Preston Curve

• Suggestive of causal link – greater economic success increases life expectancy
• Could also suggest health is key to development – economies grow with a health population
• Belief by many that poor health is holding back the development of many countries – especially in Africa

What we do in this lecture

• Isolate pathways through which health can impact growth. Provide:
  – Theoretical link
  – Empirical evidence
• Consider some special cases (malaria and AIDS)
  – High incidence diseases and serious consequences
  – Have these diseases hindered growth?
Bloom and Canning

4 pathways linking health to growth
1. Productivity
2. Education
3. Investments in Physical Capital
4. Demographic dividend

Health and productivity

• Many good papers demonstrate a link between health shocks and productivity later in life
• Much from developing country
• One quick example from the US -- 1918 Flu epidemic

1918 Flu Epidemic

• Spanish flu
• World wide epidemic
  – Killed 30-50 million, 675K in the US
• Those particularly vulnerable
  – Children
  – Compromised immune system
  – Pregnant women

Fig. 1: All cause mortality

1. Death rates shown are adjusted to standard population of U.S. in 1900.
Bloom and Canning

4 pathways linking health to growth
1. Productivity
2. Education
3. Investments in Physical Capital
4. Demographic dividend

Fig 1: Cardiovascular disease (1982–1990) and mean height (1984–1986) by birth year: (a) National Health Interview Surveys (NHIS) of 1982–1986 (USA), shown as unadjusted or adjusted for cohort trend and year for sample aged 66 to 85 years. (b) Male height at ages 20 to 77 years, by birth year at enrollment in 1941 and 1942, from the National Archives and Records Administration (numbers of registers in parentheses).
Evidence: Rise of Crack Cocaine

- Crack in 1982 on coasts – spreads to center
- Devastating to young black males
  - $2\times$ ↑ murder rate
  - $4\times$ ↑ in incarceration rates
- Human capital models – should see ↓ investment
  - ↓ life expectancy
  - ↓ job prospects (due to prison records)
  - ↑ “outside” option

When Crack Arrives

- 1982: NY, LA, Miami
- 1983: Atlanta, Riverside, SF
- 1984: Seattle, Tampa, San Jose, Ft. Lauderdale
- 1985: Detroit, Houston, KC, Orange Co., Philly, DC
- 1986: Boston, Chicago, Cleveland, Indy, Memphis, MSP, New Orleans, Newark, Sacramento
- 1987: Dallas, Portland, Milwaukee, Hartford, Newark, Providence, Greensboro/WS

Murder rates black males 57 cities

Murder rates white females 57 cities
HS grad. Rates in Males, 57 MSAs

Are there other situations where there are rapid changes in mortality that one can use in the same manor?

Bloom and Canning

4 pathways linking health to growth
1. Productivity
2. Education
3. Investments in Physical Capital
4. Demographic dividend
Figure 1: Saving as a share of household income: 1950-2009. Source: Mckinnon and Cox (2004) and the OECD Satellite Account (various issues).

Figure 3: Household saving rate (left axis) and ratio of parents, age 20-39, to children, age 0-19.
Alternate story: Black Plague

- Plague strikes Europe 1348-1350
- Carried by fleas living on black rats
- Shipping routes spread the disease quickly
- Kills 75 – 200 million
- Reduces pre-plague population in England by 50%

Table 1. Population of selected European countries, 1300-1800
(in thousands)

<table>
<thead>
<tr>
<th>Country</th>
<th>1300</th>
<th>1400</th>
<th>1500</th>
<th>1600</th>
<th>1700</th>
<th>1800</th>
</tr>
</thead>
<tbody>
<tr>
<td>England and Wales</td>
<td>5,750</td>
<td>3,000</td>
<td>3,500</td>
<td>4,410</td>
<td>5,450</td>
<td>9,250</td>
</tr>
<tr>
<td>Netherlands</td>
<td>800</td>
<td>600</td>
<td>950</td>
<td>1,590</td>
<td>1,950</td>
<td>2,100</td>
</tr>
<tr>
<td>Belgium</td>
<td>1,290</td>
<td>1,000</td>
<td>1,400</td>
<td>1,600</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Italy</td>
<td>13,500</td>
<td>9,000</td>
<td>13,300</td>
<td>13,500</td>
<td>15,100</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>5,500</td>
<td>4,950</td>
<td>5,800</td>
<td>7,000</td>
<td>9,400</td>
<td>11,000</td>
</tr>
<tr>
<td>Total Europe</td>
<td>94,200</td>
<td>67,950</td>
<td>82,950</td>
<td>107,350</td>
<td>114,950</td>
<td>192,250</td>
</tr>
</tbody>
</table>

Source: Paolo Malanima (unpublished manuscript).

