Health and Heterogeneity

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Outline

Objective of the paper

- There is ample evidence that **health** and **socioeconomic status** are related.
- In particular, **more educated** people have better health and higher life expectancies
- More educated people also do **better things** for their health

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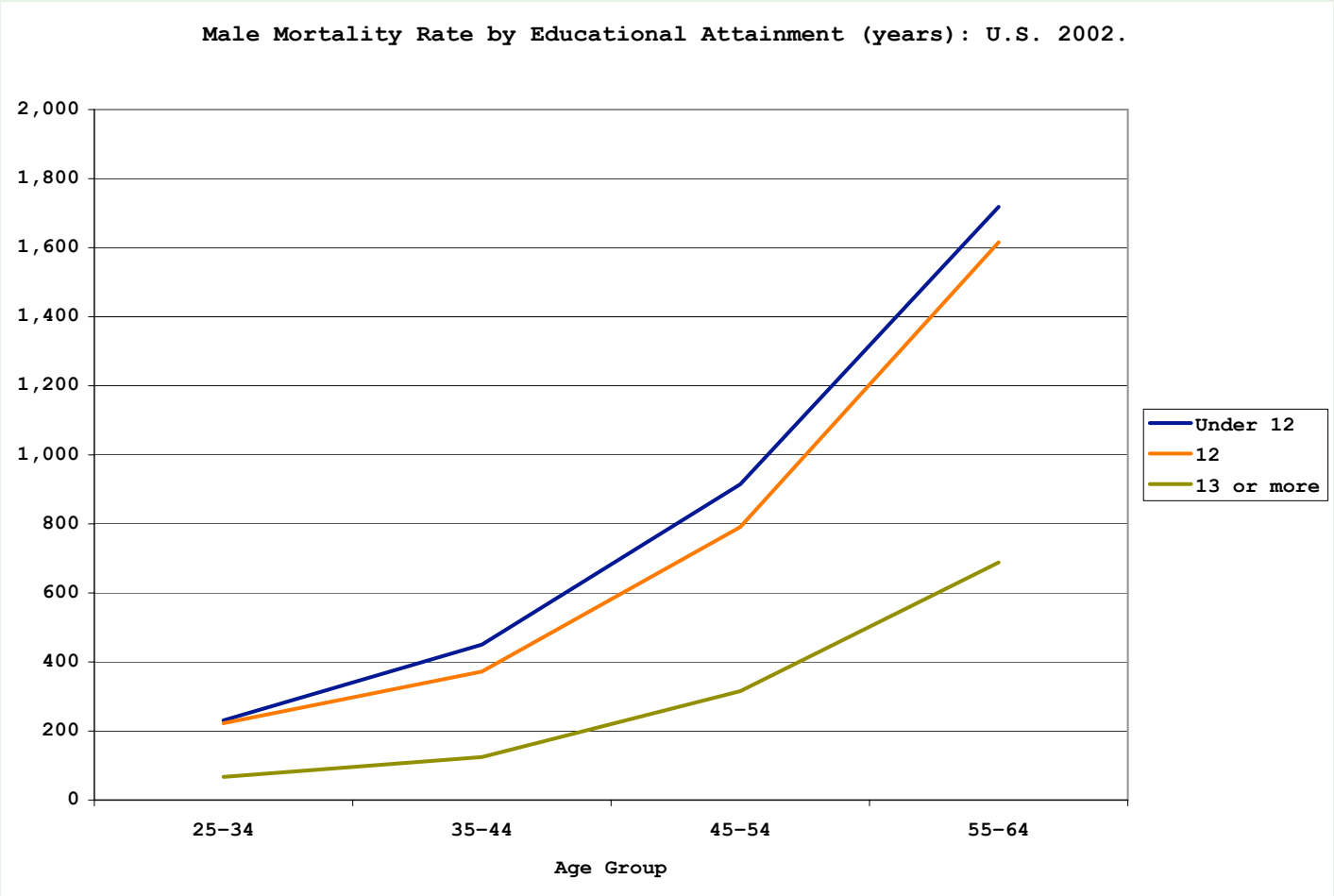
- We want to understand the sources of heterogeneity between people that are behind the correlation between health and education
- We will exploit household level data on *health outcomes*, *health investment* and *consumption growth* to find out in **which dimensions people are different**.

