Modern correlates of health

ECON 40565
Health Economics
Fall 2018

Introduction

• Most of this class we will examine markets for medical care
  – How they operate
  – What are economic issues
• Medical care is however only interesting in that it is an intermediate product – used to produce what people care about – health
• This section – discuss what inputs can be transformed into health outputs

Three main issues

• How is health measured?
• Some predictors of outcomes?
• Extended discussion about the role of socioeconomic status and health

Aggregate measures of health

• Mortality rates
  – death per period among a define population
• Infant mortality rate
  – deaths 1st year of life/births
  – Neonatal mortality: deaths 1st 28 days
• Life expectancy
  – At birth
  – Conditional on a particular age
Self-reported health status

- Benefits
  - Easy/low cost variable to collect
  - Predicts other measures of health that are difficult to collect

- Shortcomings
  - No way to compare people
  - No way to compare aggregate data across countries
  - May be difficult to compare groups over time
    - Rise in disability
    - “Harvesting”

% Reporting Health Status, Males

<table>
<thead>
<tr>
<th>Health</th>
<th>Age 30-44</th>
<th>Age 45-64</th>
<th>Age 65-74</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>43.7%</td>
<td>30.6%</td>
<td>18.1%</td>
</tr>
<tr>
<td>Very good</td>
<td>30.3%</td>
<td>26.9%</td>
<td>22.5%</td>
</tr>
<tr>
<td>Good</td>
<td>19.8%</td>
<td>26.1%</td>
<td>31.6%</td>
</tr>
<tr>
<td>Fair</td>
<td>4.7%</td>
<td>10.6%</td>
<td>18.5%</td>
</tr>
<tr>
<td>Poor</td>
<td>1.5%</td>
<td>5.8%</td>
<td>9.3%</td>
</tr>
</tbody>
</table>

5-Year Mortality Rate, Males

<table>
<thead>
<tr>
<th>Health</th>
<th>Age 30-44</th>
<th>Age 45-64</th>
<th>Age 65-74</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>0.7%</td>
<td>2.4%</td>
<td>8.6%</td>
</tr>
<tr>
<td>Very good</td>
<td>0.9%</td>
<td>2.9%</td>
<td>10.9%</td>
</tr>
<tr>
<td>Good</td>
<td>1.6%</td>
<td>5.2%</td>
<td>16.7%</td>
</tr>
<tr>
<td>Fair</td>
<td>2.9%</td>
<td>11.7%</td>
<td>25.2%</td>
</tr>
<tr>
<td>Poor</td>
<td>10.4%</td>
<td>22.8%</td>
<td>42.9%</td>
</tr>
</tbody>
</table>

5-Year Mortality Rate, Females

<table>
<thead>
<tr>
<th>Health</th>
<th>Age 30-44</th>
<th>Age 45-64</th>
<th>Age 65-74</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>0.3%</td>
<td>1.7%</td>
<td>5.6%</td>
</tr>
<tr>
<td>Very good</td>
<td>0.4%</td>
<td>1.9%</td>
<td>6.3%</td>
</tr>
<tr>
<td>Good</td>
<td>0.9%</td>
<td>2.9%</td>
<td>8.8%</td>
</tr>
<tr>
<td>Fair</td>
<td>1.8%</td>
<td>6.2%</td>
<td>14.1%</td>
</tr>
<tr>
<td>Poor</td>
<td>7.1%</td>
<td>15.6%</td>
<td>32.2%</td>
</tr>
</tbody>
</table>
Biomarkers

- Mortality limited for some populations
- SRHS difficult to compare across people
- Objective way to measure health status across people?
- Biomarkers
  - Clinical markers of physiology
  - Predictive of future health outcomes
  - Measurable across people
  - Easily collect

Examples

- Blood pressure
  - High BP can lead to stroke, AMI, heart failure, kidney failure
- Cholesterol
  - HDL, LDL and total
  - High chol. can lead to heart attack
- Resting heart rate
- Glycated hemoglobin
- Body mass index (kg's/cm²)
  - Increased risk of diabetes
  - High BMI correlated w/ increased mortality

Mortality rates in the 20th century

- Tremendous changes in aggregate statistics
- Two halves
  - Decline in infant deaths (1/2 half) and infections
  - Conquering cardiac disease
What causes big changes in life expectancy?

