Can Wealth Buy Health?
A Model of Pecuniary and Non-Pecuniary Health Investments

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Les enjeux économiques des inégalités démographiques Montreal 2022

- Gap in life expectancy for males at age 25 between college and high school graduates 5.5 years in US
  - Similar patterns in other developed countries (Bohacek et al., 2018)
- What are sources of this striking inequality?
- What does this imply for government interventions that aim to improve access to healthcare such as Medicare-for-all?

Introduction

Stylized Facts - Health

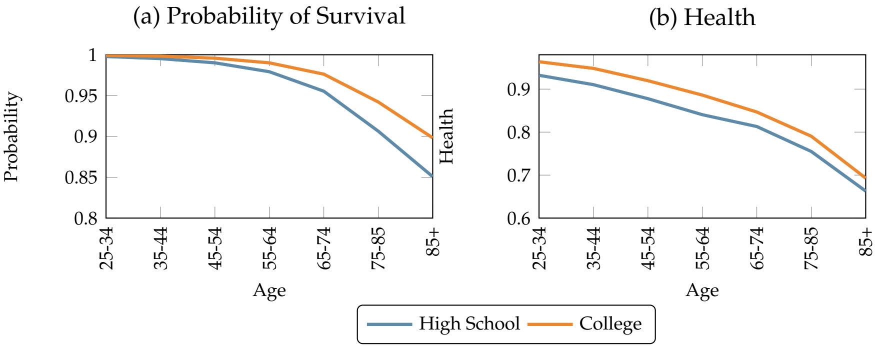


Figure: Health and Conditional Probability of Survival by Education and Age

Notes: Figure (a) shows the conditional probability of survival by education and age, excluding homicides and accidents. Figure (b) shows average health by age and education, where health is measured by 1-frailty index and 1 corresponds to the best health and 0 to the worst (death).

Source: MEPS, CDC and ACS, 2000-13.

Introduction

Stylized Facts - Spending

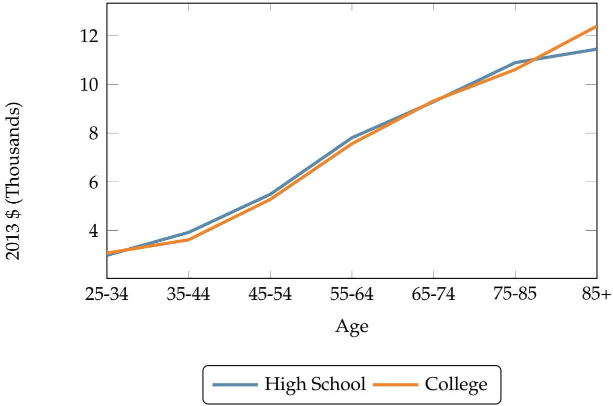


Figure: Total healthcare Spending by Education and Age

Notes: Total healthcare spending includes aggregate healthcare spending taking into account out-of-pocket medical spending, payments by private and public insurance and other sources, excluding over the counter drugs and indirect payments not related to specific medical events.

Source: MEPS, 2000-13.

Introduction

Stylized Facts - Spending

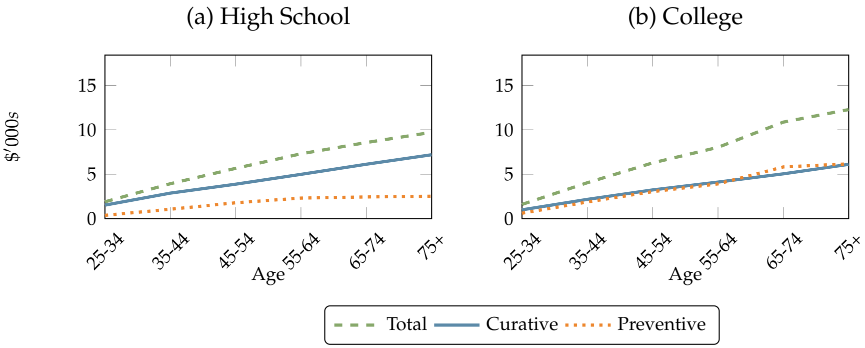


Figure: Total, Curative and Preventive Medical Spending by Education and Age

Notes: Model predicted total, curative and preventive medical spending.