Mortality rates and economics are related

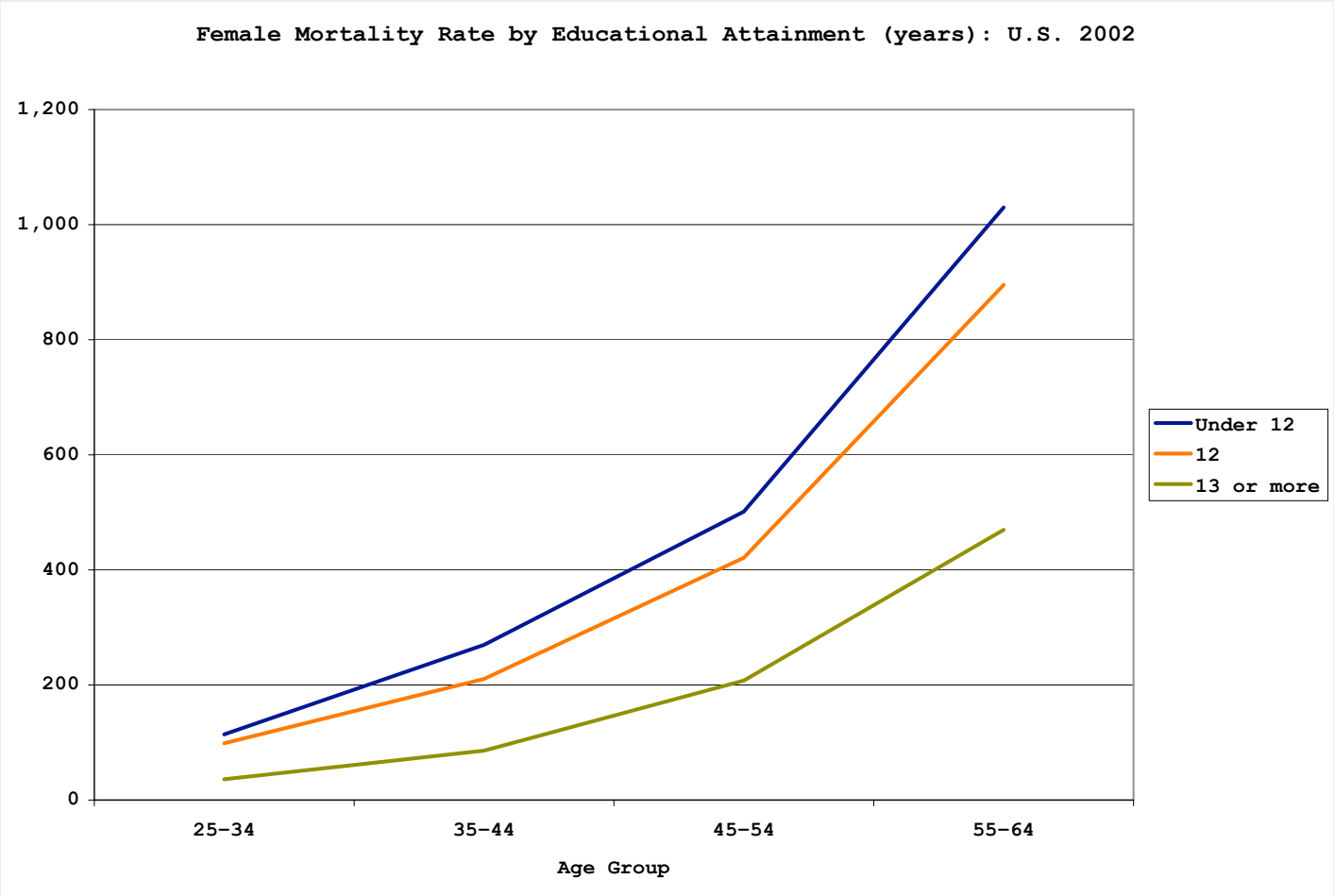
Education for males



Source: National Vital Statistics Report

Mortality rates and economics are related

Education for females



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Health and economics are related

Education for males ...