- Most deaths are to the elderly
- But, when an infant dies, you add a small number to the numerator in a life expectancy calculation
- Big changes will be generated by
  - Changes in the infant mortality rate
  - Changes in mortality for the elderly which are a large fraction of deaths

Numeric Example

- Population with 100 people
- 10% die at age 1
  - ~ the 1900 infant mortality rate
- If they survive, they live to age 75
- Life expectancy = (.1)(1) + (.9)(75) = 67.6
- Suppose infant mortality rates drops to 1%
  - ~ the 1980 Infant mortality rate
- Life expectancy = (.01)(1) + (.99)(75) = 74.3
Describing determinants of mortality in a cross section

- 323 million people
- ~3.9 millions births
- ~2.7 million deaths

Leading Causes of Death, 2016
- Heart disease: 633,842
- Cancer: 595,930
- Accidents: 146,571
- Chronic lower resp. disease: 155,041
- Stroke: 140,323
- Alzheimer’s: 110,561
- Diabetes: 79,535
- Influenza/Pneumonia: 57,062
- Nephritis: 49,959
- Suicide: 44,193
Distribution of Deaths by Age

- Age Fraction of deaths
  - <1 1.0%
  - 1-14 0.3%
  - 15-24 1.1%
  - 25-34 1.7%
  - 35-44 2.8%
  - 45-54 7.3%

- Age Fraction deaths
  - 55-64 12.9%
  - 65-74 16.5%
  - 75-84 24.9%
  - 85+ 31.3%

72.7% of deaths are to people aged 65+

Actual Causes of Death

<table>
<thead>
<tr>
<th>Cause of death</th>
<th># (% of deaths) 1990</th>
<th># (% of deaths) 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco</td>
<td>400,000 (19%)</td>
<td>435,000 (18%)</td>
</tr>
<tr>
<td>Diet/inactivity</td>
<td>300,000 (15%)</td>
<td>400,000 (17%)</td>
</tr>
<tr>
<td>Alcohol</td>
<td>100,000 (5%)</td>
<td>85,000 (5%)</td>
</tr>
<tr>
<td>Microbial agents</td>
<td>90,000 (4%)</td>
<td>75,000 (4%)</td>
</tr>
<tr>
<td>Toxic agents</td>
<td>60,000 (3%)</td>
<td>66,000 (3%)</td>
</tr>
<tr>
<td>Motor Vehicles</td>
<td>25,000 (1%)</td>
<td>43,000 (2%)</td>
</tr>
<tr>
<td>Firearms</td>
<td>35,000 (2%)</td>
<td>29,000 (1%)</td>
</tr>
<tr>
<td>Sexual Behavior</td>
<td>30,000 (1%)</td>
<td>20,000 (&lt;1%)</td>
</tr>
<tr>
<td>Illegal drugs</td>
<td>20,000 (&lt;1%)</td>
<td>17,000 (&lt;1%)</td>
</tr>
<tr>
<td>Total</td>
<td>1,060,000 (50%)</td>
<td>1,060,000 (48%)</td>
</tr>
</tbody>
</table>

% that Died in Next 5 Years, Adults, 40-64 Years of Age, NLMS (late 1970)

- By sex
  - Males 6.9%
  - Females 3.6%

- By race
  - Black 7.1%
  - White 4.9%

- By ethnicity
  - Non-Hispanic 5.2%
  - Hispanic 4.2%

- By marital status
  - Not married 7.0%
  - Married 4.6%

- By education
  - < HS 6.9%
  - HS 4.4%

- By college
  - College 3.6%

- By income
  - <$35K 6.0%
  - $35K-$50K 3.4%
  - >$50K 2.7%
Gompertz Equation

- 1825 British actuary Benjamin Gompertz
- "the number of living corresponding to ages increasing in arithmetical progression, decreased in geometrical progression."
- geometrical decrease in survival with age existed because of a geometric increase in the "force of mortality"

\[ M_a = c e^{ba} \]
- \( M_a \) = mortality rate at age \( a \)
- \( a \) = age
- \( c \) = initial mortality rate
- \( b \) = Gompertz parameter – exponential rate of change in mortality with age

