Health Shocks and the Evolution of Earnings over the Life-Cycle

Elena Capatina, Michael Keane, Shiko Maruyama

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Aims

Goal is to evaluate the contribution of health shocks – and the risk of health shocks – to life-cycle earnings inequality:

1. Use Medical Expenditure Panel Survey (MEPS) to estimate the laws of motion for health shocks and health, and the cost of health shocks.
2. Build health and health shocks into the life-cycle labor supply model with human capital.
3. Combine (1) the laws of motion and (2) the structural model to simulate how health shocks – and the risk of health shocks – affect earnings and earnings inequality.

Direct vs Behavioral Effects of Health Shocks

Health shocks affect earnings in three ways:

- Direct effects:
  (1) A health shock reduces earnings by reducing work hours (sick days).
  (2) It may also reduce health which reduces productivity (wage rate).
- Indirect Human Capital effect:
  By reducing work hours a health shock slows rate of human capital investment, which reduces future wages.
- Behavioral effect of Health Risk:
  Low skill workers have an incentive to curtail labor supply and human capital investment to maintain eligibility for means-tested social insurance that covers costs of health shocks

Direct vs Behavioral Effects of Health Shocks

Assess the impact of these three channels on earnings via three different experiments with the model:

- Direct effects:
  Simulate the impact of a health shock on earnings holding human capital fixed on its baseline path.
- Indirect Human Capital effect:
  Simulate the impact of a health shock allowing human capital to adjust.
- Behavioral effect of Health Risk:
  Simulate how workers behave in a different environment where there is no risk of health shocks. They re-optimze to the new situation – so decision rules for labor supply and consumption adapt.

Some Key Results

Impact of health shocks is greatly amplified by Human Capital accumulation:

1. Example: For a 40 year-old male college graduate, our model implies a major persistent health shock reduces the PV value of remaining lifetime earnings by $45k or 4.5%.

2. We estimate 40% of this impact is due to the knock-on effect of reduced human capital accumulation after the shock.

Some Key Results

The Behavioral impact of Health Risk is Large:

1. Low-skill workers in the US – who often lack employer sponsored insurance – curtail labor supply substantially to maintain eligibility for means-tested transfers that protect them from risk of high health care costs.
2. Provision of public health insurance would substantially increase their labor supply and human capital accumulation.
3. Reduced transfer spending and increased tax revenue would cover most of the cost of the program (in the very long run – all cohorts born into the new environment)

Some Key Results

Health shocks account for 15% of lifetime earnings inequality for U.S. males, with 2/3 of this due to behavioral responses.

Negative effects of means-tested transfers (and lack of employer provided insurance) on human capital accumulation of low-skilled workers is substantial.

This behavioral response to health risk reduces their earnings, thus increasing income inequality.

Related Literature:

- Life-cycle models with health risk:
  - Attanasio, Kitao, Violante (2010), Khwaja (2010), De Nardi et al. (2010, 2017), French and Jones (2011), Cole, Kim, Krueger ('18), Hosseini, Kopecky, Zhao ('18).
- Life-cycle models of human capital accumulation
  - Keane and Wolpin (1997, 2001), Imai and Keane (2004), Hokayem and Ziliak (2014).
- Effects of health shocks on labor market outcomes
  - Smith (1999, 2004), Pelkowski and Berger (2004), Blundell et al. (2016), Heckman, Humphries, Veramendi (2018), Conti et al. (2010), Hai and Heckman (2019)
- Effects of Means-tested social insurance:
  - Hubbard, Skinner, Zeldes (1995), French and Jones (2011), Moffitt and Wolfe (1992), Pashchenko and Porapakkarm (2017)

Model Overview

- Life-cycle labor supply model with both human capital and health capital
- Individuals enter the model at age 25, face survival risk each period, and live to a max of 100 years
- Both HC and health affect wage offers
- Learning by doing human capital accumulation
- Job offers may or may not come with employer provided health insurance
- Two decisions: discrete labor supply (FT/PT/NE) and continuous consumption/saving
- Retirement is mandatory at age 65

