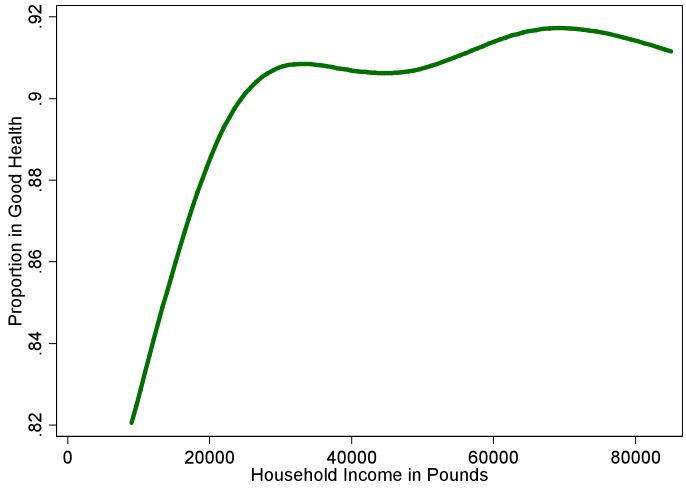
# Income and Health
# Econ G041, Lecture 3



## Background

- Income and health are *correlated*.
- Persistent findings in many countries and datasets.
- Important policy topic: should we:
  - redistribute income to improve health?
  - or improve health to increase productivity?
- The answers depends on:
  - The causal channels going between income and health.
  - The shape of the relationship between income and health.

## Proportion of Individuals in Good or Very Good Health (Age and Sex adjusted), UK 2000




Source: Health Survey for England, 2000



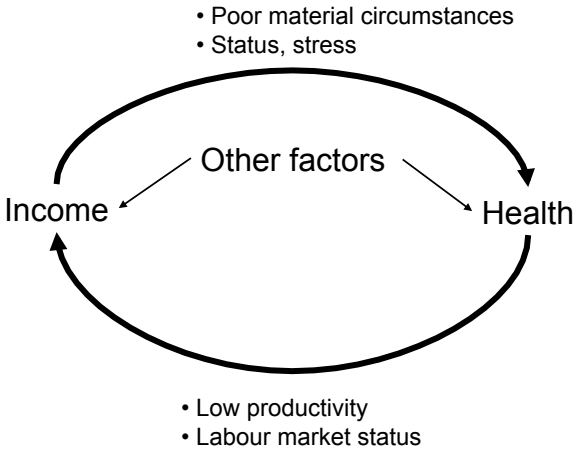
## Effect of (Log) Income on Various Health Measures

| | Coefficient | Std. Err. |
|---|---|---|
| Self-reported Good Health | 0.415 | 0.010 |
| Self-reported Poor Health | -0.491 | 0.014 |
| Longstanding Illness | -0.213 | 0.009 |
| Cardiovascular condition | -0.130 | 0.013 |
| Blood pressure condition | -0.067 | 0.012 |
| High bloodpressure | -0.053 | 0.011 |
| Respiratory condition | -0.092 | 0.012 |
| Mental condition (GHQ 12) | -0.535 | 0.018 |

Note: Regressions control for education, year effect, sex and age

Source: Health Survey for England

## Causal Channels between Income and Health






## Uncovering the causal effect of income on health

- Plenty of studies show a correlation between income and health.
- This does not necessarily mean that low income *causes* poor health.
- Some attempts to uncover a causal mechanism:
  - Van den Berg et al (2006) "Economic Conditions Early in Life and Individual Mortality", *AER*.
  - Ruhm (2000) "Are Recession Good for your Health?", *QJE*.
  - Lindahl (2005) "Estimating the effect of income on health and mortality using lottery prizes as an exogenous source of variation in income", *Journal of Human Resources*.
  - Adda et al (2009) "The Impact of Income Shocks on Health: Evidence from Cohort Data", *JEEA*.
  - Lechner and Vazquez-Alvarez (2003) "The Effect of Disability on Labour Market Outcomes in Germany"
  - French (2005) "The Effects of Health, Wealth, and Wages on Labor Supply and Retirement Behavior", *Review of Economic Studies*.

## Economic Conditions Early in Life and Individual Mortality Van den Berg et al (2006)

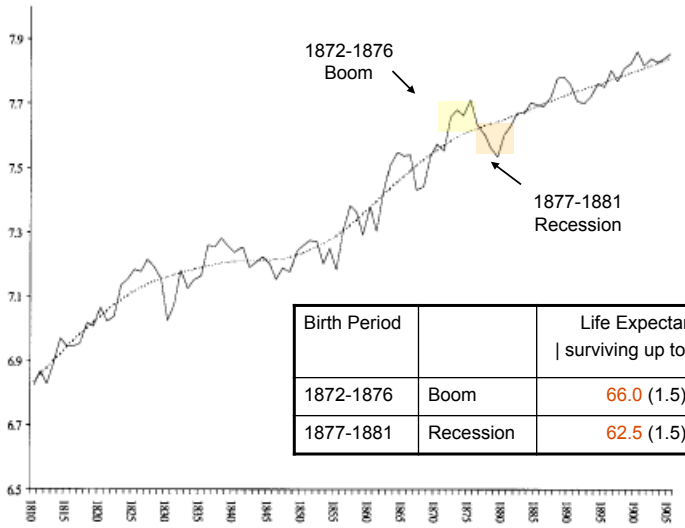
- Investigate the effect of income at birth on subsequent mortality.
- Role of malnutrition in early life.
- Difficult to analyse the effect of socio-economic position of parents at birth on mortality as these characteristics are correlated with many factors that affect health of children.
- This study focus on the role of business cycles, taken as exogenous shocks.



## Design of the Study

- Data covers about 14000 individuals born in the Netherlands between 1812-1912 and followed up to 2000.
- Information on date of death and date of birth.
- Information on parental background and region of birth.
- Compare those who are born during a boom to those who are born during a recession.

# Log Annual Real per Capita GNP




| Birth Period | | Life Expectancy \| surviving up to age 2 |
|---|---|---|
| 1872-1876 | Boom | 66.0 (1.5) |
| 1877-1881 | Recession | 62.5 (1.5) |



# Effect of Boom/Recession at Birth on Mortality

| Variable | Estimate | Standard error |
|---|---|---|
| *Baseline regression* | | |
| Boom (instead of recession) at birth | 1.58 | 0.95* |
| Birth Period I | 48.92 | 1.29 |
| Birth Period II | 46.42 | 1.18 |
| Birth Period III | 45.24 | 1.17 |
| Birth Period IV | 46.82 | 1.57 |
| Birth Period V | 48.72 | 1.80 |
| Birth Period VI | 57.05 | 1.33 |
| Birth Period VII | 63.19 | 1.18 |
| Birth Period VIII | 68.68 | 1.40 |
| Interaction boom at birth × Birth Period VIII | −5.16 | 2.01 |
| # of individuals | 4774 | |
| *Three birth periods with strongest cycle only* | | |
| Boom (instead of recession) at birth | 2.36 | 1.33* |
| # of individuals | 1885 | |

*Notes:* * denotes significance at the 5-percent level according to a one-sided test of a zero effect of the boom/recession indicator at birth. In both regressions, the outcome variable is the individual lifetime conditional on survival beyond age two. The explanatory variables in the second regression include dummy variables for Birth Periods II, VI, and VII.

