Labor share and aging population

Fabien Petit

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Declining labor share

Figures/LS_data.png

- **Main determinants** :
  - Biased technical change
  - Institutions
  - Globalization
- **Key references** :
  - Blanchard (1997, 2006)
  - Acemoglu (1997, 2002, 2003)
  - Caballero & Hammour (1998)
  - Bentolila & Saint-Paul (2003)
  - Karabarbounis & Neiman (2014)
  - Autor et al. (2017)

Aging population

- Literature on labor share paid hardly any attention to structure of population : only Schmidt and Vosen (2013)
- Why would this matter ?
- **Key issue** : baby boomers and aging of population in high-income countries

Figures/dep_data.png

Research question

How does age structure affect the income allocation between capital and labor in high-income countries ?

What I do

- Focus on two elements :
  - **Direct cohort effect** : factor accumulation
  - **Indirect policy mechanism** : age-structure affects policy / institutions
- OLG Model calibration to analyze the co-movement between labor share and age structure in high-income countries
- Attempt to quantify the role of population growth and survival rate
- Important implications for predicted labor share

Contribution of the paper

1. Consider the impact of policy change due to aging population on the labor share
2. Quantify the role of population growth and survival rate on the labor share

Overlapping generations model

- Standard OLG model with logarithmic utility function and CES production function Details
- Closed economy and capital fully depreciates between two periods : $R_t = r_t$ and $K_t = S_{t-1}$
- Each cohort : continuum of homogeneous agents
  - Young households : supply labor inelastically, earn income, pay taxes, consume and save for retirement
  - Old households : consume the return on their savings, pay taxes and derive utility from government health spending
- Perfect annuities market : $\hat{R}_t \equiv \frac{R_t}{p_t}$

Demography and labor share

- Young households : $N_t^y = n_t N_{t-1}^y, \quad \text{with } n_t > 0$
- Old households : $N_t^o = p_t N_{t-1}^y, \quad \text{with } p_t \in (0,1]$

- Old-age dependency ratio :

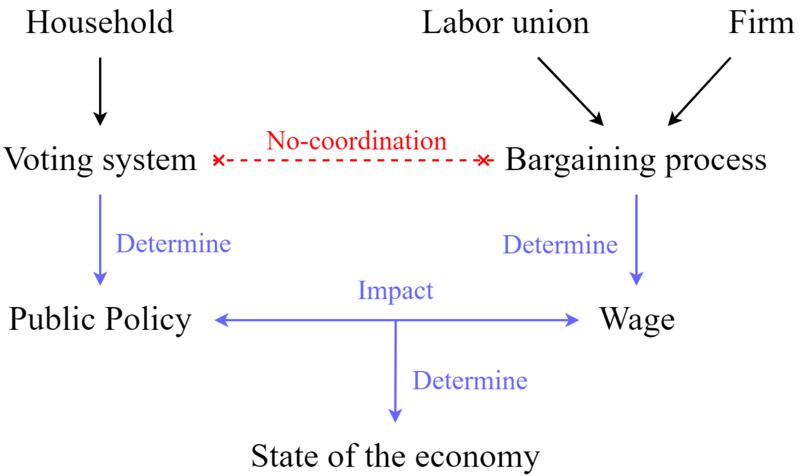
$$\frac{N_t^o}{N_t^y} = \frac{p_t}{n_t}$$

- Labor share :

$$\theta_t = \frac{w_t L_t}{Y_t} = \left(1 + \frac{\phi}{1-\phi} k_t^{\frac{\sigma-1}{\sigma}}\right)^{-1}$$

$\sigma \in \mathbb{R}_+^\star \setminus \{1\}$ the capital-labor elasticity of substitution

Diagram of the model



Public policy preferences

- Age-related conflict in the public policy :
  - Young households desire more unemployment benefit (b)
  - Old households desire more health spending (h)
  - Both desire less taxes (τ)
- Government budget constraint :

$$\tau_t Y_t = b_t u_t N_t^y + h_t N_t^o$$

- Political objective function :

$$W_t(.) = \omega \left\{ u_{t-1} N_t^o U_t^{o,u} + (1 - u_{t-1}) N_t^o U_t^{o,e} \right\} + N_t^y \left\{ \mathbb{E}\left(U_t^y \right) \right\}$$