Model

Heterogeneity:

- Education is exogenous, three observed types:

  <=High School, Some College and College

  - Both offer wage function and health process parameters are allowed to differ by education

- Latent productivity types
  - Discrete types as in KW('97)

Model Overview

Health Shocks

- Health shocks play three roles:
  1. generate medical treatment costs,
  2. reduce work hours,
  3. reduce health/life expectancy
- The model contains different types of health shocks that differ by persistence and predictability

Health

- Health has two dimensions:
  - Functional Health (H) affects current productivity
  - Latent Risk (R) affects risk of health shocks (e.g., hypertension)

Model

A Detailed Process for Health over the Life-cycle:

- In the MEPS data respondents' medical conditions are coded according to the International Classification of Diseases (ICD)
- 989 3-digit ICD-9 codes
- We classify health shocks by impact on productivity, predictability and persistence.
- Each condition is categorized based on:
    1. Does it affect productivity (daily functioning ability)?
    2. Is it is a risk factor for other health problems?
    3. Is it predictable (based on state variables)?
    4. Does it affect future health (persistence)?

Model: Health Process

Process for Health over the Life-cycle:

Multiple dimensions of health and health shocks:

1. Two stocks:
   1.1 Functional health H_t, affects productivity + distribution of future shocks
   1.2 Underlying health risk R_t, affects *only* distribution of future shocks (e.g., hypertension, cholesterol)
2. Three types of health shocks:
   2.1 Predictable persistent shocks d_t^p that affect H_{t+1} (e.g., a stroke predicted by hypertension)
   2.2 Unpredictable persistent shocks d_t^u that affect H_{t+1} (e.g., some hard to predict cancers)
   2.3 Unpredictable transitory shocks s_t – do not affect H_{t+1} (e.g., a broken bone)

Model: Health Process

Process for Health over the Life-cycle:

Variable	Discrete Set	Transition Probability Matrix / Probability
H_t	{G, A, P}	$\Lambda_H(H', H, t, d^p, d^u, O, educ, inc)$
R_t	{H, M, L}	$\Lambda_R(R', R, t, d^p, d^u, H, O, educ, inc)$
d_t^p	{0, 1}	$\Gamma^{dp}(R, H, t, educ)$
d_t^u	{0, 1}	$\Gamma^{du}(t)$
s_t	{0, 1}	$\Gamma^s(t)$

Model

State Variables:

- H = "Functional" Health
- R = Risk Factor
- I^{DI} = disability status
- HC = Human Capital
- A = Assets
- Time invariant: Education, Productivity type

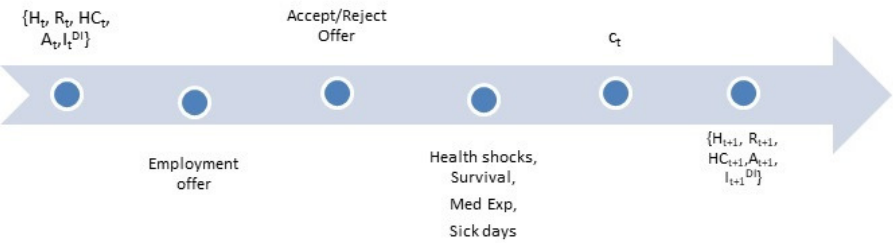
Decision Variables:

- Discrete labor supply (FT/PT/NE)
- Continuous consumption/saving

Note: Medical Costs are determined by health shocks
(medical spending is not a choice)

Model: Timing

When information is revealed and decisions are made:



- Employment offer: $\{W^*, h^*, ins^*\}$
  - Tied offer includes hours (FT/PT) and insurance status
- Survival: $\varphi(H_t, t, d_t^p, d_t^u)$
- Medical expenditures: $ME(H_t, d_t^p, d_t^u, s_t, t, \varepsilon^{ME})$
- Sick days: $sd(educ, H_t, d_t^p, d_t^u, s_t)$

