Redistributive effects of pension reforms: Who are the winner s and losers?

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Motivation

- **Negative and increasing correlation between mortality rates and** higher socieconomic status (**SES**) by occupation, education, income, and wealth (Preston and Elo 1995, Lleras-Muney 2005, Waldron 2007, Manchester and Topoleski 2008, Luy et al. 2011, Olshansky et al. 2012, Chetty et al. 2016)

  ▸ Figure by income ▸ Figure by education

- Heterogeneity in life expectancy by SES and its **implication on pension schemes** (Ayuso et al. 2016, Auerbach et al. 2017, R. D. Lee and Sánchez-Romero 2020, Palmer and Gosson de Varennes 2019, Haan et al. 2020, Holzmann et al. 2019, and Sánchez-Romero and Prskawetz 2023)

  Are pension systems becoming more **regressive**?

  Do low-SES groups **subsidize** pension benefits of high-SES groups?

  ▸ Figure pension regressivity

- **Individuals may react to changes in the pension system** (Pestieau and Racionero 2016; Sánchez-Romero, R. D. Lee, et al. 2020; Sánchez-Romero and Prskawetz 2020), which may lead to unwanted results.

  Study redistributive properties of pension reform over the **whole lifecycle** not just at time of retirement.

Part I

The model

Dynamic general equilibrium model with overlapping generations

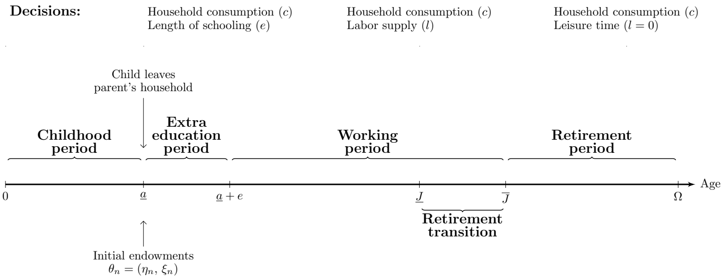
- **Households**:
  - Population: **500** cohorts $\times$ **25** heterogeneous agents (**initial characteristics**) per cohort
  - Control variables: Consumption (c), labor supply (l), and education (e)
  - State variables: Financial wealth (k), pension points (pp), human capital (h)

- **Firm**:
  - Demands K, L using a Cobb-Douglas technology and produces the final good

- **Government**:
  - Provides public goods and services, collects taxes, and runs the pension system

Household head problem

- Agent's timeline:



A general framework to model pension systems I/II

- **Pension benefit (b):**

$$b_a = \max\left\{\text{pp}_a \cdot \varphi(\text{pp}_a) \cdot \lambda_a, b^{\text{min}}\right\} \cdot \rho \tag{1}$$

Pension repl. rate	$\varphi(\text{pp}_a) = \varphi$ (with $\varphi = 0.80$ in the benchmark)
Adjustment factors	λ_a corrects for years worked and retirement age
Minimum pen. ben.	$b^{\text{min}} = \varphi(\text{pp}^{\text{min}}) \cdot \text{pp}^{\text{min}}$
Sustainability factor	$\begin{cases} \rho = 1 \text{ and } 0.70\mathcal{S} = \tau^s wL & \text{if } \tau^s < \overline{\tau^s}, \\ \rho < 1 \text{ and } 0.70\mathcal{S} = \overline{\tau^s} wL & \text{if } \tau^s \geq \overline{\tau^s}. \end{cases}$

A general framework to model pension systems II/II

- **Pension points (*pp*) dynamics**

$$\text{pp}_{a+1} = [\alpha_J(l_a) + (1 - \alpha_J(l_a))\mathcal{R}_a]\,\text{pp}_a + \phi^p(n)\text{PBI}(y_a; \mathbf{p}_a),$$

Capitalization index	$\mathcal{R}_a = (1 + i_a)/\bar{\pi}_a$
Fraction retired	$\alpha_J(l_a) = \max(0, 1 - l_a/\bar{L})$ for $a \geq \underline{J}$
Accrual rate	$\phi^P(n) = \frac{1.00}{n}$
Pensionable income years	$n \in [15, 45]$ based on historical and current laws
Pensionable income	$\mathbf{p}_a = \{(p_1, p_2, \ldots, p_n) \in \mathbb{R}^n_+ : p_1 > p_2 > \ldots > p_n\}$
Pension base increment	$\text{PBI}(y_a; \mathbf{p}_a) = \max\{y_a - p_n, 0\}$

Population

- Historical and projected Austrian demography (from XIX century on)
- Exogenous differences in mortality and fertility (consistent with the pop. structure)

Education level, e	Primary	Secondary	College
Highest learning ability	0	+3.5	+5
Average learning ability	-5	-1.5	0 (Ref.)
Lowest learning ability	-10	-6.5	-5

Table: Fixed differences in life expectancy at age 15 by educational attainment and learning ability level. Note: Differences based on Goujon et al. 2016, Chetty et al. 2016, and Murtin et al. 2022.

