally, agents may receive (or have to finance) specific compensation payments ν_j which are described in more detail below.

2.3 The production side

A large number of identical firms, the sum of which is normalized to unity, use the factors capital and labor to produce a single good with the Cobb-Douglas production technology

$$Y = \Phi K^{\varepsilon} L^{1-\varepsilon}$$

with Y, K and L denoting aggregate output, capital and labor, respectively. The parameter ϵ marks the share of capital in production while Φ represents a technology parameter which is adjusted in order to normalize the wage rate of effective labor to unity. Firms maximize their profits renting capital from aggregate private savings and hiring labor from households so that the marginal product of capital equals the market interest rate r plus the depreciation rate of capital δ and the marginal product of labor equals the wage rate for effective labor ω, i.e.

$$r = \varepsilon\Phi\left(\frac{L}{K}\right)^{1-\varepsilon} - \delta \tag{4}$$

$$\omega = (1-\varepsilon)\Phi\left(\frac{K}{L}\right)^{\varepsilon} \tag{5}$$

holds.

2.4 The government sector

The government sector in our model comprises the tax system and the social security system. In each period t, the government issues debt $B_{G,t+1} - B_{G,t}$ and collects accidental bequest B_t and taxes on income and consumption from households in order to finance general government expenditure G which is fixed per capita as well as interest payments on existing debt,[2] i.e.

$$B_{G,t+1} - B_{G,t} + B_t + T_t + \tau_c C_t = G + rB_{G,t}, \tag{6}$$

[2] Since we assume a population growth rate of zero, the government can't issue new debt in a long-run equilibrium.

where T_t and C_t define aggregate income taxes and consumption, respectively. Aggregate income tax revenue T_t from workers and pensioners is calculated with different tax functions so that

$$T_t = \sum_{j=1}^{J_R-1} \int_{\mathcal{Z}} T\left(y_j^w(z_j)\right) \mathrm{d}X_t(z_j) + \sum_{j=J_R}^{J} \int_{\mathcal{Z}} T\left(y_j^p(z_j)\right) \mathrm{d}X_t(z_j),$$

where y_j^w and y_j^p define taxable income of workers and pensioners, respectively. The income tax code is replicating the UK income tax system where income from labor and capital is taxed progressively. Contributions to public pensions are exempt from income taxation. Earnings-related pension b_j^e are fully taxed during retirement, means-tested benefits b_j^m on the other hand are exempt from taxation. Consequently, taxable income during the working phase is computed from gross labor income and returns on assets net of pension contributions and personal allowances a^w while taxable retirement income sums earnings-related benefits and asset returns net of personal allowances of pensioners a^p:

$$y_j^w = w_j(1 - \tau^m - \tau^e) + ra_j - a^w \qquad \text{and} \qquad y_j^p = b_j^e + ra_j - a^p.$$

Finally, the consumption tax rate τ^c is adjusted in every period in order to balance the government budget.

All agents are required to participate in the mandatory social security program that features key elements of the UK social security system. The first tier provides benefits b_j^m which consist of basic state pensions (BSP) $\underline{b}$ and the means-tested income guarantee. The amount of the latter is determined by the minimum income guarantee (MIG) $\overline{b}$, the BSP $\underline{b}$ and the taper rate φ which defines the means-test against liquid asset income and second pillar old-age pensions, i.e.

$$b_j^m = \max\left\{\overline{b} - \varphi\left[\theta \max(a_j - \kappa\,;0) + b_j^e\right]\,;\underline{b}\right\}. \tag{7}$$

As in the UK, liquid asset income for the means-test is derived by subtracting a fixed allowance κ from assets and applying the imputed return $\theta \in [0,1]$ on non-exempt assets. Consequently, the level of the basic state pension $\overline{b} \geq \underline{b} \geq 0$ determines the generosity of the first pillar benefit. If $\overline{b} = \underline{b}$, the system provides a universal pension for all retirees, while with $\underline{b} = 0$ all first pillar benefits are means-tested. With a means-test in place, the amount of b_j^m depends on individual characteristics of the retiree. The taper rate $\varphi \in [0,1]$ determines the precision of the asset- and pension income-test: If $\varphi = 1.0$, all assessable income is taken into account and the first tier benefit b_j^m is reduced by one £ for every additional £ of asset and pension income received by the agent. If the taper rate is reduced (i.e. $\varphi < 1$), first pillar benefits b_j^m are reduced by φ £ for every additional £ of asset and pension income. Of course, if $\varphi = 0$ we again end up at a universal pension for all retired agents.

Second tier S2P-pensions in the UK depend on the individual earnings record at the end of the working career $\hat{w}_{J_R}$. Benefits b_j^e are derived applying the benefit function $\Gamma(\hat{w}_{J_R})$ which is explained in detail below.

Aggregating over all retirees the budgets of first- and second-pillar pensions in period t are

$$\sum_{j=J_R}^{J} \int_{\mathcal{Z}} b_j^m(z_j)\mathrm{d}X_t(z_j) = \tau^m \omega L_t \qquad \text{and} \qquad \sum_{j=J_R}^{J} \int_{\mathcal{Z}} b_j^e(z_j)\mathrm{d}X_t(z_j) = \tau^e \omega L_t, \tag{8}$$

where τ^m and τ^e are adjusted annually to balance the respective budgets.

2.5 Equilibrium conditions

An equilibrium path for a given policy schedule $(\tau^m, \tau^e, \overline{b}, \underline{b}, \theta, \kappa, \varphi, \dots)$ represents a set of value functions $\{V(z_j)\}_{j=1}^J$, household decisions $\{c_j(z_j), \ell_j(z_j)\}_{j=1}^J$, measures of households $\{\xi_t(z_j)\}_{j=1}^J$ and relative prices of capital and labor $\{r, \omega\}$ that satisfy the following conditions $\forall t$:

1. The household decisions $\{c_j(z_j), \ell_j(z_j)\}_{j=1}^J$ solve the household decision problem (1) subject to the respective constraint (2).
2. Factor prices $\{r, w\}$ are competitive, i.e. (4) and (5) hold.
3. Aggregation holds so that

$$L_t = \sum_{j=1}^{J} \int_{\mathcal{Z}} [1 - \ell_j(z_j)] \epsilon_j \eta_j \mathrm{d}X_t(z_j) \tag{9}$$

$$C_t = \sum_{j=1}^{J} \int_{\mathcal{Z}} c_j(z_j) \mathrm{d}X_t(z_j) \tag{10}$$

   and K_t is derived from (4).

4. Defining $\mathbf{1}_{h=x}$ as an indicator function to return 1 if $h = x$ and 0 otherwise, the following law of motion for the measure of households $\{\xi_t(z_j)\}_{j=1}^J$ holds:

$$\xi_{t+1}(z_{j+1}) = \psi_j \int_{\mathcal{A}\times\mathcal{W}\times\mathcal{E}} \mathbf{1}_{a_{j+1}=a_{j+1}(z_j)} \times \mathbf{1}_{\hat{w}_{j+1}=\hat{w}_{j+1}(z_j)} \pi(\eta_{j+1}) \mathrm{d}X_t(z_j) \tag{11}$$

5. Unintended bequests satisfy

$$B_t = \sum_{j=1}^{J} \int_{\mathcal{Z}} (1 - \psi_{j+1})(1 + r) a_{j+1}(z_j) \mathrm{d}X_t(z_j) \tag{12}$$

6. The budgets of the government (6) and the pension system (8) are intertemporally balanced.
7. The goods market clears, i.e.

$$Y_t = C_t + G + K_{t+1} - (1 - \delta)K_t + \mathcal{X}_t \tag{13}$$

   holds for the small open economy, where $\mathcal{X}_t$ mark the net exports in period t.

3 Calibration and initial equilibrium

We calibrate our model to closely reflect the UK economy before the pension reform of 2003. The following subsection explains the chosen preference, technology and fiscal parameters, then we discuss the resulting initial equilibrium.