Self-rated health is a very good predictor of mortality
(See Idler and Benyamini, 1997 and 1999)

Health	*share of individuals, by column (%)*		
	$edu = d$	$edu = h$	$edu = c$
excellent	9.8	20.0	30.2
very good	20.6	33.4	40.0
good	37.0	30.0	22.7
fair	20.3	13.3	5.0
poor	12.3	3.6	2.0
N	316	952	397

Note: White males aged 54-59, from HRS. Proportion of individuals by rows.

▶ Proportion of individuals with good self-rated health status increases with education

Health and economics are related

... assets and income also matter ...

Health	*Assets*		*Income*		*N*
	mean	*med*	*mean*	*med*	
excellent	248.7	131.8	43.1	29.9	282
very good	208.2	99.9	35.8	24.6	542
good	147.0	79.1	28.5	22.1	470
fair	120.7	47.1	21.0	16.8	240
poor	50.6	28.5	15.1	11.5	105

Note: White males aged 54-59, from HRS. Thousands of 1992 dollars.

- Both wealth and income increase with the health status

Health and economics are related

... conditional on education, wealth still matters.

Health	*Assets in different education categories*					
	$edu = d$		$edu = h$		$edu = c$	
	mean	*med*	*mean*	*med*	*mean*	*med*
exc. or v.g.	91.1	45.0	156.4	81.4	303.8	148.2
good	45.2	30.8	125.9	64.0	235.6	122.5
fair or poor	39.4	13.2	97.1	41.4	160.6	65.3

Note: White males aged 54-59, from HRS. Thousands of 1992 dollars.

- Conditional on education, the average and median wealth are also increasing by health category.
- And the other way around also works: conditional on wealth quartiles, variation in education also implies variation in health

Health outcomes and education are related

Why?

Various possibilities of why:

1. Better education $\Rightarrow$ more income $\Rightarrow$ you buy better health.
2. Schooling develops different tastes and attitudes.
3. Schooling allows to produce better health.
4. Old age is relatively more enjoyable with more educ/money.
5. There is a (are) third variables(s) that influence both schooling and health choices.

Health outcomes and education are related

Some facts

- Grossman (1975): The relationship between health and schooling persists once we control for income and other socio-economic variables.

  Therefore, hypothesis 1, insufficient.

- Farrell and Fuchs (1982): A gradient of smoking behavior with years of schooling persists (and is very strong) when smoking is measured at age 17, before the later years of schooling are completed.

  Therefore, hypothesis 2 seems also insufficient.

- Kenkel (1991): the relationship between behavior and education persists once we control for knowledge of its effect on health.

  Hence, hypothesis 3 not enough.

Health and human capital

▶ Hypotheses 4 and 5 point to the traditional idea of human capital investment:

- Both education and health require some investment: one has to sacrifice current utility in order to accumulate them.
- Any variable affecting the trade-off between current and future utilities should equally affect education and health.
- Their respective investments are complementary $\Rightarrow$ Any variable affecting investment in one variable triggers investment in the other

Health and human capital

- Then, two questions arise
  - How much of heterogeneity in health outcomes is due to people own actions?
  - Why some people choose to live longer than others?

Health investment and education

Smoking

	mar m	sing m	mar f	sing f
edu=d	0.32	0.46	0.27	0.32
edu=h	0.21	0.36	0.18	0.27
edu=c	0.12	0.22	0.08	0.13

Note: White individuals aged 54-59, from HRS.

As known, more educated people smoke less.

(But also females and married people)

Health investment and education

Cholesterol tests

	mar m	sing m	mar f	sing f
edu=d	0.58	0.47	0.68	0.65
edu=h	0.71	0.59	0.73	0.69
edu=c	0.79	0.68	0.80	0.73

Note: White individuals aged 54-59, from HRS.

More educated people are more likely of having had a cholesterol test in the last two years.

(Also married individuals and females invest more in health)

• The same behavior arises with flu vaccination and breast and prostrate cancer tests.

Outline

Some related work

- Using the NLSY, **Belzil and Hansen (1999)** claim that differences in β are important to explain observed years of education, wages and unemployment.

  In addition, they find that discount rates are correlated with ability (more able are more patient).

- Using the NLSY, **Munasinghe and Sicherman (2000)** show that non-smokers experience higher wage growth.

  – Do smokers self-select into professions with lower wage growth?
  – Do smokers invest less in human capital during their careers?