Model: Wages

Offer Wage Function:

- Wage offers are given by W^*:

$$\ln W^* = w(educ, HC, H, h^*) + \kappa + \varepsilon^W$$

where:

$$\text{w(educ,HC,H,h}^*) = \beta_0 + \beta_1 HC + \beta_2 HC^2 + \beta_3 HC^3$$
$$+\beta_4 I_{H\in\{F,G\}} + \beta_5 I_{H=G} + \beta_6 I_{h^*=hrs^{PT}}$$

- κ is a latent productivity type (discrete)
- ε^W is a transitory productivity shock
- Parameters $\beta_0 - \beta_6$ are all education-level specific
- Note that health (H) directly affects wages

Model: Sick Days

- Health shocks do not affect wages in the same period
  - This seems consistent with data – see Table 1
- But they reduce earnings by generating sick days that reduce work hours (as in Grossman, 1972):

$$h(educ, h^*, H_t, d_t^p, d_t^u, s_t) = h^* - sd(educ, H_t, d_t^p, d_t^u, s_t)$$

- A worker can have high human capital and wages, but low earning capacity due to health shocks.

Model: Human Capital Accumulation

Our human capital process allows for learning by doing and persistent productivity shocks:

$$HC_{t+1} = (HC_t + h_t)\varepsilon_{t+1}^{HC}$$

$$\varepsilon_{t+1}^{HC} = \begin{cases} 1+\nu & \text{with probability } p^1 \\ 1 & \text{with probability } 1 - p^1 - p^2 \\ 1-\nu & \text{with probability } p^2 \end{cases}$$

- Probabilities $p^1(educ, I_w)$ and $p^2(educ, I_w)$ depend on education and employment status ($I_w = 1$ if employed).
- $p^1 = p^2$ if employed
- $p^1 = 0$ if not employed
- Wage growth more likely for better educated + employed

Model: Medical Expenditures and Insurance

Recall: Medical Costs are determined by health shocks (not a choice)

- Medical Expenditure Distribution:
  - $ME(H_t, d_t^p, d_t^u, s_t, t, \varepsilon^{ME})$
  - ε^{ME} determines whether medical costs are "normal" or "catastrophic" (top 5%)
- Health Insurance – covers a fraction of medical expenses:
  - Employer Provided - covers 70% of expenses
  - Medicaid - Covers expenses that would push a person below a consumption floor
  - Medicare - pays 50% of expenses for retirees (65+)

Model: Government Programs

Means-tested transfers captured by consumption floor

- Like Hubbard et al 1995 and many subsequent papers
- Consumption floor $= \bar{c}(educ, I^{DI})$
- Captures array of programs: Medicaid, Foodstamps, etc.
- Disability insurance modelled as higher consumption floor
    - People under 65 in Poor health are eligible for DI ($I^{DI} = 1$) with probability $\eta(educ)$

Other programs:

- Social Security and Medicare for retirees (65+)
- Agents pay income, payroll and consumption taxes

Model: Preferences

- Agents get utility from consumption and leisure each period:

$$u(c, l) = \frac{[c^{\alpha} l^{(1-\alpha)}]^{(1-\sigma)}}{1-\sigma} + \zeta I_{death}$$

- Leisure is determined by contract hours h^*
  - Leisure is not increased by sick days.
- Leisure equals the time endowment (normalized to one) minus dis-utility of work expressed in units of leisure time:

$$l = 1 - I_w \phi(educ, H, h^*)$$

- Disutility of death is calibrated to insure person at the consumption floor working full-time still prefers to live

Calibration Strategy

Model calibrated to the U.S. male population.

Data on health shocks and health spending from the Medical Expenditure Panel Survey (MEPS), 2000-2012.

Wages, employment, assets from CPS, PSID, MEPS, CEX.

