Optimal Income, Education and Bequest Taxes in an Intergenerational Model

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Parents can transfer resources to children through education or bequests.
An Intergenerational Model of Bequests and Education

- Dynamic intergenerational model à la Barro-Becker: altruistic preferences.

- Parents can transfer resources in two ways:
  - **Bequests** yield safe, uniform return.
  - **Education** yields idiosyncratic return: persistent, stochastic “ability.”

- Wage of child = f(education, ability)
  - “Ability:” broad, multi-dimensional, exogenous component.

- Government: maximize expected welfare of today’s generation.
  - Baseline tools: linear education subsidy, income taxes, bequest taxes.
  - Extend to fully unrestricted mechanism (the “best” we could possibly do).
Goal 1: Derive Simple Operational Optimal Formulas

- For education subsidy, bequest tax, income tax:

- In terms of estimable sufficient stats
  - robust to heterogeneity in preferences and primitives.

- Given all other (not necessarily optimally set) taxes.

- Isolating each tool’s redistributive impact.
  - Can use generalized social welfare weights to accommodate any redistributive preferences.

- First, intuition from one-period model. Dynamic formulas look like static ones with appropriately redefined elasticities (of long-term tax base).
Goal 2: How should tax system account for bequests and education investments?

- Should parental human capital expenses be fully tax-deductible?
  - “Siamese Twins” result, Bovenberg and Jacobs (2005).

- Not generally true unless relative efficiency cost = relative distributional
effect for bequests and education investments.

- Education subsidies and income taxes need not co-move.

- Bequest and income taxes need not co-move.

- Extend to OLG model to capture credit constraints: will typically ↑
optimal education subsidy, not change bequest tax.
Goal 3: Introduce and Use Reform Specific Elasticities

- Hard to estimate relevant elasticities in practice: can we target formulas to existing reforms?
- Yes: For any reform: can derive optimal formulas using “reform-specific elasticities.”
Goal 4: Solve for Fully Unrestricted Taxes

- Mechanism design approach.

- Optimal to distort parental trade-off between education and bequests.
  - Except in very special case in which Hicksian coefficient of complementarity $\rho_{\theta s} = 1$ for kids.
  - I.e., only if wage = ability $\times$ education.

- If education benefits mostly less able kids – should subsidize it relative to bequests (who benefit everybody equally).
Related Literature

**Human Capital:** Heckman (1976), Heckman, Lochner and Taber (1997),

**Human Capital and Taxation:** Bovenberg and Jacobs (2005), Jacobs (2007),

**Bequest taxation:** Piketty and Saez (2013), Farhi and Werning (2010, 2013).

**Quantitative models with bequests:** Krueger and Ludwig (2013, 2014).

**Credit constraints for education:** Carneiro and Heckman (2002), Jacobs and Yang (2011),
Outline

1. Intergenerational Model
2. Simple One-Period Version
3. Optimal Linear Dynamic Policies
4. Credit Constraints
5. Optimal Unrestricted Policies (Mechanism)
Education investments and bequests

- Agents live for 1 period: born, have single child, die.

- Agent from dynasty $i$ at generation $t$ denoted $ti$.

- Parents in generation $t$ purchase education $s_{t+1i}$ for child.

- Ability $\theta$: stationary, ergodic process with correlation between generations (possibly, multidimensional).

- Wage: $w_{ti}(s) \equiv w(s, \theta_{ti})$
  - How complementary are education and ability ($\frac{\partial^2 w}{\partial \theta \partial s}$)?
  - Early Childhood investments vs. College?
  - Wlog, different types of human capital: $w(s_1, ..., s_N, \theta_{ti})$.

- Income: $y_{ti} = w_{ti}/l_{ti}$. 
Dynastic Setup and Taxes

- Flow utility: \( u_{ti}(c, y, s) \equiv u\left(c, \frac{y}{w(s, \theta_{ti})}; \eta_{ti}\right) \)

- Expected utility of dynasty \( i \)
  \[
  U_{1i} = E\left(\sum_{t=1}^{\infty} \beta^{t-1} u_{ti}(c_{ti}, y_{ti}, s_{ti})\right)
  \]

- Bequests left by generation \( t, b_{t+1i} \), yield \( R \).

- Linear taxes: \( \tau_{Lt}, \tau_{St}, \tau_{Bt} \).