3.1 Parametrization

Table 1 reports the central parameters of the model. In order to reduce computational time, each model period covers five years. Agents reach adulthood at age 20 ($j = 1$), retire mandatorily at age 65 ($J_R = 10$) and face a maximum possible life span of 100 years ($J = 16$). Conditional survival probabilities ψ_j for the UK are calculated over the years 2001-2011 from the life tables of both sexes reported in the Human Mortality Database. The resulting life expectancy is then 77.5 years. We distinguish low-, regular- and high-skilled individuals (i.e. $S = 3$). The initial distribution of skill-classes is extracted from the OECD educational attainment estimates for the UK population of age between 25 and 64 reported in Barro and Lee (2001, 35). According to this data base 24 percent are below upper-secondary (i.e. low-skilled), 54 percent are upper secondary (i.e. regular-skilled) and 21 percent are tertiary educated (i.e. high-skilled).

Table 1: Parameter selection

Demographic parameters		*Preference parameters*	
(Adult) Life span (J)	16	Intertemporal elasticity of substitution (γ)	0.20
Retirement period (J_R)	10	Intratemporal elasticity of substitution between	
Skill levels (S)	3	... consumption and leisure (ρ)	0.58
		Coefficient of leisure preference (α)	1.63
		Discount factor (β)	0.86
Technology/Income process		*Government parameters*	
Factor productivity (Φ)	1.49	Debt-to-output (B_G/Y)	0.40
Capital share (ε)	0.30	Government consumption (G/Y)	0.20
Depreciation rate (δ)	0.26	MIG value ($\bar{b}$)	$0.3\bar{w}$
World interest rate (r)	0.24	Basic state pension ($\underline{b}$)	0.00
Shock variance (σ^2)	0.065	Exemption asset test (κ)	$0.45\bar{w}$
		Imputed interest (θ)	0.10
		Taper rate (φ)	1.00

With respect to preferences we use the very same calibration as Sefton et al. (2008). Consequently, the period utility function is defined as

$$u(c_j, \ell_j) = \frac{1}{1-\frac{1}{\gamma}} \left(c_j^{1-\frac{1}{\rho}} + \alpha \ell_j^{1-\frac{1}{\rho}} \right)^{\frac{1-\frac{1}{\gamma}}{1-\frac{1}{\rho}}},$$

where γ denotes the intertemporal elasticity of substitution between consumption at different ages, ρ defines the intratemporal elasticity of substitution between consumption and leisure at each age j and α is an age-independent leisure preference parameter. Following Sefton et al. (2008) we set the intertemporal elasticity of substitution γ to 0.2 and the intratemporal elasticity of substitution ρ to 0.58. The leisure preference parameter α to 1.63 and the annual discount factor is 0.97 which yields a periodic discount factor $\beta = 0.86$. This is within the range of commonly used values, see Auerbach and Kotlikoff (1987).

The technology parameter Φ is set to a value of 1.49 in order to normalize the wage rate of effective labor to unity. Furthermore, we follow Sefton et al. (2008) and set the capital share in production to

a value of $\varepsilon = 0.3$ as well as assuming a world interest rate of 4% p.a. for the UK as a small open economy. The resulting periodic interest rate is then 24 percent. Following Kumru and Piggott (2010) we assume an annual depreciation rate of 4.8 % which implies a periodic depreciation of 26 percent.

The calibration of the income process follows mostly Kumru and Piggott (2010). Consequently, the deterministic age-dependent mean efficiency profiles for skill class s $\epsilon_{j,s}$ is taken from Robinson (2003), who estimates average earnings profiles over the life cycle for different educational backgrounds for the UK using General Household Survey Data. As Kumru and Piggott (2010), we use their predicted weekly earnings-profiles for men with lower, medium and higher educational backgrounds from the reported quadratic specification. The profiles are normalized around the weekly earnings of a medium-skilled male with one year of experience. We interpolate missing values of the normalized profiles by fitting a cubic spline and use the resulting profiles as mean productivity profiles over the life cycle for three skill classes.

The idiosyncratic productivity shock η_j is assumed to be log-normally distributed with

$$log(\eta_j) \sim \mathcal{N}(\mu, \sigma^2).$$

The distribution of the shock η_j is approximated by five evenly spaced discrete values in logs on the interval $\left[\frac{-\sigma^2}{2} - 3\sigma\ ;\ \frac{-\sigma^2}{2} + 3\sigma\right]$. The value for the variance of the idiosyncratic shock of $\sigma^2 = 0.065$ reported in Table 1 is taken from Kumru and Piggott (2010) as well as the probabilities $\pi(\cdot)$ for the discretized shock $log(\eta_j)$:

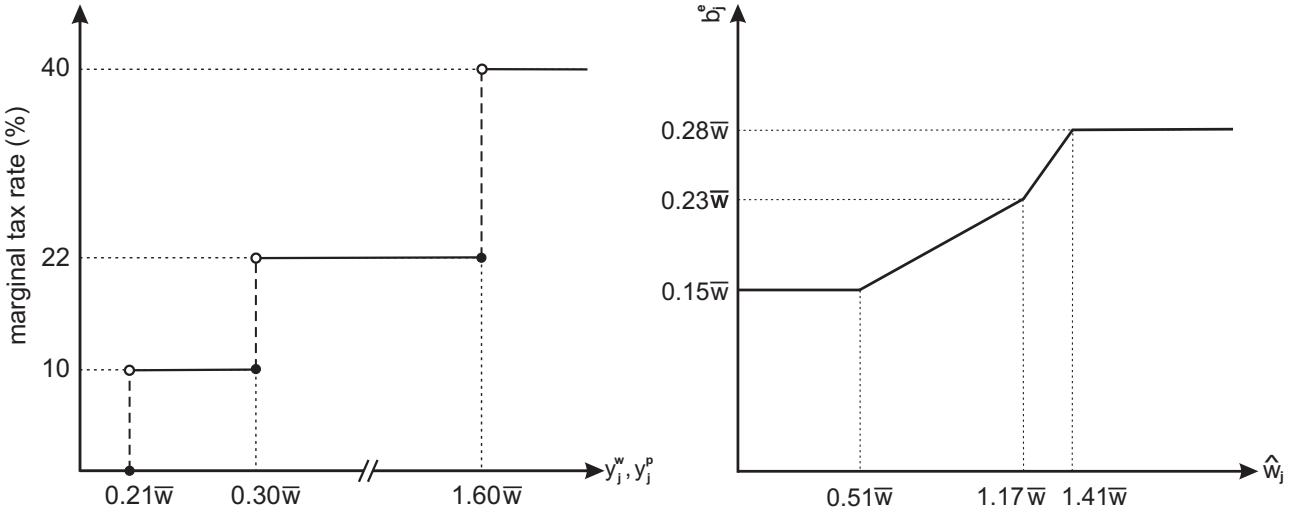
$$\pi(\cdot) = [0.0122; 0.2144; 0.5468; 0.2144; 0.0122].$$

With respect to the public sector we set the GDP shares of government consumption G/Y and government debt B_G/Y to the respective values of 20% and 40% as reported by Eurostat for the year 2003. Taxable income of agents comprises labor income, returns on assets as well as pension benefits and is taxed progressively. Our model closely replicates the UK income tax code of 2003, see Adam and Shaw (2003) for an extensive survey. Given taxable income of workers and pensioners, four taxable bands and rates are applied (see the tax schedule in the left part of Figure 1): the first £ 4,600 of taxable income are not taxed at all. After this basic allowance the next £ 2,000 are taxed at a rate of 10%, income between £ 6,600 and £ 35,000 is taxed at the rate of 22%, while all taxable income above £ 35,000 is taxed at a tax rate of 40%. Given this tax schedule, the personal allowances a^w, a^p are derived endogenously in order to match income tax revenues and net income data. Hereby we take into account that the personal allowance for pensioners exceeds the respective one for workers by £ 2,000.[3]

As in Kumru and Piggott (2010), we include second tier pensions and concentrate on the MIG as the means-tested program of interest, i.e. BSP-benefits $\underline{b}$ are zero for all retirees. In 2003 the MIG grants a maximum benefit equal to the pension guarantee of £ 102 per week for a single pensioner, which is roughly equivalent to 25% of average equivalent labor income calculated from FES-Data. In order to generate realistic benefit outlays we increase this level slightly. Therefore, we compute average labor income $\bar{w}$ and set $\overline{b} = 0.3\bar{w}$. This maximum benefit is reduced by a taper rate of $\varphi = 1.0$ for every £ in private assessable savings and investment income. Currently the first £ 10,000 of savings are ignored for means-testing. This is roughly 45% of household average income, i.e. $\kappa = 0.45\bar{w}$. Finally,

[3] The additional personal allowance of £ 1,100 for pensioners older than 75 years is disregarded.