- Each cohort is comprised of $\mathcal{N} = 25$ different representative agents that differ in terms of their permanent unobservable characteristics: i) innate learning ability (ξ_n) and ii) schooling effort (θ_n).
- Unobservable characteristics calibrated (using Bayesian melding) to replicate the historical evolution of the educational transition in Austria Figure Parametrization/Calibration

Part II

Policy analysis

Pension reforms

Pension system	Pension rule			
	Working years wy	Retirement age J^N	Replacement rate φ	Soc. contr. rate
Reform 0: Benchmark or status quo	45	65	80%	τ_S
Reform 1: Sustainability factor (SF)	–	–	–	$\overline{\tau}_S \leq 22\%$
Reform 2: SF + Delayed retirement age	50	70	80%	$\overline{\tau}_S \leq 22\%$
Reform 3: SF + Same work length	45		80%	$\overline{\tau}_S \leq 22\%$
Reform 4: SF + Ayuso-Bravo-Holzmann (ABH) proposal	–	–	$80\% \frac{\overline{\text{LE}}}{\text{LE(pp)}}$	$\overline{\tau}_S \leq 22\%$
Reform 5: SF + Sanchez-Prskawetz (SP) proposal†	–	–	$80\% + \nu \frac{\overline{\text{pp}} - \text{pp}}{\text{pp}}$	$\overline{\tau}_S \leq 22\%$
Reform 6: SF + Front-loading	–	–	$100\% \cdot e^{-1\%(a-J)}$	$\overline{\tau}_S \leq 22\%$

† $\nu = \frac{\text{LE}(\text{pp}^{max}) - \text{LE}(\text{pp}^{min})}{\text{LE}(\text{pp}^{max})} \Big/ \frac{\text{pp}^{max} - \text{pp}^{min}}{\text{pp}^{max}}$.

Parametric components

Macroeconomic impact

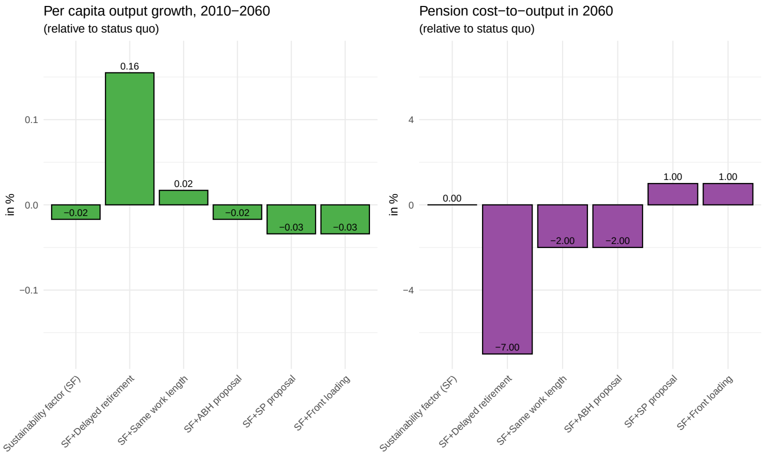


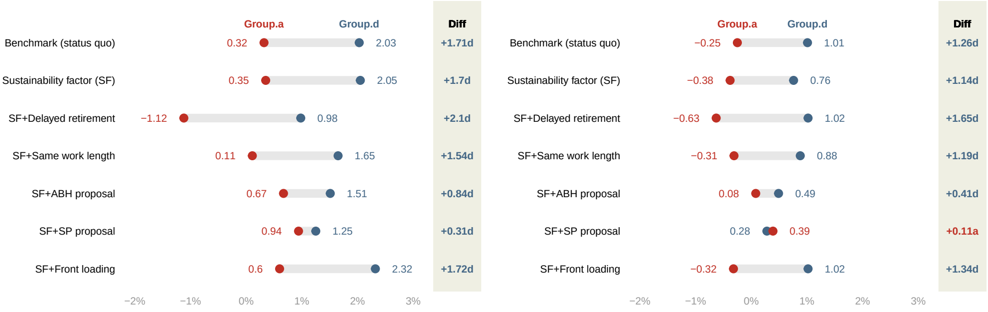
Figure: Macroeconomic impact of pension reforms (mean values)