- \( G_t \): lump-sum demogrant.

- Agents’ per-generation budget constraint:
  \[
  c_{ti} + b_{t+1i} + (1 - \tau_{St}) s_{t+1i} = Rb_{ti}\left(1 - \tau_{Bt}\right) + w_{ti}(s_{ti}) l_{ti}\left(1 - \tau_{Lt}\right) + G_t
  \]
Equilibrium and Government Budget

- Aggregate (or per capita): $y_t$, $b_t$, and $s_t$.

- Stochastic processes for $\theta$ and $\eta$ assumed to be ergodic.
  
  ▶ at constant $(\tau_L, \tau_B, \tau_S, G)$, unique ergodic steady state independent of initial distribution of $s_{1i}$ and $b_{1i}$.

  ▶ If tax policy $(\tau_{Lt}, \tau_{Bt}, \tau_{St}, G_t)$ converges to long-run constant policy $(\tau_L, \tau_B, \tau_S, G)$ then $s_{t+1}$, $y_t$, and $b_t$ also converge to steady state levels and depend on steady tax policies.

- Government budget constraint in equilibrium (per period):

  $$G_t = \tau_L y_t + \tau_B R b_t - \tau_S s_{t+1}$$

  ▶ With golden rule followed, such that $\beta = 1/R$, this is wlog.
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Simple One-period Version of the Model

- Utility: $U_i = u_i(c_i, y_i, s_i)$

- Budget constraint: $c_i + (1 - \tau_S) s_i = w_i(s_i) l_i(1 - \tau_L) + G$

- Social Welfare: $SWF = \int \omega_i u_i(c_i, y_i, s_i) \, di$
  - For any set of Pareto weights $\{\omega_i\}_i$.

- Government BC: $G = \tau_L y - \tau_S s$
Elasticities and Distributional Characteristics

- Aggregate elasticities of $y$ and $s$ to $1 - \tau_L$:
  \[ \varepsilon_Y \equiv \frac{dy}{d(1-\tau_L)} \frac{1-\tau_L}{y}, \quad \varepsilon_S \equiv \frac{ds}{d(1-\tau_L)} \frac{1-\tau_L}{s} \]

- Aggregate elasticities of $y$ and $s$ to $\tau_S - 1$:
  \[ \varepsilon_S \equiv \frac{ds}{d(\tau_S-1)} \frac{\tau_S-1}{s}, \quad \varepsilon_Y \equiv \frac{dy}{d(\tau_S-1)} \frac{\tau_S-1}{y} \]

- Distributional characteristic of output and education:
  \[ \bar{y} \equiv \frac{\int_i \omega_i u_{c,i} y_i di}{y \int_i \omega_i u_{c,i} di}, \quad \bar{s} \equiv \frac{\int_i \omega_i u_{c,i} s_i di}{s \int_i \omega_i u_{c,i} di} \]

- $\bar{s}$ large if $s$ concentrated among high $u_c$ (low $c$) agents
  - If $s$ and ability not very complementary (Early Childhood Investments)?
  - $\bar{s}$ depends on what type of human capital subsidized (free public education?)

- $\bar{y} \ll 1$ typically.
Optimal Static Linear Tax and Subsidy

- Optimal Labor Tax:
  \[ \tau_L^* = \frac{1 - \bar{y} - \tau_S \frac{y}{y} \varepsilon_Y}{1 - \bar{y} + \varepsilon_Y} \]

- Typical trade-off between redistribution \((1 - \bar{y})\) and efficiency \((\varepsilon_Y)\).

- Fiscal spillover on education tax base: \(\tau_S \frac{y}{y} \varepsilon_Y\) (0 if \(\tau_S = 0\)).

- Optimal Education Subsidy:
  \[ \tau_S^* = \frac{1 - \bar{s} + \frac{y}{s} \varepsilon_Y \tau_L}{1 - \bar{s} + \varepsilon_S} \]

- Redistributive effect of education \((1 - \bar{s})\) ↑ \(\tau_S\).
  - (1 - \bar{s}) large for Early Childhood Investment.