$\omega \geq 0$ the per-capita relative political influence of old agents

- Maximization program characterizing equilibrium policy choices in period t :

$$\max_{\{\tau_t, b_t, h_t\} \geq 0} \ln(1-\tau_t) + \beta \ln h_t + \eta_t \ln\left[(1-u_t)(1-\tau_t)w_t + u_t b_t\right] + \dots$$

$$\text{s.t.} \quad \tau_t Y_t = b_t u_t N_t^y + h_t N_t^o$$

η_t the weight of the young generation within the social welfare function :

$$\eta_t = \frac{n_t}{p_t} \frac{1+\alpha p_{t+1}}{\omega}$$

- Focusing on the interior solution, first order conditions give :

$$\frac{b_t}{(1-\tau_t)w_t} = \frac{1-u_t}{u_t}\left(\eta_t \frac{1-\theta_t}{\theta_t} - 1\right)$$
$$\tau_t = 1 - \left[(1-\theta_t)\left(1+\beta+\eta_t\right)\right]^{-1}$$
$$h_t = \left(\tau_t \frac{Y_t}{N_t^y} - b_t u_t\right)\frac{n_t}{p_t}$$

Wage bargaining

- Right-to-manage model *à la* Nickell & Andrews (1983) :
  - Single union that represents workers and bargains only over wages
  - Employer retains the prerogative to hire and fire

- Maximization program characterizing equilibrium wage bargaining :

$$\max_{w_t>0} \quad \{\left(L_t[U_t^{y,e} - U_t^{y,u}]\right)^{\gamma}\left(Y_t - w_t L_t\right)^{1-\gamma}\}, \quad \gamma \in (0,1)$$

$$\text{s.t.} \quad U_t^{y,e} - U_t^{y,u} = \left(1 + \alpha p_{t+1}\right) \ln\left[\frac{(1-\tau_t)w_t}{b_t}\right]$$

- From the first-order condition :

$$k_t(X_t) = \left[\frac{1-\phi}{\phi}\frac{1-\gamma(1-\sigma)}{\gamma}\frac{X_t}{1-\sigma X_t}\right]^{\frac{\sigma}{\sigma-1}}$$

where $X_t = \ln\left[\frac{(1-\tau_t)w_t}{b_t}\right]$ is the value-added to be employed in utility terms.

Equilibrium

- Using first order conditions from the voting and wage bargaining, the **capital-to-labor ratio** (k) **at the equilibrium** solves :

$$X_t = \ln\left(\frac{\frac{N_t^y}{K_t}k_t - 1}{\frac{\phi}{1-\phi}k_t^{\frac{\sigma-1}{\sigma}}\eta_t - 1}\right) \tag{1}$$

$$X_t = \left(\sigma + \frac{1-\phi}{\phi}\frac{1-\gamma(1-\sigma)}{\gamma}k_t^{\frac{1-\sigma}{\sigma}}\right)^{-1} \tag{2}$$

- Uniqueness of the equilibrium : ▸ Details

Comparative statics : public policy and households

- The longer you expect to live, the more you save : $\frac{\partial S_t}{\partial p_{t+1}} > 0$
- Young households desire...
  - more redistribution : $\frac{\partial \tau_t}{\partial \eta_t} > 0$
  - a higher unemployment replacement rate : $\frac{\partial \frac{b_t}{(1-\tau_t)w_t}}{\partial \eta_t} > 0$
- Unemployment benefits increases the labor income share : $\frac{\partial \theta_t}{\partial b_t} > 0$

Comparative statics : labor share

- Labor share : $\theta_t = \frac{w_t L_t}{Y_t} = \left(1 + \frac{\phi}{1-\phi} k_t^{\frac{\sigma-1}{\sigma}}\right)^{-1}$
- Comparative statics :

$$\left\{ \ \frac{\partial w_t}{\partial k_t} > 0, \ \ \frac{\partial (Y_t/L_t)}{\partial k_t} > 0, \ \ \frac{\partial \theta_t}{\partial k_t} \lesseqgtr 0 \ \right\}, \quad \sigma \gtrless 1$$

- It implies that :

$$\left\{ \ \frac{\partial w_t}{\partial k_t} \lesseqgtr \frac{\partial (Y_t/L_t)}{\partial k_t} \ \right\}, \quad \sigma \gtrless 1$$

- Finally,

$$\frac{\partial \theta_t}{\partial X_t} < 0, \quad \forall \sigma \in \mathbb{R}_+^\star \setminus \{1\}$$

Calibration

- Objectives :
  1. Match the labor share dynamics over the period 1970 to 2010
  2. Model prediction over the period 2010 to 2080

- Period length : 40 years
- Four sequences of model prediction :
  - 1^{st} sequence : 1970, 2010, 2050, ...
  - 2^{nd} sequence : 1980, 2020, 2060, ...
  - 3^{rd} sequence : 1990, 2030, 2070, ...
  - 4^{th} sequence : 2000, 2040, 2080, ...