Figure 1: Marginal tax schedule and benefit function for earnings-related pensions (in £)



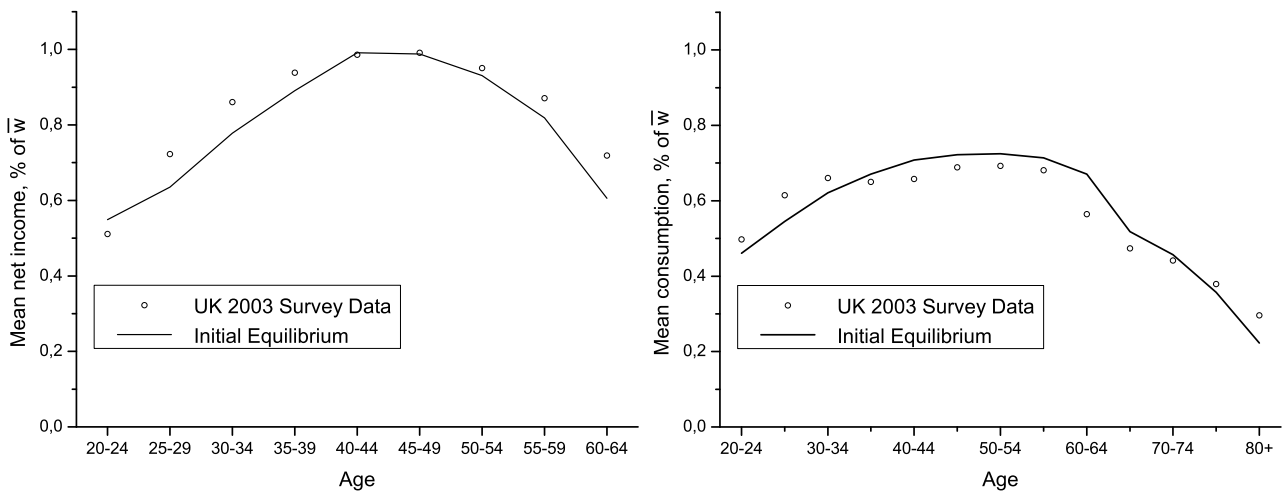
for every £ 500 assets above this exemption level £ 1 is added to the weekly income figure. This implies an annual imputed return of $\theta = 0.1$.

With respect to second tier pension benefits, we apply the function $\Gamma(\hat{w}_{J_R})$ shown in the right part of Figure 1 below. If average income during working years was below £ 11,200, S2P benefits are flat at £ 3,310. In case average income is above this threshold but below £ 25,600, benefits rise linearly up to £ 4,966. For average incomes beyond that bracket benefits rise further until they reach a maximum amount of £ 6,212 at an average income above £ 30,900.

3.2 Initial Equilibrium

The exogenous parameters as well as tax and benefit functions are selected in order to generate an initial equilibrium which represents the UK economy in year 2003 before the MIG was replaced by the Pension credit. Figure 2 compares simulated mean net income profiles over the life cycle as well as

Figure 2: Mean net income and consumption by age - simulated vs. survey data



simulated mean consumption profiles from the benchmark equilibrium with actual UK survey data. Mean net income profiles for different age groups are taken from HM Revenue and Customs (2003), mean equivalent consumption profiles over the life cycle were calculated from 2002/2003 data of the UK Expenditure and Food Survey using the modified OECD equivalence scale, see Haagenars et al. (1994). Numbers are reported as proportions of average annual gross income of £ 21,900 reported in HM Revenue and Customs (2003). As already discussed above, the allowance levels a^w, a^p are adjusted to generate a good match between simulated and survey data on average income dynamics over the life cycle as shown in the left part of Figure 2.

Table 2 compares key features of the simulated income and wealth distribution with UK data. The percentage share of net income and assets is the share that accrues to subgroups of the model population ranked by their net income and liquid asset holdings, respectively. Our model replicates the income- and wealth distribution relatively well but understates the share of income and assets of the richest 10 percent of the population. This simply reflects the fact that our model does not capture the extreme ends of the income and wealth distribution present in reality.

Table 2: Income and wealth distribution

		Percentage share of income/assets		
		Lowest 10%	Highest 10%	Gini Index
Model	Net income	3.5	19.7	0.271
	Assets	0.0	29.6	0.546
UK	Net income[a]	2.8	27.0	0.335[b]
	Assets[c]	0.1	44.1	0.610

[a]DWP (2010, p.25) and [b]OECD (2013): UK 2003 values, [c]ONS (2009, p.10): UK 2006-2008 values

Table 3 reports some key figures of the resulting initial equilibrium. Given the gross capital income share of 30 percent and the depreciation rate as well as the world interest rate, the annual capital-output ratio is (0.3/0.088 ≈) 3.4 and the investment share in output is (0.048 × 3.4) 16.3 percent. Since the private consumption share is roughly 61 percent, net exports are 3 percent of GDP. Interest rate payments on periodic debt are (0.04 × 0.4) 1.6 percent of output while aggregate bequests account for 5.6 percent of GDP. Since the endogenous consumption tax rate is 12 percent, government outlays are financed by consumption and income tax revenues which are (0.12 × 0.61) 7.3 and (21.6-5.6-7.3=) 8.7 percent of GDP, respectively.

Table 3: The initial equilibrium (in %)

K/Y	$\delta K/Y$	C/Y	B/Y	τ^c	τ^m	τ^e
3.4[a]	16.3	61.0	5.6	12.0	1.2	6.1

[a]p.a.

The pension parameters are calibrated in order to generate two key figures of the UK pension system. First, 34 percent of retirees are entitled to receiving means-tested retirement benefits which is closely in line with the estimate by Brewer and Emmerson (2003). Second, the contribution rates reported

in Table 3 imply that roughly 5 % of GDP is spent for public pension outlays which is closely in line with estimates of the OECD (2011). Finally, since in all skill classes agents of the youngest cohort with negative productivity shocks would like to borrow, roughly 70 percent of younger cohorts are liquidity constraint (i.e. they don't save). For older cohorts, this fraction decreases sharply and we hardly observe any liquidity constrained households older than 40 years.

4 Simulation results

The remainder of this paper will focus on the macroeconomic, welfare and efficiency consequences of various reforms of the UK public pension system. In the first subsection we explain how welfare and efficiency effects are computed. Then we follow Sefton et al. (2008) and simulate alternative taper rates φ in a single-tier pension system. The resulting macroeconomic effects are explained in detail and the difference between long-run welfare and aggregate efficiency is highlighted. The third subsection considers the benchmark model with a two-tier pension system. We first rerun the reforms of the previous subsection and then quantify the impact of the benefit level $\overline{b}$ and the basic pension $\underline{b}$. Finally, we present some sensitivity analysis with respect to key parameter values. The considered reforms are all financed by endogenous payroll and consumption tax rates computed from the respective periodic budgets of the pension system and the government.

