Optimal Taxation with Risky Human Capital and Retirement Savings

Radek Paluszynski\textsuperscript{1}  Pei Cheng Yu\textsuperscript{2}

\textsuperscript{1}University of Houston
\textsuperscript{2}University of New South Wales

May 2019
Motivation

Classic PF problem:
- How to insure against risk in lifetime income?

Two concerns:
- Income distributions different between college and non-college
- Recent studies suggest that individuals are present biased

Current policies and proposals:
- Pay as You Earn Repayment Plan
- Retirement Parity for Student Loans Act
This paper

Mirrlees taxation + education + present-biased agents

Traditional Mirrlees taxation:
- unobservable productivity $\Rightarrow$ efficiency vs. equity
- exogenous productivity + time-consistent agents

This paper:
- education $\Rightarrow$ endogenous productivity
- present-biased agents $\Rightarrow$ paternalistic government

New insights on policy design
Preview of Findings

1. Generous student loans to entice present-biased agents

2. Education dependent retirement policies
   - help all college graduates save
   - only help non-college grads with low-income with savings

3. Income tax quantitatively similar to time-consistent case

4. Retirement Parity for Student Loans Act

5. Potentially significant welfare gains
Related literature

1. **Mirslees taxation with behavioral bias:**

2. **Optimal human capital policy**
Model
Setup overview

Three periods: student $\rightarrow$ work $\rightarrow$ retire

Student:
- Innate ability: $\gamma \in \{H, L\}$ each with share $\pi_{\gamma}$
- Education: $e \in \{e_L, e_H\}$
- Human capital: $\kappa(e, \gamma)$ strictly increasing in $e$ and $\gamma$

Work:
- Productivity $\theta$ drawn from $F(\theta|\kappa)$
  - FOSD: for any $\theta$ and $\kappa > \kappa'$, $F(\theta|\kappa) < F(\theta|\kappa')$
- Production technology: $y = \theta l$

Retire:
- Consume savings
Present bias

\((\gamma, \theta)\)-workers have utility

\[
U_1 (c_1, c_2, y; \gamma, \theta, e) = u (c_1) - h \left( \frac{y}{\theta} \right) + \beta \delta_2 u (c_2)
\]

\(\gamma\)-students have utility

\[
U_0 \left( \{c_t\}_t, e, y; \gamma \right) = u (c_0) + \beta \delta_1 (e) \int_{\Theta} \left[ u (c_1) - h \left( \frac{y}{\theta} \right) + 1 \delta_2 u (c_2) \right] f (\theta|\kappa (e, \gamma)) \, d\theta
\]

Key:

- Immediate gratification \((\beta < 1)\)
- Disagreement between selves (time inconsistency)
Government

- Only observes education $e$ and output $y$
- $H$-agents invest $e = e_H$ and $L$-agents invest $e = e_L$
- Paternalistic: offset present bias

Mechanism design approach:

- Gov. designs: $P = \{c_0(\gamma), c_1(\gamma, \theta), c_2(\gamma, \theta), y(\gamma, \theta)\}$
- Require $P$ to be incentive compatible
Incentive compatibility

**Ex-post IC:** workers report $\theta$ truthfully

- $\forall \gamma, \theta, \theta'$
  \[ U_1(\gamma, \theta) = U_1(\theta; \gamma, \theta) \geq U_1(\theta'; \gamma, \theta) \]