Cohort groups

Cohort group				
Group a. Low learning ability- high schooling effort	Less than high school	Early entrance Early retirement Longer than the avg. working life	Life expectancy 5 years lower than the average	Lifetime consumption 50% lower than that of the average worker
Group d. High learning ability- low schooling effort	University	Late entrance Late retirement Shorter than the avg. working life	Life expectancy 3 years higher than the average	Lifetime consumption 200% higher than that of the average worker

Redistributive effects: Internal rate of return (IRR)

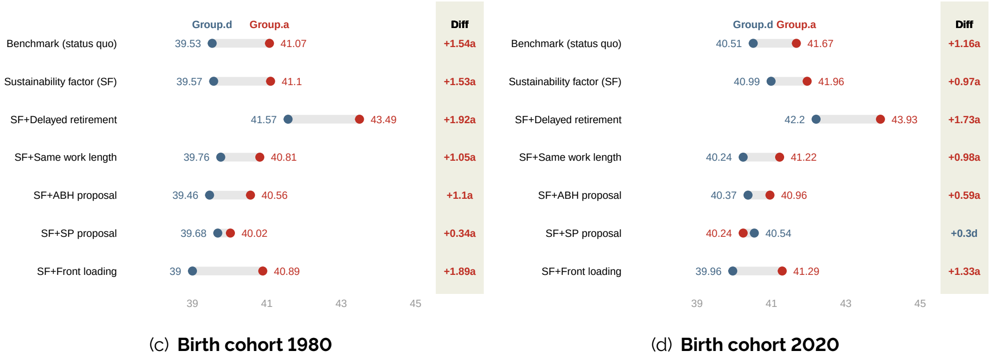
DEFINITION: the *IRR* is the expected rate of return received from contributing to the pension system



(a) **Birth cohort 1980** (b) **Birth cohort 2020**

Notes: (**Group.a**) low learning ability and high schooling effort, (**Group.d**) high learning ability and low schooling effort

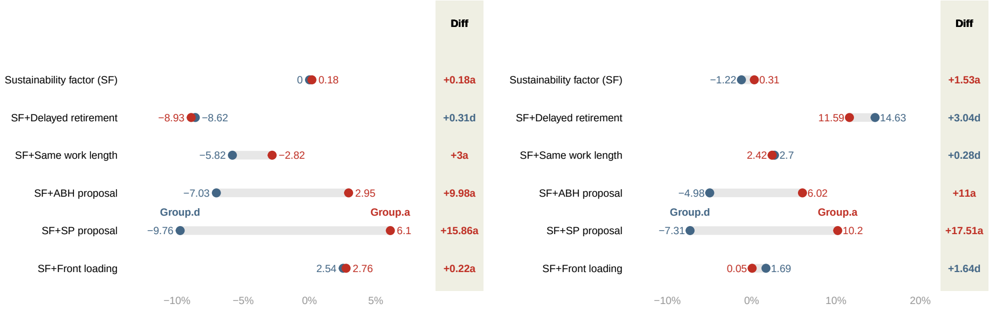
Impact on labor supply: Years worked



Notes: (**Group.a**) low learning ability and high schooling effort, (**Group.d**) high learning ability and low schooling effort

Impact on welfare: Veil of ignorance

DEFINITION: the percentage change in the baseline consumption path that makes the expected lifetime utility in the status quo equal to the expected lifetime utility in the pension reform



(e) **Birth cohort 1980**

(f) **Birth cohort 2020**

Notes: (**Group.a**) low learning ability and high schooling effort, (**Group.d**) high learning ability and low schooling effort

Main conclusions

- In a non-progressive PAYG pension system that is almost actuarially fair, we obtain
  1. agents with high SES receive a higher IRR than those with low SES
  2. population ageing will lead to a decline in the IRR for all SES groups
  3. despite the decline in IRR, highly-educated workers will continue receiving an IRR that doubles that of low-educated workers

- Pension reforms:

  No one-size-fits-all solution

Main conclusions

Pension system	Pros	Cons
Reform 1: Sustainability factor (SF)	Pension sustainability; Labor supply; Lower inequality in labor, IRR, and welfare	Lower IRR
Reform 2: SF + Delayed retirement age	Pension sustainability; Labor supply; Economic growth; Birth cohort 2020	Highest inequality in labor, IRR, and welfare; Birth cohort 1980
Reform 3: SF + Same work length	Lower inequality in labor; Birth cohort 2020	Labor supply; Economic growth; short labor histories; Birth cohort 1980
Reform 4: SF + ABH proposal	Less inequality in labor, IRR, and welfare; Short-lived and poorer worker	Labor supply; Education; Economic growth; Long-lived and richer worker
Reform 5: SF + SP proposal	Less inequality in labor, IRR, and welfare; Short-lived and poorer worker	Labor supply; Education; Economic growth; Long-lived and richer worker
Reform 6: SF + Front-loading	Higher IRR; Birth cohort 1980	Labor supply; Economic growth; More inequality in labor, IRR, and welfare