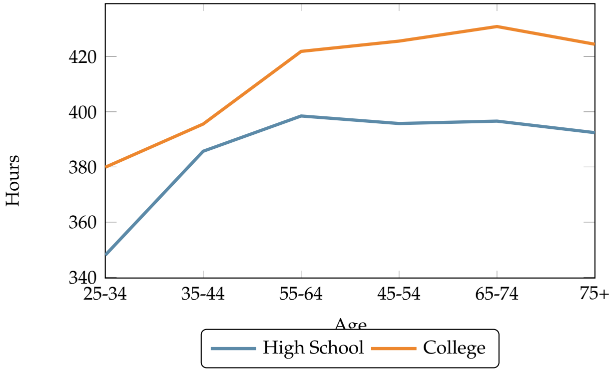
Source: MEPS, 2000-13.

- Nearly 50% of all deaths in the US attributed to modifiable behavioural factors
  - Positive - healthy diet, exercise, wearing seatbelt
  - Negative - smoking, heavy drinking
- Focus on the positive that require time investment

Introduction

Stylized Facts - Non-Pecuniary Investment

Figure: Non-Pecuniary Investment by Education and Age



Notes: Non-pecuniary investment consists of total time spent on (i) sports and exercise, (ii) visiting doctor and (iii) selfcare (excluding sleep).

Source: ATUS, 2003-13.

Introduction

Stylized Facts - Non-Pecuniary Investment

Table: Preventive Service Utilization over Education (in Last 2 Years)

Activity	Routine Check	Blood Pressure	Flu Shot	Dentist
High School	69.77%	82.06%	38.22%	49.75%
College	79.10%	90.07%	51.73%	71.56%

Notes: Percentage of individuals that report utilizing preventive medical services such as routine check, blood pressure check, flu shot and visiting the dentist within the last two years.
Source: MEPS, 2000-2013.

- After 65 - Medicare
- Before 65
  - Group Health Insurance (GHI) - Employer-subsidized health insurance
  - Private Health Insurance (PHI) - Individually-purchased health insurance
  - Medicaid

Introduction

Stylized Facts - Health Insurance

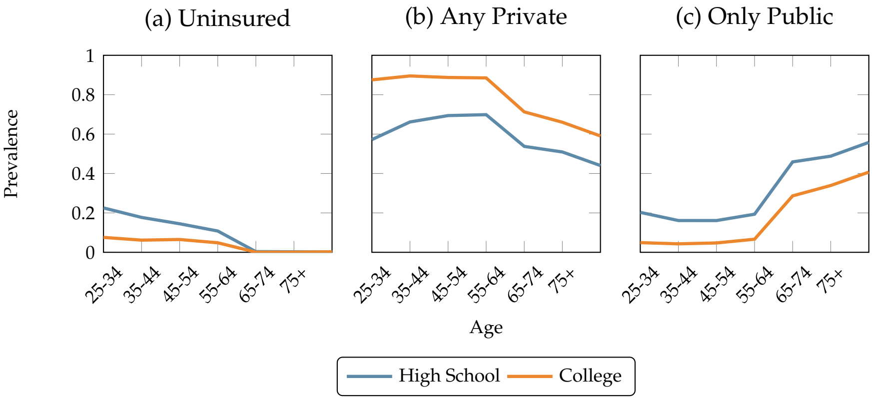


Figure: PREVALENCE OF INSURANCE COVERAGE BY EDUCATION AND AGE

Notes: Figure (a) shows the percentage of uninsured individuals over education. Figure (b) shows the percentage that has any type of private insurance and Figure (c) shows the percentage that is only covered by public insurance programs.

Source: MEPS, 2008-13.