4.1 Computation of welfare and efficiency effects

The concept we apply to quantify welfare effects is compensating variation à la Hicks. Due to the homogeneity of our utility function,

$$u\big[(1+\phi)c_j, (1+\phi)\ell_j\big] = (1+\phi)^{1-\frac{1}{\gamma}} u\big[c_j, \ell_j\big]$$

holds for any c_j, ℓ_j and ϕ. In consequence, since utility is additively separable with respect to time, if consumption and leisure were simultaneously increased by the factor $1+\phi$ at any age, life-time utility would increase by the same factor. With this considerations lets again turn to our simulation model. Assume an individual at state z_j had utility $V^b(z_j)$ in the initial long-run equilibrium path and $V^r(z_j)$ after the policy reform. The compensating variation between the baseline and the reform scenario for the individual characterized by z_j is then given as

$$\phi = \left(\frac{V^r(z_j)}{V^b(z_j)}\right)^{\frac{1}{1-\frac{1}{\gamma}}} - 1.$$

ϕ then indicates the percentage change in both consumption and leisure individual z_j would require in the initial equilibrium in order to be as well of as after the policy reform. We may also say that an individual is ϕ better (or worse) off in terms of resources after the reform. If $\phi > 0$, the reform is therefore welfare improving for this individual and vice versa.

A special rule applies to individuals not having entered their economically relevant phase of life in the year before we conduct our pension reforms (the so-called future generations). We evaluate their utility behind the Rawlsian veil of ignorance, i.e. from an ex-ante perspective where neither their skill level nor any labor market shock has been revealed. The concept of compensating variation thereby applies likewise.

In order to isolate the pure efficiency effects of the reform, we apply the hypothetical concept of a Lump-Sum Redistribution Authority (LSRA) in a separate simulation.[4] The LSRA thereby proceeds as follows: to all generations already being economically active before the reform it pays lump-sum transfers or levies lump-sum taxes ν_j in order to make them as well off after the reform as in the initial equilibrium. Consequently their compensating variation amounts to zero. Having done that, the LSRA may have run into debt or build up some assets. It now redistributes this debt or assets across all future generations in a way that they all face the same compensating variation. This variation can be interpreted as a measure of efficiency. Consequently, if the variation is greater than zero, the reform is Pareto improving after compensation and vice versa. With this concept in hand, we can now proceed to our simulation results.

4.2 Means-testing pensions in a single-tier system

Our first simulation exercise follows Sefton et al. (2008) as well as Kumru and Piggott (2010) and abstracts from modeling the State Second Pension S2P, i.e. we concentrate on the MIG as a single tier. In order to do this, we keep all parameter choices discussed in the previous section but set all earnings-related benefits b_j^e to zero, so that the means-test applied to retirement benefits b_j^m boils down to a test of assessable returns on assets only. Hence, the reported reforms in the taper regimes isolate the economic effects of asset-testing. Since we consider the UK as a small open economy the initial equilibrium of the single-tier system is very similar to the calibrated benchmark equilibrium reported in Table 3. Of course, without S2P-benefits the first tier becomes more generous so that the initial contribution rate τ^m increases from 1.2 percent to 4.9 percent. When we now reduce the taper rate to 40 percent (i.e. the so-called pension credit) and to zero (i.e. a universal benefit system), the resulting long-run macroeconomic and welfare effects are qualitatively quite similar as in the previous papers.

However, we want to highlight the difference between long-run welfare effects and aggregate efficiency effects of a specific policy reform. For this reason we simulate the whole transition path after the reform and isolate aggregate efficiency by means of compensating transfer payments. When the taper rate is reduced, aggregate efficiency effects are due to changes in insurance provision and behavioral distortions:[5]

- Insurance provision against longevity and income risk rises when more retirees receive flat benefits (efficiency enhancing).
- When the system becomes more generous, contribution rates have to increase, so that labor supply distortions rise (efficiency deteriorating).
- Lower taper rates reduce the savings distortions of those who are already receiving (means-tested) pension benefits, but they increase the savings distortions of those who become new members of the system. Consequently, the impact on savings distortions is not fully clear. When the taper rate is high a marginal reduction may even increase savings distortions, while a

[4] The LSRA was introduced by Auerbach and Kotlikoff (1987, 62f.) and has recently been applied by Nishiyama and Smetters (2007) as well as Fehr et al. (2013) in similar stochastic frameworks.

[5] Of course, economic efficiency is also affected by liquidity effects, but since they go in the same direction as labor supply distortions we neglect them in the following discussion.

marginal reduction of an already low taper rate will clearly reduce savings distortions. Savings distortions are completely eliminated in a universal pension system.

In order to explain these channels in detail we report the short- and long-run macroeconomic implications first and then move on to the welfare and efficiency effects.

Macroeconomic implications Before we report the aggregate effects of the considered pension reform, it is useful to discuss the individual responses to the introduction of the pension credit and the universal benefit system. Table 4 shows the skill-specific changes in labor supply and savings for different cohorts. As one can see there is a remarkable difference between low-skilled and high-skilled cohorts. While the former due to their low savings typically already receive means-tested benefits before the reform, the latter only become eligible in old age when the taper rate is sufficiently reduced. Consequently, lower taper rates improve labor supply and savings incentives for low-skilled individuals of all ages while the opposite applies to high-skilled households. Middle-skilled households work more when young and less before retiring. They also reduce their savings either to receive means-tested benefits (with the pension credit) or as a response to higher benefits (with the universal system).[6] Note that some very old medium and high-skilled households even increase their savings after the reforms. Of course, this reflects the dramatic distortions of savings induced by means-testing which have now been mitigated with lower taper rates. Consequently, our results largely confirm behavioral responses to reforms in the taper rates reported by earlier studies, in particular the opposing reactions of poor and rich households.

Table 4: Long-run behavioral responses to pension credit vs. universal benefits[a]

Variable	Age	Pension credit ($\varphi = 0.4$)			Universal benefit ($\varphi = 0.0$)		
		Skill level			Skill level		
		low	median	high	low	median	high
Labor supply (change in %)	30-34	0.9	0.2	-0.3	1.4	0.7	-0.3
	40-44	1.2	0.7	-1.0	1.9	2.2	-1.3
	50-54	1.3	0.8	-1.1	2.3	2.1	-1.9
	60-64	2.6	-1.7	-1.3	4.2	-1.7	-0.7
Assets (change in %)	30-34	0.0	-5.6	-8.6	0.0	-7.4	-14.3
	40-44	2.8	-6.2	-10.9	2.4	-8.2	-16.5
	50-54	3.2	-5.7	-11.5	3.6	-6.4	-18.0
	60-64	4.7	-8.0	-13.2	6.7	-8.9	-21.3
	70-74	19.0	-7.9	-19.3	40.5	6.2	-18.1
	80-84	26.1	11.5	-14.2	70.9	62.4	18.1

Given these behavioral responses we can now turn to the aggregate effects in Table 5. The left part reports the macroeconomic effects of the introduction of the pension credit. When the taper rate is reduced to 40 percent, the rising eligibility for flat benefits increases the contribution rate immediately by 1.2 percent to 6.1 percent. Higher benefits increase initial consumption slightly and aggregate labor supply falls initially by 1 percent. Aggregate household assets fall immediately after the reform

[6] Sefton et al. (2008) report quite similar disaggregated effects. Comparing our life-cycle profiles with the ones reported by Kumru and Piggott (2010), there are striking similarities. Of course, this data is available upon request.

since negative savings effects dominate the positive ones. With respect to the government budget, lower income tax revenues have to be balanced by a rising consumption tax rate. During the transition aggregate savings decrease further so that means-tested benefits and the respective contribution rate steadily increase. Lower savings reduce the revenues from unintended bequest so that the government has to increase consumption taxes throughout the transition. Since fiscal burdens rise for future cohorts, they work more again and consume less than younger cohorts. In the long run, the MIG contribution rate and the consumption tax rate have increased by 1.8 and 1.4 percentage points respectively.

Table 5: Macroeconomic effects of pension credit and universal benefits (single-tier)[a]

	Pension credit ($\varphi = 0.4$)				Universal benefit ($\varphi = 0.0$)			
Period	1	3	5	∞	1	3	5	∞
Labor supply	-1.0	-0.4	-0.2	0.0	-1.1	0.2	0.6	0.6
Consumption	0.1	0.1	-0.5	-1.5	-0.9	0.8	0.7	-0.1
Private assets	0.0	-2.6	-4.6	-7.4	0.0	-0.8	-2.2	-3.8
Consumption tax rate[b]	0.5	0.4	0.7	1.4	1.6	0.2	-0.2	0.4
Contribution rate MIG[b]	1.3	1.4	1.6	1.8	4.9	4.9	4.9	4.9

[a]Changes in percent over value in initial equilibrium. [b]Changes in percentage points.