**Ex-ante IC:** students report $\gamma$ truthfully

- \[ U_0(H) = U_0(H; H) \geq U_0(L; H) \]
Planning problem

Paternalistic gov. maximizes

\[
\max_{\pi} \sum_{\gamma} \pi_{\gamma} \left\{ \begin{array}{l}
\sum_{\gamma} \pi_{\gamma} \left\{ u(c_0(\gamma)) \\
+ 1 \delta_1(e_{\gamma}) \int_{\Theta} \left[ u(c_1(\gamma, \theta)) - h \left( \frac{y(\gamma, \theta)}{\theta} \right) + 1 \delta_2 u(c_2(\gamma, \theta)) \right] f(\theta|\kappa_{\gamma}) d\theta \right. \\
\end{array} \right. \\
\right. \\
\right. \\
\subject{to}{\sum_{\gamma} \pi_{\gamma} \left\{ -c_0(\gamma) - e_{\gamma} + \frac{1}{R_1(e_{\gamma})} \int_{\Theta} \left[ -c_1(\gamma, \theta) - \frac{1}{R_2} c_2(\gamma, \theta) \right] f(\theta|\kappa_{\gamma}) d\theta \right\} \leq \sum_{\gamma} \pi_{\gamma} \left\{ \frac{1}{R_1(e_{\gamma})} \int_{\Theta} y(\gamma, \theta) f(\theta|\kappa_{\gamma}) d\theta \right\},}
\]

and ex-ante and ex-post IC constraints.
**Wedges**

Assume $R_t \delta_t = 1$

- **Savings wedge for $\gamma$-students:**

  $$\tau_0^k(\gamma) = 1 - \frac{u'(c_0(\gamma))}{\mathbb{E}_{\theta}[u'(c_1(\gamma, \theta))]}$$

- **Savings wedge for $(\gamma, \theta)$-workers:**

  $$\tau_1^k(\gamma, \theta) = 1 - \frac{u'(c_1(\gamma, \theta))}{u'(c_2(\gamma, \theta))}$$

- **Labor wedge for $(\gamma, \theta)$-workers:**

  $$\tau^w(\gamma, \theta) = 1 - \frac{\frac{1}{\theta} h'(\frac{y(\gamma, \theta)}{\theta})}{u'(c_1(\gamma, \theta))}$$
THEORETICAL CHARACTERIZATION
**Savings wedges: time-consistent case**

Intertemporal distortion of $\gamma$-student:

\[
\frac{1}{u'(c_0(\gamma))} = \mathbb{E}_\theta \left( \frac{1}{u'(c_1(\gamma, \theta))} \right)
\]

- $u'(c_0(\gamma)) < \mathbb{E} [u'(c_1(\gamma, \theta))]$
- $\tau^k_0(\gamma) > 0$: restricted savings
  - High savings $\Rightarrow$ expensive to reward high output in future

Intertemporal distortion of $(\gamma, \theta)$-worker:

\[
u'(c_1(\gamma, \theta)) = u'(c_2(\gamma, \theta))
\]

- $\tau^k_1(\gamma) = 0$: consumption smoothing
- No uncertainty after work life $\Rightarrow$ no need for distortions in future
Savings wedges: present-biased students

For $H$-agents:

\[
\frac{1}{u'(c_0(H))} > \mathbb{E}_\theta \left( \frac{1}{u'(c_1(H, \theta))} \right)
\]

- $\tau_0^k(H)$ is larger $\Rightarrow$ intertemporal distortion exacerbated

For $L$-agents:

\[
\frac{1}{u'(c_0(L))} < \mathbb{E}_\theta \left( \frac{1}{u'(c_1(L, \theta))} \right)
\]

- $\tau_0^k(L)$ is smaller $\Rightarrow$ intertemporal distortion is weakened
**Discussion of savings wedge**

Encouraging education investment:

1. $c_0 \uparrow$ for educated agents

2. commitment device for educated agents

3. additional distortions for uneducated agents

Therefore,

1. increase $\tau^k_0$ of educated relative to uneducated
   - Policy implication: generous student loans

2. help educated agents smooth consumption
   - Policy implication: subsidize retirement savings for college grads

3. help uneducated commit only if output is likely from $L$-agent
   - Policy implication: subsidize retirement savings of low income
Savings wedges: present-biased workers

For $H$-agents:

$$\frac{u'_1(c_1(H, \theta))}{u'_2(c_2(H, \theta))} > \beta$$

- offset present bias

For $L$-agents: there exists $\Gamma$ such that

$$\begin{cases} 
  > \beta & \text{if } \Gamma > \frac{f(\theta|\kappa_L,H)}{f(\theta|\kappa_L)} \\
  = \beta & \text{if } \Gamma = \frac{f(\theta|\kappa_L,H)}{f(\theta|\kappa_L)} \\
  < \beta & \text{if } \Gamma < \frac{f(\theta|\kappa_L,H)}{f(\theta|\kappa_L)}
\end{cases}$$