Parameters

	Parameter	Method	Target
ϕ	Capital share in 1970	Data	$1 - \hat{\theta}_{1970}$
γ	Relative bargaining power of the union	Fixed	0.5
α	Discount rate	Fixed	0.699
σ	Capital-labor elasticity of substitution	Estimate using León-Ledesma, McAdam & Willman (2013, AER)	
ω	Relative per-capita influence of old households	Matches	$\hat{k}_{1970}$
β	Preference for government health expenditure	Matches	$\hat{\tau}_{1970}$
A	Scale parameter of the production function	Matches	$\hat{\theta}_{2010}$

Note : Initial variables are normalized to 1970. Variables with hat are from data. "Matches" refers to "*set such that the model prediction matches the target*". Data from Penn World Table 9.0, World Population Prospect (United Nations) and OECD database.

▸ León-Ledesma, McAdam & Willman (2013, AER)

Parameters

	Parameter	France	United S
ϕ	Capital share in 1970	0.27	0.3
γ	Relative bargaining power of the union	0.5	0.5
α	Discount rate	0.669	0.6
σ	Capital-labor elasticity of substitution	1.279	1.2
ω	Relative ideological spread-out	0.983	1.5
β	Preference for government health expenditure	0.739	0.1
A	Scale parameter of the production function	28.23	22.8

Note : Single-equation estimation of σ from the two first-order conditions of the pro mization with normalized CES production function. σ estimates are significant at p < France and $p < 0.05$ for the United States. Details in appendix C.

Labor share : data versus model prediction

Figures/FRDM1.png

(a) France

Figures/USDM1.png

(b) United States

Labor share : data versus model prediction

Figures/FRDM2.png

(a) France

Figures/USDM2.png

(b) United States

Demographic effects decomposition

- (Reminder) Old-age dependency ratio :

$$\frac{N_t^o}{N_t^y} = \frac{p_t}{n_t}$$

- Aging is due to two phenomena :
  1. Declining population growth : $n_t \searrow$
  2. Increasing survival rate : $p_t \nearrow$, $p_{t+1} \nearrow$
- Through two channels :
  1. Direct cohort effect : n_t, p_t, p_{t+1}
  2. Indirect cohort effect : $\eta(n_t, p_t, p_{t+1})$

Labor share in France : counterfactual (2010)

Figures/FR_SRPG2_2010_large.png

Labor share in France : counterfactual (2010)

Figures/FR_SRPG3_2010_large.png

Labor share in France : counterfactual (2010)

Figures/FR_SRPG4_2010_large.png

Labor share in France : counterfactual (2010)

Figures/FR_SRPG5_2010_large.png

Labor share in France : counterfactual (1970)

Figures/FR_SRPG5_1970_large.png

Aging-effect decomposition : sources

Figures/FR_SRPG_1970_large.png

Aging-effect decomposition : transmission channels

Figures/FR_DEIE_1970_large.png

Baby-boomer generation in France

- When they were young :
  - **Direct effect** : increased savings ($K_{t+1} \nearrow$) and labor supply ($N_t^y \nearrow$)
  - **Indirect effect** : increased the outside option of workers ($w_t \nearrow \;\Rightarrow\; L_t \searrow$)
- Nowadays they are old :
  - **Indirect effect** : reduces the outside option of workers ($w_t \searrow \;\Rightarrow\; L_t \nearrow$)

Figures/FRDM2.png

Conclusion

- OLG Model able to **link the labor share to demographic dynamics** : through
  - Age-related conflict within public policy
  - Wage bargaining

- Biased technical change is a response of firms to **income share *grability* of workers** (Caballero & Hammour, 1998)
- Demographic dynamics may be a determinant of this *grability* and thus be the source of the bias