# Duration Analysis

- The previous results can be biased if being born in a recession is correlated with growing up during a boom.
- Next step is to control for business cycles along the life-cycle.
- Requires a duration analysis.
- Denote by t age, T the life expectancy and **τ** current calendar time.
- The conditional probability of survival is expressed as:

$$\frac{\Pr ob(t \le T < t+dt \mid T \ge t, \tau, X)}{dt} = \theta(t, X, z(\tau), z_c(\tau - t + i))$$

$$i \in \{0, \ldots, t-1\}$$

age

Characteristics at birth

Current macro condition

Cyclical component



# Effect of Boom/Recession on Mortality Rate

| Variable | Estimate | *t*-statistic | Estimate | *t*-statistic |
|---|---|---|---|---|
| *Individual background characteristics* | | | | |
| Female | −0.10 | 4.3 | −0.10 | 4.4 |
| Social class father at birth | −0.031 | 3.0 | −0.032 | 3.2 |
| Father not illiterate | −0.07 | 2.2 | −0.07 | 2.0 |
| Mother unmarried at the time of birth | 0.05 | 0.6 | 0.05 | 0.6 |
| Born in urban area | 0.08 | 2.7 | 0.07 | 2.6 |
| Born in province Utrecht* | 0.23 | 7.4 | 0.24 | 7.6 |
| Born in province Zeeland* | 0.30 | 10.7 | 0.30 | 10.6 |
| *Business cycle early in life* | | | | |
| Boom (instead of recession) at birth | −0.09 | 3.5 | −0.08 | 2.8 |
| Cycle indicator for age 1 to 6 | 0.00 | 0.0 | 0.00 | 0.1 |
| *Contemporaneous macro conditions* | | | | |
| 1849 cholera in Utrecht | 0.81 | 4.2 | 0.72 | 3.7 |
| 1870–71 smallpox | 0.51 | 5.2 | 0.52 | 5.3 |
| 1918 influenza | −0.25 | 1.4 | −0.16 | 0.9 |
| World War II (GNP missing) | −2.88 | 10.5 | −2.01 | 6.3 |
| Current log(annual real per capita GNP) | −0.36 | 11.2 | | |
| idem at age 0 | | | −0.33 | 3.7 |
| idem at age 1 | | | −0.46 | 2.5 |
| idem at age 2–6 | | | −0.91 | 5.1 |
| idem at age 7–14 | | | −1.35 | 5.0 |
| idem at age 15–34 | | | −1.42 | 9.3 |
| idem at age 35–59 | | | −0.26 | 6.0 |
| idem at age 60–69 | | | −0.27 | 6.5 |
| idem at age 70–79 | | | −0.24 | 6.5 |
| idem at age 80–89 | | | −0.27 | 7.0 |
| idem at age 90+ | | | −0.27 | 4.3 |
| *Age* | | | | |
| Age 0 | 1.30 | 5.5 | 1.07 | 1.6 |
| Age 1 | 0.04 | 0.2 | 0.79 | 0.6 |
| Age 2–6 | −1.24 | 5.2 | 2.81 | 2.2 |
| Age 7–14 | −2.45 | 10.1 | 4.93 | 2.5 |
| Age 15–34 | −2.27 | 9.4 | 5.74 | 5.0 |
| Age 35–59 | −1.86 | 7.3 | −2.66 | 8.0 |
| Age 60–69 | −0.63 | 2.4 | −1.42 | 4.3 |
| Age 70–79 | 0.47 | 1.8 | −0.50 | 1.6 |
| Age 80–89 | 1.44 | 5.2 | 0.59 | 1.8 |
| Age 90+ | 2.25 | 7.8 | 1.42 | 2.5 |
| −log likelihood | 29067 | | 29017 | |
| # of individuals | 9276 | | 9276 | |

*Notes:* Effects on log mortality rate reported. GNP-related variables are not mean-centered.
* Province Friesland as reference.

Negative number means longer life.

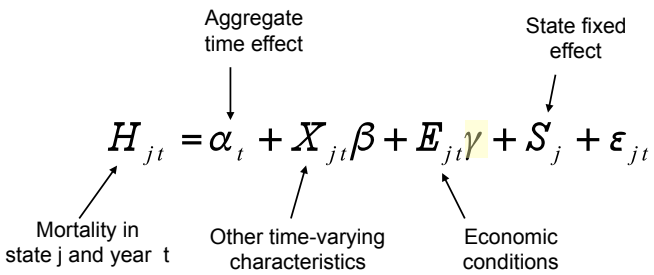
## Conclusion of Study

- Being born in a recession is associated with an 8-percent increase in the mortality rate.
- Importance of income during early life.
- Can we extrapolate these results into the XXth and XXIst centuries?
- How exogenous are business cycles? Work by Dehejia and Lleras-Muney (2004) on the timing of births with respect to business cycles.



## Effect of Business Cycles on Mortality Ruhm (2000)

- Examines how health responds to transitory changes in economic conditions.
- Fixed-effect models using longitudinal data for 1972-1991 period, across American states.
- Health is proxied by mortality and cause-specific mortality.



# Results

| | Basic specification | | | | | With state-specific time trends | | | | | Deaths in levels | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Full sample estimates | (a) | (b) | (c) | (d) | (e) | (a) | (b) | (c) | (d) | (e) | (a) | (b) |
| State unemployment rate | −.0052 | −.0044 | −.0065 | | −.0069 | −.0054 | −.0041 | −.0068 | | −.0069 | −4.574 | −4.224 |
| | (.0005) | (.0006) | (.0004) | | (.0006) | (.0004) | (.0006) | (.0003) | | (.0005) | (0.429) | (0.527) |
| U. S. unemployment rate | | | | −.0067 | .0006 | | | | −.0070 | .0002 | | |
| | | | | (.0005) | (.0008) | | | | (.0005) | (.0007) | | |
| Personal income | | .0037 | | | | | .0060 | | | | | −1.572 |
| | | (.0016) | | | | | (.0017) | | | | | (1.378) |
| Year effects | Yes | Yes | No | No | No | Yes | Yes | No | No | No | Yes | Yes |

| | 1971–1982 | | 1983–1991 | | 10 largest states | | Fast growing states | | Slow growing states | |
|---|---|---|---|---|---|---|---|---|---|---|
| Split-sample estimates | (a) | (b) | (a) | (b) | (a) | (b) | (a) | (b) | (a) | (b) |
| State unemployment rate | −.0045 | −.0034 | −.0061 | −.0047 | −.0057 | −.0035 | −.0080 | −.0076 | −.0057 | −.0078 |
| | (.0007) | (.0008) | (.0007) | (.0008) | (.0009) | (.0012) | (.0009) | (.0013) | (.0010) | (.0013) |
| Personal income | | .0076 | | .0077 | | .0077 | | .0013 | | −.0123 |
| | | (.0026) | | (.0023) | | (.0030) | | (.0027) | | (.0046) |

- A one percentage point increase in unemployment decreases the death rates by about 0.5 percent



