Education, Lifestyles, and Health Inequality

Jesús Bueren[◇] Josep Pijoan-Mas[☆] Dante Amengual[□]

[◇] EUI

[☆] CEMFI, CEPR

[□] CEMFI

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INTRODUCTION

- Health inequalities in the United States are large
- Two important facts:
  a) Strong connection between economic and health inequality
     Kitagawa, Hauser (1973); Pijoan-Mas, Rios-Rull (2014); Chetty et al. (2016)
  b) Growing educational gradients of health inequality
     Preston, Elo (1995); Meara et al. (2009); Montez et al. (2011); Case, Deaton (2015)

  → Reasons not well-understood
- We study to which extent differences in health behaviors across education groups can account for these two facts
  - Health behaviors are an important driver of health outcomes
    McGinnis, Foege (1993); Li et al. (2018); Zaninotto et al. (2020)
  - Individuals with higher education are more likely to adopt health-enhancing behaviors
    Lantz et al. (1998); Cutler, Lleras-Muney (2010)

Objectives

1. Measure the impact of lifestyles on health dynamics and economic outcomes
   - Lifestyle → propensity to engage in different health-related behaviors
2. Understand the joint determination of education and lifestyles
   → Why is there an education gradient of lifestyles?
      a) Are the returns to health-protecting lifestyles higher for the more educated? Why?
      b) Do individuals raised in healthier environments self-select into higher education?
3. Understand the increase in the education gradient of life expectancy (not today)
   → Quantify the role played by the increase in the education wage premium

Health Dynamics and Health Behavior

The Data

- HRS and PSID
  - Unbalanced panels of individuals $i = 1, ..., N$ followed $t = 1, ..., T$ periods
- Demographic information: birth cohort (c), sex (s), education (e), age (a_t)
- Wide array of information on health status and health behavior
  - Health state h_t: self-reported health (good/bad) + death
  - Health behavior $z_{mt} \in \{0, 1\}$:
    - Preventive cancer tests (mammography / prostate check)
    - Cholesterol test
    - Flu shot
    - Heavy drinking (2+ drinks every day)
    - Smoking
    - Exercise

  → Across demographic groups: associated w/ health outcomes

  → At individual level: imperfectly correlated across individuals and over time

[See data]

Latent types

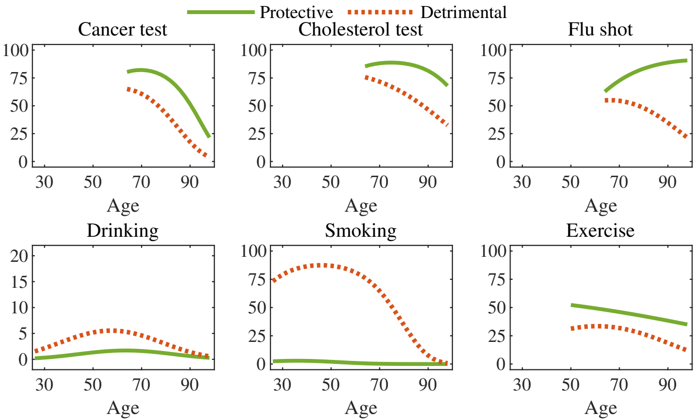
- We assume that observed health behavior is the (noisy) result of a latent time-invariant factor $y \in Y \equiv \{y_1, y_2, ...\}$
  - We interpret y as the individual lifestyle: propensity to engage in healthy behaviors
- We propose a novel econometric model to
  - Allocate individuals to lifestyles y
  - Measure the importance of lifestyles on health dynamics
- We *jointly estimate* health dynamics and lifestyles using a mixture model:

$$
\begin{aligned}
p(\boldsymbol{z}, \boldsymbol{h} | \mathrm{c}, \mathrm{s}, \mathrm{e}, a_0) &= \sum_{y \in Y} p(\boldsymbol{z}, \boldsymbol{h} | \mathrm{c}, \mathrm{s}, \mathrm{e}, a_0, y)\, p(y | \mathrm{c}, \mathrm{s}, \mathrm{e}, a_0) \\
&= \sum_{y \in Y} p(\boldsymbol{z} | \boldsymbol{h}, \mathrm{c}, \mathrm{s}, \mathrm{e}, a_0, y)\, p(\boldsymbol{h} | \mathrm{c}, \mathrm{s}, \mathrm{e}, a_0, y)\, p(y | \mathrm{c}, \mathrm{s}, \mathrm{e}, a_0) \\
&\simeq \sum_{y \in Y} \underbrace{p(\boldsymbol{z} | \boldsymbol{h}, a_0, y)}_{\text{health behavior}}\ \underbrace{p(\boldsymbol{h} | \mathrm{s}, \mathrm{e}, a_0, y)}_{\text{health dynamics}}\ \underbrace{p(y | \mathrm{c}, \mathrm{s}, \mathrm{e}, a_0)}_{\text{lifestyle distribution}}
\end{aligned}
$$

