Health and Heterogeneity

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Extremely Preliminary
Part I

Data
Known facts

- **Empirical evidence:** health and education are positively related

- **More educated** also face lower mortality rates
  Kitagawa and Hauser (1973); Elo and Preston (1996)

- In addition, more educated also do better things for their health
  Cutler and Glaesser (2005)

- We want to understand the sources of heterogeneity between people that are behind the correlation between health and education
The Health and Retirement Study

- Bi-annual panel, 9 waves, from 1992 to 2008
- Initial HRS cohort aged 50-61 in 1992 and 66-77 in 2008
- Two additional younger cohorts and two additional older cohorts
- This gives around 125,000 individual-year observations (white, aged 50-95, non-missing)
- Rich socio-economic data (marital status, education, income, wealth)
- Rich health related data:
  - health stock: self-assessed and diagnostics
  - health investment: expenditures and behavior
  - mortality: keep track of mortality
Comparison to National Vital Statistics Data
Life Expectancies

<table>
<thead>
<tr>
<th>Source</th>
<th>Male</th>
<th>Female</th>
<th>Gap</th>
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<tbody>
<tr>
<td>NVS 96</td>
<td>27.5</td>
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<tr>
<td>HRS 92-07</td>
<td>28.1</td>
<td>31.9</td>
<td>3.8</td>
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</table>

Life Expectancies at age 50, white population.
## Life Expectancies

Death rates, education

<table>
<thead>
<tr>
<th>Source</th>
<th>Male 55-64</th>
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<td>HSD</td>
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<td>NVS 96</td>
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<td>NVS 00</td>
<td>1.81</td>
<td>1.59</td>
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<td>0.93</td>
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<td>NVS 05</td>
<td>2.00</td>
<td>1.47</td>
<td>0.67</td>
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<td>2.04</td>
<td>1.46</td>
<td>0.81</td>
<td>1.23</td>
<td>1.41</td>
<td>0.83</td>
<td>0.37</td>
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<td>HRS 92-07 (white)</td>
<td>1.90</td>
<td>1.35</td>
<td>0.80</td>
<td>1.10</td>
<td>1.13</td>
<td>0.71</td>
<td>0.29</td>
<td>0.84</td>
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</table>

Death rates: dead people per 100. All races, unless stated.
Death rates, marital status

Death rates, marital status

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<tr>
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<td>NVS 96 (white)</td>
<td>1.05</td>
<td>2.47</td>
<td>1.42</td>
<td>0.62</td>
<td>1.18</td>
<td>0.56</td>
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<tr>
<td>NVS 00 (white)</td>
<td>0.93</td>
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<td>1.19</td>
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<td>1.11</td>
<td>0.54</td>
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<td>0.81</td>
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<td>1.38</td>
<td>0.51</td>
<td>1.07</td>
<td>0.56</td>
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<tr>
<td>HRS 92-07</td>
<td>1.24</td>
<td>2.53</td>
<td>1.29</td>
<td>0.66</td>
<td>1.39</td>
<td>0.73</td>
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<tr>
<td>HRS 92-07 (white)</td>
<td>1.17</td>
<td>2.19</td>
<td>1.02</td>
<td>0.61</td>
<td>1.05</td>
<td>0.44</td>
</tr>
</tbody>
</table>

Death rates: dead people per 100. All races, unless stated.
Survival probabilities

Education and health

1) Survival increases between education groups
   - within education groups, survival increases with assets
   - sample of non-retired: survival increases with earnings, not with assets
     (sample of retired: survival still increases with assets)

2) Survival increases between (self-assessed) health groups
   - within health groups, survival does not change with assets
   - sample of non-retired: survival increases with earnings
     (but barely significant)
Survival probabilities
Survival by education groups

Survival rates, white males

$R^2$ from 0.111 to 0.116

Source: HRS
Survival probabilities

Survival by health groups

Survival rates, white males

R^2 from 0.111 to 0.195

Source: HRS
Survival probabilities

Health and education

3) Conditional on health and education: only health seems to matter
   ▶ Education non-significant in logit regression
Survival probabilities
Survival by health and education groups

(a) all health categories
(b) top health
(c) average health
(d) worst health

Source: HRS
Life Expectancies at 50
How to build them

1. Initial health distribution by education e. \( x_{50}^{e,h} \).

2. Education specific health transitions. \( p_i^e(h' | h) \).

3. Education and Health specific Survival Rates. \( \gamma_i^{e,h} \).

4. Then,

\[
\ell^e = \sum_{i=51}^{99} \sum_{h \in H} \left( 1 - \gamma_i^{e,h} \right) x_i^{e,h} \\
\]

\[
\gamma_i^{e,h} = \sum_h p_i^e(h' | h) \gamma_i^{e,h} x_i^{e,h} 
\]
## Life Expectancies at 50