# Results: Cause Specific Mortality

| | (a) | (b) | (c) | (a) | (b) | (c) | (a) | (b) | (c) |
|---|---|---|---|---|---|---|---|---|---|
| | 20–44 year olds | | | 45–64 year olds | | | ≥65 year olds | | |
| State unemployment rate | −.0203 | −.0098 | −.0193 | .0003 | −.0025 | .0002 | −.0032 | −.0026 | −.0043 |
| | (.0016) | (.0018) | (.0019) | (.0009) | (.0010) | (.0009) | (.0005) | (.0006) | (.0007) |
| U. S. unemployment rate | | | −.0001 | | | −.0017 | | | −.0005 |
| | | | (.0026) | | | (.0023) | | | (.0009) |
| Personal income | | .0508 | | | −.0134 | | | .0028 | |
| | | (.0048) | | | (.0028) | | | (.0016) | |
| | Heart disease | | | Cancer | | | Flu/pneumonia | | |
| State unemployment rate | −.0046 | −.0052 | −.0071 | .0004 | .0000 | .0002 | −.0066 | −.0060 | −.0084 |
| | (.0008) | (.0010) | (.0010) | (.0006) | (.0008) | (.0006) | (.0023) | (.0029) | (.0032) |
| U. S. unemployment rate | | | .0038 | | | −.0005 | | | −.0138 |
| | | | (.0013) | | | (.0009) | | | (.0045) |
| Personal income | | −.0025 | | | −.0017 | | | .0027 | |
| | | (.0026) | | | (.0020) | | | (.0075) | |
| | Liver disease | | | Vehicle accidents | | | Other accidents | | |
| State unemployment rate | −.0039 | −.0060 | −.0075 | −.0302 | −.0180 | −.0319 | −.0166 | −.0185 | −.0200 |
| | (.0023) | (.0029) | (.0024) | (.0022) | (.0026) | (.0024) | (.0020) | (.0025) | (.0022) |
| U. S. unemployment rate | | | −.0010 | | | −.0137 | | | .0116 |
| | | | (.0034) | | | (.0034) | | | (.0030) |
| Personal income | | −.0095 | | | .0544 | | | −.0085 | |
| | | (.0076) | | | (.0067) | | | (.0065) | |
| | Suicide | | | Homicide | | | | | |
| State unemployment rate | .0127 | .0116 | .0110 | −.0189 | −.0153 | −.0221 | | | |
| | (.0022) | (.0027) | (.0022) | (.0035) | (.0043) | (.0041) | | | |
| U. S. unemployment rate | | | −.0084 | | | .0073 | | | |
| | | | (.0030) | | | (.0057) | | | |
| Personal income | | −.0048 | | | .0163 | | | | |
| | | (.0070) | | | (.0112) | | | | |

## Conclusion

- Unemployment rates mostly affect younger individuals (20-44).
- Affects mainly deaths from vehicle accidents, other accidents and homicides. As expected, no effect on cancers.
- Recessions decreases the likelihood of death (except suicide).
- Could operate through changes in health behavior.



## Lottery prizes and Health
## Lindahl (2005)

- Use information on monetary lottery prizes to create exogenous variation in income.
- Use the Swedish Level of Living Surveys which reports:
  - Income and lottery gains
  - Health (a large range of illnesses and symptoms combined into one index).
  - Mortality
- Correlate health with lottery gains

# Caveat

- Lottery gains:
  - Only observes those who gained a prize: Those who play the lottery may not be representative of the population, or may even be selected on health grounds.
  - Do not observe the intensity of playing: if some play more, they are more likely to win: non random experiment.
  - Do not observe the exact year when the lottery was won. Only the gains between two waves (6 to 7 years).



# Descriptive Statistics

| | Players (n = 626) | | Nonplayers (n = 2,322) | | |
|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | *p*-value |
| Main health variables | | | | | |
| *Standardized Index of Bad Health*, 1981 | 0.003 | 0.997 | –0.001 | 1.001 | 0.927 |
| Number of health-related symptoms in 1981 | 5.51 | 4.71 | 5.68 | 4.79 | 0.435 |
| Number of immobility symptoms in 1981 | 0.51 | 0.96 | 0.52 | 0.96 | 0.829 |
| Number of poor mental health symptoms in 1981 | 0.54 | 0.95 | 0.55 | 0.99 | 0.664 |
| Number of cardiovascular diseases in 1981 | 0.76 | 1.18 | 0.74 | 1.18 | 0.805 |
| Overweight in 1981 | 0.19 | 0.45 | 0.16 | 0.41 | 0.170 |
| Headache in 1981 | 0.41 | 0.63 | 0.51 | 0.67 | 0.000 |
| Dead in 5 years | 0.065 | 0.248 | 0.063 | 0.244 | 0.844 |
| Dead in 10 years | 0.131 | 0.338 | 0.141 | 0.348 | 0.521 |
| Main lottery variables | | | | | |
| Player = 1 | 1 | 0 | 0 | 0 | |
| Player before 1969 = 1 | 0.18 | 0.38 | | | |
| Average lottery prize | 0.25 | 0.64 | 0 | 0 | |

# Determinants of Lottery Playing

| Dependent variable | Average lottery prize 1969–81 | Average lottery prize 1969–74 | | Average lottery prize 1975–81 | |
|---|---|---|---|---|---|
| | OLS | OLS | Tobit | OLS | Tobit |
| | (1) | (2) | (3) | (4) | (5) |
| Women = 1 | −0.10 (0.03) | −0.12 (0.04) | −0.17 (0.09) | −0.02 (0.07) | −0.11 (0.10) |
| Age | 0.16 (0.15) | 0.41 (0.16) | 0.72 (0.32) | 0.06 (0.28) | −0.10 (0.35) |
| $Age^2/k_1$ | −0.36 (0.29) | −0.83 (0.32) | −1.45 (0.63) | −0.20 (0.57) | 0.12 (0.72) |
| $Age^3/k_2$ | 0.20 (0.15) | 0.42 (0.16) | 0.74 (0.32) | 0.14 (0.31) | −0.02 (0.38) |
| Foreign = 1 | 0.03 (0.06) | 0.08 (0.11) | .06 (0.21) | −0.04 (0.08) | 0.05 (0.17) |
| Health problem growing up = 1 | −0.10 (0.04) | −0.07 (0.04) | −0.13 (0.10) | −0.13 (0.07) | −0.17 (0.11) |
| Economic problem growing up = 1 | −0.01 (0.05) | 0.02 (0.04) | 0.05 (0.09) | −0.05 (0.09) | −0.08 (0.13) |
| Years of schooling in 1968/1974 | −0.00 (0.01) | 0.01 (0.01) | 0.03 (0.02) | −0.02 (0.01) | −0.04 (0.02) |
| Married in 1968/1974 = 1 | 0.01 (0.05) | −0.05 (0.06) | −0.12 (0.11) | −0.06 (0.11) | −0.04 (0.14) |
| Worker in 1968/1974 = 1 | −0.09 (0.05) | −0.09 (0.05) | −0.14 (0.11) | 0.17 (0.15) | 0.13 (0.18) |
| Low wealth in 1968/1974 = 1 | −0.01 (0.05) | −0.05 (0.05) | −0.21 (0.11) | 0.02 (0.10) | 0.08 (0.14) |
| Very low wealth in 1968/1974 = 1 | −0.09 (0.03) | −0.06 (0.04) | −0.27 (0.13) | 0.01 (0.09) | 0.03 (0.15) |
| The standardized index of bad health in 1968/1974 | −0.02 (0.02) | 0.00 (0.02) | 0.01 (0.05) | −0.02 (0.03) | −0.04 (0.04) |
| Log income in 1974 | | | | 0.10 (0.08) | 0.05 (0.11) |
| Log income in 1973 | | | | 0.08 (0.07) | 0.13 (0.11) |
| Log income in 1967 | 0.01 (0.04) | −0.05 (0.03) | −0.16 (0.07) | −0.01 (0.05) | −0.02 (0.09) |
| Player before 1969 = 1 | 0.19 (0.10) | 0.19 (0.09) | 0.34 (0.15) | 0.19 (0.19) | 0.17 (0.23) |
| Average lottery prize 1969–74 | | | | −0.05 (0.08) | −0.68 (0.48) |
| *P*-value from partial *F*-test | 0.196 | 0.310 | 0.444 | 0.865 | 0.929 |
| $R^2$ | 0.032 | 0.057 | — | 0.023 | — |