Results: Lifestyles and health behavior

1. Lifestyles "well" approximated by 2 types: protective and detrimental

Probability of reporting health behaviors by lifestyle



Results: Lifestyles and health dynamics

2. LE at age 50 is 8.5 years larger for protective than for detrimental

LE at age 50 by education and lifestyles: males born in 1970s

	All		HSD		HSG		CG		Δ_eLE (CG-HSD)		
	%	LE	%	LE	%	LE	%	LE	Data	(a)	(b)
All	100.0	**29.4**	100.0	24.8	100.0	28.0	100.0	32.8	8.0	4.3	3.8
PRO	74.6	**31.6**	42.9	28.6	68.1	30.1	93.3	33.4	4.9		
DET	25.4	**23.0**	57.1	22.0	31.9	23.3	6.7	24.1	2.1		
Δ_y	49.3	**8.5**	-14.2	6.6	36.2	6.8	86.5	9.4	2.8		

(a) Gradient explained by difference in health dynamics across education groups for given lifestyle, $\Delta_e p(\boldsymbol{h}|\mathrm{e}, y)$
(b) Gradient explained by difference in lifestyles across education groups for given health dynamics, $\Delta_e p(y|\mathrm{e})$

Results: Lifestyles, education, and health dynamics

3. Effect of lifestyle on LE larger for the more educated (almost 3 years)

LE at age 50 by education and lifestyles: males born in 1970s

	All		HSD		HSG		CG		Δ_eLE (CG-HSD)		
	%	LE	%	LE	%	LE	%	LE	Data	(a)	(b)
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(b) Gradient explained by difference in lifestyles across education groups for given health dynamics, $\Delta_e p(y|e)$

Results: Lifestyles, education, and health dynamics

4. Lifestyles explain almost 1/2 of the education gradient of LE

LE at age 50 by education and lifestyles: males born in 1970s

	All		HSD		HSG		CG		Δ_eLE (CG-HSD)		
	%	LE	%	LE	%	LE	%	LE	Data	(a)	(b)
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The Model

The Model

Two different stages

1. Early life
   - Choice of education and lifestyle

2. Life cycle

   a) Working age:
      - standard life-cycle incomplete-markets model of consumption
      - health and labor market risks that are related to education and lifestyle

   b) Retirement: as before, but without labor market risks

Stage 1: Early life

Set up

- Teenager/parents in cohort c make once-and-for-all simultaneous choices of
  - education $\mathsf{e} \in \{\mathsf{HSD}, \mathsf{HSG}, \mathsf{CG}\}$
  - lifestyle $\mathsf{y} \in \{\mathsf{DET}, \mathsf{PRO}\}$
- They solve $\max_{\mathsf{e},\mathsf{y}} \left\{ V_0^{\mathsf{eyc}} - \tau_{\mathsf{e}} - \tau_{\mathsf{y}} \right\}$
  - Value V_0^{eyc} of starting stage 2 with type $(\mathsf{e}, \mathsf{y}, \mathsf{c})$
  - Cost τ_{e} of education e: $\tau_{\mathsf{HSD}} = 0 \quad | \quad \tau_{\mathsf{HSG}} = \mu_{\mathsf{HSG}} + \sigma_{\mathsf{HSG}} \epsilon_e \quad | \quad \tau_{\mathsf{CG}} = \mu_{\mathsf{CG}} + \sigma_{\mathsf{CG}} \epsilon_e$
  - Cost τ_{y} of lifestyle y: $\tau_{\mathsf{DET}} = 0 \quad | \quad \tau_{\mathsf{PRO}} = \mu_{\mathsf{PRO}} + \sigma_{\mathsf{PRO}} \epsilon_{\mathsf{PRO}}$
  - *Independent* and normal distributions: $\epsilon_e, \epsilon_{\mathsf{PRO}} \sim N(0,1)$
- There are complementarities between education and lifestyle choices if:

$$V_0^{\mathsf{CG,PRO}} - V_0^{\mathsf{CG,DET}} > V_0^{\mathsf{HSD,PRO}} - V_0^{\mathsf{HSD,DET}} \Leftrightarrow V_0^{\mathsf{CG,PRO}} - V_0^{\mathsf{HSD,PRO}} > V_0^{\mathsf{CG,DET}} - V_0^{\mathsf{HSD,DET}}$$