Note that if \( y = e^{at} \)
- Then \( \ln(y) = bt \)
- And then \( \ln(M_a) = \ln(c) + ba \)
- Log mortality rates are linear in age
Six-Year Mortality Rates by Age, NLMS 6c

Gompertz Curve -- ln(Six-Year Mortality Rates), NLMS 6c

- $\frac{d \ln(M)}{d \text{age}} = b$
- $\ln(M) = \frac{dM}{M} = \text{percentage change in } M$
- $\ln(M) = \frac{dM}{M} = \% \text{ change in } M \text{ for a one year increase in age}$
- In the model above
  - $-7.75$
  - $b=0.0816$
- Mortality increases by $8.2\%$ per year of age
• \( b = \frac{dM}{M} / da \),
• \( b(da) = \frac{dM}{M} \)
  – If \( a = 10 \) years, mortality is predicted to increase 82% over 10 year period (same regardless of the starting age)
  – \( M = ce^{ab} \)
  – \( C = \exp(-7.75) = 0.000495 \)
• \( M = 0.00043e^{0.081a} \)
• Given \( a \), one can predict the mortality rate for this group

### Income/Health Relationship

• Health improves with income
  – \( \frac{dH}{dI} > 0 \)
  – \( \frac{d^2H}{dI^2} < 0 \)
• Relationship is true for
  – Nearly all measures of health
  – For all subgroups (by sex, race, age, etc)
  – For nearly all populations
  – For nearly all time period
  – For nearly all countries
• Similar relationship with education

\[ H=f(I) \]
## Percent Died within 5 years of Survey, Males NLMS

<table>
<thead>
<tr>
<th>Income Group</th>
<th>30-49 years of age</th>
<th>50-64 years of age</th>
<th>65-79 years of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to $25,000</td>
<td>3.1</td>
<td>10.8</td>
<td>20.6</td>
</tr>
<tr>
<td>$25,001 to $50,000</td>
<td>1.8</td>
<td>6.8</td>
<td>15.3</td>
</tr>
<tr>
<td>$50,001 +</td>
<td>1.4</td>
<td>5.1</td>
<td>12.3</td>
</tr>
</tbody>
</table>

## % Died in 6 Years, NLMS 6c

### Age groups

<table>
<thead>
<tr>
<th>Income Category</th>
<th>30-49</th>
<th>50-64</th>
<th>65-79</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; $20K</td>
<td>2.14</td>
<td>7.52</td>
<td>18.4</td>
</tr>
<tr>
<td>≥ $20K, &lt; $40K</td>
<td>1.15</td>
<td>4.37</td>
<td>14.6</td>
</tr>
<tr>
<td>≥ $40K, &lt; $60K</td>
<td>0.85</td>
<td>3.12</td>
<td>13.4</td>
</tr>
<tr>
<td>≥ $60K, &lt; $75K</td>
<td>0.82</td>
<td>2.41</td>
<td>12.8</td>
</tr>
<tr>
<td>≥ $75K</td>
<td>0.71</td>
<td>2.35</td>
<td>10.8</td>
</tr>
</tbody>
</table>

## % Died in 6 Years, NLMS 6c

### Education Group

<table>
<thead>
<tr>
<th>Education Group</th>
<th>35-54 years of age</th>
<th>55-64 years of age</th>
<th>65-74 years of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than high school</td>
<td>2.0</td>
<td>6.0</td>
<td>11.7</td>
</tr>
<tr>
<td>High school graduate</td>
<td>1.3</td>
<td>4.3</td>
<td>9.7</td>
</tr>
<tr>
<td>College graduate</td>
<td>0.9</td>
<td>4.0</td>
<td>8.0</td>
</tr>
</tbody>
</table>
### 18-64 year olds, BRFSS 2005-2009 (% answering yes)

<table>
<thead>
<tr>
<th>EDUC Level</th>
<th>Fair or poor health</th>
<th>No exer. in past 30 days</th>
<th>Current smoker</th>
<th>Obese</th>
<th>Any bad mental health past 30 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;12 Years</td>
<td>40.9</td>
<td>45.8</td>
<td>37.8</td>
<td>43.6</td>
<td>43.7</td>
</tr>
<tr>
<td>12-15 years</td>
<td>17.8</td>
<td>27.3</td>
<td>26.5</td>
<td>34.7</td>
<td>38.4</td>
</tr>
<tr>
<td>16+ Years</td>
<td>7.2</td>
<td>13.5</td>
<td>10.8</td>
<td>24.8</td>
<td>34.2</td>
</tr>
</tbody>
</table>