# Effect of Lottery on Index of Bad Health

| | All players (n = 626) | | | Players: Age> = 60 (n = 204) | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | Dependent variable *The Standardized Index of Bad Health* in 1981 | | | | | |
| Main independent variable | | | | | | |
| Average lottery prize 1969–81 (the reduced form) | −0.069 (0.029) | −0.045 (0.029) | −0.037 (0.029) | −0.086 (0.043) | −0.036 (0.040) | −0.016 (0.044) |
| Log average income 1967–81 (OLS) | −0.51 (0.12) | −0.22 (0.12) | −0.22 (0.12) | −0.80 (0.22) | −0.33 (0.23) | −0.34 (0.23) |
| Predicted log average income 1967–81 (IV) | −0.78 (0.42) | −0.53 (0.40) | −0.43 (0.39) | −1.18 (0.59) | −0.54 (0.58) | −0.22 (0.61) |
| | Dependent variable Log average income 1967–81 | | | | | |
| Average lottery prize 1969–81 (the first stage) | 0.088 (0.023) | 0.085 (0.019) | 0.086 (0.020) | 0.073 (0.021) | 0.066 (0.019) | 0.070 (0.020) |
| Controls | | | | | | |
| Gender, cubic in age | Yes | Yes | Yes | Yes | Yes | Yes |
| *X* variables in 1968 and *Standardized Index of Bad Health*, 1968 | No | Yes | Yes | No | Yes | Yes |
| Player before 1969 | No | No | Yes | No | No | Yes |

10000 SEK increase health by 0.069 standard deviation

# Effect of Lottery Gains on More Health Outcomes

| Dependent variables | Average lottery prize 1969–81 (the reduced form) | | Log average income 1967–81 | | Predicted log average income 1967–81 | |
|---|---|---|---|---|---|---|
| | OLS | Poisson/ ordered Probit | OLS | Poisson/ ordered Probit | IV | Poisson/ ordered Probit |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Outcome variables | | | | | | |
| Number of immobility symptoms | −0.057 | −0.163 | −0.17 | −0.29 | −0.65 | −1.87 |
| | (0.040) | (−0.180) | (0.11) | (0.21) | (0.48) | (2.08) |
| Number of poor mental health symptoms | −0.061 | −0.283 | −0.23 | −0.46 | −0.70 | −3.26 |
| | (0.027) | (0.144) | (0.12) | (0.20) | (0.31) | (1.69) |
| Number of cardio-vascular diseases | 0.063 | 0.070 | −0.34 | −0.42 | 0.73 | 0.74 |
| | (0.065) | (0.056) | (0.13) | (0.18) | (0.71) | (0.55) |
| Headache | −0.033 | −0.129 | −0.14 | −0.29 | −0.39 | −1.50 |
| | (0.024) | (0.102) | (0.08) | (0.18) | (0.27) | (1.17) |
| Overweight | −0.034 | −0.212 | 0.04 | 0.18 | −0.39 | −2.52 |
| | (0.019) | (0.137) | (0.06) | (0.20) | (0.23) | (1.61) |
| Dead in 5 years, all players | −0.020 | | −0.023 | | −0.227 | |
| | (0.007) | | (0.031) | | (0.078) | |
| Dead in 10 years, all players | −0.029 | | −0.032 | | −0.334 | |
| | (0.011) | | (0.039) | | (0.129) | |
| Dead in 5 years, players age> = 60 | −0.023 | | −0.020 | | −0.324 | |
| | (0.020) | | (0.091) | | (0.282) | |
| Dead in 10 years, players age> = 60 | −0.042 | | −0.080 | | −0.594 | |
| | (0.017) | | (0.111) | | (0.245) | |



# Summary

- Winning SEK 100,000 on lotteries in a 13-year period (almost 8,000 per year)
  - increases general health by 3 percent of a standard deviation at the end of this period.
  - decreases the probability of dying within five years after the end of this period by two percentage points.

## The Impact of Income Shocks on Health: Evidence from Cohort Data

Jerome Adda, James Banks and Hans-Martin von Gaudecker



## Motivation

- Income and health are empirically correlated.
- Potentially, income causes health and health causes income.
- Difficult to disentangle both effects.
- Important question for public policy.

## Contribution

- We develop a model that links income and health allowing for endogeneity at individual level.
- The model decomposes income and health shocks into permanent and transitory components.
- We set up a data set that follows income and health for up to 25 years at cohort level.
- We use GMM to estimate the effect of *permanent* shocks to income on health.



## Contribution: Identification

- Identification is achieved at cohort level:
  - We fully allow for endogeneity at individual level.
  - We use the fact that during the 80s and 90s income profiles have changed at cohort level:
    - Changes in the return to education.
    - Skill-biased technological change.
    - Declines in unionization.
    - Increased competition.
  - These sources of variation are not commonly thought to originate from changes in health.
  - We use this variation to identify the model.

## Contribution: Data

- It is rare to have detailed data on *both* income and health over time.
- Especially over working-age period.
- We construct data for synthetic cohort that follows income and health over 25 years, for individuals between the age of 30-60.
- Cohorts are defined by year of birth, sex and education.
- We estimate the effect of permanent income shocks on a range of health measures:
  - Self-assessed health.
  - Limiting illness.
  - Blood pressure, cardio-vascular diseases, respiratory diseases…
  - Health behavior.



## Contribution: Results

- We find evidence of permanent income shocks to income, especially for low educated individuals.
- These shocks have an impact on behavior:
  - Total expenditures.
  - Smoking and drinking behavior.
- We do not find an effect on health outcomes

## Model: Income Process

- Log-Income for household *i* in period *t*.

$$Y_{it} = Y_{it-1} + (1-L)u_{it}^{Y} + v_{it}^{Y}$$

- Two types of income shocks:
  - Transitory $u_{it}^{Y}$
  - Permanent $v_{it}^{Y}$



## Model: Income Process

$$u_{it}^{Y} = \varepsilon_{ct}^{Y} + \xi_1 \varepsilon_{ct}^{H} + \varepsilon_{it}^{Y} + \varphi_1 \varepsilon_{it}^{H}$$

$$v_{it}^{Y} = \zeta_{ct}^{Y} + \xi_2 \zeta_{ct}^{H} + \zeta_{it}^{Y} + \varphi_2 \zeta_{it}^{H}$$

- Transitory and Permanent shocks are functions of:
  - Individual and cohort specific shocks to income.
  - Individual and cohort specific shocks health

## Model: Health Process

$$H_{it} = H_{it-1} + m_{ia}^{H} + (1-L)u_{it}^{H} + v_{it}^{H}$$

- Health evolves as a random walk with a drift which is individual (age) specific.
- Transitory and permanent shocks.