Proposition: Selection

- Let the distributions of ϵ_e and ϵ_{PRO} be independent
- Let $F\left(\tau_{\text{PRO}}|\text{e}\right)$ be the CDF of τ_{PRO} conditional on education choice e
- Let's consider only two education choices $\text{e} \in \{\text{HSD}, \text{CG}\}$
- Proposition:
  - If the choices of education and lifestyle are complementary, the distribution $F\left(\tau_{\text{PRO}}|\text{HSD}\right)$ first-order stochastically dominates $F\left(\tau_{\text{PRO}}|\text{CG}\right)$. That is,

$$F(\tau_{\text{PRO}}|\text{HSD}) \leq F(\tau_{\text{PRO}}|\text{CG}) \quad \forall \tau_{\text{PRO}}$$

    with strict inequality for some τ_{PRO}.
  - Instead, if the choices of education and lifestyle are independent we have that,

$$F(\tau_{\text{PRO}}|\text{HSD}) = F(\tau_{\text{PRO}}|\text{CG}) \quad \forall \tau_{\text{PRO}}$$

Stage 2: Life cycle

STATE VARIABLES

- Working agents are heterogeneous with respect to:

1. Types
   - Education $e \in \{\text{HSD}, \text{HSG}, \text{CG}\}$
   - Lifestyle $y \in \{\text{DET}, \text{PRO}\}$
   - Cohort $c \in \{1930, 1970\}$
2. Exogeneous and deterministic state
   - Age $t \in \{25, 27, 29, ...\}$
3. Exogeneous and stochastic states
   - Health status $h_t \in \{h_g, h_b\}$
   - Shock to earnings $\zeta_t \in \mathbb{R}$
4. Endogenous state
   - Cash-on-hand $x_t \in [\underline{x}, \infty)$

Worker's problem

- Worker's problem can be written as:

$$V_t^{\text{eyc}}(h,\zeta,x) = \max_{c,k'}\left\{u(c) + \beta\left(s_t^{\text{ey}}(h)\sum_{h'}\Gamma_t^{\text{ey}}\left(h'|h\right)\mathbb{E}\left[V_{t+1}^{\text{eyc}}(h',\zeta',x')\right] + \left(1 - s_t^{\text{ey}}(h)\right)v_{t+1}(k')\right)\right\}$$

$$\begin{aligned} \text{s.t.} \quad k' + c &= x \\ \tilde{x}' &= (1+r)\,k' + T\left[l_{t+1}^{\text{ec}}(\varepsilon',h')w_{t+1}^{\text{ec}}(\zeta',\epsilon',h')\right] - m_{t+1}^{\text{e}}(\xi',h') \\ x' &= \max\left\{\tilde{x}',\underline{x}\right\} \end{aligned}$$

$$\text{Flow utility:} \quad u(c) = \frac{c^{1-\sigma}-1}{1-\sigma} + b$$

$$\text{Bequest motive:} \quad v_{t+1}(k) = \beta^{T-(t+1)}\theta_1\frac{(k+\theta_2)^{1-\sigma}-1}{1-\sigma}$$

Perceptions Model

Calibration

Estimation

- Life-cycle:
  - External:
    - Parameters related to: demographics, taxes, social security
    - Cohort-specific wages $w_t^{ec}(\zeta, \epsilon, h)$ and labor force participation $l_t^{ec}(\varepsilon, h)$
    - Cohort-independent health dynamics $s_t^{ey}(h)$, $\Gamma_t^{ey}(h'|h)$, and medical spending $m_t^{e}(\xi, h)$
  - Internal: SMM to calibrate remaining 5 parameters (β, $\underline{x}$, θ_1, θ_2, b)
    - Median wealth across age (by education and lifestyles) for the 1930s cohort
    - Value of statistical life
- Early life:
  - Match the joint distribution of education and lifestyles for two different cohorts: 1930, 1970

Counterfactuals

Two questions

1. Type formation:

   → *Why is there an education gradient of lifestyles?*

2. Increasing inequalities (not today):

   → *What has been the effect of the rise in the education wage premium on the increase in the education gradient of LE?*

Question 1: Education gradient of lifestyle

Education gradient of lifestyle

Mechanisms

- Why higher educated individuals are more likely to be protective?