1. Parameters of exogenous processes are estimated directly from the data:
   - Laws of motion for health (H and R)
   - Distributions of health shocks, medical expenditures, and sick days
2. Wage process and preference parameters are calibrated so the model matches key moments on wages, assets, labor supply and employment transition rates

Calibration Strategy

Big Picture:

We use MEPS to estimate how *health shocks* affect health, sick days and medical costs.

We use a structural model fit to CPS, PSID, MEPS, CEX to assess how all of the above affect life-cycle earnings.

Combining the two, we can forecast how health shocks affect present value of lifetime earnings, accounting for:

1. Direct effects of health shocks on health and sick days,
2. Effects of health shocks on human capital accumulation, labor supply and saving.
3. Behavioral effects of health risk on decision rules.

Results: Effects of Major Health Shocks

- Simulate the impact of a "major" unpredictable persistent health shock (d^u) that causes health H to deteriorate next period.
  - Note: Such shocks have a 6.3% annual frequency for men aged 50-60.
- Example: If such a shock occurs at age 50 we predict a cumulative (non-discounted) earnings loss of $40k over the next ten years.
- Comparison: Smith (2004) estimates a cumulative income loss of $37k over ten years (1994-2003) following major health shocks for men in the HRS.
- So the way our model maps health shocks into earnings losses looks plausible.

Results: Effects of Major Health Shocks

- We decompose effects of health shocks on earnings into direct and human capital effects:
- Effects of health shocks on PV of Earnings:
  - Direct effects:

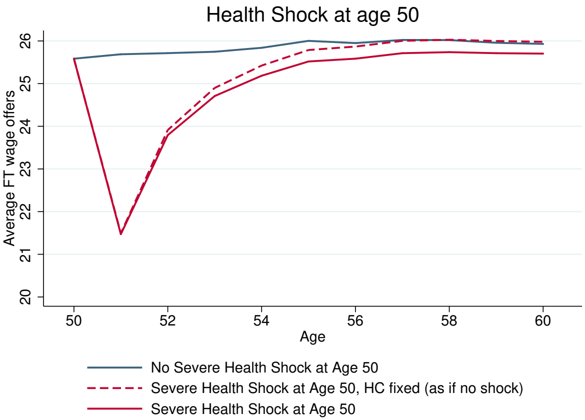
    $\uparrow$ sick days, $\downarrow$ health

    The drop in health directly reduces wages, tastes for work and labor supply, thus reducing earnings.
  - Indirect Human Capital effects:

    The drop in hours slows rate of human capital accumulation, which amplifies the drop in the wage rate in long-run

Effects of Major Health Shocks on Wage Offers

Figure 7: Simulate major health shock d^u at age 50



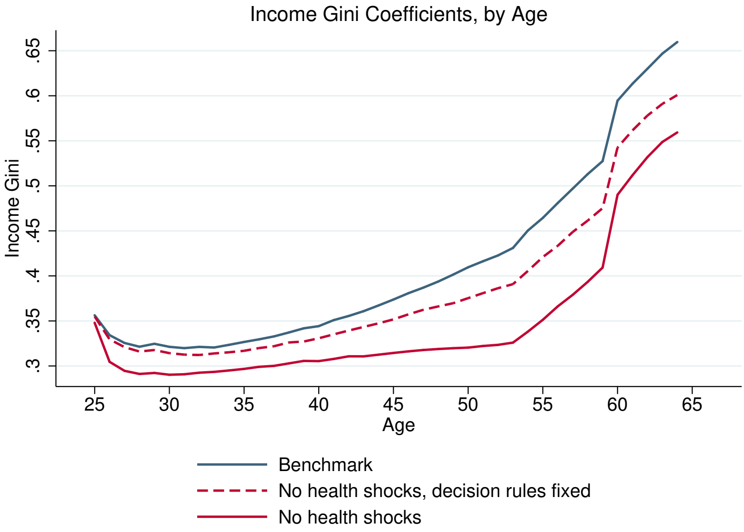
Human capital effect generates long-run drop in offer wages. This increases the PV of earnings loss by about 20%.