Outline

The model

Exogenous variables

First the types (fixed heterogeneity),

- Ability to learn θ
- Ability to earn η
- Patience β
- Taste for health-related behavior z

Let $\tau = \{\eta, \beta, z\}$ denote a subset of types.

- Since we will only focus on first and second moments, we can state

$$[\theta, \eta, \beta, z] \sim N(\mu, \Sigma)$$

The model

Exogenous variables

Next the shocks

- Labor earnings shock ϵ with transition $\Gamma_{\epsilon,\epsilon'}$
- Shock to health ζ that affects (deteriorates) health, it is i.i.d.

The model

Preferences and endogenous states

Individuals live for a maximum of I periods.

Within period utility function, $u^z(c, y)$ (y is health investments).

Health stock h evolves stochastically $h' = \psi_i(\zeta', h, y)$

Health improves survival odds, $\gamma_i(h)$.

The endogenous state variables are:

- Education $e \in E \equiv \{e_1, e_2, ...e_{n_e}\}$ (chosen when young)
- Health $h \in H \equiv \{h_l, h_m, h_h\}$ (updated every period)
- Wealth $a \in A \equiv [\underline{a}, \infty)$ (updated every period)

The model

Optimization problem

- Agent's problem at $i > 0$,

$$V_i^{\tau,e}(\epsilon, a, h) = \max_{c,y,a',h'} \left\{ u^z(c,y) + \beta\, \gamma_i(h)\; E_{\zeta',\epsilon'|\epsilon}\left[V_{i+1}^{\tau,e}(\epsilon', a', h') \right] \right\}$$

with
$$c + a' = R\,a + \mathbb{I}_{ret}\, g(e,\eta) + (1 - \mathbb{I}_{ret})\, wf(e,i)\; \eta\,\epsilon$$
$$h' = \psi_i(\zeta', h, y)$$

- At $i = 0$, *youth*, individuals choose their education level e,

$$\max_{e,y,a'} \left\{ W^{\tau,\theta}(a, a', e, \epsilon, y) + \beta\, \gamma_0(h)\, E_{\zeta',\epsilon'|\epsilon}\left[V_1^{\tau,e}(\epsilon', a', h') \right] \right\}$$

with a yet to be determined current return $W(\cdot)$

The model

The consumption Euler equation

The consumption Euler equation is standard,

$$u_c^z(c, y) = R\,\beta\,\gamma_i(h)\; E_{\zeta',\epsilon'|\epsilon}\left[u_c^z(c', y')\right]$$

- If consumption and health related behavior are separable then age profiles of c only differ due to $\{h, \epsilon, \beta\}$

If we only look at retirees (possibly 65 or older to avoid self-selection), we have

$$u_c(c) = R\,\beta\,\gamma_i(h)\; E_{\zeta'}\left[u_c(c')\right]$$

- If h is observable, the age-profiles for c reveal differences in time preferences, β.

  We need a data set containing at the same time health status and consumption (or wealth and income instead of consumption).

The model

The health Euler equation

The FOC condition:

$$-u_y^z(y) = \beta\,\gamma_i(h)\;E_{\zeta',\epsilon'|\epsilon}\left[\psi_{y,i}(\zeta',h,y)\,V_{h,i+1}^{\tau,e}(\epsilon',a',h')\right]$$

and the envelope condition:

$$V_{h,i}^{\tau,e}(\epsilon,a,h) = u_y^z(y)\,\frac{\psi_{h,i}(\zeta',h,y)}{\psi_{y,i}(\zeta',h,y)} + \beta\,\gamma_{h,i}(h)\,E_{\zeta',\epsilon'|\epsilon}\left[V_{i+1}^{\tau,e}(\epsilon',a',h')\right]$$

- With information on $\psi_i(\zeta',h,y)$ and $\gamma_i(h)$ ...

  ... differences in observed y within individuals with same assets a, education e, earnings categories ϵ and η and patience β will be accounted for differences in z.

The model

The educational choice

Finally, we have the optimality condition at *youth* that sorts out people in different educational categories

This will give us information on the ability to learn or utility cost of education θ

Note that all the fixed heterogeneity elements, z, β, η and θ may generate $corr\left(e,h\right)>0$

▶ By using the model, we want to infer the relative importance of each source of fixed heterogeneity and their (possible) correlations.