- Direct effects

1. Income: $w_t^{\text{ec}}(\zeta, \epsilon, h)$ and $l_t^{\text{ec}}(\varepsilon, h)$
2. Health yield of lifestyle: $s_t^{\text{ey}}(h)$ and $\Gamma_t^{\text{ey}}(h'|h)$

$\Rightarrow$ They generates complementarities: $V_0^{\text{CG,PRO}} - V_0^{\text{CG,DET}} > V_0^{\text{HSD,PRO}} - V_0^{\text{HSD,DET}}$

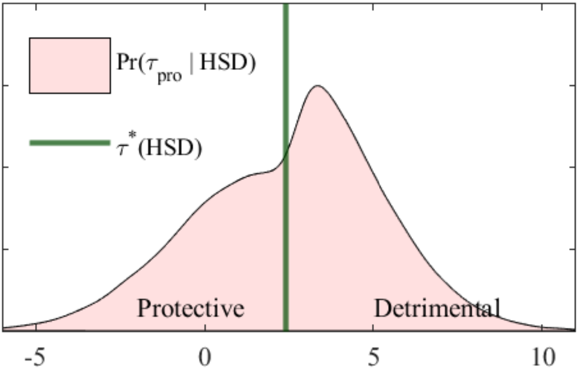
- Induced by complementarities

3. Selection: $F(\tau_{\text{PRO}}|\text{HSD}) \leq F(\tau_{\text{PRO}}|\text{CG}) \quad \forall \tau_{\text{PRO}}$

Education gradient of lifestyle

Lifestyle Choice for HSD

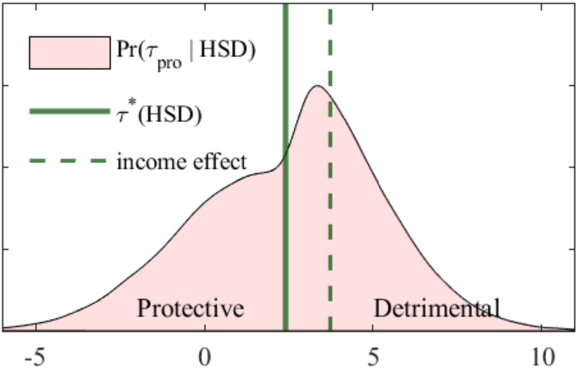
- HSD choose y = PRO iff $\tau_{\text{PRO}} < V_0^{\text{HSD,PRO}} - V_0^{\text{HSD,DET}} \equiv \tau^*(\text{HSD})$



Education gradient of lifestyle

1. Income Effect

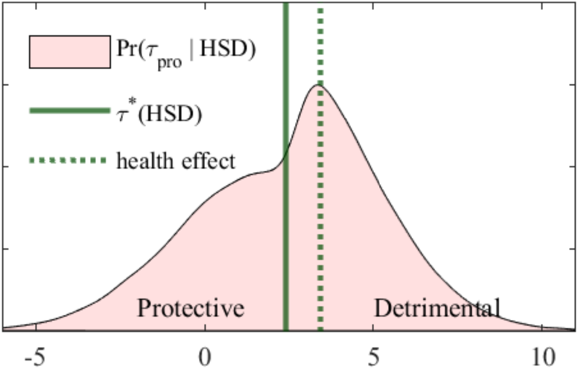
→ If HSD had same income prospects as CG: 21pp more of PRO (1.3 more years of LE)



Education gradient of lifestyle

2. Health Effect

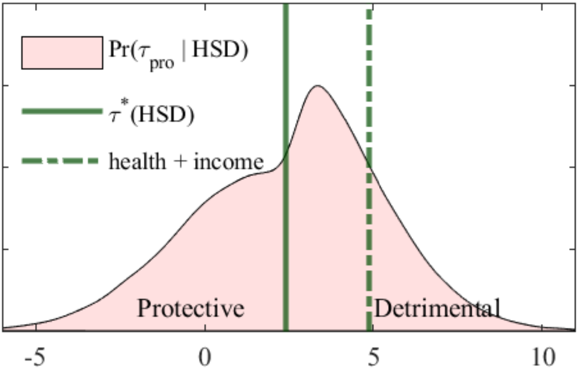
→ If HSD had same health gain of PRO as CG: 16pp more of PRO (1 more year of LE)