Introduction

Stylized Facts - Health Shocks

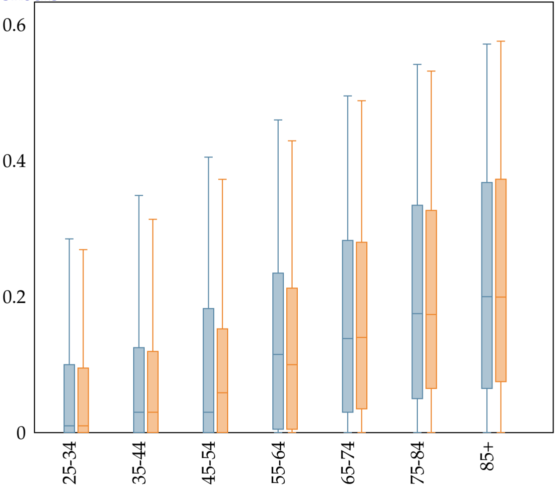


Figure: DISTRIBUTION OF HEALTH SHOCKS BY AGE AND EDUCATION

Notes: The graph presents the distribution of health shocks by age and education, as measured by the cumulative health condition severity weights. The line represents the mean, the edges of the box the 25th and 75th percentiles and the whiskers the 5th and 95th percentiles. The blue and orange boxplots represent the health shock distributions of high school and college graduates, respectively.

- Conditional on health and age high school graduates experience larger health shocks
  - Educated individuals more likely to comply with treatments that require complex technologies and lifestyle changes (Goldman and Smith, 2002)
  - Significant effect of schooling on mortality (Lleras-Muney, 2002)
  - Habits (Cutler and Lleras-Muney, 2010)
  - Early life conditions (Almond and Currie, 2011)

Develop life cycle model to

- Rationalize gradients in health and life expectancy
- Study effects of Medicare-for-all type policy

Key feature are:

- Pecuniary and non-pecuniary investments in health
- Curative medical spending
- Education specific distribution of health shocks

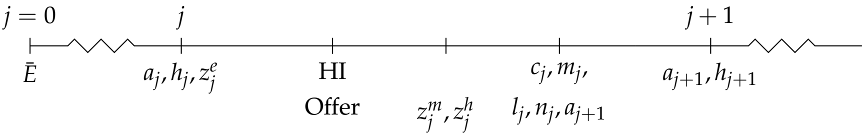
Introduction
Literature

- Empirical literature on drivers of health investments
  - Health insurance coverage (Finkelstein et al. (2012), Kolstad and Kowalski (2012), Barbaresco et al. (2015))
  - Income (Acemoglu et al. (2007), Finkelstein et al. (2013))
  - Education (Cutler and Lleras-Muney (2010), Conti et al. (2010))
- Life-cycle literature
  - Exogenous medical spending (French (2005), De Nardi et al. (2009), Violante et al. (2010), Kopecky and Koreshkova (2014))
  - Endogenous medical spending (Hall and Jones (2007), Zhao (2014), Halliday et al. (2017), Ozkan (2017), Fonseca et al. (2021))

- Medicare-for-all
  - Does little to close the life expectancy gap - depending on financing mechanism life expectancy can drop
  - Improves welfare if financed by increase in income tax progressivity
  - Reduction in consumption inequality
- Differences in income, preferences, and health shocks explain the lion's share of life expectancy gap
  - Eliminating differences in initial health has little impact on the life expectancy gap

Model

- Life cycle model where households choose consumption, savings, preventive medical spending and time spent in work and health promoting activities
- Agents face uncertainty with respect to labor income, curative medical spending, health, and health insurance status
- Education affects productivity, distribution of health shocks, and probability of receiving GHI offer
- Health affects utility, probability of survival, labor productivity and distributions of health and curative medical spending shocks



Agents have preferences over consumption c_j, health h_j, time spent on work l_j and healthy activities n_j:

$$u_j\left(c_j, l_j, n_j, h_j\right) = v_0 \ln c_j - v_{1,i}\frac{l_j^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}} - v_{2,i}\frac{n_j^{1+\frac{1}{\nu}}}{1+\frac{1}{\nu}} + v_3 \ln h_j \tag{1}$$

- Evolution of health stock:

$$h_j = \left(1 - z_j^h\right) h_{j-1} + Q_j m_j^{\psi_j} n_j^{1-\psi_j} \tag{2}$$

where m_j and n_j denote pecuniary and non-pecuniary investments

- Mortality risk:

$$p_j^d\left(h_j, j\right) = \bar{p}_j^d \exp\left(\rho_h\left(h_j - h_{\max}\right)\right) \tag{3}$$