Outline

Mapping the model to data

Health functions

- We need to know (possibly only one of them age dependent)
  1. the relationship between health and behavior, $\psi_i(\zeta', h, y)$
  2. the survival probabilities at different health levels $\gamma_i(h)$

- HRS reports several measures of health stock
  - self-rated health, diagnosed conditions

and various measures of health behavior

  - smoking, exercise habits, cholesterol tests, cancer tests, ...

plus we see people die

  - Additionally, HRS reports self-assessed probabilities of survival to age 75 and 85. Hurd and McGarry (1993, 1995) show they correlate very well with risk factors and that they actually predict mortality

Introducing heterogeneity in types

We need to back out:

- Population average for each parameter
- Amount of dispersion over each parameter
- Possible correlations between parameters

$$\begin{bmatrix} \theta \\ \eta \\ \beta \\ z \end{bmatrix} \sim N \left[\begin{pmatrix} \mu_\theta \\ \mu_\eta \\ \mu_\beta \\ \mu_z \end{pmatrix}, \begin{pmatrix} \sigma_\theta^2 & \sigma_{\theta\eta} & \sigma_{\theta\beta} & \sigma_{\theta z} \\ & \sigma_\eta^2 & \sigma_{\eta\beta} & \sigma_{\eta z} \\ & & \sigma_\beta^2 & \sigma_{\beta z} \\ & & & \sigma_z^2 \end{pmatrix} \right]$$

▷ We will introduce heterogeneity in each dimension step by step

Introducing heterogeneity in types sequentially

Ability to learn, θ

- We can match σ^2_θ by targeting the *share of highly educated* individuals

Then, check whether the model of investment in human capital delivers:

- corr(h, e) and corr(y, e)

This answers the question:

Does education cause the correlation between education and health?

Introducing heterogeneity in types sequentially

Discount factors, β

Let's define,

$$x_i \equiv \log\left(\frac{c_{i+1}}{c_i}\right) \quad \Rightarrow \quad x_i = \frac{1}{\sigma}\log R + \frac{1}{\sigma}\log\beta + \frac{1}{\sigma}\log\gamma_i(h)$$

- We can match σ^2_β by targeting $\text{Var}_h\left[E\left[x_i \mid h\right]\right]$, where

$$\begin{aligned}\text{Var}_h\left[E\left[x_i \mid h\right]\right] &= \sigma^{-2}\,\text{Var}_h\left[E\left[\log\beta \mid h\right]\right] + \sigma^{-2}\,\text{Var}_h\left[\log\gamma_i(h)\right] \\ &+ \sigma^{-2}\,\text{Cov}_h\left[E\left[\log\beta \mid h\right], \log\gamma_i(h)\right]\end{aligned}$$

– *If $\sigma^2_\beta = 0$ or if there is no of self-selection of higher β into better health, the 1st and 3rd terms are zero*

Introducing heterogeneity in types sequentially

Discount factors, β

- We can match $\sigma_{\theta\beta}$ by looking at $\text{Var}_e\left[E\left[x_i \mid \bar{h}, e\right]\right]$, where

$$\text{Var}_e\left[E\left[x_i \mid \bar{h}, e\right]\right] = \sigma^{-2}\,\text{Var}_e\left[E\left[\log\beta \mid \bar{h}, e\right]\right]$$

  - *In absence of self-selection of higher β into better education, this is zero*
  - *Positive variance will come through*
    - (i) *individuals with higher β choosing more education and*
    - (ii) $\sigma_{\theta\beta} > 0$

Introducing heterogeneity in types sequentially

Taste for bad life, z

- We need to identify σ_z^2 plus the correlations $\sigma_{\theta z}$ and $\sigma_{\beta z}$
- We need three types of statistics

Additional information

Exploit the panel

- Shocks ζ to health status should trigger responses in savings
- Shocks ϵ to income should trigger responses in health investment
- Heterogeneity in responses according to types?

Additional information

Marital status

- Mortality rates after 55 for *married individuals* are about **one half** of those for the rest of population (2001 data, from National Vital Statistics Report).
- Self-rated health is also very related to marital status
- Health-related behavior also varies substantially according to marital status.
- In HRS we have data on spouses (when present).