## Model: Health Process

$$u_{it}^{H} = \varepsilon_{it}^{H} + \varepsilon_{ct}^{H} + \sum_{j=0}^{q} \gamma_1 \varepsilon_{c,t-j}^{Y} + \sum_{j=0}^{q} \theta_{1j} \varepsilon_{i,t-j}^{Y}$$

$$v_{it}^{H} = \zeta_{it}^{H} + \zeta_{ct}^{H} + \sum_{j=0}^{q+1} \gamma_{2j} \zeta_{ct-j}^{Y} + \sum_{j=0}^{q+1} \theta_{2j} \zeta_{i,t-j}^{Y}$$

- Health shocks are functions of:
  - Individual and cohort specific shocks to health.
  - Individual and cohort specific shocks to income, with a possible lag of order *q*.

## Aggregation

$$\varepsilon_{it}^{Y} \sim iid(m_a^{Y,T}, \sigma^2_{\varepsilon^{Y,i}}) \qquad \zeta_{it}^{Y} \sim iid(m_a^{Y,P}, \sigma^2_{\zeta^{Y,i}})$$
$$\varepsilon_{it}^{H} \sim iid(m_a^{H,T}, \sigma^2_{\varepsilon^{H,i}}) \qquad \zeta_{it}^{H} \sim iid(m_a^{H,P}, \sigma^2_{\zeta^{H,i}})$$
$$m_{ia}^{H} \sim iid(m_a^{H}, \sigma^2_{m^{H,i}})$$

- All shocks are assumed to be independently and identically distributed over time.
- This defines the nature of permanent and transitory shocks.
- Their mean is a function of age and cohort.



## Aggregation

$$Y_{ct} = Y_{c,t-1} + m_a^Y + \zeta_{ct}^Y + \xi_2 \zeta_{ct}^H + (1-L)\varepsilon_{ct}^Y + \xi_1(1-L)\varepsilon_{ct}^H + (1-L)\upsilon_{ct}^Y$$
$$H_{ct} = H_{c,t-1} + m_a^H +$$
$$\sum_{j=0}^{q} \gamma_{2j} \zeta_{ct-j}^Y + \zeta_{ct}^H + \sum_{j=0}^{q} \gamma_{1j}(1-L)\varepsilon_{ct-j}^Y + (1-L)\varepsilon_{ct}^H + (1-L)\upsilon_{ct}^H$$

- We aggregate the model at cohort level.
- The idiosyncratic shocks are subsumed into age and cohort specific trends.
- General model where health affects income and vice-versa.

## Aggregation

$$Y_{ct} = Y_{c,t-1} + m_a^Y + \zeta_{ct}^Y + \xi_2 \zeta_{ct}^H + (1-L)\varepsilon_{ct}^Y + \xi_1(1-L)\varepsilon_{ct}^H + (1-L)\upsilon_{ct}^Y$$

$$H_{ct} = H_{c,t-1} + m_a^H + \sum_{j=0}^{q} \gamma_{2j}\zeta_{ct-j}^Y + \zeta_{ct}^H + \sum_{j=0}^{q} \gamma_{1j}(1-L)\varepsilon_{ct-j}^Y + (1-L)\varepsilon_{ct}^H + (1-L)\upsilon_{ct}^H$$

- We aggregate the model at cohort level.
- The idiosyncratic shocks are subsumed into age and cohort specific trends.
- General model where health affects income and vice-versa.
- Identification restriction we impose: $\xi_2 = 0$
- Income at cohort level is not driven by cohort health shocks.
- We partially relax this assumption later on.



## Unexplained Growth in Income and Health

$$g_{ct}^Y = \zeta_{ct}^Y + (1-L)\varepsilon_{ct}^Y + \xi_1(1-L)\varepsilon_{ct}^H + (1-L)\upsilon_{ct}^Y$$

$$g_{ct}^H = \sum_{j=0}^{q} \gamma_{2j}\zeta_{ct-j}^Y + \zeta_{ct}^H + \sum_{j=0}^{q} \gamma_{1j}(1-L)\varepsilon_{ct-j}^Y + (1-L)\varepsilon_{ct}^H + (1-L)\upsilon_{ct}^H$$

- The unexplained growth of income and health is thus a function of transitory and permanent shocks to income and health.

# Identifying Some Relevant Parameters

$$E\left[g_{ct}^{Y}\left(\sum_{j=-1}^{1} g_{c,t+j}^{Y}\right)\right]-E\left[g_{ct}^{Y}\right]E\left[\sum_{j=-1}^{1} g_{c,t+j}^{Y}\right]=\sigma_{\xi^Y}^2$$

$$E\left[g_{ct}^{H}\left(\sum_{j=-(q+1)}^{q+1} g_{c,t+j}^{H}\right)\right]-E\left[g_{ct}^{H}\right]E\left[\sum_{j=-(q+1)}^{q+1} g_{c,t+j}^{H}\right]=\left(\sum_{j=0}^{q+1}\gamma_{2j}\right)^2\sigma_{\xi^Y}^2+\sigma_{\xi^H}^2$$

$$E\left[g_{ct}^{H}\left(\sum_{j=-(q+1)}^{1} g_{c,t+j}^{Y}\right)\right]-E\left[g_{ct}^{H}\right]E\left[\sum_{j=-(q+1)}^{1} g_{c,t+j}^{Y}\right]=\left(\sum_{j=0}^{q+1}\gamma_{2j}\right)\sigma_{\xi^Y}^2$$

- We can identify three key parameters:
  - The variance of the permanent income shock (at cohort level).
  - The (cumulated) effect of income on health.
  - The variance of the permanent health shock (at cohort level).
- These parameters are related to the variance and covariances of health and income.



# Estimation Strategy

- The estimation strategy consists of three steps:
  - Regress the health and income variables on cohort dummies and age functions.
  - Use the residuals to compute the moments decribed on the previous slide.
  - Estimate the three key parameters using GMM and obtain confidence intervals by bootstrapping.

## Data Sets

- Family Expenditure Survey
- General Household Survey
- Health Survey for England
- Human Mortality Data Base

- All are repeated cross-sectional datasets.



## Data

- Family Expenditure Survey:
  - Household income.
  - Demographic variables.
  - 148517 individuals, from 1978 to 2003.
  - Income converted into January 2000 prices using CPI.
  - OECD Equivalence scale:
    Equiv= 1 + 0.6 (# Adults-1)+ 0.4 # Children

## Data

- General Household Survey
  - Covers health behaviors
  - Self-reported health (good/fair/bad)
  - Limiting illness
  - Demographics
  - 277,084 individuals over period 1978-2003.