- Agents face following budget constraint:

$$\tilde{y}_j = (1 + \tau^c)\, c_j + \mu_j + a_j \tag{4}$$

- where $\tilde{y}_j$ denotes total net income:

$$\tilde{y}_j = \left(1 - \tau\left(y_j\right) - \tau_{ss}\right) l_j e\left(h_j, j, i, z_j^l\right) + (1 + r)\, a_{j-1} + ss_j + Tr_j + DIB_j \tag{5}$$

  - Tr_j - transfers that guarantee minimum level of consumption
  - DIB_j - disability insurance benefits
  - ss_j - social security benefits

Total out-of-pocket medical spending:

$$\mu_j = \left(1 - q\left(ins_j\right)\right)\left(m_j + z_j^m\right) + pr\left(ins_j\right) \tag{6}$$

where m_j, z_j^m, pr and q denote preventive medical spending, curative medical spending, health insurance premium and coinsurance rate

5 health insurance states ins_j:

$$ins_j = \begin{cases} Medicare, & if \quad j \geq J_R \\ Medicaid, & if \quad c_j < \bar{c}, \quad y_j < y_{Medicaid} \\ GHI, & w/prob. \quad \zeta\left(\bar{E}, j\right) \\ PHI, & \\ Uninsured & \end{cases} \tag{7}$$

- Agents face uncertainty with respect to health insurance status until age 65
- Receiving a GHI offer results in automatic enrollment
- PHI or being uninsured is a choice

Government provides:

- Social Security benefits and Medicare after eligibility age
- Medicaid for individuals with income below Medicaid threshold
- Disability benefits for individuals that drop out of the labor market and with health below DIB threshold
- Transfers that guarantee minimum level of consumption

Government spending financed by:

- Progressive income tax

$$\tau\left(y_j\right) = 1 - \tau_0 y_j^{\varphi} \tag{8}$$

- Consumption tax
- Medicare premium
- Social Security tax

Parameterization

- Two-step parameterization
  - Estimate as many parameters as possible from the data and exogenously set parameters that are common in the literature
  - Indirect Inference for the remaining parameters
- Use data from
  - Medical Expenditure Panel Survey (MEPS)
  - American Time Use Survey (ATUS)
  - Panel Survey of Income Dynamics (PSID)
  - Center of Prevention and Disease (CDC)
  - American Community Survey (ACS)

Parameterization

Estimated Parameters - Health and Curative Medical Spending Shocks

- Estimate distribution of health shocks using medical conditions from MEPS and severity index from WHO's Global Burden of Disease
- Divide health shocks into 3 bins, bottom 50th, 50-95th and top 5th percentiles by age, education, and health (De Nardi et al., 2018)
- Regress magnitude of shock on polynomials of age and health for each bin separately

- Estimate the probability of receiving a GHI offer using Probit controlling for age and education

$$\zeta\left(\bar{E},j\right)=F\left(o_1+o_2j+o_3j^2+o_{\bar{E}}\right) \tag{9}$$

- Health insurance coinsurance rate and premium:

Table: Health Insurance Coinsurance Rate and Premium

Type of Insurance	Coinsurance Rate	Insurance Premium
GHI	0.71	1,947
PHI	0.67	-
Medicare	0.73	546
Medicaid	0.9	0

Notes: The coinsurance rates are estimated as the fraction of out-of-pocket payments over the total medical spending. The GHI premium is estimated using MEPS data and the PHI is set endogenously in the model.
Source: MEPS

We follow Hosseini et al. (2021) and use a system GMM dynamic panel estimator and a selection correction procedure to estimate the effect of health on productivity:

$$\begin{bmatrix} y_{i,t} \\ \Delta y_{i,t} \end{bmatrix} = \gamma \begin{bmatrix} h_{i,t} \\ \Delta h_{i,t} \end{bmatrix} + a_1 \begin{bmatrix} y_{i,t-1} \\ \Delta y_{i,t-1} \end{bmatrix} + a_1 \begin{bmatrix} y_{i,t-2} \\ \Delta y_{i,t-2} \end{bmatrix} + \delta \begin{bmatrix} Z_{i,t} \\ \Delta Z_{i,t} \end{bmatrix} + \varepsilon_{i,t} \tag{10}$$

Parameterization

Exogenous Parameters - Preferences

Table: Preference Parameters

Parameter	Description	Value
β	Discount factor	0.97
η	Frisch Elasticity	0.33
γ	Concavity of disutility from healthy time	0.33

Notes: Parameters set exogenously in the model.