The right part of Table 5 reports the aggregate macroeconomic consequences when the taper rate is fully removed. With a universal system, all households automatically receive benefits independent of their private assets. Consequently, the dynamic adjustment process changes and the contribution rate immediately increases by 4.9 percentage points to its long-run level of 9.8 percent. Since people do not have to run down their assets in order to receive pension benefits, aggregate consumption even decreases initially due to higher contribution rates. In order to balance the budget, the consumption tax rate has to increase immediately by 1.6 percentage points. Since savings distortions of the means-test are now completely removed, aggregate assets decrease now by only 3.8 percent in the long run (in contrast to 7.4 percent with the pension credit before). The reduction is mainly due to the fact that now all retirees receive pensions benefits during retirement so that old-age savings decrease.[7] Note that despite higher contribution rates, agents work more than before during the transition. This is mostly due to the intra- and intergenerational income redistribution from future low-skilled towards current high-skilled households.[8]

Welfare and efficiency With the above discussion in mind, we can now turn to the welfare effects of the two considered reforms reported in Table 6. For cohorts already taking economic decisions in the reform year, we report average welfare changes grouped by skill level. For future generations, we apply the concept of ex-ante welfare and therefore only report aggregate numbers for each cohort. The first column indicates the age of the respective cohort in the reform year.

When the pension credit is introduced, the oldest cohorts experience welfare losses. They already

[7] Economically, the elimination of means-testing is quite similar to the introduction of a paygo pension!

[8] Table 4 clearly shows that especially low-skilled work more in the long run, while future high-skilled work significantly less.

receive maximum benefits so that they are mainly hurt by higher consumption taxes. For low-skilled retirees of the cohort aged 85-89 years in the reform period this welfare loss is equivalent to a fall in remaining lifetime resources of 0.6 percent. Younger (and especially medium- and high-skilled) households experience welfare gains due to higher pension benefits. Welfare gains decrease quickly for younger cohorts since their benefit phase lies in the future while they are hurt by rising contributions and consumption taxes throughout the transition. Very young and future cohorts even experience welfare losses. Cohorts living in the new long-run equilibrium lose roughly 0.9 percent of remaining lifetime resources with the pension credit.

Table 6: Welfare effects of pension credit and universal benefits (single tier)[a]

Age in	Pension credit ($\varphi = 0.4$)				Universal benefits ($\varphi = 0.0$)			
reform	Skill level			with	Skill level			with
year	low	median	high	LSRA	low	median	high	LSRA
85-89	-0.6	-0.6	-0.3	0.0	-1.0	-0.9	-0.5	0.0
65-69	1.9	3.3	2.4	0.0	4.8	10.4	12.5	0.0
45-49	0.3	0.7	0.4	0.0	0.3	1.7	2.3	0.0
25-29	-0.5	-0.2	-0.3	0.0	-1.3	-0.7	-0.3	0.0
15-19		-0.5		0.4		-1.2		2.4
5-9		-0.6		0.4		-1.0		2.4
∞		-0.9		0.4		-1.2		2.4

[a]Changes are reported in percentage of initial resources.

The right part of Table 6 reports the welfare changes, when the taper rate is completely eliminated and universal benefits are provided. In this case welfare gains of young retirees are significantly higher than before while welfare losses of future cohorts have also increased. These long-run welfare changes are qualitatively in line with the results from Kumru and Piggott (2010). However, since we adjust the consumption tax rate the intergenerational redistribution is less pronounced than in the previous study. But in principle we confirm that future cohorts would lose if we reduce the taper rate of means-tested benefits so that from this perspective the existing strictly means-tested system is optimal.

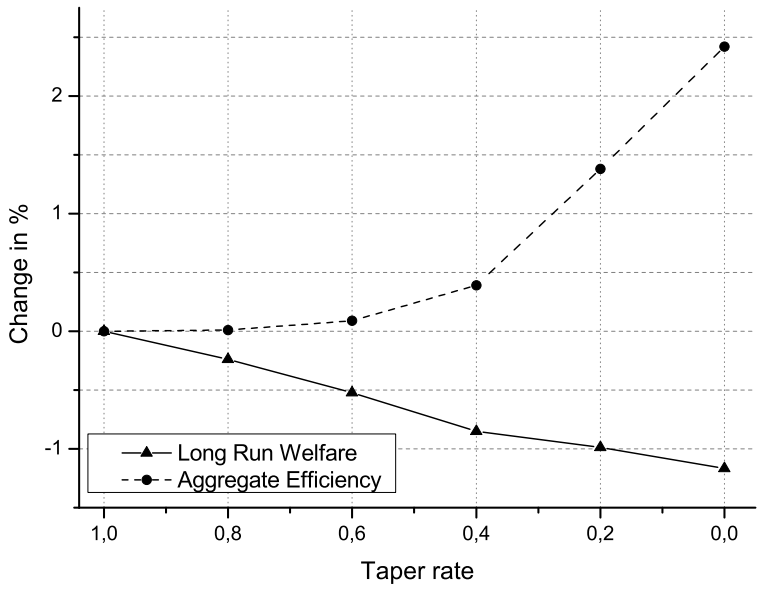
However, long run welfare changes reflect changes in economic incentives but also the induced income redistribution across generations. Since the considered policy reforms clearly redistribute from future towards current cohorts, long-run welfare losses indicate the intergenerational redistribution pattern but not the efficiency effects of the reforms. In order to isolate induced efficiency consequences, one has to compensate households using LSRA transfers as discussed above. The LSRA makes all existing cohorts as well off as in the initial equilibrium and redistributes resources across future generations to make them all face the same welfare changes.

As already discussed above, the reduction of the taper rate has three major efficiency consequences: While higher insurance provision increases aggregate efficiency, higher labor supply distortions decrease efficiency. Changes in savings incentives are a priori unclear as high distortions for few pensioners are traded against less severe distortions for more pensioners. Most likely savings distortions rise with the pension credit and fall with the universal benefit. The column marked "with LSRA" of Table 6 reveals the aggregate efficiency effects of both considered policy reforms. In contrast to the re-

ported respective long-run welfare, aggregate efficiency is increasing monotone with the falling taper rate. While both reforms improve economic efficiency, the universal benefit reform performs better in terms of economic efficiency than the pension credit. The former induces an aggregate efficiency gain of 2.4 percent percent of initial resources while the efficiency gain of the former reform amounts to only 0.4 percent. This result is mainly due to the fact that benefits from insurance provision and reduction of savings distortions overcompensate losses from rising labor supply distortions.

Figure 3 highlights the difference between long-run welfare and aggregate efficiency effects for alternative reforms of the asset taper regime. The already discussed results for $\varphi = 0.4$ and $\varphi = 0.0$ are highlighted in the figure.

Figure 3: Long-run welfare vs. aggregate efficiency effects



Based on these efficiency figures, the conclusion for public policy changes dramatically. While Sefton et al. (2008) recommend to keep means-testing of private wealth at least with a taper rate of 40 percent in order to increase long-run welfare and Kumru and Piggott (2010) even promote a taper rate of 100%, we argue that the asset test should be completely removed in order to improve economic efficiency. The next section clarifies whether our conclusion remains robust in the two-tier benchmark system.

4.3 Benchmark model: Means-testing pensions in a two-tier system

In this subsection we introduce the fully calibrated version of the model by including the S2P in the initial equilibrium. The means-test in the first tier then comprises both a test against assets as well as S2P benefits. Similar as in Kumru and Piggott (2010) the earnings-related benefit remains unchanged when we introduce the pension credit and the universal benefit reform. As in the previous subsection, we first discuss the macroeconomic consequences and then move on to welfare and efficiency results.