- Model marital decisions and exploit these data?

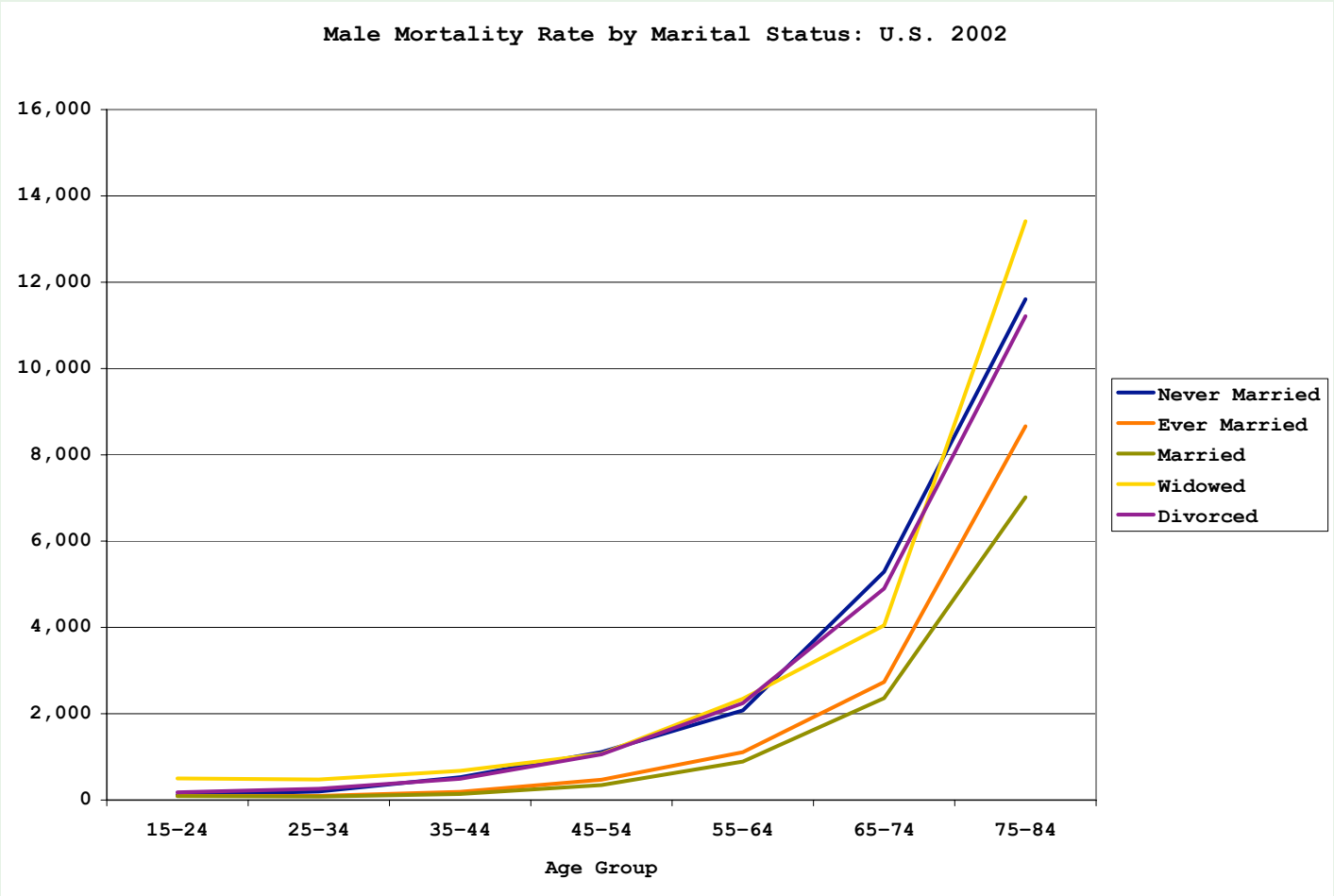
Outline

Final comments

- If we succeed in the quantitative exercise, we can tell which sources of heterogeneity are more relevant for the observed correlation between health and education
- This can inform policy actions.
- If you want the poor to live more,
  - Spend in free health care?
  - Subsidize education? (role of θ)
  - Subsidize preventive behavior? (role of η)
  - Teach people to think ahead? (role of β)
- What if you want smart kids in poor families to study?
  - Subsidize education? (role of θ)
  - Subsidize health care? (role of η)
  - Teach people to think ahead? (role of β)