### 18-64 year olds, BRFSS 2005-2009 (% answering yes)

<table>
<thead>
<tr>
<th>INCOME Level</th>
<th>Fair or poor health</th>
<th>No exer. in past 30 days</th>
<th>Current smoker</th>
<th>Obese</th>
<th>Any bad mental health days past month</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;$25K</td>
<td>41.0</td>
<td>41.5</td>
<td>36.4</td>
<td>41.8</td>
<td>52.0</td>
</tr>
<tr>
<td>$25-75K</td>
<td>13.6</td>
<td>24.0</td>
<td>23.1</td>
<td>32.6</td>
<td>37.4</td>
</tr>
<tr>
<td>&gt;$75K</td>
<td>5.0</td>
<td>12.7</td>
<td>11.8</td>
<td>23.8</td>
<td>30.2</td>
</tr>
</tbody>
</table>
Questions for class

• What are the possible mechanisms through which income (or education) can improve health?

• What data supports or refutes each of these hypotheses?
  – List possible explanations
  – Give some evidence for and against
  – Decide whether the pathway is a causal mechanism

What do we mean by causal pathway?

• If causal, we assume that health is determined by income
  – For example, \( H = f(\text{Income}) \)
  – Therefore, \( \frac{dH}{dI} > 0 \)
  – An exogenous change in income will alter health
  – Example: Suppose we change social security benefits – if income is causal, this should alter mortality of the elderly

Why is it hard to determine whether the income/health relationship is causal

• Many factors that determine high income
  – Drive/ambition/intelligence/risk taking/luck/background

• Many of these same factors can also impact health

• Therefore, we do not know whether income is causing better health, or some third factor that is unmeasured

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Economic Effects of New Health Asset</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Health</td>
</tr>
<tr>
<td>HRS</td>
<td></td>
</tr>
<tr>
<td>Mid asset only</td>
<td>-1,308</td>
</tr>
<tr>
<td>Source assets</td>
<td>-20,596</td>
</tr>
<tr>
<td>AHEAD</td>
<td></td>
</tr>
<tr>
<td>Any asset</td>
<td>-15,491</td>
</tr>
<tr>
<td>HRS-asset only</td>
<td>-17,821</td>
</tr>
<tr>
<td>With health insurance</td>
<td>-17,912</td>
</tr>
<tr>
<td>HRS-asset only</td>
<td>-18,348</td>
</tr>
<tr>
<td>Below median income</td>
<td>-25,777</td>
</tr>
<tr>
<td>Above median income</td>
<td>-25,777</td>
</tr>
<tr>
<td>AHEAD-asset only</td>
<td>-17,040</td>
</tr>
<tr>
<td>Below median income</td>
<td>-17,040</td>
</tr>
<tr>
<td>Above median income</td>
<td>-17,040</td>
</tr>
</tbody>
</table>
Clark and Royer

- Examines education/health link using shock to education in England
  - 1944 law
    - Raised age of comp. schooling from 14-15
    - Went into effect April 1, 1947
    - Raised comp. years of schooling to 10
    - Gave Minister of Ed power to increase to 16 under certain conditions
    - Did so in Sept 1 1972
  - Raised comp. years of schooling to 10

- Produce large changes in education across birth cohorts
- Changes in education and health are “smooth” over birth cohorts
- If education alters health, should see a structural change in outcomes across cohorts as well
- What assumptions have to be true for this to generate an unbiased estimate of the impact of schooling on health?
This figure is not in the paper but in a previous version. It shows birth cohorts versus Ln(gross weekly earnings). What does this graph show and why is this informative?
Sullivan and von Wachter

- Consider the opposite of Gardner and Oswald – what happens when someone loses income
- Lost income due to job loss
- Focus on displacement?
  - What is displacement?
  - Why displacement and not job loss?