- Fiscal spillover: \(\frac{y}{s} \varepsilon_Y \tau_L\) increasing in \(\tau_L\).
“Siamese Twins Result” Revisited

- Benchmark: Full deductibility of education expenses.
  \[ \tau_S = \tau_L \iff \text{equivalent to taxable income being } y - s. \]

- Full deductibility optimal iff:
  \[
  \frac{\left( \frac{y}{s} \varepsilon_Y^S - \varepsilon_S \right)}{\left( \frac{s}{y} \varepsilon_Y^Y - \varepsilon_Y \right)} = \frac{1 - \bar{s}}{1 - \bar{y}}
  \]

- If \( 1 - \bar{s} \gg 1 - \bar{y} \), then optimal to have: \( \tau_S^* > \tau_L^* \).

- Bovenberg and Jacobs (2005) find \( \tau_S = \tau_L \), because:
  - \( w = \theta s \) and quasilinear utility.
  - Hence: \( \bar{y} = \bar{s}, \varepsilon_Y^S = \gamma, \varepsilon_Y = 1 - \gamma, \varepsilon_Y^S = -\gamma, \varepsilon_S = \gamma - 1 \)
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A Variational Approach – One instrument at a time

- **Social Welfare:**

\[
SWF = \max E \sum_{t=1}^{\infty} \beta^{t-1} \left[ u_{ti} \left( (1 - \tau_{Lt})y_{ti} - s_{t+1i}(1 - \tau_{St}) \right) 
+ R(1 - \tau_{Bt})b_{ti} - b_{t+1i} + G_t, y_{ti}, s_{ti} \right]
\]

subject to

\[
G_t = \tau_{Lt}y_t + \tau_{Bt}Rb_t - \tau_{St}s_{t+1}
\]

- **Variation:** \( d\tau_{St} = d\tau_S \) for \( t > T \).

- \( dSWF = \) direct welfare (by envelope theorem) + mechanical revenue effect + behavioral effects (anticipatory and post-reform).
Elasticities of the Present Discounted Tax Bases

- Long run elasticities of PDV of tax bases:

\[ \varepsilon'_S \equiv (1 - \beta) \sum_{t \geq 1} \beta^{t-1-T} \varepsilon_{St+1} \]

\[ \varepsilon'_Y \equiv (1 - \beta) \sum_{t \geq 1} \beta^{t-1-T} \varepsilon_{Yt} \]

\[ \varepsilon'_B \equiv (1 - \beta) \sum_{t \geq 1} \beta^{t-1-T} \varepsilon_{Bt} \]

- Mix both children’s and parents’ responses.

- Mix income and substitution effects.

- Redistributive factors:

\[ \bar{y} \equiv \frac{E(u_{c,ti}y_{ti})}{E(u_{c,ti})y_t}, \quad \bar{s} \equiv \frac{E(u_{c,ti}s_{t+1i})}{E(u_{c,ti})s_{t+1}}, \quad \bar{b} \equiv \frac{E(u_{c,ti}b_{ti})}{E(u_{c,ti})b_t} \]
Optimal Linear Taxes and Subsidies

- Optimal education subsidy:

\[ \tau^*_S = \frac{1 - \bar{s} + \varepsilon_Y \tau_L \frac{y}{s} + \varepsilon_B \tau_B \frac{R}{e}}{1 - \bar{s} + \varepsilon_S'} \]

- Decreasing in \( \varepsilon_S' \) (like in static, but now it’s elasticity of full base).

- Tax deductibility not optimal in general: \( \tau_S \) and \( \tau_L \) need not even co-move (unless no income effects).

- \( \tau_S \) and \( \tau_B \) may or may not co-move (substitution vs. income effects).

- Can use formula to evaluate reforms (at any given \( \tau_B \) and \( \tau_L \)).
  - Maybe most useful application, only requires knowing \( \varepsilon, \bar{s} \) at status quo.

- Distributional effects again crucial.
  - Depend on complementarity and institutional setup.

- Can use generalized Social Welfare Weights (Saez and Stantcheva 2014).
Generalized Social Welfare Weights

Instead of standard weights derived from SWF ($\omega_{ti} u_{c,ti}$), use **generalized social welfare weights** $g_{ti}$

- $g_{ti}$: Social marginal value of giving $1$ to person $i$.

$$\bar{s} = \frac{E(g_{ti} s_{ti})}{E(g_{ti}) s_t}, \quad \bar{y} = \frac{E(g_{ti} y_{ti})}{E(g_{ti}) y_t}, \quad \bar{b} = \frac{E(g_{ti} b_{ti})}{E(g_{ti}) b_t}$$

All redistributive considerations translate into different values for $\bar{s}$, $\bar{y}$, $\bar{b}$.