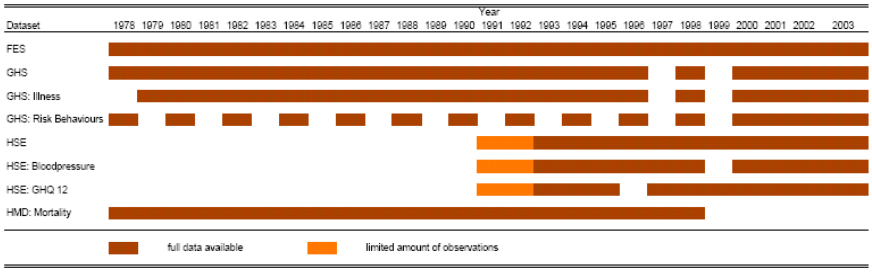


## Data

- Health Survey for England
  - Monitor population health in England
  - Blood pressure (1 if above 140/90 mmHg or taking medication).
  - Cardio-vascular disease.
  - Respiratory disease.
  - Mental health: GHQ
  - 80,541 individuals over the period 1991-2003.

# Data

Table 1: Data Availability by Year






# Cohort

- Defined by
  - Date of birth: 3 year band.
  - Education level: beyond compulsory level or not.
  - Sex
- Age between 30 and 60.
- Born between 1918 and 1973.
- In total we have 72 cohorts followed up to 25 years.
- Sample size: 944 points of data.

# Cell Size After Aggregation

| Dataset | Mean | Median | First Percentile | Minimum | Total Number of Individuals |
|---|---|---|---|---|---|
| FES | 137.3 | 134.5 | 65 | 55 | 148,517 |
| GHS | 257.3 | 221 | 84 | 58 | 277,084 |
| HSE | 149.6 | 140.5 | 25 | 18 | 80,541 |
| HSE, 1993+ | 164.0 | 152 | 62 | 51 | 76,943 |

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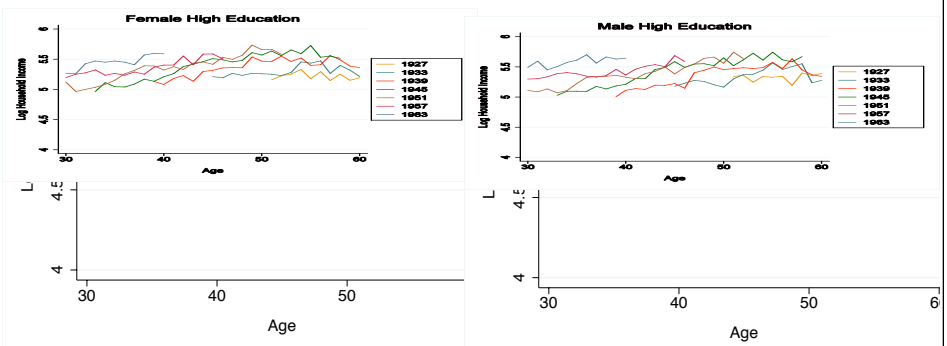
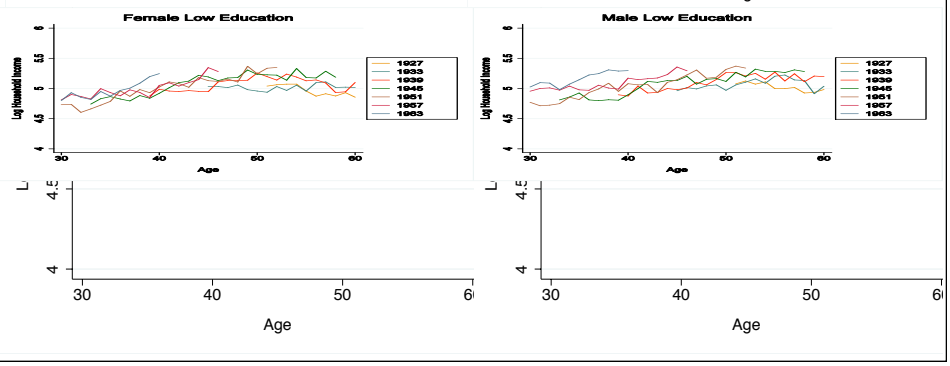
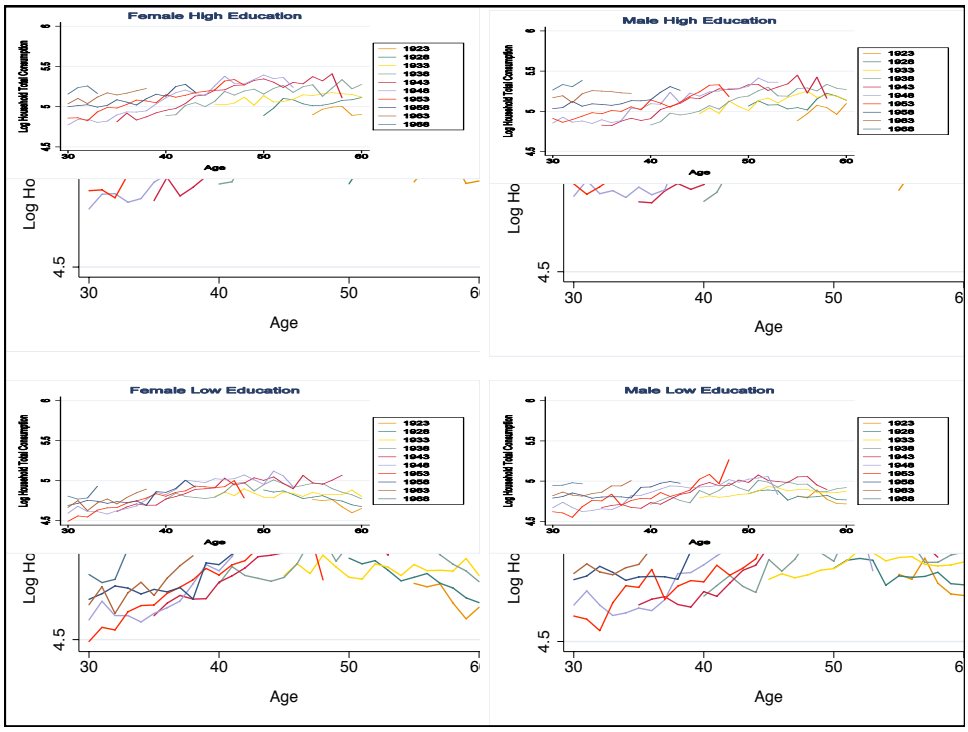
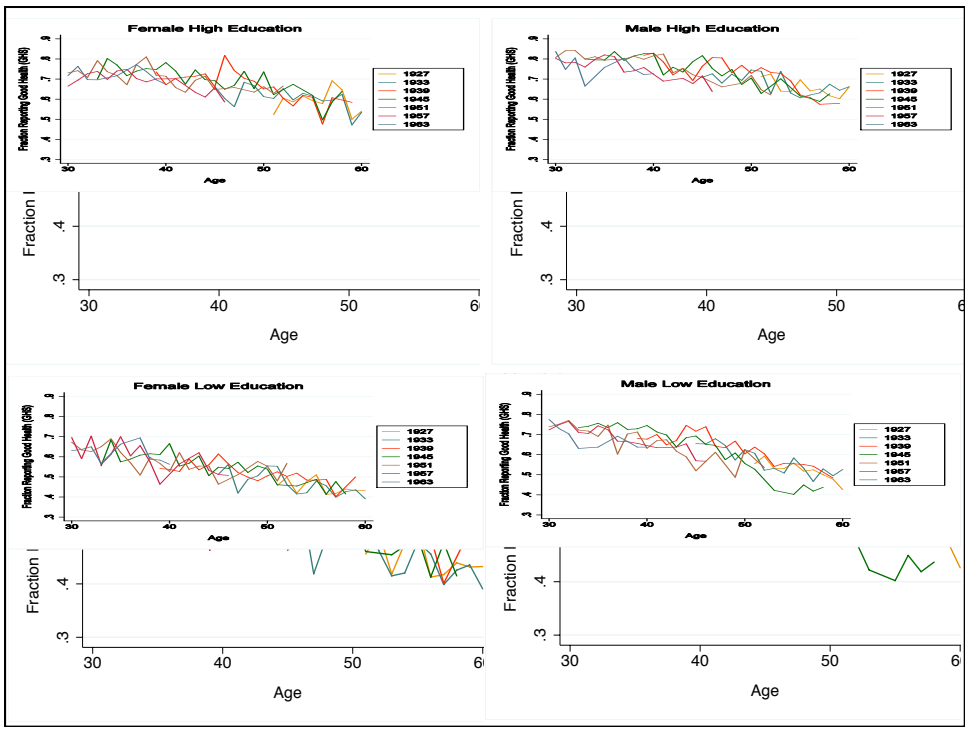
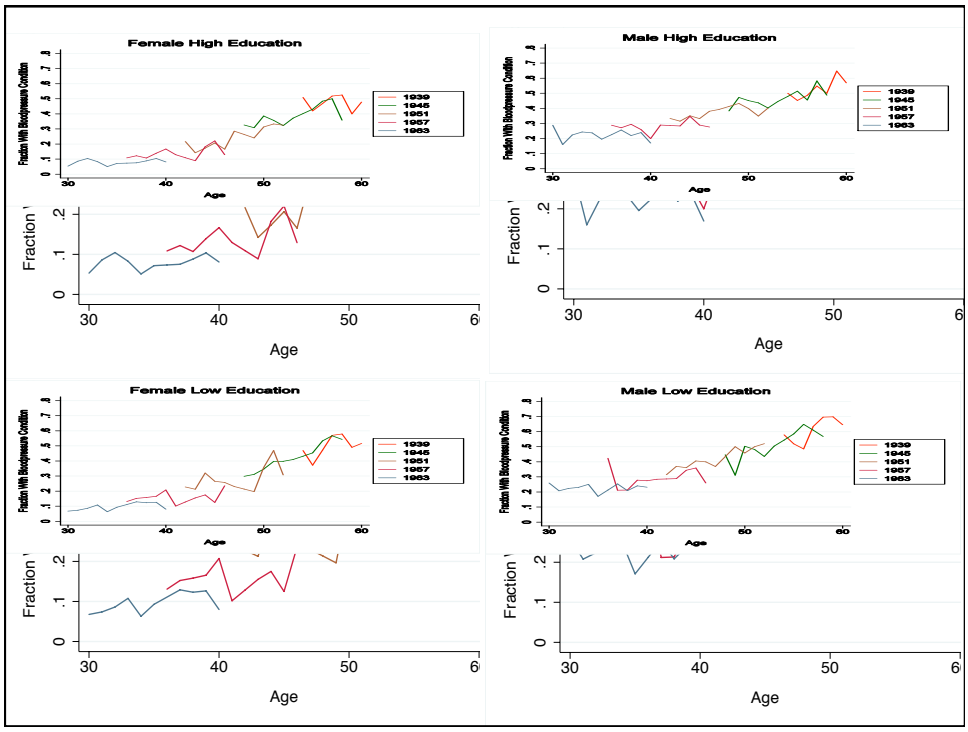
EconG041, Jerome Adda