Education gradient of lifestyle

3. Income + Health

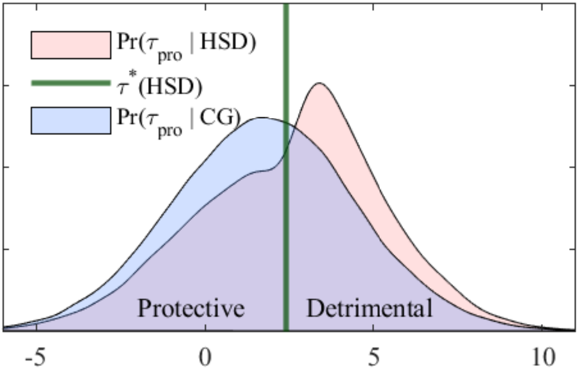
→ Both together: 37pp more of PRO (2.4 more year of LE)



Education gradient of lifestyle

4. Selection

→ If HSD had same distribution of τ_{PRO} as CG: 15pp more of PRO (1 more year of LE)



Conclusions

Conclusions

- We develop an econometric model to identify latent types in lifestyles

  ⇒ Differences in lifestyles across education groups account for 48% of the LE gradient (3.8 out of 8 years)

- HA model w/ complementarities in education and lifestyle investments

  1. Education gradient of lifestyles
     - Income advantage and health advantage explain 2/3 (⇒ 2.4 years)
     - Both similarly important
     - Selection explains 1/3 (⇒ 1 year)
     - Not explained by lifestyles (⇒ 4.5 years)
  2. 2.0 years increase in education gradient of LE between 1930s and 1970s cohorts
     - Direct effect of wage changes explains 4.8 months
     - Indirect effect through selection explains 7.2 months
     - Both together explain 1 year

Econometric Model

1. Health Behavior

- How to model $p(\boldsymbol{z}|\boldsymbol{h}, a_0, y)$?
- We assume that, conditional on $(\mathrm{y}_i, h_{it}, a_{it})$ health behaviors $z_{m,it}$ are
  - independent between them
  - independent over time
- Hence, we can write the probability of a given history $\boldsymbol{z}_i$ of health behaviors as

$$p(\boldsymbol{z}_i|\boldsymbol{h}_i, \mathrm{y}_i, a_{it}) = \prod_t \prod_m p\left(z_{m,it} \,|\, \mathrm{y}_i, h_{it}, a_{it}\right)$$

- We model each element $p\left(z_{m,it}|\mathrm{y}_i, h_{it}, a_{it}\right)$ as a probit

Back to Mixture Model

Econometric Model

2. Health Dynamics

- How to model $p(\boldsymbol{h}|\mathsf{s}, \mathsf{e}, a_0, y)$?
- We assume that, conditional on $(\mathsf{s}, \mathsf{e}, a_0, y)$, the evolution of health outcomes is markovian
- Hence, we can write the probability of a given history $\boldsymbol{h}_i$ of health outcomes as

$$p(\boldsymbol{h}_i|\mathsf{s}_i, \mathsf{e}_i, a_{it}, \mathsf{y}_i) = \prod_t p\left(h_{it}|\, \mathsf{s}_i, \mathsf{e}_i, a_{it}, \mathsf{y}_i, h_{i,t-1}\right)$$

- We model each element $p\left(h_{it}|\, \mathsf{s}_i, \mathsf{e}_i, a_{it}, \mathsf{y}_i, h_{i,t-1}\right)$ as a nested probit
  - First we model survival
  - Next, we model health changes conditional on survival

Back to Mixture Model

Econometric Model

3. Weights

- How to model the mixture weights $p(y|\mathsf{c}, \mathsf{s}, \mathsf{e}, a_0)$?
- The conditional mixture weights are different at each age of entry a_0 because of differential health dynamics by type y
  - Detrimental lifestyles become less frequent at older ages because they die.
- What we do
  - Use the health dynamics to express $p\left(y|\ \mathsf{c}_i, \mathsf{s}_i, \mathsf{e}_i, a_{it}, h_{it}\right)$ as a function of $p\left(y|\ \mathsf{c}_i, \mathsf{s}_i, \mathsf{e}_i, a_{it-1}, h_{it-1}\right)$
  - Estimate the mixture weights at the initial age of 25, $p\left(y|\ \mathsf{c}_i, \mathsf{s}_i, \mathsf{e}_i, 25, h_{i,25}\right)$
- We model each element $p\left(y|\ \mathsf{c}_i, \mathsf{s}_i, \mathsf{e}_i, 25, h_{i,25}\right)$ as a multinomial probit