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SCAN ME

Unequal life expectancy (LE) by socioeconomic status (income)

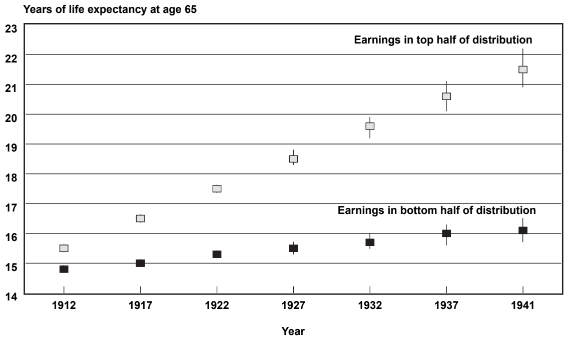

Figure: Cohort life expectancy at age 65 (and 95 percent confidence intervals) for US male Social Security-covered workers, by selected birth years and earnings group *Source*: Waldron (2007)

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Unequal life expectancy (LE) by socioeconomic status (education)

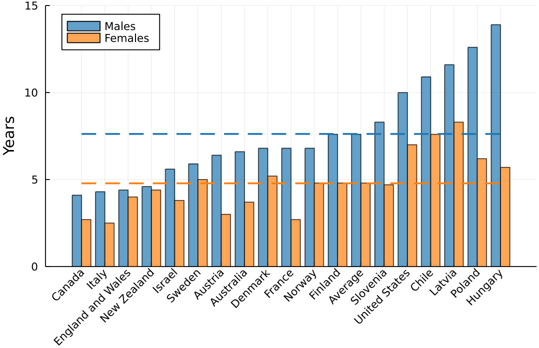

Figure: Life expectancy gap between the highest and the lowest educational groups at the age of 25. *Source*: Murtin et al. (2021)

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Are pension systems becoming more regressive?

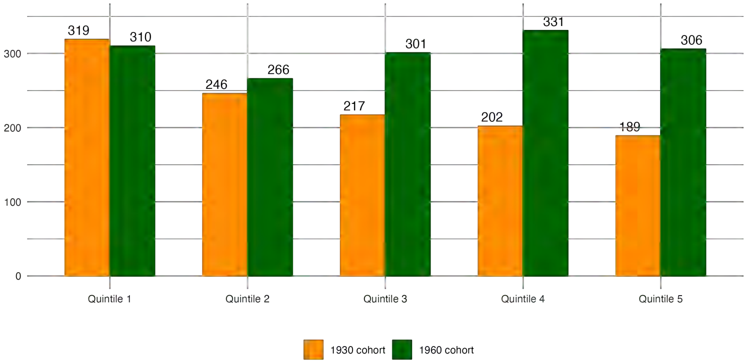

Figure: Average total lifetime net benefits at age 50 for males (present value in thousands of dollars), by lifetime earnings quintile. Source: National Academy of Sciences, Engineering, and Medicine (2015). The Growing Gap in Life Expectancy by Income: Implications for Federal Programs and Policy Responses.

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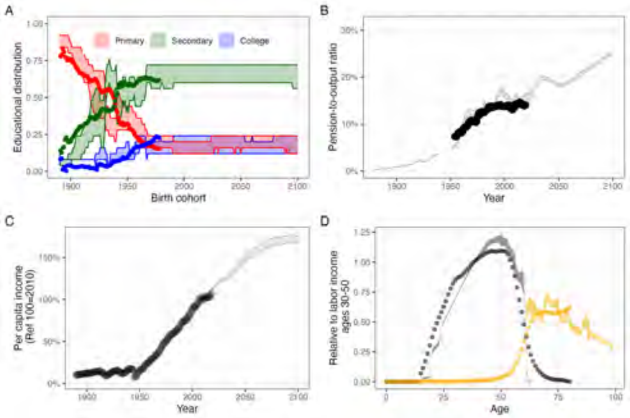
Parametrization/Calibration



Model fit

- **First-stage**: Parameter values on human capital and preferences using the literature
- **Second-stage**: Evolution of the educational attainment

→
Permanent unobserved heterogeneity, which is the same across cohorts, and is estimated using the Bayesian Melding Method with the IMIS algorithm