Macroeconomic implications The left part of Table 7 reports the macroeconomic effects of the introduction of the pension credit in the benchmark model. Qualitatively, the effects are very similar as in Table 5 but the amplitude is much higher. When the taper rate is reduced to 40 percent, the contribution rate rises immediately from 1.2 percent to 3.6 percent. The stronger redistribution towards the elderly increases initial consumption by 4.4 percent and reduces initial labor supply by 4 percent. The significantly lower income tax revenues are balanced by the higher consumption tax base, so that the consumption tax rate rises almost as before by only 0.6 percentage points. Aggregate household assets now decline much stronger during the transition so that the long-run asset level decreases by almost 35 percent. Consequently, means-tested benefits and the respective contribution rate now increase by 4.7 percentage points while the government has to increase consumption taxes by 7 percentage points in the long run.[9]

Table 7: Macroeconomic effects of pension credit and universal benefits (benchmark model)[a]

	Pension credit ($\varphi = 0.4$)				Universal benefit ($\varphi = 0.0$)			
Period	1	3	5	∞	1	3	5	∞
Labor supply	-4.0	-1.8	-0.8	0.3	-5.7	-1.5	-0.1	0.9
Consumption	4.4	-0.4	-3.7	-6.9	4.8	0.5	-3.6	-8.0
Private assets	0.0	-16.5	-25.6	-34.9	0.0	-20.8	-32.6	-43.0
Consumption tax rate[b]	0.6	5.0	5.8	7.0	2.2	4.1	6.4	8.2
Contribution rate MIG[b]	2.4	4.1	4.4	4.7	8.6	8.6	8.6	8.6

[a]Changes in percent over value in initial equilibrium. [b]Changes in percentage points.

The right part of Table 7 reports the complete elimination of means-testing. Again, the adjustment is qualitatively the same as with the pension credit but changes in economic variables are much stronger now. The contribution rate for flat benefits immediately rises to 9.8 percent inducing a fall in labor input by 5.7 percent and a rise in consumption by 4.8 percent. Since all households now receive very generous first-tier benefits, aggregate savings decline much further during the transition. In the long run, consumption tax rate and first tier contribution rate rise by more than eight percentage points each.[10] Finally, note that in both reforms the second tier contribution rate is hardly affected.

Welfare and efficiency Table 8 summarizes welfare consequences for different cohorts in the benchmark model. Compared to Table 6 above, now even the oldest cohorts gain strongly, since they receive higher first tier benefits which compensate for higher consumption taxes. Of course, the rise in benefits depends on second tier pension benefits and accumulated assets, therefore low-skilled pensioners experience higher welfare gains than high-skilled. Welfare gains of the cohort aged 85-89 years in the reform period range from 13.4 percent of remaining lifetime resources (for low-skilled) to 10.2 percent of lifetime resources (for high-skilled). In contrast, cohorts living in the long-run equilibrium experience a welfare decrease of almost 4 percent of remaining lifetime resources. This intergenerational welfare redistribution is further amplified when the taper rate is completely elimi-

[9] Kumru and Piggott (2010) only adjust the MIG contribution rate and compute a long run increase of roughly 9 percentage points.

[10] Kumru and Piggott (2010) compute an increase of about 18.5 percentage points for the MIG contribution rate.

Table 8: Welfare effects of pension credit and universal benefits[a]

Age in	Pension credit ($\varphi = 0.4$)				Universal benefits ($\varphi = 0.0$)			
reform	Skill level			with	Skill level			with
year	low	median	high	LSRA	low	median	high	LSRA
85-89	13.4	11.7	10.2	0.0	21.0	18.4	16.3	0.0
65-69	9.5	6.4	3.4	0.0	18.2	16.6	14.0	0.0
45-49	1.5	0.9	-0.2	0.0	1.7	1.5	0.9	0.0
25-29	-1.4	-1.5	-1.8	0.0	-3.1	-3.0	-2.9	0.0
15-19		-2.3		-1.4		-4.1		-0.4
5-9		-3.1		-1.4		-4.6		-0.4
∞		-3.9		-1.4		-5.5		-0.4

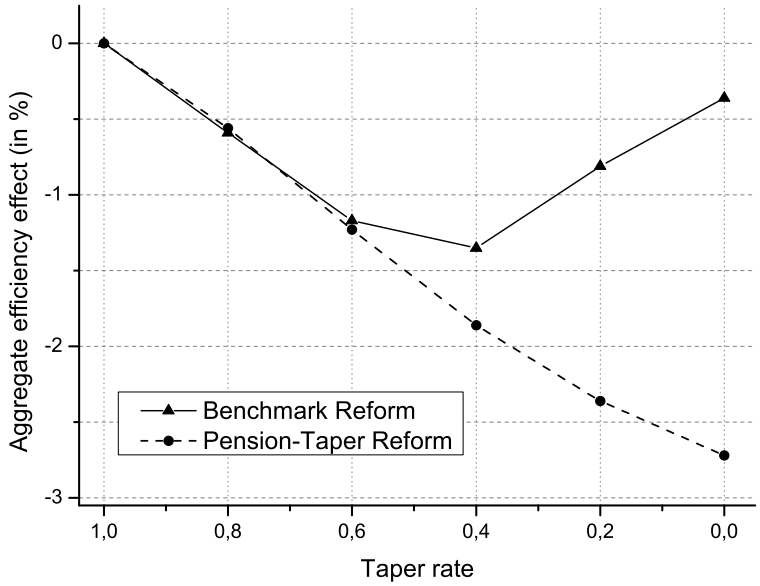
[a]Changes are reported in percentage of initial resources.

nated in the right part of Table 8. The welfare changes amount to 21 and 16.3 percent for the oldest low- and high-skilled in the reform year, respectively. Welfare gains decrease quickly for younger cohorts and cohorts living in the new long-run equilibrium loose 5.5 percent of remaining lifetime resources.

The column marked "with LSRA" of Table 8 reveals the aggregate efficiency effects of both considered policy reforms. In contrast to the previous subsection, aggregate efficiency is now decreasing with the falling taper rate. While now both reforms reduce economic efficiency, the pension credit reform performs worse in terms of economic efficiency than the universal benefit reform. The former induces an aggregate efficiency loss of 1.4 percent while the universal benefit reform reduces aggregate efficiency by roughly 0.4 percent of initial resources. With a (progressive) second-tier pension system in place, insurance benefits against longevity and income risk mostly disappear. Consequently, aggregate efficiency losses of the pension credit are mainly due to higher labor supply and savings distortions. When the taper rate is further reduced to zero, labor supply distortions rise further, but now savings distortions are completely eliminated. Since the latter dominates the former, efficiency losses are dampened compared to the pension credit reform.

Figure 4 reports efficiency effects for alternative taper rate reforms. The line of the benchmark reform shows that aggregate efficiency decreases initially with the taper rate (i.e. higher labor supply distortions dominate lower savings distortions) and then increases again (i.e. higher labor supply distortions are dominated by lower savings distortions). The respective figures for $\varphi = 0.4$ and $\varphi = 0.0$ can be found in Table 8. In order to isolate the differing effects of tests against pension income and private wealth, we present an alternative policy reform where only the taper rate on pension income is reduced while the taper rate on private wealth remains at the pre-reform level of 100%. The line marked as "Pension-Taper reform" compares the resulting aggregate efficiency effects. Means-testing against pension income does not distort savings. Consequently, lowering just the taper rate on pension income does not produce gains from lower savings distortions, only labor supply

Figure 4: Benchmark reform vs. pension taper reform



distortions rise.[11] Figure 4 as well as figure 3 reveals an important result of our study. The optimality of means-testing retirement benefits from an aggregate efficiency perspective does strongly depend on two factors:

- The level of initial insurance provision by the social security system. The more generous a (partially) progressive system, the less are the gains from additional insurance provision.
- The kind of resources pension benefits are tested against. Our results show that strictly universal benefits with respect to private wealth is optimal while the opposite holds true for second pillar pension income.