Preferences

- Household maximization program :

$$\max_{\{c_{1,t},c_{2,t+1}\}\geq 0} \ln(c_{1,t}) + \alpha p_{t+1}\left\{\ln(c_{2,t+1}) + \beta \ln(h_{t+1})\right\}$$

$$\text{s.t.} \quad \begin{cases} c_{1,t} + s_t = y_t \\ c_{2,t+1} = (1-\tau_{t+1})s_t\hat{R}_{t+1} \end{cases}$$

- Each young household faces an idiosyncratic unemployment risk with probability $u_t \in [0,1]$.
- Net income of a young household :

$$y_t = \begin{cases} (1-\tau_t)w_t & \text{if employed} \\ b_t & \text{if unemployed} \end{cases}$$

Return

- Solving the household maximization program ▸ FOC, **aggregate saving** in the economy is :

$$S_t = \frac{\alpha p_{t+1}}{1+\alpha p_{t+1}} \left[(1-u_t)(1-\tau_t)w_t + u_t b_t\right] N_t^y$$

- Indirect and expected utilities : ▸ Details
- Gap between between being employed and unemployed in utility terms :

$$U_t^{y,e} - U_t^{y,u} = (1+\alpha p_{t+1}) \ln\left[\frac{(1-\tau_t)w_t}{b_t}\right]$$

◂ Return

Production

- Representative firm with a standard CES production function :

$$Y_t = A\left[\phi K_t^{\frac{\sigma-1}{\sigma}} + (1-\phi) L_t^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \quad \text{with} \quad \begin{cases} \sigma \in \mathbb{R}_+^\star \setminus \{1\} \\ \phi \in (0,1) \\ A > 0 \end{cases}$$

- Production in units of labor :

$$\frac{Y_t}{L_t} = A\left(\phi k_t^{\frac{\sigma-1}{\sigma}} + 1 - \phi\right)^{\frac{\sigma}{\sigma-1}}, \quad \text{with} \;\; k_t \equiv \frac{K_t}{L_t}$$

Return

Labor demand

- Labor-demand equation (from profit maximization) :

$$w_t = (1-\phi)A\left(\phi k_t^{\frac{\sigma-1}{\sigma}} + 1 - \phi\right)^{\frac{1}{\sigma-1}}$$

- Labor-demand elasticity :

$$\mathcal{E}_t^{L,w} = \frac{\partial L_t}{\partial w_t}\frac{w_t}{L_t} = -\sigma\left(1 + \frac{1-\phi}{\phi}k_t^{\frac{1-\sigma}{\sigma}}\right)$$

Return

- First order conditions for an i-type young household at time t :

$$c^i_{1,t} = \frac{1}{1+\alpha p_{t+1}} y^i_t$$
$$c^i_{2,t+1} = \frac{\alpha p_{t+1}}{1+\alpha p_{t+1}} (1-\tau_{t+1}) \hat{R}_{t+1} y^i_t$$
$$s^i_t = \frac{\alpha p_{t+1}}{1+\alpha p_{t+1}} y^i_t$$

- Aggregate saving is :

$$S_t = (1-u_t) N^y_t s^e_t + u_t N^y_t s^u_t$$

Return

- Indirect utility of an i-type old household at time t :

$$U_t^{o,i} = \ln\left(\frac{\alpha p_t}{1+\alpha p_t}(1-\tau_t)y_{t-1}^i \hat{R}_t\right) + \beta \ln(h_t) \quad \forall i = \{e, u\}$$

- Indirect utility of an i-type young household at time t :

$$U_t^{y,i} = \ln\left(\frac{1}{1+\alpha p_{t+1}} y_t^i\right) + \alpha p_{t+1} U_{t+1}^{o,i} \quad \forall i = \{e, u\}$$

- Expected utility of a young household at time t :

$$\mathbb{E}(U_t^y) = \ln\left(\frac{1}{1+\alpha p_{t+1}}\mathbb{E}\left(y_t\right)\right) +$$
$$\alpha p_{t+1}\left\{\ln\left(\frac{\alpha p_{t+1}}{1+\alpha p_{t+1}}(1-\tau_{t+1})\mathbb{E}(y_t)\hat{R}_{t+1}\right) + \beta \ln(h_{t+1})\right\}$$