- No need to rederive anything.
- No SWF, only variations/reforms.

- Rawlsian case: $\bar{s} = 0$.
- Pure Efficiency consideration: $\bar{s} = 1$.
- Value altruistic parents most: $\bar{s} >> 1$.
- Worry about kids from poor background: $\bar{s} = \frac{E(s_{ti}| \text{poor background})}{\text{Prob}(\text{poor background}) s_t}$.
Optimal Linear Taxes and Subsidies

- Optimal Bequest Tax:

$$\tau_B^* = \frac{1 - \bar{b} + \varepsilon'_B \frac{s}{b} \tau_S - \varepsilon'_Y \tau_L \frac{Y}{b}}{1 - \bar{b} + \varepsilon'_B}$$

- Generically not zero – contrast to zero capital taxation result (Chamley, Judd):

- Fiscal spillover/constraint on other tax instruments.

- $\varepsilon'_B$ finite (true with uncertainty), breaks down with perfect certainty.

- $\bar{b} \neq 1$: except if utility linear in $c$, or purely accidental bequests uncorrelated with income.
Reform-Specific Elasticities

- What if we cannot estimate all cross-elasticities needed?

- Target formulas to specific reforms (shifts in several instruments), and care only about total effect. Formulas are “reform-specific.”

- E.g.: \( d\tau_{St} = d\tau_S \) for \( t > T \), with \( d\tau_{Lt} \) to maintain budget balance, \( \tau_B \) unchanged.

- Optimal education subsidy with reform-specific elasticities:

\[
\tau_S^* = \frac{1 - \frac{s}{y} \left(1 - \varepsilon'_Y \frac{\tau_L}{1-\tau_L}\right) + R^b_s \varepsilon'_B \tau_B}{1 - \frac{s}{y} \left(1 - \varepsilon'_Y \frac{\tau_L}{1-\tau_L}\right) + \varepsilon'_S}
\]

- Long-run elasticities \( \varepsilon'_B, \varepsilon'_Y \) and \( \varepsilon'_S \) estimated from a revenue neutral reform changing \( \tau_S \) and adjusting \( \tau_L \) for budget balance.
Reform-Specific Elasticities: Discussion

- Most useful formulation for reforms that have been done so can use “ready” estimates.

- Best to evaluate reforms around status quo where elasticities estimated.

- If we knew primitives (Slutsky matrices), formulas are equivalent.

- Not necessary to assume that $\tau_L$ or $\tau_B$ optimally set.
Unobservable Education or Human Capital Spending

- Need to provide indirect incentive for human capital *indirectly* through labor and bequest tax only.

- Optimal labor tax with unobservable education:

\[
\tau^*_L, \text{unobs} = \frac{1 - \bar{y} - b \varepsilon_Y^' \tau_B}{1 - \bar{y} + \varepsilon_Y'}
\]

- If \( \varepsilon_Y^' < 0 \), then if \( \tau^*_S > 0 \) was optimal, \( \tau_L \) lower with unobservable education.

- Optimal bequest tax with unobservable education:

\[
\tau^*_B, \text{unobs} = \frac{1 - \bar{b} - \varepsilon_Y^' \tau_L \frac{Y}{b}}{1 - \bar{b} + \varepsilon_B^'}
\]

- If education and bequests substitutes overall, \( \varepsilon_S^B < 0 \), and if \( \tau^*_S > 0 \) had been optimal, \( \tau_B \) higher to indirectly encourage education.
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An Augmented Dynastic OLG Model

- Generation $t$ born at time $t$ lives for 3 periods:
  1. “Young:” receive $s_t$ from their parents.
  2. “Adult:” have one child each, work to earn $y_{t+1}$, save $k_{t+1}$, invest $s_{t+1}$.
  3. “Old:” Receive bequests $b_{t+1}$ at beginning of period, consume, leave bequests $b_{t+2}$, die.

- Unit mass of each young, adult, and old at each $t$.

- Inelastic labor supply for exposition only: $y_{t+1i} = w_{t+1}(s_{ti}, \theta_{t+1i})$.