Consequences

- Europe in 1300s was mired in stagnant wages and high population
- Massive decline in population increased value of labor
- Jump-started income growth in Europe
- Young: “Gift of Dying.” Argues the same for Africa and AIDS
Case study: Malaria

- **Burden**
  - 300-500 million cases per year
  - 1-3 million fatalities, mostly children
  - 90% of malaria mortality in Africa

- **Centered on tropics**
  - Transmission less likely when temp < 18°C (64.4)
  - Parasite dies at 16°C (60.8)

- Has been successfully eradicated in the US
• “…malaria not only takes an enormous human toll in Africa, but also contributes to an enormous economic loss and is a barrier to economic growth. Investments in malaria control thus offer an enormous return in lives saved and improved, and in economic benefits for Africa.”

• [health…] is a key precondition to economic development. The burden of disease in some low-income regions, especially in sub-Saharan Africa, is a major challenge to economic growth. Health must therefore be addressed directly in any comprehensive development strategy.

How malaria impacts the pathways in Bloom and Canning

• Education
  – Lost school days (11% of primary school days lost in Kenya to malaria alone)
  – 13-50% of lost school days in Kenya
  – Malaria impacts nutrition and brain development
  – Malaria can impact fetal development

• Physical capital
  – Health shocks reduce savings by decreasing work
  – Increase out of pocket spending

Economic impact

• $Y_n = $Annual GDP growth rate in 5 year period
• $M_n = $Malaria morbidity rate (cases/100,000)
• $X_n = $other covariates
• $t=1983-88$, $1988-93$, $1993-98$
• Consider cross sectional regression

\[ Y_{it} = \beta_0 + X_{it} \beta_1 + M_{it} \beta_2 + \varepsilon_{it} \]

• Would \( \beta_2 \) be unbiased?

• Consider pooled cross sectional/time series regression

\[ Y_{it} = \beta_0 + X_{it} \beta_1 + M_{it} \beta_2 + u_i + v_t + \varepsilon_{it} \]

\( u_i \) is a country fixed effect
\( v_t \) is a year fixed effect

• Would \( \beta_2 \) be unbiased?

• Coefficient (standard error) on \( \beta_2 \) in the pooled regression is \(-0.000062 (0.000028)\)

• Malaria incidence rates
  – Medium \( \sim 600 \) (median for world)
  – High \( \sim 10000 \) (75th percentile for Africa)
  – \( \Delta M = 9400 \)

\[ \Delta Y/\Delta M = -0.000062 \]

\[ \Delta Y = \beta_2(\Delta M) = -0.000062(9400) = -0.58 \]

• Is this a big number?

• Assume per capita GDP is 2000

• At 3%/year growth, grows to $3507 in 20 years

• At 2.5% growth, grows to $3197, which is 8% less
Bleakley – Hookworm Removal in South

- Intestinal parasite, absorbs nutrients
- Symptoms: lethargy and anemia
- Death is rare
- Hookworm eventually dies, but re-infection high
- Two ways to reduce harm
  - Treatment (cheap de-worming medicine)
  - Prevention (reduced exposure to fecal matter)

Rockefeller Sanitation Commission

- Formed in 1910
- Goal – eradicate hookworm in the US
- Dr. Charles Stiles convinced Rockefeller of the problem
- Surveyed 600 counties in south
- Found 40% hookworm infection rate among kids

Campaign

- Primary period was 1910-15
- Treated over 400K with de-worming medicine
- Educated doctors to recognize disease
- Public education about prevention
- Program eventually taken over by state/local governments

Questions

- Did campaign reduce hookworm incidence?
- Did campaign improve educational outcomes?
Research Strategy

- Hookworm infection rates differ across areas
- Areas with high infection rates should benefit more from the campaign
- Basic difference-in-difference model
  - Low infection rate areas – treated
  - High infection rates are control
- Sound familiar?

Econometric model

\[ Y_{ijt} = (H_{ij}^m \times Post_j) \beta + \delta_j + \gamma_j + X_{ijt} \Gamma + \epsilon_{ijt} \]

- person \( i \), area \( j \), time \( t \)
- \( Y_{ijt} \) outcome (like enrolled in school)
- \( Post_j = 1 \) after 1915
- \( H_{ij}^m = \) hookwork incidence rate before 1910
- \( \delta_j \) and \( \gamma_j \) are time and area effects
- \( X_{ijt} \) are control variables
Will reductions in Malaria necessarily lead to higher education?