- More likely from $L$-agent than $H$-agent $\Rightarrow$ offset present bias
- More likely from $H$-agent than $L$-agent $\Rightarrow$ exacerbate present bias
Discussion of savings wedge

Encouraging education investment:
1. $c_0 \uparrow$ for educated agents
2. commitment device for educated agents
3. additional distortions for uneducated agents

Therefore,
- increase $\tau_0^k$ of educated relative to uneducated
  - Policy implication: generous student loans
- help educated agents smooth consumption
  - Policy implication: subsidize retirement savings for college grads
- help uneducated commit only if output is likely from $L$-agent
  - Policy implication: subsidize retirement savings of low income
Discussion of savings wedge

Encouraging education investment:
1. $c_0 \uparrow$ for educated agents
2. commitment device for educated agents
3. additional distortions for uneducated agents

Therefore,
- increase $\tau_0^k$ of educated relative to uneducated
  - Policy implication: generous student loans
- help educated agents smooth consumption
  - Policy implication: subsidize retirement savings for college grads
- help uneducated commit only if output is likely from $L$-agent
  - Policy implication: subsidize retirement savings of low income
**Labor wedge**

\[
\frac{\tau^w(H, \theta)}{1 - \tau^w(H, \theta)} = A_H(\theta) B_H(\theta) [C_H(\theta) - D_H(\theta) + E_H(\theta)],
\]

\[
\frac{\tau^w(L, \theta)}{1 - \tau^w(L, \theta)} = A_L(\theta) B_L(\theta)
\times \left[ C_L(\theta) - \left( \frac{1 - F(\theta|\kappa_L,H)}{1 - F(\theta|\kappa_L)} \right) D_L(\theta) + \frac{h(\theta|\kappa_L)}{h(\theta|\kappa_L,H)} E_L(\theta) \right],
\]

where \( h(\theta|\kappa) = \frac{f(\theta|\kappa)}{1 - F(\theta|\kappa)} \)

- **Intratemporal component**: \( A, B, C \) (Diamond, 1998; Saez, 2001)
- **Intertemporal component**: \( D \) (Golosov et. al., 2016)
- **Present-bias component**: \( E \)
Effects of present bias on labor wedge

\[ E_\gamma(\theta) = \left[ \frac{u'(c_1(\gamma, \theta))}{\beta u'(c_2(\gamma, \theta))} - 1 \right] - \left( \frac{1 - \beta}{\beta} \right) \frac{u'(c_1(\gamma, \theta))}{\phi} \]

Myopic component:
- Present-biased students undervalue returns from education
- Lockwood (2018)

Disagreement component:
- Present-biased worker views savings subsidies as 'distortion'

Opposing forces: ambiguous effect on labor wedge
Policy implementation
Current policy debate on student loans

Consensus: ease student loan burden

How?

- **Employer Participation in Repayment Act of 2019**
  - employer helps repay student loans using pretax income

- **Retirement Parity for Student Loans Act of 2018**
  - employer contributes to 401(k) while employees repay student loans

This paper: foundation for Retirement Parity for Student Loans Act
Retirement Parity for Student Loans Act

Education policy:
- Student loans: $L(e)$
- Income-contingent repayment: $r(e, y)$

Retirement policy:
- Income-contingent social security benefits: $a(y)$
- 401(k): matching rate $\alpha$ and contribution limit $\bar{s}$ and $\alpha r(e, y)$ saved

Taxes:
- Income tax: $T(y)$
- Tax deduction on student loans: $g(r)$
- Tax on bonds: $T^k(b)$
- Tax on retirement account: $T^{ra}$

Optimum can be implemented with above policies

Comparison with literature

Paluszynski & Yu
Human Capital with Present Bias
May 2019
Numerical analysis
## Parameterizing the Model