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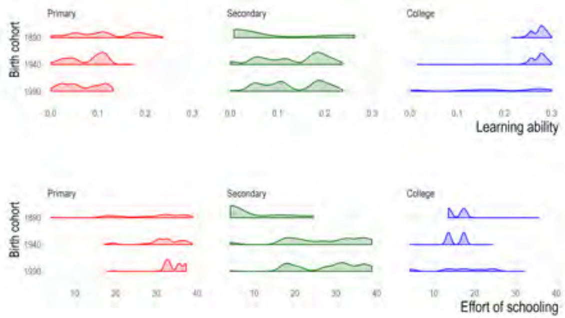
Calibration: Characteristics of the educational groups



Negative selection

- **Primary educated agents**: Younger cohorts → More homogeneous with higher effort of schooling (trapped)
- **College educated agents**: Younger cohorts → More heterogeneous

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Effective Tax on Labor

Formula:

$$\tau^L_{a,\cdot} = \frac{\tau^c_a + \tau^l_a + \tau^S_{a,\cdot} + \tau^J_{a,\cdot}(-\alpha'_J(l_{a,\cdot}))}{1 + \tau^c_a}$$

τ^c	Consumption tax
τ^l	Labor income tax
τ^S	Eff. soc. contrib. rate
$\tau^J_{a,\cdot}(-\alpha'_J(l_{a,\cdot}))$	Eff. retirement tax

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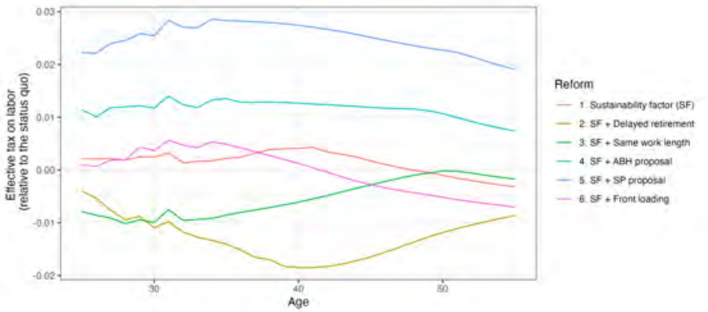

Figure: Age profile of the difference in the effective tax on labor between the pension reforms and the status quo. Birth cohort 2020. *Source: Authors' calculations using the model. Notes: Each panel shows the average value for each simulation across the 200 models.*

Household problem (FOCs)

The first-order conditions (FOCs) of this problem are:

$$U_c(c_{a,e,n}, l_{a,e,n}) = \beta \pi_{a+1,e,n} \frac{\partial V(\mathbf{x}_{a+1,e,n})}{\partial k_{a+1,e,n}} (1+\tau_a^c), \tag{2}$$

$$-U_l(c_{a,e,n}, l_{a,e,n}) = U_c(c_{a,e,n}, l_{a,e,n}) \left(1 - \tau_{a,e,n}^L\right) w_{a,e,n}, \tag{3}$$

where $\tau_{a,e,n}^L = \frac{\tau_a^c + \tau_a^l + \tau_{a,e,n}^S + \tau_{a,e}^J(-\alpha_J'(l_{a,e,n}))}{1+\tau_a^c}$ is the effective labor income tax. Notice that the effective labor income tax includes the effective social security tax rate at the intensive margin, denoted by $\tau_{a,e,n}^S$, and the retirement tax/subsidy rate, denoted by $\tau_{a,e,n}^J$, which are given by

$$\tau_{a,e,n}^S = \tau_a^s(1-\tau_a^l) - \mathcal{P}_{a+1,e,n}\phi^p \mathrm{PBI}'(y_{a,e,n}), \tag{4}$$

$$\tau_{a,e,n}^J = (1-\tau_a^l)\left(1+\varepsilon_{b,\alpha_J,e,n}\right)\frac{b_{a,e,n}}{w_{a,e,n}} - (\mathcal{R}_a - 1)\frac{\mathrm{pp}_{a,e,n}\mathcal{P}_{a+1,e}}{w_{a,e,n}}. \tag{5}$$

The term $\varepsilon_{b,\alpha_J,e,n}$ is the retirement-elasticity of pension benefit; i.e. $\frac{1}{b_{a,e,n}}\frac{\partial b_{a,e,n}}{\partial l_{a,e,n}}\frac{\alpha_J(l_{a,e,n})}{\alpha_J'(l_{a,e,n})}$. Eqs. (4)-(5) coincide with the effective social security tax rate and the retirement tax/subsidy rate in Sánchez-Romero, Lee, and Prskawetz (2020).