Results: Health Shocks and Earnings Inequality

- Eliminate health shocks at working ages (25-64)
- Experiment 1: Hold decision rules for labor supply and consumption fixed
- Experiment 2: Allow decision rules for labor supply and consumption to adapt to the new environment

Results: Effects of Health Shocks on Inequality

Figure 10: Gini Coefficient for Income by Age



Results: Health Shocks and Earnings Inequality

- Eliminate health shocks at working ages (25-64) but holding decision rules fixed:
- The Gini earnings inequality measure decreases 4.9% from 0.304 to 0.289
- But the Gini decreases by 15.1% from 0.304 to 0.258 if we let decision rules adapt to the new environment.
- Thus, health shocks generate about 15% of inequality in present value of lifetime earnings for men.
- Direct effects of health shocks on health/productivity account for only about 1/3 of their impact on inequality, while behavioral responses account for 2/3.
- Much of the paper is devoted to understanding the behavioral effects of health risk on behavior.

Results: Health Shocks and Earnings Inequality

Table 13: Effects of Health Shocks on PV of Lifetime Earnings

	Benchmark		No Health Shocks			
			Decision Rules Fixed		Decision Rules Change	
	Mean	CV	Mean	CV	Mean	CV
≤High School						
Low Prod.	293,730	0.300	+12.85%	0.273	+37.49%	0.169
Med Prod.	539,185	0.150	+7.14%	0.130	+7.43%	0.125
High Prod.	734,667	0.134	+5.47%	0.122	+5.36%	0.124
Some College						
Low Prod.	425,701	0.256	+9.18%	0.233	+23.80%	0.140
High Prod.	997,662	0.127	+4.24%	0.114	+4.04%	0.114
College						
Low Prod.	661,093	0.312	+7.09%	0.279	+17.43%	0.166
High Prod.	1,521,622	0.158	+3.26%	0.152	+3.10%	0.150

Low skill types earn much more if health shocks are eliminated.

Results: Health Risk, Labor Supply and Transfers

Why does earnings of low skill types increase so much?

- Eliminating health shocks increases employment rate of low-skill high school types from 57.1% to 84.3% ...
- and reduces the fraction who receive means-tested social transfers from 42% to 9%.

- Eliminating ONLY the Financial Costs of health shocks has almost as big an effect:
  - Work increases from 57.1% to 71.7%
  - Transfer receipt drops from 42% to 22%
- Thus, when we simulate providing health insurance for the 35% without lack employer provided insurance, we get a big increase in labor supply and drop in transfer payments.
- This pays for most of program cost (in very long run).

Health Insurance Experiment

- In the baseline environment 35% of working age men lack employer provided health insurance (ESHI).
- 12.9% rely on means-tested social insurance (including disability benefits) to pay health care costs.
- We use our model to simulate the impact of providing government funded health insurance to uninsured workers.
- In our experiment we leave ESHI as in the benchmark, but require all uninsured individuals to participate in a government funded health insurance program.
- They pay a premium of $652 per year, and face a co-insurance rate of 30%, which are comparable to the typical employer (ESHI) plan.

Health Insurance Experiment

- Introduction of public health insurance reduces fraction of working-age men who rely on means-tested transfers from 12.9% to 8.8%.
- Employment rate increases from 83.1% to 85.3%.
  - The increase is concentrated among low-skill types who no longer have an incentive to curtail earnings to maintain eligibility for transfers.
- Per-capita gov't spending on means-tested transfers drops from \$2098 to \$1336, saving \$762 per capita.
- The cost of the program is \$4032 per participant or \$689 per capita. So it is self-financing!
  - Limitations: We don't account for possible increase in demand for health services by the previously uninsured.
  - This is steady state - human capital is higher.