What are definitive predictions about outcomes?
- Income/consumption
- education

Cutler et al.,
Malaria Eradication in India
Malaria Eradication in India

- National Malaria Control Program launched April of 1953
- Heavy use of DDT
  - Effective, nontoxic for humans, cheap
  - Eradicating malaria in Taiwan, Caribbean, Balkans, parts of North Africa, north Australia, large parts of South Pacific
- Prior to program, 75 million annual cases in India and 800K annual deaths (~350 million people)

- Two annual rounds of spraying
  - 1/3 of country initially part of program
  - Program reformulated in 1958
  - Whole country part of program in 1960-61
- Strategy – Difference-in-Difference
  - Compare outcomes of groups – some born before and after eradication program
  - Variation in timing of program across regions
  - Some areas had higher pre-treatment malaria rates so allow treatment to vary

Model

\[ y_{icd} = x_{icd} \gamma + POST_i \times \text{Malaria}_d \beta + \delta_i + \alpha_d + \epsilon_{icd} \]

- \( i = \text{person}, c = \text{cohort}, d = \text{district} \)
- \( y = \text{outcome} \)
- \( x = \text{covariates} \)
- \( POST_i = 1 \text{ if cohort was born after eradication program} \)
- \( \text{Malaria}_d = \text{malaria incidence rate prior to program} \)
- \( \alpha_d = \text{district effects} \)
- \( \delta_i = \text{cohort effects} \)
AIDS in Sub Saharan Africa

- 12% of world's population but 67% of world's AIDS cases
- Approximately 40 million cases worldwide in 2006
- Greatly reduced life expectancy

- Swaziland (26.0%)
- Lesotho (23.3%)
- South Africa (17.3%)
- Zimbabwe (14.9%)
- Namibia (13.4%)
- Mozambique (11.3%)
- Malawi (10.0%)
- Uganda (7.2%)
Acemoglu and Johnson (JPE)

- International epidemiological transition
  - Began in 1940
  - Large improvements worldwide in life expectancy
- Three factors
  - Drugs (mass production of penicillin, antibiotics), vaccines (polio, measles, etc.), DDT
  - WHO
  - Change in universal values – encouraged spread of changes to poor countries
• IDT was “technology” based
• Therefore – it impacted poor countries the most (impacted those most in need)
• Exogenous change in mortality
• Since it impacted poor countries the most, we should see a greater change in GDP for this group if health has an impact on the economy

Explaining results
• Drop in mortality increases population
• Should increase output but because capital is fixed, use this output more intensely and decrease wages
• Growth in output from more people not enough to compensate for loss in productivity per worker
• Black plague argument
### TABLE 2
LIFE EXPECTANCY, POPULATION, BIRTHS, AND PERCENTAGE OF POPULATION UNDER 20: OLS ESTIMATES

<table>
<thead>
<tr>
<th></th>
<th>Low- and Middle-income Countries Only</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Whole World</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Log life expectancy</td>
<td>1.69</td>
<td>1.75</td>
<td>1.82</td>
<td>1.86</td>
</tr>
<tr>
<td>Number of countries</td>
<td>120</td>
<td>59</td>
<td>47</td>
<td>56</td>
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</tbody>
</table>

\[ \text{A. Dependent Variable: Log Population} \]

### TABLE 3
LIFE EXPECTANCY, GDP, GDP PER CAPITA, AND GDP PER WORKING AGE POPULATION: OLS ESTIMATES

<table>
<thead>
<tr>
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<td>Whole World</td>
<td>(1)</td>
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<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Log life expectancy</td>
<td>1.17</td>
<td>1.55</td>
<td>.78</td>
<td>.65</td>
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<tr>
<td>Number of countries</td>
<td>(36)</td>
<td>(35)</td>
<td>(33)</td>
<td>(42)</td>
</tr>
</tbody>
</table>

\[ \text{A. Dependent Variable: Log GDP} \]

<table>
<thead>
<tr>
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<td>Whole World</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Log life expectancy</td>
<td>(-.42)</td>
<td>(-.19)</td>
<td>(-.84)</td>
<td>(-1.14)</td>
</tr>
<tr>
<td>Number of countries</td>
<td>(36)</td>
<td>(34)</td>
<td>(38)</td>
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</tbody>
</table>

\[ \text{B. Dependent Variable: Log GDP per Capita} \]

<table>
<thead>
<tr>
<th></th>
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<td>Whole World</td>
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<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Log life expectancy</td>
<td>(-.56)</td>
<td>(-.54)</td>
<td>(-.30)</td>
<td>(-.39)</td>
</tr>
<tr>
<td>Number of countries</td>
<td>(36)</td>
<td>(34)</td>
<td>(38)</td>
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