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Household problem (ECs)

The envelope conditions (ECs) imply that:

(Euler condition) $$U_c(c_{a,e,n}, l_{a,e,n}) = R_{a+1,e,n}\beta\pi_{a+1,e,n}\frac{1+\tau^c_a}{1+\tau^c_{a+1}}U_c(c_{a+1,e,n}, l_{a+1,e,n}), \quad (6)$$

(Value of pension points) $$R_{a,e,n}\mathcal{P}_{a,e,n} = (1-\tau^l_a)\frac{\partial b_{a,e,n}}{\partial \mathrm{pp}_{a,e,n}}\alpha_J(l_{a,e,n}) + \mathcal{P}_{a+1,e,n}\frac{\partial \mathrm{pp}_{a+1,e,n}}{\partial \mathrm{pp}_{a,e,n}}, \quad (7)$$

(Value of human capital) $$R_{a,e,n}\mathcal{H}_{a,e,n} = \left(1-\tau^l_a-\tau^S_{a,e,n}\right)\frac{y_{a,e,n}}{h_{a,e,n}} + \mathcal{H}_{a+1,e,n}\frac{\partial h_{a+1,e,n}}{\partial h_{a,e,n}}, \quad (8)$$

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Austrian demography

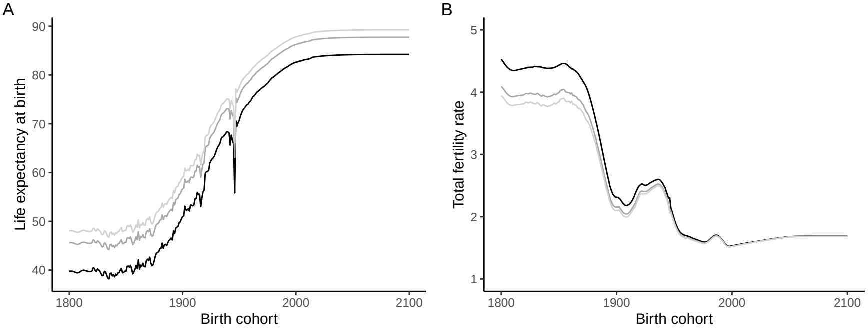

Figure: Simulated average vital rates by educational attainment for birth cohorts born between 1800 and 2100 in Austria: Primary or less (black), secondary (dark gray), and college (light gray).
Source: Differences in life expectancy and in total fertility rate across the educational groups are based on assumptions taken from Goujon et al. 2016. The average life expectancy and the total fertility rate across educational groups are based on historical reconstructions of the Austrian population done by the authors using data from Rivic 2019. *Notes*: Panel A shows the life expectancy at birth by educational attainment. Panel B shows the total fertility rate (TFR) by educational attainment.

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Impact of pension reforms on consumption

Table: Impact of pension reforms on lifetime consumption relative to the average of the same birth cohort in the status quo (Average=100)

Cohort	Learning ability & schooling effort $\xi - \eta$	Bench. **0.**	SF **1.**	(**1.**) – (**0.**)	Absolute difference with respect to reform **1.** (the sustainability factor, SF)				
					Pension reform (P.R.)				
					2.	**3.**	**4.**	**5.**	**6.**
1980	1. low-high	54.07	54.15	0.08	-0.97	-1.12	-0.41	-1.88	0.45
	2. low-low	64.68	64.81	0.13	-1.03	-1.35	-0.65	-1.79	0.44
	3. high-high	107.56	107.74	0.18	-2.35	-2.04	-2.34	-3.86	0.84
	4. high-low	200.13	199.70	-0.43	-4.46	-8.25	-11.59	-15.59	1.83
2020	1. low-high	55.24	55.06	-0.18	3.03	-0.01	0.30	0.03	-0.07
	2. low-low	65.59	65.36	-0.23	4.07	0.02	0.12	-0.60	0.20
	3. high-high	107.77	107.06	-0.71	5.63	0.27	-1.19	-2.54	0.24
	4. high-low	196.79	194.68	-2.11	12.44	2.04	-6.95	-10.72	2.27

Notes: '**low**' means lower than the median and '**high**' means higher than the median. **0.** Benchmark (status quo), **1.** Sustainability factor (SF), **2.** SF+Delayed retirement, **3.** SF+Same work length, **4.** SF+ABH proposal, **5.** SF+SP proposal, **6.** SF+Front loading.