- Utility (realized in old age at time $t + 2$): $u_{t+2}(c_{t+2i}, \eta_{t+2i})$.

- Budget constraint of adult $i$ from generation $t$:
  $$(1 - \tau_{Lt+1})w_{t+1}(s_{ti}, \theta_{t+1i}) = k_{t+1i} + s_{t+1i}(1 - \tau_{St+1})$$

- Budget constraint of old agent $i$ from generation $t$:
  $$k_{t+1i} + Rb_{t+1i}(1 - \tau_{Bt+2}) = c_{t+2i} + b_{t+2i}$$
Government Transfers, SWF and Credit Constraints

- $G_t$ given at beginning of old age (after bequests received have been taxed). Transfer at time $t$ (to old of generation $t - 2$):
  $$G_t = \tau_{Lt-1}y_{t-1} + \tau_{Bt}Rb_{t-1} - \tau_{St-1}s_{t-1}$$

- Social Welfare:
  $$SWF_0 = \max E \sum_{t=1}^{\infty} \beta^{t-1} [u_{ti}(1 - \tau_{Lt-1})y_{t-1} - s_{t-1}(1 - \tau_{St-1}) + R(1 - \tau_{Bt})b_{t-1} - b_{t+1} + G_t)]$$

- If no credit constraints: all periods collapsed into 1, equivalent to before.

- Credit constraints: $k_t = (1 - \tau_{Lt})w_t(s_{t-1}, \theta_t) - s_t(1 - \tau_{St}) \geq 0$, multiplier $\gamma_{ti}$.

- Redistributive incidence of credit constraints: $\tilde{s} \equiv \frac{E(\gamma_{ti}s_{t-1})}{E(u_{c,ti})s_{t-1}}$

- $\tilde{s}$ higher if credit constraints hit mostly parents who invest a lot in $s$. 
Government Transfers, SWF and Credit Constraints

- Optimal human capital subsidy:

\[ \tau^{\star,cc}_{S} = \frac{1 - (\bar{s} + \tilde{s}) + \varepsilon_{Y}^{S'}\tau_{L}y_{s} + \varepsilon_{B}^{S'}\tau_{B}R_{b}s}{1 - (\bar{s} + \tilde{s}) + \varepsilon'_{S}} \]

- Additional term \( \tilde{s} \) acts exactly like \( \bar{s} \).

- Credit constraints concentrated among parents who invest a lot in their children \( \iff \) high social marginal value on parents investing a lot.

- Tend to increase optimal human capital subsidy, all else equal.

- Bequest tax unchanged: bequests occur too late in life to relieve credit constraints. Could change?
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Optimal Unrestricted Mechanism: Setup

- Simplify: no preference shocks $\eta$.
- $\theta_t$ follows Markov process $f_t(\theta_t|\theta_{t-1})$.
  - Parents have some advance info, but not full info about kids’ abilities.
- Utility separable: $\tilde{u}_t(c_t, y_t, s_t; \theta_t) = u_t(c_t) - \phi_t\left(\frac{y_t}{w_t(\theta_t, s_t)}\right)$
- Key parameter: **Hicksian coefficient of complementarity** between ability and education in the wage function
  \[ \rho_{\theta s} \equiv \frac{w_{\theta s} w}{w s w_\theta} \]
  - $\rho_{\theta s} < 0$: lower ability kids have a higher marginal benefit from education (Early Childhood Investments, evidence from J. Heckman).
  - $\rho_{\theta s} > 0$: higher ability kids have a higher marginal benefit from education (Heckman and Cunha evidence for College).
  - $\rho_{\theta s} > 1$: higher ability kids have a higher proportional benefit from education (Wage elasticity w.r.t ability increasing in education).
Solution Method: First-order Approach + Dynamic Programming

- Farhi and Werning (2013) and Stantcheva (2014).

- Imagine direct revelation mechanism: specify allocations as functions of reported $\theta^t$.