Parameterization

Exogenous Parameters - Government

Tax parameters:

Parameter	Description	Value
τ_0	Tax level	0.902
ϕ	Tax progressivity	0.036
ϕ	Social Security tax	0.124
τ^c	Consumption tax	0.05

Source: Guner et al. (2014)

Marginal replacement rates for social security:

Average Lifetime Earning	Marginal Replacement Rate
$y_i \in [0, 0.2\bar{y})$	90%
$y_i \in [0.2, 1.25\bar{y})$	33%
$y_i \in [1.25, 2.46\bar{y})$	15%
$y_i \in [2.46, \infty)$	0%

Source: Zhao (2017)

Parameterization

Indirect Inference

Remaining parameters:

- The health production function - Q_j and ψ_j
- Preferences - v_0, $v_{i,1}$, $v_{i,2}$, v_3
- Probability of survival - ρ_h
- Health insurance - ω, h_{DIB}

To match following moments:

- Mean healthcare spending by age and education
- Mean level of health by age and education
- Life expectancy gap
- Share with PHI by education
- Ratio (college/high school) of time spent in health promoting activities
- Employment rates at age 63 by education
- Disability benefit collection rates at age 61 by education

Minimize distance:

$$\hat{\boldsymbol{\theta}} = \arg\min \left[\hat{\psi}^d(\boldsymbol{\theta}) - \hat{\psi}^s(\boldsymbol{\theta})\right]' W \left[\hat{\psi}^d(\boldsymbol{\theta}) - \hat{\psi}^s(\boldsymbol{\theta})\right] \tag{11}$$

where

- $\hat{\boldsymbol{\theta}}$ is vector of parameters to be estimated
- $\hat{\psi}^d$ and $\hat{\psi}^s$ are vectors of data and simulation moments respectively
- W is weighting matrix

Model Fit

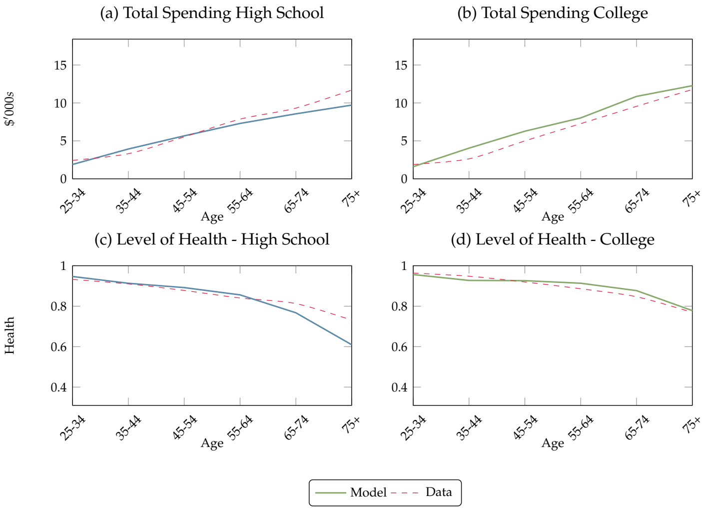


Figure: TOTAL MEDICAL SPENDING BY EDUCATION AND AGE

Notes: Total medical spending, model vs. data.

Source: MEPS (2000-13) and simulation results.

Aggregates

Table: Model Fit

	Model	Data
Life Expectancy Gap	5.63	5.50
Pecuniary Ratio	1.15	1.06
PHI (HS)	0.19	0.14
PHI College	0.14	0.19
DIB at 61 (HS)	15.30	15.39
DIB at 61 (College)	0.00	7.83
LFP Age 63 (HS)	56.63	53.84
LFP Age 63 (College)	69.17	68.45

Notes: Data and model predicted moments for: (i) life expectancy gap, (ii) ratio of non-pecuniary investment for college relative to high school graduates, (iii) PHI by education, (iv) disability benefit claiming at age 61 by education, and (v) employment at age 63 by education
Source: MEPS (2000-13), ATUS (2003-13), PSID (2000-13), CDC (2000-13), ACS (2000-13) and simulation results.