Data

- 5% random sample of unemployment records in PA 1974-1991
- Have quarterly earnings
- Select sample of workers with the same employer 1974-1979 (firms > 50 workers)
- Identify people who have been “displaced”
  - Lost job 1980-1986
  - And when firm size falls by 30% or more

Impact of displacement on earnings

\[ y_{it} = \alpha_i + \lambda_t + \beta x_{it} + \sum_{k=1}^{20} D^k_{it} \delta_k + \epsilon_{it} \]

- \( i \) = person, \( t \) = quarter
- \( y_{it} = \ln(\text{quarterly earnings}) \)
- \( \alpha_i \) = person effect
- \( \lambda_t \) = quarter (time) effect
- \( x_{it} \) = time-varying characteristics
- \( D^k_{it} = 1 \) if person \( i \) was displaced \( k \) quarters ago (after)
- \( \delta_k \) = effect of displacement

![Graph showing the impact of displacement on earnings](image.png)
Impact of displacement on mortality

\[ y_{it} = \alpha + \lambda_i + \beta x_t + D_t \delta_i + \epsilon_{it} \]

\( i = \text{person}, \ t = \text{year} \)

Sample: people alive 1/1/1980

\( y_{it} = 1 \) if person dies in period \( t \), \( 0 \) otherwise

\( D_{it} = 1 \) if person \( i \) was displaced in the year

\( \delta_i = \text{effect of displacement} \)

\[
\frac{0.0012}{0.007} = 0.17 = 17\% \text{ increase in mortality risk}
\]
Stress as an explanation for the SES/Health Gradient

- Usual suspects don’t explain gradient
- Leading candidate is Stress
- Low SES face more persistent stress
- Body reacts to stress in a good way in the short run
- Persistent stress can cause more permanent damage

HPA Axis

- Hypothalamic-pituitary-adrenal axis
- Put into work when the body faces stress
- Regulates many body functions including digestion, immune, mood, emotions, energy storage
- Concern: activation of system is “good” under stress, but it does come at a cost. Therefore, persistent stress generates more permanent damage to the body’s systems
**Cortisol**

- Circadian rhythm. Rises when awake, in late afternoon
- Regulates many activities
- Under stress, more cortisol is produced
  - Increases availability of glucose
  - Suppressed energy available to other systems like immune
  - Cortisol reduces after the stress subsides
- Problems
  - Constant stress leads to dysregulation of HPA
  - Stress in early life can generate dysfunction of HPA

**Problems**

- Constant stress leads to dysregulation of HPA
- Stress in early life can generate dysfunction of HPA

**Cortisol**

- Stress increases cortisol
  - Higher among residents
  - Higher among accountants near April 15th
- Poor have elevated cortisol at all times
  - They are more exposed to stress
- Elevated cortisol thought to
  - "Burn out" major organs – they just work harder
  - Increases susceptibility of immune system

**Primate research**

- Observational studies show worse health among subordinate male baboons
  - Elevated stress hormone (glucocorticoid) levels, worse cholesterol profile
- Experimental manipulation of status provides more compelling evidence
  - Causal effects of subordination and harmful effects of “status competition”
Baseball Hall of Fame

- Baseball Writers Association of America
  - Annual voting held since 1936
  - Eligibility: >10 seasons in MLB, retired 5+ years, max of 15 ballot appearances
  - Voting: ~450 voters, mail-in ballot, can name up to 10 players
  - Induction: Must be named on 75% of total ballots cast
  - Complete voting results are reported to public (newspapers)

- Committee on Baseball Veterans (Veterans)
  - Select former MLB players not chosen by BBWAA
  - Historically voting was held annually
  - Much smaller committee (~15), but similar 75% required for induction
  - Voting results not publicly disclosed and accusations of cronyism
  - Major reforms in 2001 (expanded voting pool, public disclosure)

Sample

- All players alive while appearing on at least one ballot between 1945-2006
- Restrict analysis to pre-1946 births to reduce censoring (N=597)
- Key derived variables:
  - Indicators of induction status (BBWAA and veterans)
  - Maximum vote share ever received (categorical: <1, 1-2, ..., 51-74, 75-78…)
  - Number of “close losses” (defined as vote share ≥ 50 but <75)

Adjusted life duration by maximum vote share

[Graph showing adjusted life duration by maximum vote share]

Cause of death by maximum vote share

[Graph showing probability of acute cardiovascular death by maximum vote share]
Whitehall Study