Our results advocate a reform that completely does away with testing benefits against private wealth but keeps benefits strictly means-tested against second tier pensions. This reform would result in a gain in aggregate efficiency of 0.83 percent, therefore dominating the pension credit as well as a completely universal first pillar.[12]

4.4 Sensitivity analysis I: Alternative basic pension and MIG level

In this section we test the sensitivity of the previous results with respect to alternative BSP-benefits and MIG-levels. The left part of Table 9 shows the macroeconomic reactions, when the BSP-level is increased from zero to 15 percent of average labor income and the taper rate is kept constant at

[11] We have also simulated the sole reduction of the taper rate for asset income while keeping the taper rate on pension income constant. In this case the aggregate efficiency line is always higher than in the benchmark simulation. Since means-testing against asset income strongly distorts savings, higher labor supply distortions are balanced by lower savings distortions initially. When the taper rate on assets is fully removed, the reduction of savings distortions dominates the increase in labor supply distortions so that aggregate efficiency rises by 0.83 percent compared to the initial equilibrium.

[12] Again, detailed simulation results are available upon request.

Table 9: Macroeconomic effects of BSP and MIG level[a]

	Higher BSP ($\underline{b} = 0.15\bar{w}$)				Higher MIG ($\bar{b} = 0.4\bar{w}$)			
Period	1	3	5	∞	1	3	5	∞
Labor Supply	-1.9	-0.3	0.2	0.5	-3.2	-1.7	-0.9	0.2
Consumption	0.9	0.4	-0.7	-2.2	4.0	-0.4	-3.2	-6.5
Private Assets	0.0	-5.8	-9.5	-13.0	0.0	-14.2	-22.3	-32.3
Consumption tax rate[b]	1.2	1.1	1.5	2.6	0.2	2.9	4.7	6.4
Contribution rate MIG[b]	3.6	3.7	3.7	3.7	1.1	2.3	3.1	3.6

[a]Changes in percent over value in initial equilibrium.
[b]Changes in percentage points.

100 percent. Now everybody receives first tier benefits, the basic pension and potentially additional means-tested benefits. Total first tier benefits rise so that the contribution rate increases immediately from 1.2 percent to 4.8 percent. As a result, labor input falls and consumption increases immediately. Lower income tax revenues have to be balanced by higher consumption tax rates. Since young households now receive BSP benefits in the future, they scale down their savings which reduces the stock of private assets and therefore revenues from unexpected bequest significantly. Consequently, the consumption tax has to rise during the transition despite higher tax revenues from labor income.

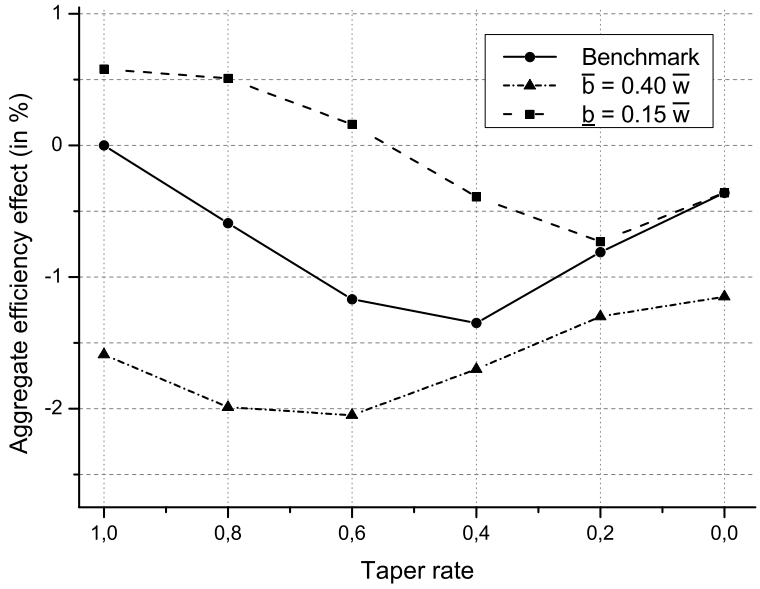
Table 10: Welfare effects of basic pensions vs. MIG level[a]

Age in	Basic pension ($\underline{b} = 0.15\bar{w}$)				Higher MIG ($\bar{b} = 0.4\bar{w}$)			
reform	Skill level			with	Skill level			with
year	low	median	high	LSRA	low	median	high	LSRA
85-89	3.3	3.5	4.2	0.0	13.0	11.0	8.6	0.0
65-69	6.4	7.8	7.1	0.0	7.1	3.9	1.7	0.0
45-49	0.4	0.9	0.8	0.0	1.5	0.5	-0.6	0.0
25-29	-1.2	-1.0	-0.9	0.0	-0.9	-1.2	-1.6	0.0
15-19		-1.4		0.6		-1.9		-1.6
5-9		-1.5		0.6		-2.6		-1.6
∞		-1.8		0.6		-3.5		-1.6

[a]Changes are reported in percentage of initial resources.

The welfare consequences of the basic pension are reported in the left part of Table 10. Not surprisingly, basic pensions induce an intergenerational redistribution from future cohorts towards existing elderly cohorts. Note that high-skilled benefit more than low-skilled since many low-skilled only experience a substitution of means-tested benefits by basic pensions. Younger cohorts are hurt by higher (and rising) tax and contribution rates. Despite higher labor supply distortions, the compensated column reports an efficiency gain of 0.6 percent of aggregate resources. This is quite surprisingly (on first sight), since we also observe a reduction in aggregate savings. However, the observed lower savings are purely due to income effects, i.e. people save less since future paygo benefits have increased. Savings distortions, however, have been reduced due to the reduction of means-tested benefits. Since the reduction of savings distortion dominates the increase of labor supply distortions,

Figure 5: Sensitivity analysis I - BSP vs. MIG level



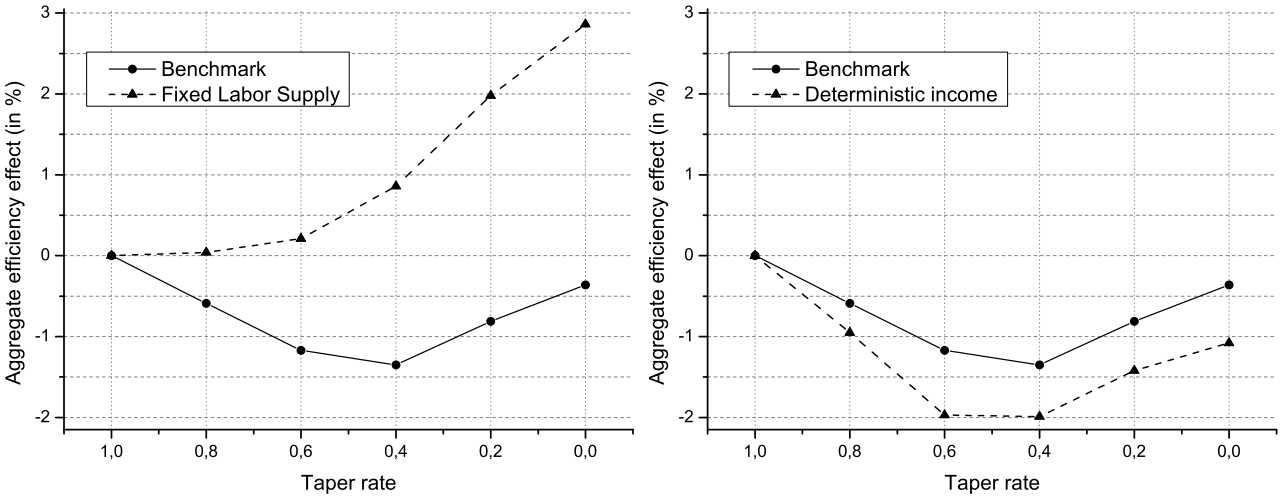
the LSRA column reports an aggregate efficiency gain. This again highlights the irrelevance of long-run welfare for economic efficiency as well as the significance of savings distortions compared to labor supply distortions!