Back to Mixture Model

Health Behaviour Data

Mean health behavior and 4-year auto-correlation

	Mean					AC	
	HSD	HSG	CG	65-70	75-80	65-70	75-80
Drinking	0.07	0.08	0.07	0.08	0.04	0.46	0.39
Smoking	0.18	0.15	0.07	0.14	0.08	0.70	0.64
Cancer test	0.60	0.71	0.79	0.77	0.72	0.40	0.41
Cholesterol	0.78	0.85	0.89	0.84	0.85	0.30	0.27
Flu shot	0.67	0.74	0.81	0.66	0.76	0.59	0.59
Exercise	0.27	0.38	0.54	0.41	0.38	0.41	0.37

Data from the HRS. HSD: high school dropout; HSG: high school graduate; CG: college graduate; 65-70: sub-sample of individuals aged 65 to 70; 75-80: sub-sample of individuals aged 75 to 80. The last two columns show the autocorrelation (AC) of each health behavior with a 4-year lag.

Back to Data

Health Behaviour Data

Cross correlation health behaviors

	Drinking	Smoking	Cancer test	Cholesterol	Flu shot	Exercise
Drinking	1.00	0.07	0.00	-0.00	-0.03	0.02
Smoking	0.12	1.00	-0.08	-0.07	-0.08	-0.06
Cancer test	-0.02	-0.15	1.00	0.28	0.19	0.10
Cholesterol	-0.02	-0.12	0.36	1.00	0.22	0.07
Flu shot	-0.05	-0.09	0.21	0.24	1.00	0.03
Exercise	0.03	-0.09	0.11	0.03	0.01	1.00

Data from the HRS. Lower diagonal: individuals aged between 65 and 70. Upper diagonal: individuals aged between 75 and 80.

Back to Data

Set up: two education choices

- An individual decides to hold a protective lifestyle if:

$$\tau_{\text{PRO}} < \max\{V^{\text{CG,PRO}} - \tau_{\text{CG}}, V^{\text{HSD,PRO}}\} - \max\{V^{\text{CG,DET}} - \tau_{\text{CG}}, V^{\text{HSD,DET}}\}$$

Go back

Set up: two education choices

- An individual decides to hold a protective lifestyle if:

$$\tau_{\text{PRO}} < \max\{V^{\text{CG,PRO}} - \tau_{\text{CG}}, V^{\text{HSD,PRO}}\} - \max\{V^{\text{CG,DET}} - \tau_{\text{CG}}, V^{\text{HSD,DET}}\}$$

- $V^{\text{CG,PRO}} - V^{\text{CG,DET}} = V^{\text{HSD,PRO}} - V^{\text{HSD,DET}}$:
  - An individual decides to be protective if:

$$\tau_{\text{PRO}} < V^{e,\text{PRO}} - V^{e,\text{DET}}$$

  - The decision of being protective is independent on the value of τ_{CG}

Go back

Set up: two education choices

- An individual decides to hold a protective lifestyle if:

$$\tau_{\text{PRO}} < \max\{V^{\text{CG,PRO}} - \tau_{\text{CG}}, V^{\text{HSD,PRO}}\} - \max\{V^{\text{CG,DET}} - \tau_{\text{CG}}, V^{\text{HSD,DET}}\}$$

- With $V^{\text{CG,PRO}} - V^{\text{HSD,PRO}} > V^{\text{CG,DET}} - V^{\text{HSD,DET}}$:
  - An individual decides to be protective if:

A. $\tau_{\text{CG}} < V^{\text{CG,DET}} - V^{\text{HSD,DET}} : \tau_{\text{PRO}} < V^{\text{CG,PRO}} - V^{\text{CG,DET}}$