- 18,000 British civil servants in early 1970
- Whitehall area of London
- Well-paid, low chance of job loss, all insured
- Strong gradient in CHD and pay grade
- Observed characteristics (e.g., smoking) could only explain 1/3 of the difference
- Less control/more stress associated with lower pay grade jobs
- Thought to suggest role of stress as a causal factor in mortality

Whitehall II

- 10,000 British Civil Servants
- Started in 1985-7
- Includes men and women, aged 35-55 from 20 Whitehall departments
- Followed frequently (e.g., every couple of years)
- Goal:
  - Document social gradient in health
  - Explain why the gradient exists

Problem?

- Those in different classes could be different
  - Suppose does not exercise, overeats, drinks too much, is also lazy on the job
    - High mortality, low promotion rate
  - Suppose someone has a high discount rate
    - Don’t invest in their job or their health
    - Again – high mortality, low promotion
- Want some “manipulation” in class rank
- Will not get experimental – but – can we get close to an experiment
Anderson and Marmot

- Sir Michael Marmot
  - Epidemiologist by training
  - PI on the Whitehall studies
  - Knighted by QE II in 2000
- Use the differences in promotion rates
  - Across departments and cohorts
  - Could be unlucky to be hired into a low promotion dept/cohort
  - If true, may systematically see differences in mortality rates if they are correlated with promotion

Data

- Whitehall II
  - In Civil Service 1985-87
  - Ages 35-55
  - Male and female
  - Already selected sample in that high tenure people likely to end up in the data
  - Detailed baseline data
- Self-reported follow-ups in 90/92/96 and 98
- Medical screenings in 92/98
- EKG 85/92/98

Employment Grades

- Lumped into 6 grades
  - 2 Administrative levels/Senior Ex. Office/Higher Ex. Office/Ex. Office/Clerical-support
- Promotion to higher grade ↑ salary by 23-48%
- No change in health benefits (NHS)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full sample</th>
<th>Analytic sample</th>
<th>1980s Subsample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade level (1-6)</td>
<td>5.29</td>
<td>1.81</td>
<td>1.50</td>
</tr>
<tr>
<td>Female</td>
<td>(1.86)</td>
<td>(1.52)</td>
<td>(0.40)</td>
</tr>
<tr>
<td>Age</td>
<td>44.4</td>
<td>44.3</td>
<td>44.3</td>
</tr>
<tr>
<td>Age</td>
<td>44.4</td>
<td>44.3</td>
<td>44.3</td>
</tr>
<tr>
<td>Age</td>
<td>44.4</td>
<td>44.3</td>
<td>44.3</td>
</tr>
<tr>
<td>Tenure</td>
<td>17.6</td>
<td>16.1</td>
<td>8.2</td>
</tr>
<tr>
<td>College</td>
<td>0.400</td>
<td>0.387</td>
<td>0.364</td>
</tr>
<tr>
<td>CHD in 1985</td>
<td>0.081</td>
<td>0.064</td>
<td>0.057</td>
</tr>
<tr>
<td>CHD in 1989</td>
<td>0.118</td>
<td>0.122</td>
<td>0.119</td>
</tr>
<tr>
<td>CHD in 1985 or 1999</td>
<td>0.135</td>
<td>0.149</td>
<td>0.133</td>
</tr>
<tr>
<td>Sample size</td>
<td>10,509</td>
<td>4,577</td>
<td>469</td>
</tr>
</tbody>
</table>

Note: Parentheses contain standard deviations. All variables are measured at baseline (1985) except CHD in 1985 and 1989. Analytic sample contains employees that joined the Civil Service at the first two grade levels and have non-missing data in the 1988 follow-up sample. 1980s subsample contains employees who joined the Civil Service in 1980 or later at the first two grade levels, thus statistics in the first column contain <10,000 observations because some values are missing.
• i indexes person, d indexes department
  \[ CHD_{id} = \beta \text{Grade}_{id} + X_i \delta + \epsilon_{id}. \]
• CHD=1 if has coronary heart disease
• X is a vector of controls
• GRADE = 1-6 with 1 being highest
• Expect \( \beta < 0 \) (higher grade, less CHD)

---

What drives \( \beta \)?