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Impact of pension reforms on education

Table: Impact of pension reforms on the additional years of schooling by unobservable characteristics (in years)

Cohort	Learning ability & schooling effort $\xi - \eta$	Bench. **0.**	SF **1.**	(**1.**) – (**0.**)	Absolute difference with respect to reform **1.** (the sustainability factor, SF) Pension reform (P.R.) **2.**	**3.**	**4.**	**5.**	**6.**
1980	1. low-high	0.50	0.50	0.00	0.00	0.00	-0.01	-0.09	0.00
1980	2. low-low	4.21	4.22	0.01	0.00	-0.20	-0.05	-0.26	-0.04
1980	3. high-high	3.79	3.79	0.00	0.00	0.00	0.00	-0.01	0.00
1980	4. high-low	7.54	7.51	-0.03	0.00	-0.36	-0.42	-0.60	0.02
2020	1. low-high	0.53	0.53	0.00	0.01	0.00	-0.02	-0.02	0.00
2020	2. low-low	4.32	4.31	-0.01	0.12	-0.15	0.01	-0.06	0.08
2020	3. high-high	3.80	3.80	0.00	0.02	0.01	-0.02	-0.02	0.01
2020	4. high-low	7.57	7.56	-0.01	0.06	0.02	-0.19	-0.40	0.04

Notes: '**low**' means lower than the median and '**high**' means higher than the median. **0.** Benchmark (status quo), **1.** Sustainability factor (SF), **2.** SF+Delayed retirement, **3.** SF+Same work length, **4.** SF+ABH proposal, **5.** SF+SP proposal, **6.** SF+Front loading.

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Impact of pension reforms on retirement

Table: Impact of pension reforms on the retirement age (in years)

Cohort	Learning ability & schooling effort $\xi - \eta$	Bench. **0.**	SF **1.**	(**1.**) – (**0.**)	Absolute difference with respect to reform **1.** (the sustainability factor, SF) Pension reform (P.R.) **2.**	**3.**	**4.**	**5.**	**6.**
1980	1. low-high	58.12	58.12	0.00	2.40	-0.25	-0.07	-0.10	-0.11
	2. low-low	58.66	58.68	0.02	2.11	0.12	-0.19	-0.43	-0.40
	3. high-high	58.59	58.59	0.00	2.11	0.07	0.04	0.06	-0.35
	4. high-low	59.70	59.71	0.01	1.73	0.43	0.12	0.32	-0.46
2020	1. low-high	58.15	58.36	0.21	2.25	-0.38	-0.20	-0.28	-0.25
	2. low-low	58.81	59.25	0.44	1.76	-0.02	-0.36	-0.65	-0.41
	3. high-high	58.90	59.28	0.38	1.74	-0.05	-0.07	-0.12	-0.38
	4. high-low	60.31	60.78	0.47	1.36	-0.17	0.07	0.20	-0.44

Notes: '**low**' means lower than the median and '**high**' means higher than the median. **0.** Benchmark (status quo), **1.** Sustainability factor (SF), **2.** SF+Delayed retirement, **3.** SF+Same work length, **4.** SF+ABH proposal, **5.** SF+SP proposal, **6.** SF+Front loading.

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Frame Title

Table: Model parameters

Parameter	Symbol	Value	Parameter	Symbol	Value
Preferences			**Human capital**		
Marginal schooling cost†	$[\overline{\eta}, \underline{\eta}]$	[0,40]	Learning ability†	$[\overline{\xi}, \underline{\xi}]$	[0.00,0.30]
Labor elasticity	σ_L	0.40	Initial human capital	$h_{\underline{a}}$	1.00
Labor weight	α_L	866.28	Returns to education	γ_h	0.65
Max. labor supply before retirement	$\overline{L}$	0.4	Experience		
Leisure in retirement	v_0	77.0552	Age	β_1	0.070
	v_1	-1.9425	Age-squared	β_2	0.00092
Subjective discount factor	β	1.02			
			Production		
			Capital depreciation rate	δ_K	0.05
			Capital share	α_Y	0.375
			Productivity growth rate	g_t^A	see Fig. ??

† Parameter calibrated using the Bayesian melding method.