- Expected income of a young household at time t :

$$\mathbb{E}(y_t) = (1-u_t)(1-\tau_t)w_t + u_t b_t$$

Return

Equation (1) analysis

- $$(1) : g(k_t) = \ln\left(\frac{\frac{k_t}{k_1} - 1}{\left(\frac{k_t}{k_2}\right)^{\frac{\sigma-1}{\sigma}} - 1}\right), \quad \text{with} \begin{cases} k_1 &= \frac{K_t}{N_t^y} \\ k_2 &= \left(\frac{1-\phi}{\phi}\frac{1}{\eta_t}\right)^{\frac{\sigma}{\sigma-1}} \end{cases}$$

(a) $\begin{cases} \sigma < 1 \\ k_1 < k_2 \end{cases}$ (b) $\begin{cases} \sigma < 1 \\ k_1 > k_2 \end{cases}$ (c) $\begin{cases} \sigma > 1 \\ k_1 < k_2 \end{cases}$ (d) $\begin{cases} \sigma > 1 \\ k_1 > k_2 \end{cases}$

Return

Equation (1) analysis

- Both cases (b) and (c) implies that the labor demand exceeds the labor force
- Since the labor supply is inelastic, there is full employment (i.e. $L_t = N_t^y$) and $X_t = 0 \Leftrightarrow (1 - \tau_t)w_t = b_t$.
- Thus, we only consider cases (a) and (d) with (2).
- $\frac{\partial g}{\partial k_t}(0) = +\infty, \quad \text{when } \sigma > 1$

Return

Equation (2) analysis

- $(2)\ :\ h(k_t) = \left(\sigma + \frac{1-\phi}{\phi}\frac{1-\gamma(1-\sigma)}{\gamma}k_t^{\frac{1-\sigma}{\sigma}}\right)^{-1}$

(a) $\sigma < 0.5$ (b) $\sigma \in (0.5, 1)$ (c) $\sigma > 1$

Return

Production and labor share under biased technical change

- Normalized CES production function :

$$Y_t = A\left[\left(E_t^K K_t\right)^{\frac{\sigma-1}{\sigma}} + \left(E_t^L L_t\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

- Linear growth rates of efficiency levels : $E_t^i = E_0^i e^{a_i(t-t_0)}$
- Same fixed point : $\begin{cases} E_0^K & = \frac{Y_0}{K_0}\left(\frac{1}{\phi_0}\right)^{\frac{\sigma}{\sigma-1}} \\ E_0^L & = \frac{Y_0}{L_0}\left(\frac{1}{1-\phi_0}\right)^{\frac{\sigma}{\sigma-1}} \end{cases}$
- Labor share :

$$\theta_t = \frac{w_t L_t}{Y_t} = \left[1 + \frac{\phi_0}{1-\phi_0}\left(\frac{K_t}{L_t}\frac{L_0}{K_0}e^{(a_K-a_L)(t-t_0)}\right)^{\frac{\sigma-1}{\sigma}}\right]^{-1}$$

Return

Estimation of the Capital-Labor elasticity of substitution

- Identification of σ following the methodology of León-Ledesma, McAdam & Willman (2010)

- Under a normalized CES production function with biased technical change, the **Capital-to-Labor income ratio** is :

$$\Theta_t = \frac{\phi_0}{1-\phi_0}\left(\tilde{k}_t \; e^{(a_K - a_L)(t-t_0)}\right)^{\frac{\sigma-1}{\sigma}}$$

- Rewriting the equation and taking logs :

$$\ln \tilde{k}_t = \pi_0 - \frac{\sigma}{1-\sigma}\ln \Theta_t + (a_L - a_K)(t - t_0)$$

◂ Return

- Balanced panel data on 4 countries over the period 1970-2010 from the PWT 9.0
- Estimated equation : $\ln \tilde{k}_{it} = \pi_{0i} + \pi_{1i} \ln \Theta_{it} + \pi_{2i}(t - t_0)$

Table: Estimation of the capital-labor elasticity of substitution.

France

α	1.460***	1.130***	1.445***	1.081***
	(0.056)	(0.040)	(0.176)	(0.039)
$\frac{1-\sigma}{\sigma}$	−0.374***	−0.614***	−0.360**	−0.273
	(0.027)	(0.055)	(0.152)	(0.184)
$\frac{1-\sigma}{\sigma}(a_K - a_L)$			−0.000	−0.007*
			(0.005)	(0.004)
Biased technical change	No	No	Yes	Yes
Hours worked correction	No	Yes	No	Yes
σ	1.598	2.593	1.564	1.375

United States