- Permanent income
- Relative income

---

Table 2

<table>
<thead>
<tr>
<th>OLS Regressions of Coronary Heart Disease (CHD) on Employment Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Grade level</td>
</tr>
<tr>
<td>Sample restrictions</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Countries</td>
</tr>
<tr>
<td>( N )</td>
</tr>
</tbody>
</table>

Note. Models with country fixed effects for gender, education in age and tenure, year of entry to Civil Service and college attendance. "Non-smoking in 1999" denotes that the sample is limited to employees that have non-smoking data in the 1999 follow-up sample. "Enter Grades 1-2" denotes that the sample is limited to employees who joined the Civil Service in 1980 or later. Parentheses contain standard errors clustered at the department level.

---

Table 3

<table>
<thead>
<tr>
<th>OLS Regressions of Coronary Heart Disease (CHD) on Grade Dummies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Grade 6</td>
</tr>
<tr>
<td>Grade 5</td>
</tr>
<tr>
<td>Grade 4</td>
</tr>
<tr>
<td>Grade 3</td>
</tr>
<tr>
<td>Grade 2</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Sample restrictions</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>( N )</td>
</tr>
</tbody>
</table>

Note. All models control for gender, education in age and tenure, year of entry to Civil Service and college attendance. Results in column (1) are estimated on the full sample; results in column (2) are estimated on the analytic sample (employees who joined the Civil Service at the first two grade levels and have non-smoking data in the 1999 follow-up sample). Parentheses contain standard errors clustered at the department level.
Change in CHD_{it} = \beta \text{Change in Grade}_{it} + X_{it} \beta + \epsilon_{it}.

Table 4
OLS Regressions of Changes in Coronary Heart Disease (CHD) on Promotions

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in grade level</td>
<td>-0.013</td>
<td>-0.026</td>
<td>-0.023</td>
<td>-0.025</td>
<td>-0.027</td>
</tr>
<tr>
<td>Change in job demand</td>
<td>-0.006</td>
<td>-0.006</td>
<td>-0.003</td>
<td>-0.005</td>
<td>-0.007</td>
</tr>
<tr>
<td>Change in social support at work</td>
<td>-0.014</td>
<td>-0.014</td>
<td>-0.013</td>
<td>-0.013</td>
<td>-0.013</td>
</tr>
<tr>
<td>Change in decision latitude</td>
<td>-0.002</td>
<td>-0.002</td>
<td>-0.002</td>
<td>-0.002</td>
<td>-0.002</td>
</tr>
<tr>
<td>Covariates</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R²</td>
<td>0.002</td>
<td>0.009</td>
<td>0.013</td>
<td>0.010</td>
<td>0.012</td>
</tr>
<tr>
<td>N</td>
<td>4,027</td>
<td>4,027</td>
<td>4,442</td>
<td>5,086</td>
<td>640</td>
</tr>
</tbody>
</table>

![Diagram of Promotions and Heart Disease](image)

Table 5
OLS Regressions of Changes in Coronary Heart Disease (CHD) on Promotions

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in grade level</td>
<td>-0.110</td>
<td>-0.120</td>
<td>-0.110</td>
<td>-0.110</td>
<td>-0.110</td>
</tr>
<tr>
<td>Covariates</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Instruments</td>
<td>Depreciation Cohort</td>
<td>Depreciation Cohort</td>
<td>Depreciation Cohort</td>
<td>Depreciation Cohort</td>
<td>Depreciation Cohort</td>
</tr>
<tr>
<td>N</td>
<td>4,027</td>
<td>4,027</td>
<td>4,027</td>
<td>4,027</td>
<td>4,027</td>
</tr>
</tbody>
</table>

Table 6
OLS Regressions of Changes in Coronary Heart Disease (CHD) on Promotions

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in grade level</td>
<td>-0.013</td>
<td>-0.026</td>
<td>-0.023</td>
<td>-0.025</td>
</tr>
<tr>
<td>Covariates</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R²</td>
<td>0.002</td>
<td>0.009</td>
<td>0.013</td>
<td>0.010</td>
</tr>
<tr>
<td>N</td>
<td>4,027</td>
<td>4,027</td>
<td>4,442</td>
<td>5,086</td>
</tr>
</tbody>
</table>