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Pension Funding and Human Capital

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Earnings related pension schemes and human capital formation

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Motivation

- Variety of pension systems around OECD countries
- Funded vs. unfunded
- Progressive vs. earnings related
- Among earnings related:
  - calculation of claims on simple average of earnings
  - Notional-defined contribution accounts

Motivation

- Variety of pension systems around OECD countries
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  - calculation of claims on simple average of earnings
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Question:

Does the design of an earnings related pension system have an impact on human capital investment behavior?

What I do

- Earnings related pension systems as described above subsidize human capital formation
- Implicit tax structure important determinant
- First: show this in a simple analytical model
- Second: quantify the importance in a large scale OLG model

Literature on pensions and HC

Growth literature:

- Docquier/Paddison (JoM, 2003)
- LeGarrec (WP, 2005)

Endogenous retirement:

- Jensen/Lau/Poutvaara (FA, 2004)
- Lau/Poutvaara (FEP, 2006)

Capital-skill complementarity:

- Cascarico/Deviallanova (JPubE, 2008)

A simple analytical model

- Individuals live in three overlapping generations
- Population grows at rate n
- Small open economy (fixed factor prices)
- Two periods work, one period retirement
- Individuals born with educational ability $s \sim U[0,1]$
- Net labor income of unskilled worker $w(1-\tau)$
- College educated worker:
  - Wage premium πs in period 1
  - Wage premium $\pi s \epsilon_2$ in period 2, $\epsilon_2 \geq 1$
- Time costs of college education ϖ

A simple analytical model

- $\mathcal{I}(s)$ indicates college choice
- Life time budget constraint:

$$c_1 + \frac{c_2}{1+r} + \frac{c_3}{(1+r)^2} =$$
$$[1 + \mathcal{I}(s)(\pi s - \varpi)]\, w[1-\tau] + \frac{[1 + \mathcal{I}(s)\pi s \epsilon_2]\, w[1-\tau]}{1+r} + \frac{p_3}{(1+r)^2}$$

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- Pension payments:

$$p_3 = \rho(r_p, n)\tau w \Big\{ [1 + \mathcal{I}(s)(\pi s - \varpi)]\, (1+r_p)^2 + [1 + \mathcal{I}(s)\pi s \epsilon_2]\, (1+r_p) \Big\}$$

A simple analytical model

- Life time budget constraint:

$$c_1 + \frac{c_2}{1+r} + \frac{c_3}{(1+r)^2} =$$

$$[1+\mathcal{I}(s)(\pi s - \varpi)]\, w[1-\tau_1(r_p, n)] + \frac{[1+\mathcal{I}(s)\pi s \epsilon_2]\, w[1-\tau_2(r_p, n)]}{1+r}$$

A simple analytical model

- Life time budget constraint:

$$c_1 + \frac{c_2}{1+r} + \frac{c_3}{(1+r)^2} =$$

$$[1 + \mathcal{I}(s)(\pi s - \varpi)]\, w[1 - \tau_1(r_p, n)] + \frac{[1 + \mathcal{I}(s)\pi s \epsilon_2]\, w[1 - \tau_2(r_p, n)]}{1+r}$$

- Implicit tax rates:

$$\tau_1(r_p, n) = \tau \left[1 - \rho(r_p, n) \cdot \left(\frac{1+r_p}{1+r}\right)^2\right] \quad \text{and}$$

$$\tau_2(r_p, n) = \tau \left[1 - \rho(r_p, n) \cdot \frac{1+r_p}{1+r}\right]$$

A simple analytical model

- College choice:

$$s^* = \frac{\varpi/\pi}{1 + \frac{\epsilon_2}{1+r} \cdot \frac{1-\tau_2(r_p,n)}{1-\tau_1(r_p,n)}}$$

A simple analytical model

- College choice:

$$s^* = \frac{\varpi/\pi}{1 + \frac{\epsilon_2}{1+r} \cdot \frac{1-\tau_2(r_p,n)}{1-\tau_1(r_p,n)}}$$