### Results

<table>
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<tr>
<th></th>
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<tbody>
<tr>
<td>male</td>
<td>77.4</td>
<td>74.2</td>
<td>76.8</td>
<td>80.1</td>
<td>5.8</td>
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<tr>
<td>female</td>
<td>81.2</td>
<td>77.6</td>
<td>81.2</td>
<td>83.5</td>
<td>5.9</td>
</tr>
</tbody>
</table>
Life Expectancies at 50

We can mechanically decompose these effects

- Is it education specific mortality?
  \( \{ x^h_{50}, p_i(h' | h), \gamma^e_i \}. \)

- Is it education specific health evolution?
  \( \{ x^h_{50}, p^e_i(h' | h), \gamma^h_i \}. \)

- Is it initial health?
  \( \{ x^{e,h}_{50}, p_i(h' | h), \gamma^h_i \}. \)
## Life Expectancies at 50

**Descomposition results**

<table>
<thead>
<tr>
<th>Life expectancy premium: CG-HSD</th>
<th>male</th>
<th>female</th>
</tr>
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<tbody>
<tr>
<td>Overall</td>
<td>5.8</td>
<td>5.9</td>
</tr>
<tr>
<td>(a) Edu-specific mortality</td>
<td>-0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>(b) Edu-specific transition</td>
<td>4.7</td>
<td>4.9</td>
</tr>
<tr>
<td>(c) Edu-specific initial health</td>
<td>1.7</td>
<td>1.1</td>
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</table>

- It is one third initial health and two thirds health transitions.

- It seems that the late health management does not matter that much.

- This is not to say that health care differences do not matter as many problems last a long time.
Do other obvious things matter? Smoking, Marital status?

1. Initial health distribution by education $e$ and marital. 
   $x_{50}^{e,m,h}$.

2. Education specific health-marital transitions. 
   $p_i^e(h', m'|h, m)$.

3. Education, Marital and Health specific Survival Rates. 
   $\gamma_i^{e,m,h}$.

4. Then,

\[
\ell^{e,m} = \sum_{i=51}^{99} i \sum_{h \in H} \left(1 - \gamma_i^{e,m,h}\right)x_i^{e,m,h}
\]
\[
x_{i+1}^{e,m',h'} = \sum_{h} p_i^e(h', m'|h, m) \gamma_i^{e,m,h} x_i^{e,m,h}
\]
Do other obvious things matter? Smoking, Marital status?

- Look at education and marital status at age 50

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<td>81.4</td>
<td>80.1</td>
<td><strong>83.7</strong></td>
<td>82.9</td>
<td><strong>7.4</strong></td>
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</tbody>
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- Look at education and smoking status at age 50

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We observe directly some actual health investment actions

- Investments are bigger for the well to do.
  - Cholesterol tests, flu shots, prostate tests, non smoking increase with education and with marriage.
  - Investments are also increasing in wealth and insurance coverage.
  - Mixed bag about health. Prostate tests are neutral. Cholesterol and flu shots decrease with health.

- Investments, however, do not improve transitions. In fact, flu shots, and cholesterol worsens them. (Mammograms and cervical cancer tests improve transition for women).
  - Insufficient measure of investment.
  - Health measured with error?
  - Some of those medical actions are not investment but maintenance.
What about other investments? Savings.

By education group. Source: PSID + CEX Consumption Imputation

Residual Consumption Growth (households headed by white males)

- HSD
- HSG
- CG
What about other investments? Savings.

By health group
In this case it is education not health what matters.

Consumption growth by education and health groups

(a) all health categories

(b) top health

(c) average health

(d) worst health
Data Conclusions

i. **Self-assessed health and education** are very good predictors of *mortality*.

ii. **Transitions** are what matter.

iii. **Health investments** increase with wealth and education. Poor effects on transitions.
   a. *Non-smoking* is the only clear investment.
   b. *Cholesterol tests* and *flu shots* worsen transition.

iv. **Consumption growth** (not only patience, survival probabilities matter) is associated to *education* and *health*.
Part II

Main Question
Where is the advantage from education coming from?

- Patience or some other preference attribute.
- More resources (money, spouses)?
- Lower costs of undertaking health investments.
- Intrinsically better built.