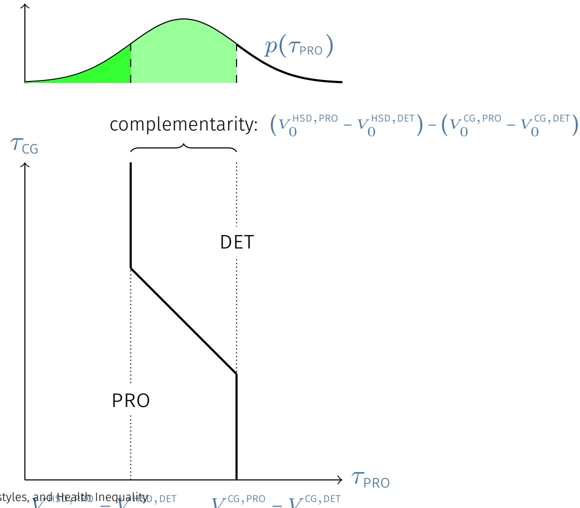
B. $\tau_{\text{CG}} > V^{\text{CG,PRO}} - V^{\text{HSD,PRO}} : \tau_{\text{PRO}} < V^{\text{HSD,PRO}} - V^{\text{HSD,DET}}$

C. $V^{\text{CG,DET}} - V^{\text{HSD,DET}} < \tau_{\text{CG}} < V^{\text{CG,PRO}} - V^{\text{HSD,PRO}} : \tau_{\text{PRO}} < V^{\text{CG,PRO}} - \tau_{\text{CG}} - V^{\text{HSD,DET}}$

Go back

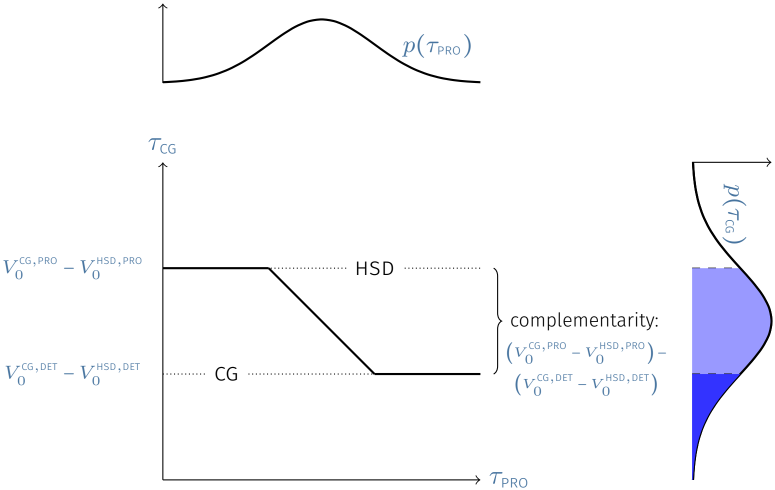
Choices: two education levels

Complementarities: $V_0^{\text{CG,PRO}} - V_0^{\text{CG,DET}} > V_0^{\text{HSD,PRO}} - V_0^{\text{HSD,DET}}$



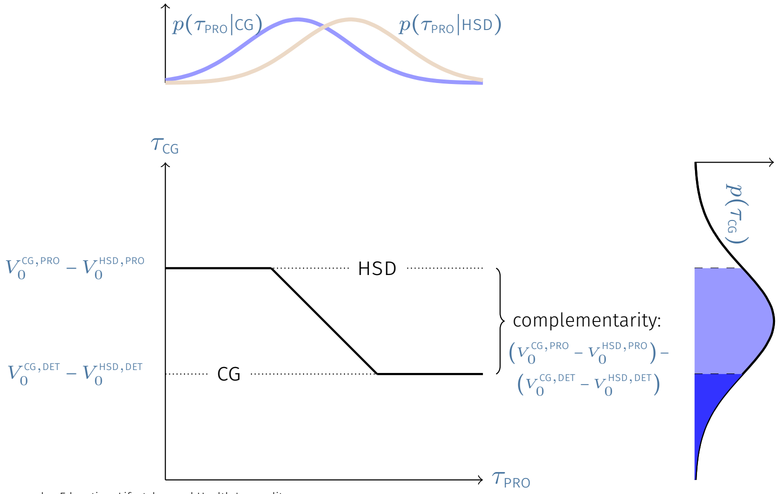
Choices: two education levels

Complementarities: $V_0^{\text{CG,PRO}} - V_0^{\text{CG,DET}} > V_0^{\text{HSD,PRO}} - V_0^{\text{HSD,DET}}$