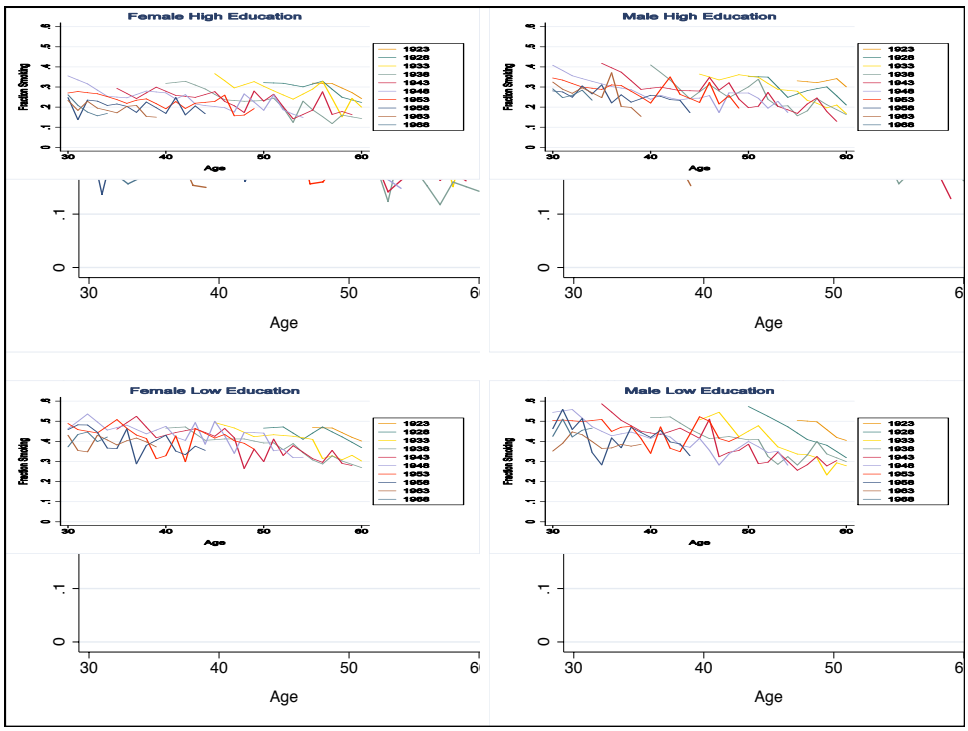


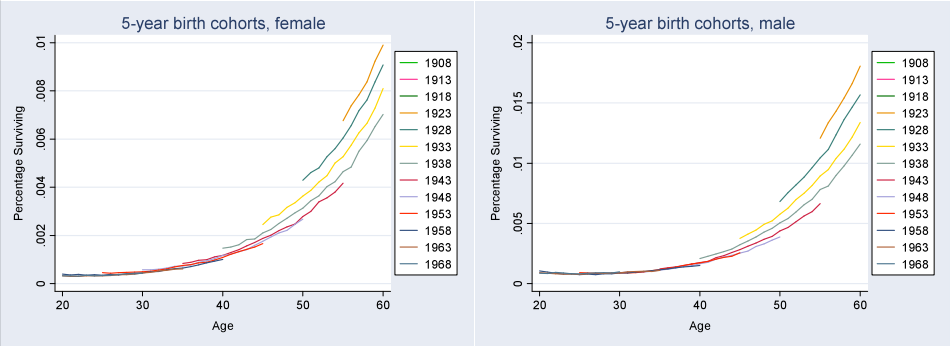




Female High Education
Male High Education
Female Low Education
Male Low Education
Log Household Total Consumption
Log Ho
4.5
30
40
50
Age