Model Fit
External Validation

- Elasticities
  - Income elasticity of 0.74 (Acemoglu et al., 2013)
  - Price elasticity of -0.24 (Ringel et al., 2002)

Universal Health Coverage

Implement Medicare-for-all

- Everyone covered by public health insurance, private health insurance market eliminated
  - Government covers fixed fraction (73%) of preventive and curative healthcare spending
- Balance government budget with increase in income tax progressivity

Universal Health Coverage

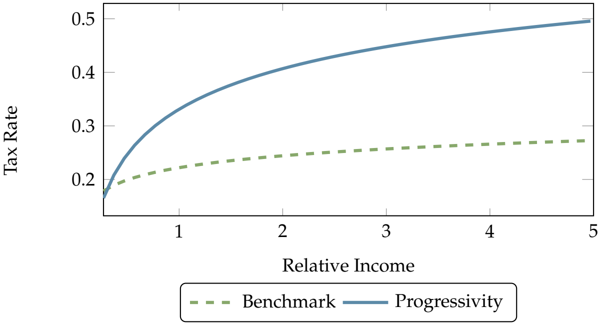


Figure: TAX RATE ADJUSTMENT

Notes: Income tax schedule when Medicare expansion financed through increase in income tax progressivity.

Source: Benchmark tax function from Guner et al. (2014), updated tax schedule based on simulation results.

Universal Health Coverage

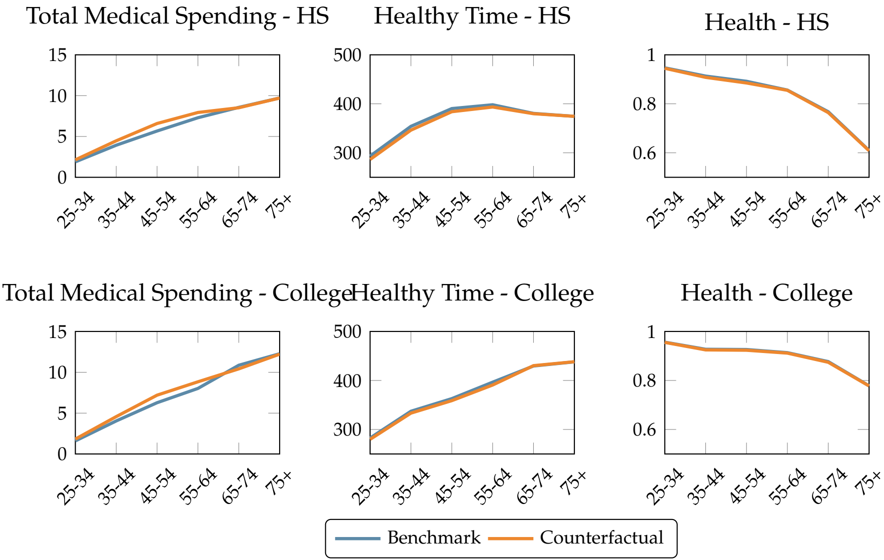


Figure: RESULTS FOR MEDICARE EXPANSION FUNDED THROUGH INCREASE IN INCOME TAX PROGRESSIVITY

Universal Health Coverage

- Welfare increase for high school graduates: 0.4%
- Consumption Gini falls from 0.23 to 0.2

Decompositions

Table: Decomposing Life Expectancy Gap

	Gap
Initial Health	-0.10
Labor Income	-2.79
Health Shocks	-2.22
Time Preference	-2.37

Notes: Change in life expectancy gap between high school and college graduates (years) from counterfactuals.
Source: Simulation Results.