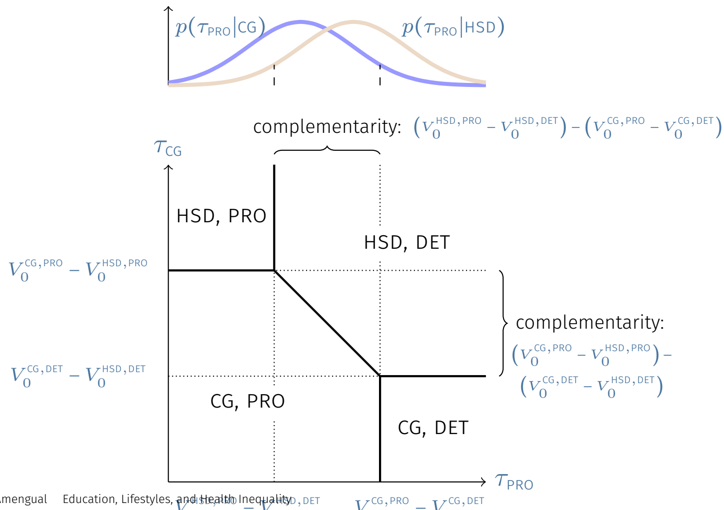
Choices: two education levels

Complementarities: $V_0^{\text{CG},\text{PRO}} - V_0^{\text{CG},\text{DET}} > V_0^{\text{HSD},\text{PRO}} - V_0^{\text{HSD},\text{DET}}$



Choices: two education levels

Complementarities: $V_0^{\text{CG,PRO}} - V_0^{\text{CG,DET}} > V_0^{\text{HSD,PRO}} - V_0^{\text{HSD,DET}}$



Choices: two education levels

Complementarities: $V_0^{\text{CG},\text{PRO}} - V_0^{\text{CG},\text{DET}} > V_0^{\text{HSD},\text{PRO}} - V_0^{\text{HSD},\text{DET}}$

- Complementarities imply:
  - Higher educated individuals are more likely to invest in protective lifestyle as the returns are larger: *direct effect*.
  - Individuals with lower cost cost of adopting health behavior (healthy parents/ peers) are more likely to go to college: *selection effect*.
- Selection drives that the distribution of τ_{PRO} across education groups is different:

$$F\left(\tau_{\text{PRO}}\middle|\text{CG}\right) \geq F\left(\tau_{\text{PRO}}\middle|\text{HSD}\right)$$

$\Rightarrow$ High-school dropouts are negatively selected in terms of τ_{PRO}

Go back

Worker's problem with perceptions

Back to Model

- Worker's problem can be written as:

$$V_t^{\text{eyc}}(h,\zeta,x) = \max_{c,k'} \left\{ u(c) + \beta \left[\lambda^{\text{c}} W_t^{\text{eyc}}(h',\zeta',x') + \left(1-\lambda^{\text{c}}\right) \widehat{W}_t^{\text{eyc}}(h',\zeta',x') \right] \right\}$$

$$W_t^{\text{eyc}}(h',\zeta',x') = s_t^{\text{ey}}(h) \sum_{h'} \Gamma_t^{\text{ey}}\left(h'|h\right) \mathbb{E}\left[V_{t+1}^{\text{eyc}}(h',\zeta',x')\right] + \left(1 - s_t^{\text{ey}}(h)\right) v_{t+1}(k')$$

$$\widehat{W}_t^{\text{eyc}}(h',\zeta',x') = s_t^{\text{e}}(h) \sum_{h'} \Gamma_t^{\text{e}}\left(h'|h\right) \mathbb{E}\left[V_{t+1}^{\text{eyc}}(h',\zeta',x')\right] + \left(1 - s_t(h)\right) v_{t+1}(k')$$

$$\begin{aligned} \text{s.t.} \quad k' + c &= c \\ \tilde{x}' &= (1+r)\,k' + T\left[l_{t+1}^{\text{ec}}(\varepsilon',h')w_{t+1}^{\text{ec}}(\zeta',\epsilon',h')\right] - m_{t+1}^{\text{e}}(\xi',h') \\ x' &= \max\left\{\tilde{x}', \underline{x}\right\} \end{aligned}$$

$$\text{Flow utility:} \quad u(c) = \frac{c^{1-\sigma}-1}{1-\sigma} + b$$

$$\text{Bequest motive:} \quad v_{t+1}(k) = \beta^{T-(t+1)}\theta_1 \frac{(k+\theta_2)^{1-\sigma}-1}{1-\sigma}$$