Conclusion

- Health Shocks account for 15% of lifetime earnings inequality
- About 1/3 of this is due to direct effects and 2/3 is due to behavioral effects.
- Lack of health insurance creates a perverse incentive for low-skill workers to work less and accumulate less human capital to maintain eligibility for means tested transfers.
- Provision of public insurance for the uninsured eliminates this perverse incentive.
- It leads to substantial government savings on transfer programs...
- ... and increases labor supply of low skill workers, who accumulate more human capital and hence obtain higher wages.

Extra Material

Results: Health Shocks and Earnings Inequality

We distinguish three ways that health shocks contribute to earnings inequality:

1. Direct effects of health shocks on health and sick days, with labor supply and savings ***decisions*** held fixed.
2. Additional direct effects that arise because health shocks alter labor supply and saving decisions, and reduce human capital accumulation, but with ***decision rules*** held fixed.
3. Behavioral effects that arise because health risk alters optimal ***decision rules*** for labor supply and saving.
   - E.g., health risk increases precautionary saving,
   - ... and generates incentives to maintain eligibility for means-tested transfers.
   - Health risk changes decision rules fundamentally.

Results: Health Shocks and Earnings Inequality

Strategy to use our model to decompose these three channels:

- Compare inequality in the benchmark calibrated model with results from 3 types of simulation experiment:
  1. Agents are “lucky” and do not experience health shocks. Labor supply and savings decisions held fixed.
  2. Same, but allow labor supply and savings to change – still using the optimal decision rules of the benchmark.
  3. Eliminate health shocks and let agents update their optimal decision rules to the new environment.

Health Risk: Employment and Social Insurance

Table 16: Effect of Health Risk on Work / Social Transfers

	Employment			% on Social Insurance		
	Bench.	**No HS**	**No Cost**	**Bench.**	**No HS**	**No Cost**
All	83.1	91.2	87.6	12.9	2.0	5.6
≤High School	80.2	89.6	85.6	15.9	2.9	7.6
Some College	82.7	92.5	87.7	14.1	1.9	6.6
College	86.9	92.2	89.9	8.2	0.9	2.4
≤High School						
Low Productivity	**57.1**	**84.3**	71.7	**41.6**	**8.6**	22.1
Med Productivity	89.0	91.8	91.1	7.3	0.4	1.6
High Productivity	92.7	92.2	92.7	0.7	0.1	0.2
College						
Low Productivity	80.1	92.0	88.5	16.4	1.8	4.9
High Productivity	93.7	92.5	91.2	0.0	0.0	0.0

Low skill types work more and rely less on means-tested transfers if health shocks are eliminated.

Results: Health Shocks and Earnings Inequality

Table 15: Eliminate Medical Costs of Health Shocks

	Benchmark		No Cost of Health Shocks			
			Decisions Rules Fixed		Decision Rules Change	
	Mean	CV	Mean	CV	Mean	CV
≤High School						
Low Prod	293,730	0.300	+1.08%	0.302	**+16.32%**	0.232
Med Prod	539,185	0.150	+0.63%	0.148	+1.04%	0.141
High Prod	734,667	0.134	-0.12%	0.132	-0.01%	0.134
<College						
Low Prod	425,701	0.256	+0.20%	0.260	+8.87%	0.198
High Prod	997,662	0.127	+0.14%	0.125	+0.11%	0.123
College						
Low Prod	661,093	0.312	+0.90%	0.303	+9.21%	0.206
High Prod	1,521,622	0.158	-0.13%	0.158	-1.24%	0.162

Low-skill earn much more if **cost** of health shocks eliminated.

Results: Health Shocks and Earnings Inequality

Explaining the large behavioral effect of health risk on earnings inequality:

- In the baseline model, low-skill types have a strong incentive to hold down their labor supply and human capital accumulation so as to maintain eligibility for social insurance that cushions against high medical costs.
- This is a perverse incentive (or "moral hazard") created by **lack** of health insurance.
- If we eliminate health shocks - or even just eliminate their financial cost - then low skill types work more and rely less on social insurance.