Decompositions - Labor Income

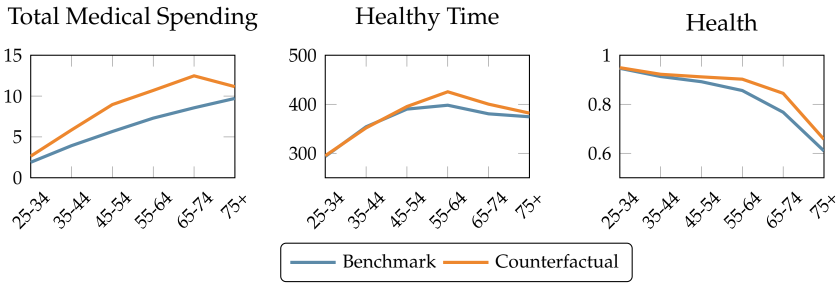


Figure: Eliminating Differences in Labor Income over Education

Notes: Total medical spending ($'000), time spent on health promoting activities (hours), and level of health (1-frailty index) of high school graduates when eliminating education wage premium.

Source: Simulation results.

Decompositions - Health Shocks

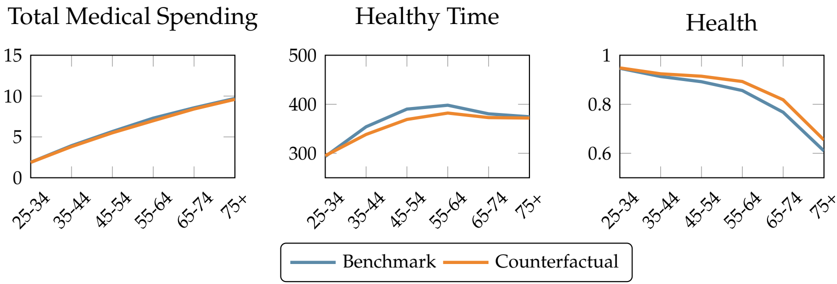


Figure: ELIMINATING DIFFERENCES IN HEALTH SHOCKS OVER EDUCATION

Notes: Total medical spending ($'000), time spent on health promoting activities (hours), and level of health (1-frailty index) of high school graduates when eliminating education differences in health shocks.

Source: Simulation results.

Decompositions - Time Preferences

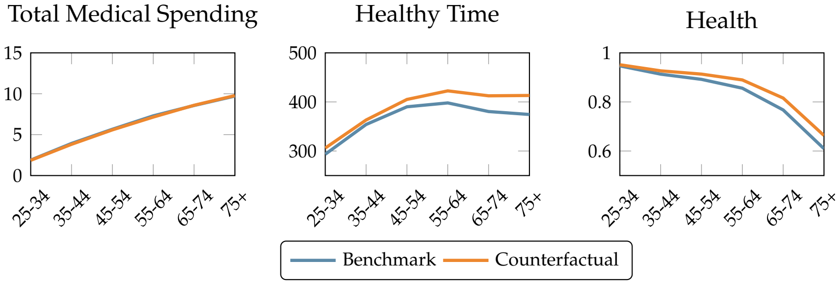


Figure: Eliminating Differences in Preferences for Healthy Time over Education

Notes: Total medical spending ($'000), time spent on health promoting activities (hours), and level of health (1-frailty index) of high school graduates when eliminating education differences in preferences for healthy time.

Source: Simulation results.

Conclusions

- Medicare-for-all, if financed with an increase in income tax progressivity, improves welfare but has small effect on life expectancy gradient
    - Non-pecuniary investment negatively affected
    - Lower incentive to invest in health when curative medical spending shocks partially insured
- Wealth *does* buy health
    - Higher pecuniary and non-pecuniary investment for rich
    - Wealthier individuals - more willing to sacrifice current consumption and leisure for better health and longer life

Health Shocks

Table: Regression Results: Health Shock

	Dependent variable:					
	Health Shock					
	HS Bottom 50%	HS 50-95	HS Top 5%	C Bottom 50%	C 50-95	C Top 5%
Age	-0.001^{***}	0.005^{***}	0.010^{***}	-0.001^{***}	0.002^{***}	0.007^{***}
	(0.0001)	(0.0003)	(0.001)	(0.0001)	(0.0004)	(0.001)
Age Squared	0.0002^{***}	0.0002^{***}	0.00004	0.0002^{***}	0.0002^{***}	0.0001^{***}
	(0.00001)	(0.00001)	(0.00002)	(0.00000)	(0.00001)	(0.00003)
Health	0.060^{***}	0.128^{***}	-0.023	0.103^{***}	0.252^{***}	-0.150^{**}
	(0.014)	(0.022)	(0.048)	(0.018)	(0.033)	(0.064)
Health Squared	-0.058^{***}	-0.183^{***}	-0.051	-0.075^{***}	-0.258^{***}	0.031
	(0.009)	(0.019)	(0.033)	(0.011)	(0.024)	(0.042)
Constant	-0.001	0.131^{***}	0.419^{***}	-0.025^{***}	0.085^{***}	0.453^{***}
	(0.006)	(0.010)	(0.019)	(0.007)	(0.010)	(0.026)
Observations	67,268	47,406	4,822	56,773	46,218	5,052
Note:						*p<0.1; **p<0.05; ***p<0.01