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Unobservable characteristics

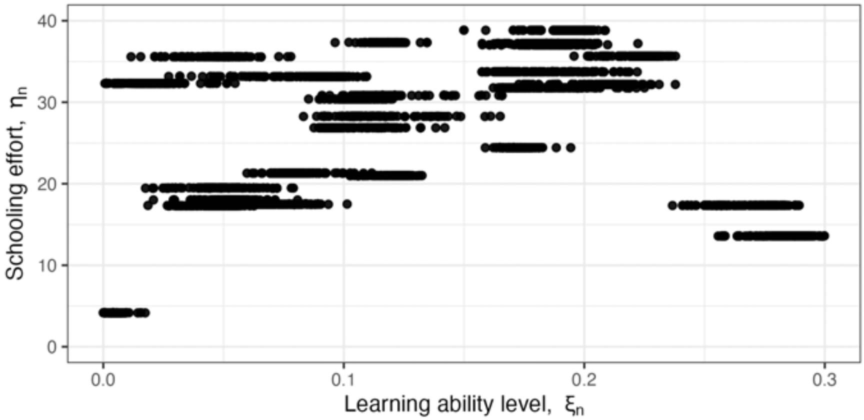

Figure: Correlation matrix of the initial endowments ϑ for the $\mathcal{N} = 25$ agents of each cohort. *Notes*: Dots represent the initial endowments of the most likely set of parameters obtained from the posterior distribution.

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Parametric components of the pension systems

Table 3. Parametric reforms of the pension system

Parameter	Symbol	Benchmark (status quo)	Pension reform: (1) Sustainability factor	(2) Delayed retirement	(3) Same work length	(4) ABH proposal	(5) SP proposal	(6) Front loading
Pension benefits	b_a	$\max(\lambda_a \varphi(pp_a) pp_a,\ b^{min})\rho$						
Working years (full pension)	wy	45	–	50	–	–	–	–
Pension points	pp_a	$pp_{a+1} = [\alpha_J(l_a) + (1-\alpha_J(l_a))\mathcal{R}_a]pp_a + \phi^p \mathrm{PBI}(y_a)$						
Capitalization index	$\mathcal{R}_a$	Growth rate of the total wage bill						
Pensionable income years	n	wy						
Accrual rate	ϕ^p	$1/n$						
Pensionable income	p_a	$p_a = \{(p_1, \ldots, p_n) \in \mathbb{R}_+^n ; p_1 \geqslant \cdots \geqslant p_n\}$ (with $p_{a+1} = [\alpha_J(l_a) + (1-\alpha_J(l_a))\mathcal{R}_a]p_a$)						
Pension base increase	$\mathrm{PBI}(y_a)$	$\max(y_a - p_n, 0)$ (if $y_a > p_n$ replace p_n for y_a in p_a)						
Proportion of people retired	$\alpha_J(l_a)$	$\begin{cases} 1 - l_a/\bar{L} & \text{if } a \geqslant \underline{J} \\ 0 & \text{otherwise} \end{cases}$						
Minimum retirement age	$\underline{J}$	62	–	67	59	–	–	–
Normal retirement age	J^N	65	–	70	NA	–	–	–
Late retirement age	$\bar{J}$	68	–	73	NA	–	–	–
Replacement rate	$\varphi(pp_a)$	0.80	–	–	–	$0.80\frac{\overline{LE}}{LE(pp_a)}$	$0.80 + \nu\frac{\overline{pp}_a - pp_a}{pp_a}$	1.0
Pension adjustment factor	λ_a	$\sum_{i=\underline{J}}^{a-1} (\lambda^{fl})^{a-1-i} \lambda_i^{yc} \lambda_i^{ra} \frac{\Delta l_{i+1}}{\bar{L}-l_i}$ with $\lambda_{\underline{J}} = 0$						
Years contributed	$\lambda_i^{yc} = 1 + \phi^{yc} f(yc_{\underline{J}} + (i - \underline{J}) - wy)$ with $yc_{i+1} = yc_i + (l_i/\bar{L})$	$\phi^{yc} = 1/wy$ $f(x) = x$	–	–	$\phi^{yc} = 3.3/wy$ $\min(0, x)$	–	–	–
Retirement age	$\lambda_i^{ra} = \begin{cases} 1 - \mathrm{pen}(J^N - i) & \text{if } \underline{J} \leqslant i \leqslant J^N \\ 1 + \mathrm{rew}(i - J^N) & \text{if } J^N < i \leqslant \bar{J} \end{cases}$	pen = 0.051 rew = 0.042	–	–	pen = 0.0 rew = 0.0	–	–	–
Front loading	$\lambda^{fl} = (1 - r_b)$	$r_b = 0\%$	–	–	–	–	–	$r_b = 1\%$
Minimum pension	b^{min}	$pp^{min} = \frac{1}{0.83}\bar{y}$	–	–	–	–	–	–
Sustainability factor	ρ	1.0	$\leqslant 1.0$	$\leqslant 1.0$	$\leqslant 1.0$	$\leqslant 1.0$	$\leqslant 1.0$	$\leqslant 1.0$

Notes: – Same value as in the benchmark.

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