- Continuation utility of the dynasty after history $\theta^t$:

$$
\omega (\theta^t) = u_t (c (\theta^t)) - \phi_t \left( \frac{y (\theta^t)}{w_t (\theta_t, s (\theta^t))} \right) + \beta \int \omega (\theta^{t+1}) f^{t+1} (\theta_{t+1} | \theta_t) \, d\theta_{t+1}
$$

- Replace by "envelope condition:'

$$
\dot{\omega} (\theta^t) := \frac{\partial \omega (\theta^t)}{\partial \theta_t} = \frac{w_{\theta, t}}{w_t} l (\theta^t) \phi_{l, t} (l (\theta^t)) + \beta \int \omega (\theta^{t+1}) \frac{\partial f^{t+1} (\theta_{t+1} | \theta_t)}{\partial \theta_t} \, d\theta_{t+1}
$$
Rewrite Problem Recursively

- Rewrite problem recursively using: promised continuation utility $v$, promised marginal continuation utility $\Delta$.

- The program of the government is:

$$K(v, \Delta, \theta_-, t) = \min \int (c(\theta) + s_{t+1}(\theta) - w_t(\theta, s_t(\theta))) l(\theta)$$

$$+ \frac{1}{R} K(v(\theta), \Delta(\theta), \theta, s_{t+1}(\theta), t + 1)) f^t(\theta|\theta_-) d\theta$$

subject to:

$$\omega(\theta) = u_t(c(\theta)) - \phi_t(l(\theta)) + \beta v(\theta)$$

$$\dot{\omega}(\theta) = \frac{w_{\theta,t}}{w_t} l(\theta) \phi_{l,t}(l(\theta)) + \beta \Delta(\theta)$$

$$v = \int \omega(\theta) f^t(\theta|\theta_-) d\theta$$

$$\Delta = \int \omega(\theta) \frac{\partial f^t(\theta|\theta_-)}{\partial \theta_-} d\theta$$

maximization is over functions $(c(\theta), l(\theta), s(\theta), \omega(\theta), v(\theta), \Delta(\theta))$. 
Characterize Marginal Distortions Using Wedges

- Distortions relative to *laissez-faire* characterized by “wedges” (pure definitions):

- Intratemporal wedge on labor $\tau_L(\theta^t)$

\[
\tau_L(\theta^t) \equiv 1 - \frac{\phi_{l,t}(l_t)}{w_t u'_t(c_t)}
\]

- Intertemporal wedge on bequests $\tau_B(\theta^t)$

\[
\tau_B(\theta^t) \equiv 1 - \frac{1}{R\beta E_t(u'_t(c_{t+1}))}
\]
Optimal Relation between Bequests and Education

- $\varepsilon_u^t$: uncompensated labor supply elasticity

- $\varepsilon_c^t$: compensated labor supply elasticity (all holding savings fixed).

At the optimum:

$$R = E \left( w_{s,t+1} l_{t+1} \left( 1 + \tau_{L,t+1} \frac{\varepsilon_c^{t+1}}{1 + \varepsilon_u^{t+1}} (1 - \rho \theta_{s,t+1}) \right) \right)$$

- LHS = Return to bequests.

- RHS = Social return to education = Private return + incentive effect.

- Bequests affect everybody equally, but education does not.
Subsidizing or Taxing Education Relative to Bequests

Education subsidized relative to bequests $\Leftrightarrow \rho_{\theta s, t} \leq 1$

Labor Supply Effect:
Education subsidy increases children’s wage
$\rightarrow \uparrow$ labor
$\rightarrow \uparrow$ resources.

Inequality Effect:
if $\rho_{\theta s} \geq 0$, education benefits more able children more
$\rightarrow \uparrow$ pre-tax inequality.

$\rho_{\theta s} \leq 1 \Rightarrow$ subsidy $\downarrow$ post-tax inequality
$\Rightarrow$ has positive redistributive and insurance effects.

$\rho_{\theta s} = 1 \Rightarrow$ No distortion between bequests and education
Benchmark case in literature $w_t = \theta_t s_t$
Conclusion

- Derive formulas for optimal linear taxes as functions of estimable behavioral elasticities and redistributive factors, robust to heterogeneities and preferences.
  - “Reform elasticities” adapted to existing reforms.

- Not optimal to make education expenses fully tax deductible, as education subsidies have differential distributional impacts.
  - $\tau_S, \tau_B, \tau_L$ can co-move positively or negatively...

- Credit constraints would typically increase optimal education subsidy.

- Fully unrestricted mechanism: if education highly complementary to ability ($\rho_{\theta s} > 1$), tax education relative to bequests.