Female High Education
Male High Education
Female Low Education
Male Low Education
Fraction Reporting Good Health (GH5)
Fraction I
.3
.4
30
40
50
Age


Female High Education
Male High Education
Female Low Education
Male Low Education
Fraction
Age
30
40
50
0
.1
.2


Female High Education
Male High Education
Female Low Education
Male Low Education
Age
30
40
50
0
.1






# Results: Variance of Permanent Income

| Time Period | Low Education | | High Education | | NT |
|---|---|---|---|---|---|
| | Men | Women | Men | Women | |
| 1978-2003 | 2.257** | 2.027** | 1.675** | 0.872 | 832 |
| | [0.60,4.09] | [0.43, 3.72] | [0.75, 2.57] | [-0.32,1.84] | |

Corresponds to annual shocks with std dev 3 to 5% of income.

# Results:Permanent Income Shocks and Mortality

| Variable | Age Trend | Moving Average Parameter ($q$) | | | NT |
|---|---|---|---|---|---|
| | | 0 | 1 | 2 | |
| Mortality | Quadratic | -0.786** | -1.108** | -1.013** | 320 / 272 / 224 |
| | | [-2.12, -0.076] | [-3.20,-0.14] | [-2.2,-0.09] | |
| Mortality | Cubic | 0.721** | 0.729 | 0.527 | 320 / 272 / 224 |
| | | [] | [] | [] | |
| Mortality | Quartic | 1.00** | 1.151 | 0.650 | 320 / 272 / 224 |
| | | [] | [] | [] | |



# Results:Permanent Income Shocks and Health Outcomes

| Variable | Time Period | Moving Average Parameter ($q$) 0 | 1 | 2 | NT $q = 0/1/2$ |
|---|---|---|---|---|---|
| Good Health | 1978-2003 | -0.0647 (-0.2189 , 0.1111) | -0.1683 (-0.5471 , 0.1532) | 0.0235 (-0.2835 , 0.3372) | 832 / 720 / 608 |
| Poor Health | 1978-2003 | 0.1074 (-0.0165 , 0.2564) | 0.1012 (-0.0684 , 0.3454) | -0.0781 (-0.3070 , 0.2196) | 832 / 720 / 608 |
| Longstanding Illness | 1979-2003 | 0.0228 (-0.1252 , 0.2361) | 0.0595 (-0.2589 , 0.2888) | 0.0592 (-0.2525 , 0.3728) | 832 / 720 / 608 |
| Limiting Illness | 1979-2003 | 0.0264 (-0.1083 , 0.1739) | 0.0750 (-0.2272 , 0.2959) | -0.0999 (-0.3416 , 0.1470) | 800 / 688 / 576 |
| Bloodpressure Condition | 1991-2003 | -0.1342 (-0.9238 , 0.2461) | 0.4226 (-0.3116 , 1.4468) | 0.1660 (-0.3655 , 0.8034) | 352 / 272 / 192 |
| High Bloodpressure | 1991-2003 | -0.2106 (-1.0594 , 0.4111) | 0.4100 (-0.1700 , 1.2800) | 0.0361 (-0.4885 , 0.7392) | 352 / 272 / 192 |
| Cardiovascular Condition | 1991-2003 | 0.0006 (-0.1917 , 0.3149) | -0.1112 (-0.3034 , 0.1809) | 0.1978 (-0.1156 , 0.8175) | 352 / 272 / 192 |
| Respiratory Condition | 1991-2003 | -0.2440 (-0.6579 , 0.0592) | -0.1751 (-0.5663 , 0.2026) | -0.2114 (-0.5878 , 0.0541) | 352 / 272 / 192 |
| Mental Health | 1991-2003 | 0.037** (0.0056 , 0.6592) | 0.2244 (-0.0052 , 0.8781) | 0.0081 (-0.0290 , 0.7814) | 352 / 272 / 192 |

## Results:Permanent Income Shocks and Health Outcomes

- A 1% increase in permanent income decrease the fraction of individual reporting good health by 0.065 percentage points.
- Equivalently: a one standard deviation change in income reduces the fraction of individual reporting good health from 60% to 59.7%.



## Results: Permanent Income Shocks and Behavior

| Variable | Time Period | Moving Average Parameter ($q$) 0 | 1 | 2 | NT $q = 0/1/2$ |
|---|---|---|---|---|---|
| Total Expenditure | 1978-2003 | 0.4365** (0.2289 , 0.6381) | 0.4524** (0.1547 , 0.7756) | 0.6491** (0.1230 , 1.0909) | 832 / 720 / 608 |
| Food Expenditure | 1978-2003 | 0.2135 (-0.0158 , 0.4572) | 0.2494 (-0.0308 , 0.6378) | 0.2435 (-0.1693 , 0.6902) | 832 / 720 / 608 |
| Fruits and Veg. Expenditure | 1978-2003 | 0.2604 (-0.0590 , 0.8441) | 0.4596 (-0.0612 , 1.2263) | -0.0085 (-0.9402 , 1.0431) | 832 / 720 / 608 |
| Fraction of Smokers | 1978-2003 | 0.0656 (-0.1485 , 0.3393) | 0.3673** (0.0521 , 0.7280) | 0.3778** (0.0132 , 0.9539) | 832 / 720 / 608 |
| Cigarettes via Self-Rep. Qty. | 1978-2003 | 0.0824** (0.0475 , 0.9420) | 0.0966** (0.0589 , 0.2549) | 0.1025** (0.0534 , 0.3999) | 832 / 720 / 608 |
| Cigarettes via Expenditure | 1978-2003 | 0.0631** (0.0354 , 0.1846) | 0.4539 (-0.0183 , 0.9135) | 0.0592** (0.0355 , 0.5185) | 832 / 720 / 608 |
| Alcohol Self-Rep. Qty. | 1978-2003 | 0.0059** (0.0024 , 0.0125) | 0.0044 (-0.0058 , 0.0374) | 0.0041 (-0.0078 , 0.2533) | 832 / 720 / 608 |
| Alcohol Expenditure | 1978-2003 | 0.5325 (-0.3041 , 1.5006) | 0.4306 (-1.0875 , 34.1617) | -0.0502 (-2.0854 , 36.3326) | 832 / 720 / 608 |

## Relation to Previous Literature

- Deaton and Paxson (2004):

$$H_{ct} = m_a + \beta_1 t + \beta_2 Y_{ct} + \beta_3 X_{ct} + u_{ct}$$

- No cohort fixed effect. No decomposition of permanent/transitory shocks.
- When we run a similar regression, we find an effect which is 10 times smaller.
- Ruhm (2000,2003,2006). Broadly consistent with our findings. But use of aggregate data precludes any non-linearity.



## Conclusion

- Methodology:
  - Permanent/transitory decomposition of income and health.
  - Identification at cohort level.
  - Use of synthetic cohorts allows us to get insight on health and income over the life-cycle.
- Results:
  - We fail to find any effect of income on health.
  - Some evidence of effects on health behavior.