- Need a model to tease this mechanisms out.
Part III

Theory
Elements of the model

- Human capital investment model, with various types of actions:
  - Savings
  - Health care investments (including efforts to quit smoking/to remain married).
  - Health maintenance.
  - Education choice in an earlier period.
The model
Exogenous state variables

- There may or may not be individual fixed heterogeneity,
  - Ability $\eta$
  - Patience $\beta$
  - Taste for health-related behavior $\alpha$

Let $\tau = \{\eta, \beta, \alpha\}$ denote the types.

- These variables may induce differential behavior in each state.
The model  Endogenous state variables

- **Age.** It is endogenous in this project.

- **Education** $e \in E$. Discrete.
  - Education leads to higher labor earnings.
  - Education may lead to longer lived partner and better health transition.

- **Health** $h \in H$. Discrete. It may include marital/smoking status.
  - Health improves survival odds, $\gamma^{ih}$
  - Choice of health investment $y$ drives markov chain $p_i(h' | h, y)$
  - Marriage and non smoking improve health transition and require efforts. (except for survival of spouse).

- **Wealth** $a \in A$. Discrete.
  - Standard budget constraint.
The model

Shocks

► Death. $\gamma^{ih}$.

► Health evolves stochastically. For now it only depends on age and investment. $p^i(h'|h, y)$.

► Earnings, $\epsilon$. Markovian conditional on age and education. $F^{ie}(\epsilon'|\epsilon, h')$. 
The model

Periods and decisions

- Individuals live for a maximum of \( I \) periods.

- Individuals choose
  - education effort \( x \) in first period
  - consumption \( c \) and health investment \( y \) in all periods

- Within period utility function:

\[
u^\alpha (h, c, y, m) = \bar{u} + \frac{c^{1-\sigma}}{1-\sigma} - \alpha \frac{y^{1+\nu}}{1+\nu} - \psi(h, m) \quad \sigma, \nu, \alpha, \bar{u} > 0\]

- \( \psi(h, m) \): health maintenance alleviates. Still have to be developed.
The model

Optimization problem

\[
V_{i+1}^{\tau,e} (\epsilon', h', a') = \max_{c,y,a',m} \left\{ u^\alpha(h, c, y, m) + \beta \gamma^ih \\
\sum_{h',\epsilon'} p^i(h'|h, y) F^{ie}(\epsilon'|\epsilon, h') \ V_{i+1}^{\tau,e} (\epsilon', h', a') \right\}
\]

with \( c + m + a' = R a + w \epsilon \)

- Agent’s problem at \( i = 0 \), is to place effort to become educated. Better types put more effort.
The model
The consumption Euler equations

- The consumption Euler equation is standard,

\[ u_c^\alpha (h, c, y, m) = R \beta \gamma^{ih} \sum_{h', \epsilon} p^i (h' | h, y) F^{ie}(\epsilon' | \epsilon, h') \ u_c^\alpha (h', c', y', m') \]

- There is a static Euler equation between consumption and maintenance.

\[ u_c^\alpha (h, c, y, m) = u_m^\alpha (h, c, y, m) \]
The model

The health-behavior FOC

\[-u_y^{\alpha}(h, c, y, m) = \beta \gamma^{ih} \sum_{h', \epsilon'} \frac{\partial p^i(h'|h, y)}{\partial y} F^e(\epsilon'|\epsilon, h') V_{i+1}^{\tau, e}(\epsilon', h', a')\]

- Health investment $y$ increases if
  - The discount factor is larger: higher $\beta$ and $\gamma^{ih}$
  - The expected value function tomorrow is larger: higher, $e$, $a$, $\epsilon$, $h$
  - The cost of health investment is lower: lower $\alpha$
Part IV

Identification and (Indirect) Estimation
Statistics to target

- Some objects can be estimated outside the model:
  - Earnings processes.

- The main targets are the age and education specific
  - Health (including marital status and smoking) Transitions.
  - Survival rates.
  - Consumption growth rates.

- There is need for other statistics associated to individual change.
  - Change in health actions or investments upon health decay.
  - Change in savings upon health decay.
Hope to have some results next time
Conclusions

- There are large differences in education specific life expectancy.
- These are associated to health as measured via self assessment.
- What matters is the health to health transition to which non-smoking and marriage contributes.
- To identify the root of the advantages of education, we need to estimate rich models.
- We have some ideas of the ingredients of these models, but we have a long way to go before we can estimate them.