- Laissez-faire economy:

$$s^*_{LF} = \frac{\varpi/\pi}{1 + \frac{\epsilon_2}{1+r}}$$

A simple analytical model

- **Proposition:**

  For any PAYG pension system with $r^p < r$*, we have* $s^*_{r_p} < s^*_{LF}$*.*

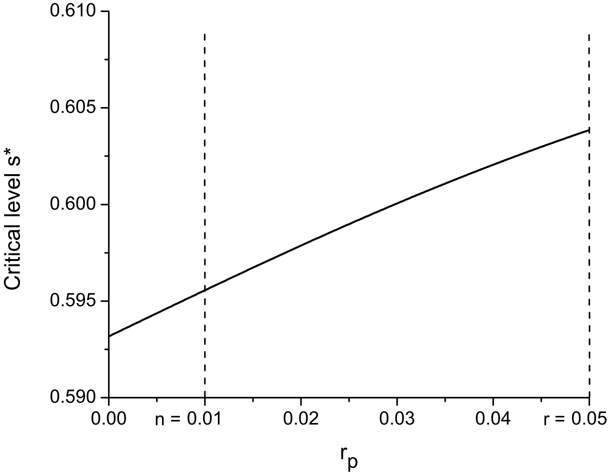
  Only for $r_p = r$ *we get* $s^*_r = s^*_{LF}$*.*

A simple analytical model

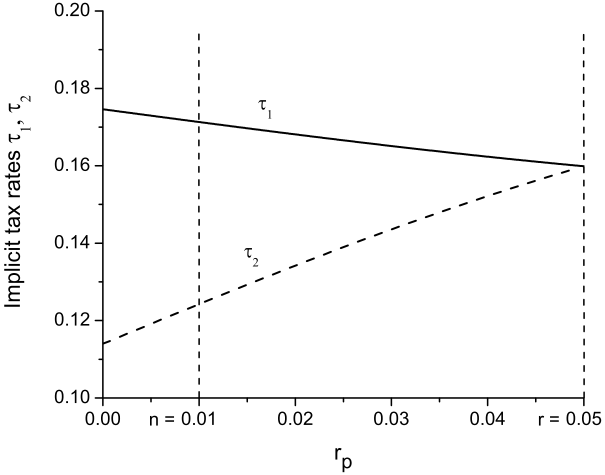
Table : Calibration of the simple model

Parameter		Value
College wage premium	π	0.30
Income profile steepness	ϵ_2	1.10
Time costs of college	ϖ	0.20
Pension contribution rate	τ	0.20
Interest rate (p.a.)	r	0.05
Population growth rate (p.a.)	n	0.01

A simple analytical model



A simple analytical model

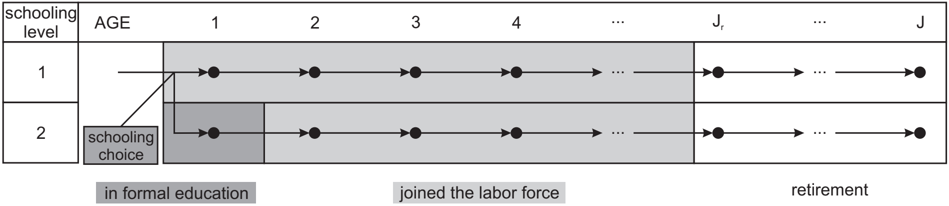


General equilibrium model

Demographics and endowments:

- J overlapping generations
- uncertain survival with conditional probability ψ_j
- $a_1 = 0$, $a_j \geq 0$
- identical level of human capital $\bar{h}_1$

The life-cycle:



General equilibrium model

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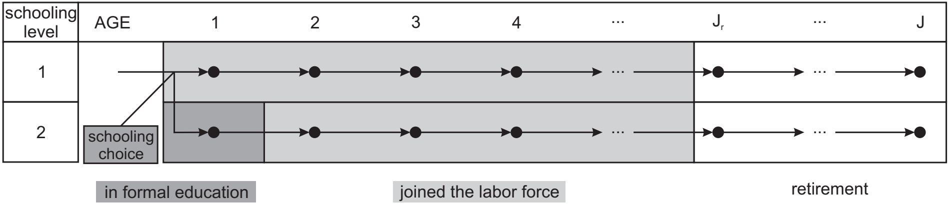

Valuation of consumption streams:

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

General equilibrium model

Dynamic programming problem:

$$V_j(z_j) = \max_{c_j, \ell_j, e_j, a_{j+1}, h_{j+1}} u(c_j, \ell_j) + \beta \psi_{j+1} V_{j+1}(z_{j+1})$$

subject to

$$a_{j+1} + (1+\tau_c)c_j + \kappa_j = \left[1 + r^{\text{net}}\right] a_j + (1-\tau_w)y_j - \tau_p \min(y_j, \varsigma \bar{y}).$$

with $y_j = w_{s_j} \cdot h_j \cdot l_j$.

General equilibrium model

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with $y_j = w_{s_j} \cdot h_j \cdot l_j$.