Mortality rates and demographics are related

Marital status for males



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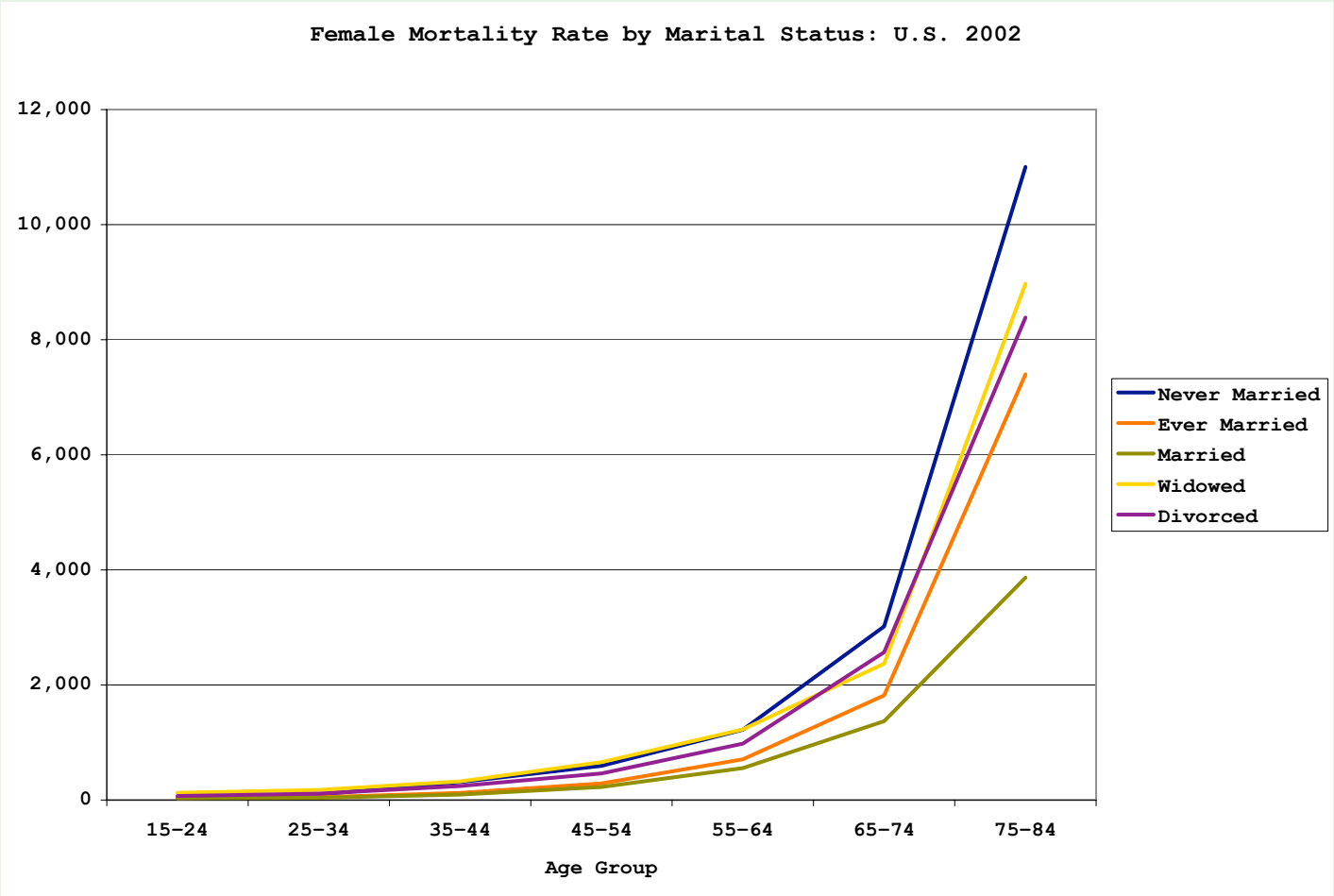

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