The right part of Table 9 reports the macroeconomic consequences when the basic pension level is kept at zero, but the income guarantee is increased from 30 to 40 percent of average income. As in the previous experiment this reform implies an increase of first tier benefits and rising contribution rates. However, in this case means-tested benefits also become more generous so that savings distortions increase. Consequently, although contribution rates rise as in the previous experiment, private savings are crowded out much stronger than before. The initial tax and contribution rate increase is dampened but due to declining bequest and consumption outlays long-run consumption taxes are much higher than in the previous simulation.

The right part of Table 10 reveals the same qualitative intergenerational welfare redistribution pattern as in the previous simulation. Note, however, that low-skilled elderly now benefit much stronger than high-skilled elderly. The redistribution towards current elderly is much stronger than before, since they can increase their benefits by running down private assets. Long-run welfare losses increase (compared to the previous simulation) since consumption taxes are much higher now. Finally, the LSRA column now reports an aggregate welfare loss of 1.6 percent of aggregate resources. This is due to both higher labor supply and higher savings distortions. Therefore, two policies with seemingly quite similar macroeconomic and welfare consequences perform completely different in terms of economic efficiency! While with the first reform case savings distortions decrease, they increase with the second reform.

In contrast to Sefton and van de Ven (2009) we do not intend to find an optimal combination of MIG-level and taper rate. In Figure 5 we simply compare the aggregate efficiency consequences when the taper rate is successively reduced from $\varphi = 1.0$ to $\varphi = 0.0$, given the arbitrarily chosen BSP and MIG levels. The two efficiency figures reported in Table 10 can be found as the starting points on the left. For better comparison we also report the aggregate efficiency results in the benchmark simulation (i.e. with $\underline{b} = 0$ and $\overline{b} = 0.3\bar{w}$). With respect to the positive BSP-level, we have already explained the

Figure 6: Sensitivity analysis II - fixed labor supply and deterministic income



reduction in the savings distortion for $\varphi = 1.0$. When the taper rate declines (starting from $\varphi = 1.0$), the savings distortion increases initially (since more retired receive benefits) and then it declines to zero (for $\varphi = 0.0$). Implicitly, the means-tested pension benefit turns to a flat benefit when the taper rate is reduced to zero. As long as $\overline{b} > \underline{b}$, the BSP-level has no effect at all since all retirees receive the guaranteed minimum pension for $\varphi = 0.0$.

With the increased MIG-level, the resulting efficiency losses are all higher than in the benchmark simulation. The MIG increases induces the strongest efficiency loss for a taper rate of $\varphi = 1.0$ due to rising savings distortions.[13] With lower taper rates, the MIG increase produces weaker savings distortions. With $\varphi = 0.0$ savings distortions completely disappear so that the increase in $\overline{b}$ only produces higher labor supply distortions due to rising contribution rates.

4.5 Sensitivity analysis II: Labor supply elasticity and income uncertainty

This subsection discusses the sensitivity of our results with respect to the chosen preference parameters and the income process. Of course, since aggregate efficiency decreases due to rising labor supply distortions, any reduction (increase) of labor supply elasticity will improve (deteriorate) the aggregate efficiency effects of the considered reforms. In order to quantify the range of possible results we completely eliminate labor supply effects by keeping labor supply of the initial equilibrium constant after the reforms.[14] Consequently, a higher contribution rate as a result of lower taper rates within the means-test regime does not distort labor anymore.

The left part of figure 6 shows that now the resulting aggregate efficiency consequences are positive for all considered taper rates. Initially they rise only slowly since higher savings distortions neutralize insurance benefits. When the taper rate is reduced significantly, they increase strongly since now both effects go in the same direction. With some cautious interpretation the vertical difference between the two lines (benchmark vs. fixed labor supply) indicates the magnitude of the labor supply distortion induced by a given system.

[13] Here we refer to the vertical difference between the benchmark graph and the graph for $\overline{b} = 0.4\overline{w}$.

[14] More technical details are available upon request.

Next, we want to isolate the insurance benefits of an enlargement of the system by lowering taper rates. In order to do so, we simulate the model with a deterministic income process, i.e. all agents of a given skill class remain on the respective mean productivity profile throughout their life cycle and the variance of the productivity shock σ^2 is zero. That way, an enlargement of the system does not provide additional insurance against income risk, even though there are still insurance effects against longevity risk. Consequently, the resulting efficiency effects due to the reduction of the taper rate should be lower than in the benchmark. This is confirmed by the right panel in figure 6 below. Not surprisingly, simulation exercises with risk-neutral households reveal very similar results.

5 Conclusion

Previous studies which have analyzed the long run effects of means-testing retirement benefits in the UK found strong support for high taper rates and argue that means-testing should play a significant role in the UK pension system. A system that provides universal retirement benefits is altogether discarded as welfare deteriorating. In a model featuring both productivity and longevity risk calibrated to the UK economy, we reassess the question whether public retirement provision should be means-tested.

Our results highlight that policy recommendations should not be based on long run welfare considerations as the latter represent a mixture of efficiency and intergenerational redistribution effects. A consistent and comprehensive approach has to compensate the intergenerational income redistribution in order to isolate aggregate efficiency consequences. While we are able to reproduce the results of previous studies arguing that a decrease in the taper rate leads to a decline in long run welfare, we show that aggregate efficiency considerations may lead to opposite policy recommendations. Based on our measure of economic efficiency, our study highlights severe savings distortions induced by means-testing of benefits against private wealth. In this case benefits from decreasing savings distortions and increased insurance provision dominate higher labor supply distortions. Consequently, lower taper rates within the means-test lead to gains in aggregate efficiency.

However, we also show that testing pension benefits against pension income from other pillars is beneficial from an efficiency point of view. As pension testing does not distort the accumulation of savings while helping to keep contribution rates low, a reduction in the pension taper rate only results in rising labor supply distortions that cannot be offset by additional insurance gains from the larger system. Consequently, our results show that the optimal taper rate strongly depends on what resources benefits are tested against. Of course, it also depends on the generosity of the existing progressive social security system as well as the underlying uncertainty structure.

Table 11 gives a final overview of the performance of selected reforms of the MIG in terms of economic efficiency. In our simulation exercises we find the 2003 pension credit reform of the UK public pension system to be efficiency deteriorating as additional labor supply distortions are not offset by gains from reduced savings distortions and a higher insurance provision. However, we show that an alternative reform that lowers the taper rate on private wealth to zero but strictly tapers benefits against second pillar pension income to be efficiency enhancing, dominating all partially means-tested as well as universal systems from an efficiency point of view. Such a program would reduce savings distortions significantly while keeping the increased labor distortions in check.

The line of argument we have pursued suggests several avenues for future research. First, one of

Table 11: Comparison of selected reform options, benchmark model

	Taper rate Pension income	Taper rate Private Wealth	Aggregate efficiency effect (in %)
Minimum Income Guarantee (Initial Equilibrium)	1.0	1.0	
Pension Credit	0.4	0.4	-1.4
Universal Benefits	0.0	0.0	-0.4
Pension-taper reform	0.0	1.0	-2.7
Asset-taper reform	1.0	0.0	+0.8
Higher MIG-level ($\bar{b} = 0.4\bar{w}$)	1.0	1.0	-1.6
Basic Pension ($\underline{b} = 0.15\bar{w}$)	1.0	1.0	+0.6

the central arguments in favor of social security and means-testing is that people are not rational enough to save for their own retirement. Feldstein (1987) examines the conditions when social security should be means-tested with myopic households. A natural extension of the present approach would therefore be to quantify how non-rational agents change the above conclusions. Second, although we have provided some sensitivity analysis with respect to income uncertainty, our analysis still incorporates too much homogeneity of agents. It would be very useful to consider very specific (and very rare) risks such as health or disability shocks which lead to long lasting (or even complete) productivity losses. As a consequence the tails of the distribution of second tier benefits would be broader and more realistic. A final issue concerns the application of the above approach to the institutional settings of other countries. Most countries operate some form of means-tested social security system but the designs vary substantially.

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