Pension accumulation:

$$m_{j+1} = \left[m_j + \min\left(\frac{y_j}{\bar{y}_t}, \varsigma\right)\right] \cdot (1 + r_p),$$

General equilibrium model

Dynamic programming problem:

$$V_j(z_j) = \max_{c_j, \ell_j, e_j, a_{j+1}, h_{j+1}} u(c_j, \ell_j) + \beta \psi_{j+1} V_{j+1}(z_{j+1})$$

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with $y_j = w_{s_j} \cdot h_j \cdot l_j$.

Pension accumulation:

$$m_{j+1} = \left[m_j + \min\left(\frac{y_j}{\bar{y}_t}, \varsigma\right)\right] \cdot (1 + r_p),$$

Human capital accumulation on the job:

$$h_{j+1} = A_s e_j^{\alpha_s} + h_j.$$

General equilibrium model

Formal education:

- students spend ϖ_{s_p} of their time on education
- Receive transfers from parents and government
- in case of success: $s_j = 2$ and initial human capital $\bar{h}_2$
- enroll in college if $V(z_1^c) + \varepsilon \geq V(z_1^{nc})$ with $\varepsilon \sim N(0, \sigma_\varepsilon^2)$

General equilibrium model

Firms:

$$Y = \Lambda \cdot K^{\chi_1} \cdot L^{1-\chi_1}$$

with

$$L = \left\{ \lambda_1 L_1^{1-\frac{1}{\chi_2}} + \lambda_2 L_2^{1-\frac{1}{\chi_2}} \right\}^{\frac{1}{1-\frac{1}{\chi_2}}}$$

Perfect competition

$$r = \frac{\partial Y}{\partial K} - \delta_k \quad \text{and} \quad w_s = \frac{\partial Y}{\partial L_s}.$$

General equilibrium model

Tax system:

$$\tau_c C \; + \; \tau_w \left[w_1 L_1 + w_2 L_2\right] \; + \; \tau_r r A \;\; = \;\; G \; + \; G_1 \; + \; G_2 \; + \; (r \; - \; n) B$$

Pension system:

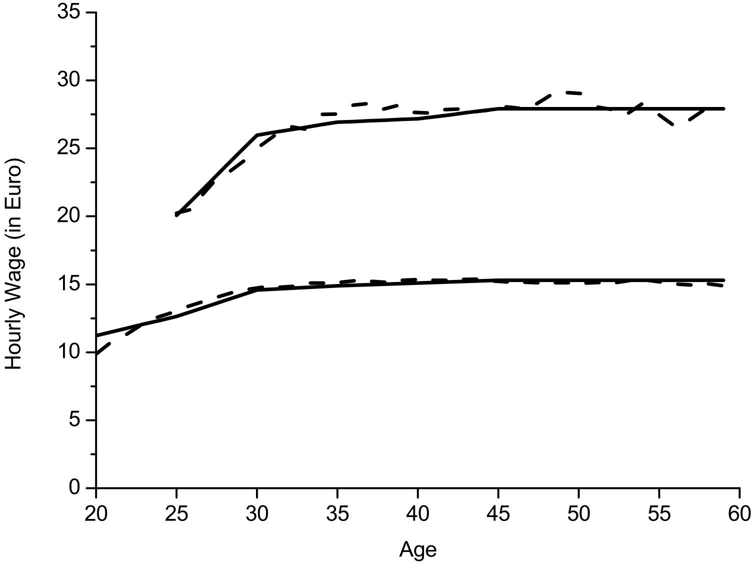
$$\tau_p \Big[w_1 L_1 + w_2 L_2 \Big] = P$$

Calibration

Calibration strategy

1. specify demographic and educational parameters;
2. estimate hourly wage profiles from SOEP panel data;
3. use these wage profiles to determine the parameters of on-the-job training via a method of moments estimator;
4. set the parameters that determine college choices;
5. calibrate the remaining model parameters.

Calibration
On-the-job training



Reform scenarios

The thought experiment

- Start from this initial equilibrium $t = 0$ with $r_p = 0$
- Introduce a fictitious accumulation factor of $r_p = r(1 - \tau_r)$
- Compute full transition path and new long-run equilibrium