Curative Medical Spending

Table: Regression Results: Medical Spending Shock

	Dependent variable:					
	Medical Spending Shock					
	HS Bottom 50%	HS 50-95	HS Top 5%	C Bottom 50%	C 50-95	C Top 5%
Age	0.006***	0.061***	0.409***	0.004***	0.031***	0.457***
	(0.001)	(0.002)	(0.070)	(0.001)	(0.002)	(0.040)
Age Squared	0.0003***	−0.00005	−0.009***	0.0004***	0.001***	−0.010***
	(0.00002)	(0.0001)	(0.002)	(0.00002)	(0.0001)	(0.001)
Health	0.403***	−1.297***	−8.923**	0.448**	−1.745***	−4.702
	(0.125)	(0.267)	(4.385)	(0.208)	(0.343)	(3.883)
Health Squared	−0.382***	−0.073	5.150	−0.399***	0.231	1.528
	(0.091)	(0.162)	(3.451)	(0.136)	(0.210)	(2.733)
Constant	−0.015	1.667***	8.066***	0.009	2.019***	5.599***
	(0.039)	(0.131)	(1.589)	(0.076)	(0.158)	(1.350)
Observations	59,770	53,779	5,980	54,030	48,610	5,411

Note: *p<0.1; **p<0.05; ***p<0.01

GHI Offer

Table: Regression Results: GHI Offer

	Dependent variable:
	GHI Offer
	Probit
Age	0.084^{***}
	(0.007)
Age Squared	-0.004^{***}
	(0.0003)
College Graduate	0.429^{***}
	(0.017)
Constant	0.246^{***}
	(0.030)
Observations	110,115
Note:	*p<0.1; **p<0.05; ***p<0.01

Labor Productivity

	(1) Earnings HS	(2) Earnings College
y_{t-1}	0.428***	0.564***
	(6.68)	(11.00)
y_{t-2}	0.178**	0.166***
	(3.16)	(3.88)
Health	1.157*	0.494
	(2.47)	(1.19)
Age	0.107**	0.0743*
	(2.65)	(2.19)
Agesq	-0.00517**	-0.00407**
	(-3.18)	(-3.13)
IndividualFixedEffects	1.842***	1.214***
	(4.74)	(3.77)
_cons	-2.263***	-1.884***
	(-3.58)	(-3.83)
N	1408	2091

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Labor Productivity

	(1) Earning HS	(2) Earnings College
Age	0.0841***	0.154***
	(8.58)	(19.49)
AgeSq	-0.00305***	-0.00643***
	(-6.23)	(-15.84)
_cons	0.218***	1.189***
	(5.20)	(40.86)
N	8625	11125

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Indirect Inference

Table: Estimated Parameters

Parameter	Description	Value
Health Production Function		
Q_1	Productivity Scale Age 25	0.81
Q_{38}	Productivity Scale Age 101	2.16
ψ_1	Share of Pecuniary Investments Age 25	0.01
ψ_{38}	Share of Pecuniary Investments Age 101	0.08
Utility		
v_0	Consumption Utility	11.35
$v_{1,1}$	Labor Disutility HS	11.31
$v_{1,2}$	Labor Disutility C	4.93
$v_{2,1}$	Time Invest. Disutility HS	15521.36
$v_{2,2}$	Time Invest. Disutility C	12254.24
v_3	Health Utility	8.02
ρ	Health in Survival Probability	4.42
Insurance		
h_{DIB}	Health Threshold for DIB	0.58
ω	PHI Premium	0.77

Notes: Model parameters estimated based on indirect inference. For age varying parameters we report the starting and ending values.
Source: Indirect inference.