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\pi(L)$</td>
<td>Share of low type</td>
<td>0.64</td>
</tr>
<tr>
<td>$\pi(H)$</td>
<td>Share of high type</td>
<td>0.36</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>Risk aversion</td>
<td>2</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Frisch elasticity</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Discount factors:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
<th>Present-bias</th>
<th>Time-cons.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>Short-term factor</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>$\delta_0(L)$</td>
<td>HS period 1 long-term factor</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>$\delta_1(L)$</td>
<td>HS period 2 long-term factor</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>$\delta_2(L)$</td>
<td>HS retirement long-term factor</td>
<td>0.254</td>
<td>0.142</td>
</tr>
<tr>
<td>$\delta_0(H)$</td>
<td>COL period 1 long-term factor</td>
<td>0.115</td>
<td>0.151</td>
</tr>
<tr>
<td>$\delta_1(H)$</td>
<td>COL period 2 long-term factor</td>
<td>0.885</td>
<td>0.849</td>
</tr>
<tr>
<td>$\delta_2(H)$</td>
<td>COL retirement long-term factor</td>
<td>0.287</td>
<td>0.167</td>
</tr>
</tbody>
</table>

Functional forms: $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, $h(\ell) = \frac{\ell^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}$
Estimating productivity distributions

- Factual and counterfactual lifetime income distributions
  - Cunha and Heckman (2007)

- Construct economy with “current policies”
  - progressive income taxes
  - Social security and corresponding taxes
  - 401(k) with matching contributions
  - (unconditional) college loan subsidy

- Assume normal-lognormal-Pareto shape distributions

- Match income dist. of simulated agent populations.
Parameterizing the productivity distributions

Distributions of skills in the model

Source: calibrated to fit income distributions in Cunha and Heckman (2007)
Present-biased vs time-consistent agents

**First-period savings wedge:**

<table>
<thead>
<tr>
<th></th>
<th>Present-biased</th>
<th>Time-consistent</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\tau_0^k(L)$</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>$\tau_0^k(H)$</td>
<td>0.3232</td>
<td>0.2776</td>
</tr>
</tbody>
</table>

**Second-period savings wedge:**
- zero for time-consistent agents
Savings wedge

Savings wedge in period 1

Lifetime income

Paluszynski & Yu
Human Capital with Present Bias
May 2019 25 / 27
Labor wedge: present-biased vs. time-cons.

Labor wedge in period 1

- Present biased – high school
- Time consistent – high school
- Time consistent – college
- Present biased – college
Welfare gains of optimal policies

- Welfare gains relative to optimal policy for time-consistent agents?
- Gains in terms of fraction of lifetime consumption.
- Under what implementation of time-consistent policies?
  - Laissez-faire savings
  - Mandatory (but uncontingent) savings
Welfare gains of optimal policies

- Welfare gains relative to optimal policy for time-consistent agents?
- Gains in terms of fraction of lifetime consumption.
- Under what implementation of time-consistent policies?
  - Laissez-faire savings
  - Mandatory (but uncontingent) savings

**Table:** Welfare gains over optimal policies for time-consistent agents

<table>
<thead>
<tr>
<th>% increase in lifetime consumption</th>
<th>Mandatory savings</th>
<th>Laissez-faire</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.12</td>
<td>1.18</td>
<td></td>
</tr>
</tbody>
</table>
CONCLUSION
Extensions and Future Work

Extensions:

- Heterogeneous $\beta$
- Non-sophisticated agents

Future work:

1. Correct for the underestimation of high-income individuals
2. Explore implementation with simple instruments
APPENDIX
Implementation in Literature

Findeisen and Sachs (2016):

- Income-contingent college loans
- Difference: FS focuses on TC $\Rightarrow$ retirement policy not important for pre-work incentives

Moser and Olea de Souza e Silva (2019):

- uses different savings tools to separate productivity
  - low-productivity $\Rightarrow$ social security, high-productivity $\Rightarrow$ retirement accounts
- Difference: MO focuses on exogenous productivity $\Rightarrow$ savings wedges in $t = 1$ are different

Back to implementation
Reference income distributions

(a) High school

(b) College

Source: Cunha and Heckman (2007)