Reform scenarios
The thought experiment

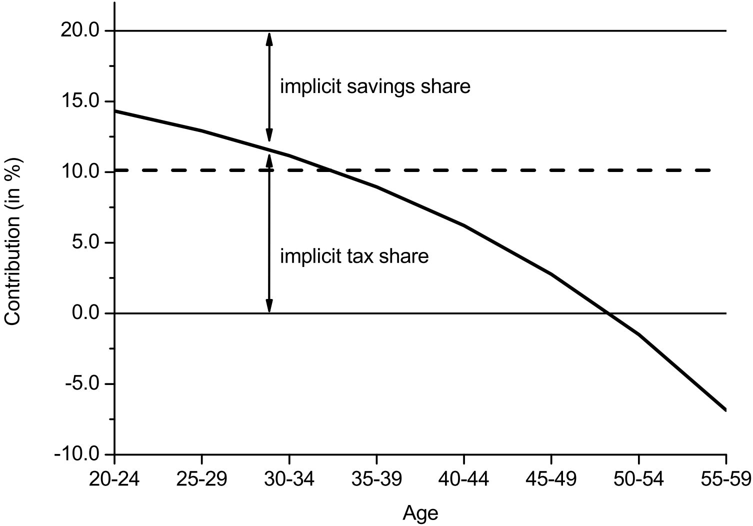
- Start from this initial equilibrium $t = 0$ with $r_p = 0$
- Introduce a fictitious accumulation factor of $r_p = r(1 - \tau_r)$
- Compute full transition path and new long-run equilibrium

The introduction of an accumulation factor of $r_p = r(1 - \tau_n)$ will

1. come along with a decline in the number of students and
2. a reduction in on-the-job training efforts.

Reform scenarios

Implicit tax structure



Reform scenarios
Methodology

Analyze in three steps:

- with fixed factor prices ($\chi = \infty$, small open economy)
- with wage adjustment ($\chi = 1.41$, small open economy)
- full model ($\chi = 1.41$, closed economy)

Reform scenarios

Fixed factor prices

χ_2	∞		1.41	
Smopec	yes		yes	
Assets	13.3		13.7	
Interest rate (p.a.)	0.0		0.0	
Cons. tax	1.0		0.9	
Number of students	-4.2		-0.4	
	$s = 1$	$s = 2$	$s = 1$	$s = 2$
Labor supply	-5.1	-10.7	-6.5	-8.0
Wages	0.0	0.0	-0.5	0.7
On-the-job training	-48.7	-52.1	-48.2	-53.5

Reform scenarios
Wage adjustments

χ_2	∞		1.41	
Smopec	yes		yes	
Assets	13.3		13.7	
Interest rate (p.a.)	0.0		0.0	
Cons. tax	1.0		0.9	
Number of students	-4.2		-0.4	
	$s=1$	$s=2$	$s=1$	$s=2$
Labor supply	-5.1	-10.7	-6.5	-8.0
Wages	0.0	0.0	-0.5	0.7
On-the-job training	-48.7	-52.1	-48.2	-53.5

Reform scenarios
Full model

χ_2	1.41		1.41	
Smopec	yes		no	
Assets	13.7		2.2	
Interest rate (p.a.)	0.0		-0.3	
Cons. tax	0.9		0.5	
Number of students	-0.8		-0.4	
	$s=1$	$s=2$	$s=1$	$s=2$
Labor supply	-6.5	-8.0	-2.2	-4.0
Wages	-0.5	0.7	1.6	2.6
On-the-job training	-48.2	-53.5	-21.6	-29.9

Reform scenarios

Transitional dynamics

Period t	1	3	5	7	9	∞
Assets[a]	0.0	2.9	2.8	2.5	2.4	2.2
Capital[a]	0.0	3.4	3.3	3.0	2.8	2.5
Interest rate (p.a.)[b]	0.3	-0.2	-0.3	-0.3	-0.3	-0.3
Cons. tax[b]	-0.9	-0.5	0.1	0.4	0.4	0.5
Number of students[a]	-2.5	-1.2	-0.2	-0.3	-0.4	-0.4

Reform scenarios
Transitional dynamics

Period t	1	3	5	7	9	∞
Labor supply[a]						
- $s = 1$	5.6	0.7	-1.6	-2.3	-2.4	-2.5
- $s = 2$	6.1	-0.6	-3.3	-4.1	-4.0	-4.0
Wages[a]						
- $s = 1$	-1.8	0.7	1.4	1.6	1.6	1.6
- $s = 2$	-2.2	1.6	2.7	2.9	2.8	2.6
On-the-job training[b]						
- $s = 1$	-21.8	-20.8	-19.5	-20.8	-21.5	-21.6
- $s = 2$	-31.1	-29.7	-28.5	-30.5	-30.3	-29.9

Conclusion

- Earnings related pension systems may subsidize human capital formation
- Reason is the implicit tax structure
- Flattening out tax structure in large scale OLG model:
  - long-run effect on college enrollment rather modest
  - wages adjust to change in college enrollment
  - short-run effects are much larger
  - significant decline in on the job training and labor supply
  - short-run labor supply increases, but only because individuals invest less in human capital
- Important implications for both pension funding and introducing NDC accounts