

Discussion of Hai & Heckman's "A Dynamic Model of Health, Education and Wealth with Credit Constraints and Rational Addiction"

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Outline

- **A. Description of the paper**
 1. Motivation
 2. Data & Descriptive Evidence
 3. Model
 4. Identification & Estimation
 5. Empirical Findings

- **B. My comments and suggestions**

Motivation

- Study determinants of individual inequality in **health, education, and wealth** by estimating a **microeconomic dynamic structural model** for the evolution of these variables.
- Motivated by well-known stylized facts.
 - (1) *Inequality in wealth, health, and education*
 - (2) *Positive correlation between wealth, health, & education*
 - (3) *Correlation between an individual's wealth-health-education as an adult and health & skills as a kid*

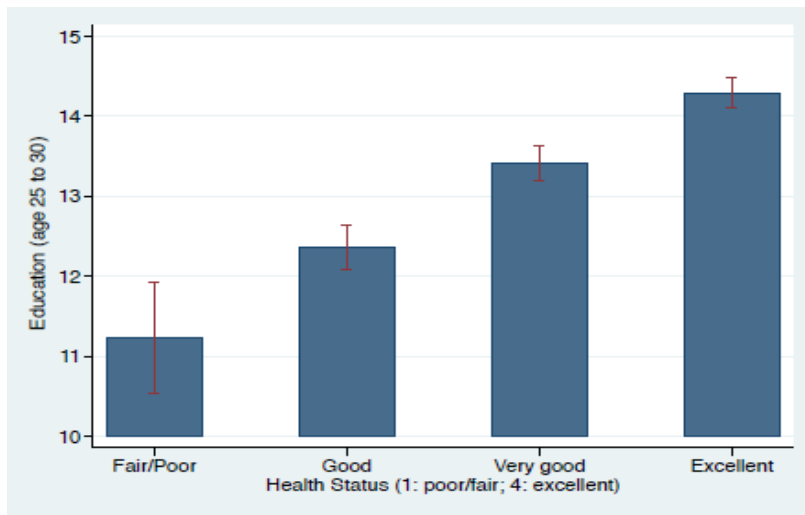
Empirical Questions

- **Main goal:** understand the contribution of different socioeconomic factors & mechanisms to explain this individual heterogeneity and these correlations.
- More specifically:
 - (1) *Causal effect from schooling to health*
 - (2) *Causal effect from health to schooling*
 - (3) *Causal effect from wealth to health & schooling (Credit constraints)*
 - (4) *Contribution of Addiction to unhealthy behavior*
 - (5) *Effects of initial endowment of skills ("Selection effect")*

Data

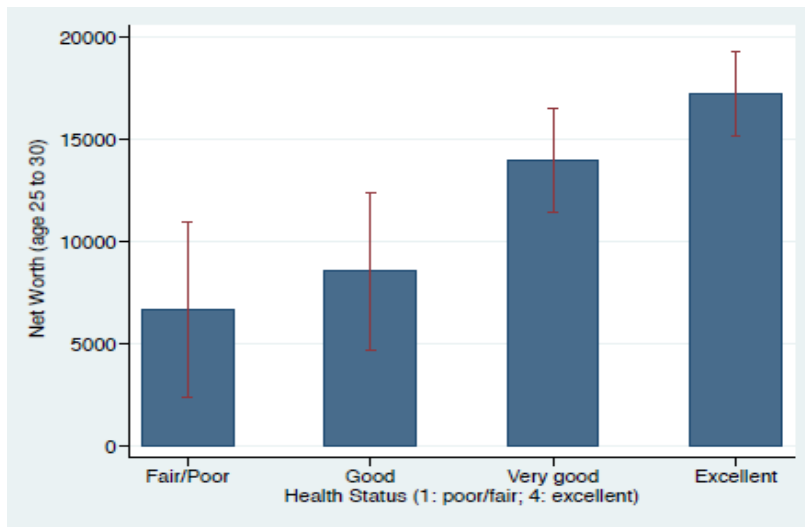
- Dataset: NLSY97 (cohort of individuals born in 1980)
- Sample period: 1997-2010. Individuals followed from age 17 until 30.
- Subsample of white males: 2,103 individuals; 27,213 individual-year observations.
- Main variables:
 - Health status (1 to 4); - BMI; - Asthma
 - Unhealthy behavior (smoking, alcohol, drugs)
 - Wealth - Wages - Education
 - Cognitive skills (ASVAB) - Non-cognitive skills;
 - Parental background (wealth, education)

Descriptive Evidence



(a) Education & Initial Health

Descriptive Evidence



(b) Net Worth & Initial Health

Model: Decision variables

- Life-cycle dynamic structural model of education, health, and savings.
- Every year, an individual decides:
 - *Consumption (Savings);*
 - *Schooling decision, dummy;*
 - *Working (no / part-time / full-time);*
 - *Unhealthy behavior (smoking, heavy drinking, drugs)*

Model: Endogenous State Variables

- The vector of endogenous state variables consists of:
 - *Health*
 - *Stock of unhealthy behavior (number of years)*
 - *Schooling years*
 - *Labor market experience*
 - *Previous year at school, dummy*
 - *Wealth*

Model: Exogenous State Variables / Attributes

- The vector of exogenous variables consists of:
 - *Cognitive skills (time invariant)*
 - *Non-cognitive skills (time invariant)*
 - *Parental background variables (Wealth, education)*
 - *iid unobservable shocks*

Model: Structural functions

- The main structural functions of the model are:
 - (a) *utility function*
 - (b) *wage function*
 - (c) *transition rule for health (health production function)*
 - (d) *credit constraints function*
 - (e) *parental transfers function*
 - (f) *time discount factor function*

Model: Utility function

$$\begin{aligned}
 U_t = & \frac{1}{1-\gamma} \left(\frac{c_t}{es_{t,e}} \right)^{1-\gamma} + \phi_h h_t + \phi_q(\theta, h_t, q_t, \epsilon_{q,t}) d_{q,t} \\
 & + \phi_e(\theta, h_t, e_t, d_{t-1}^e, \epsilon_{e,t}) d_{e,t} + \sum_{j=1,2} \phi_{k,j}(\theta, h_t) \mathbf{1}(d_{k,t} = j/2) + \phi_{k,e} d_{e,t} d_{k,t}
 \end{aligned}$$

Model: Wage function & Health PF

- Wage function:

$$w_{j,t} = r_j(e_t)\omega_t(\theta_t, h_t, e_t, k_t, \epsilon_{w,t})$$

- Health PF:

$$h_{t+1} = H(\theta, h_t, t, e_t, q_t, d_{q,t}, c_t, d_{e,t}, d_{k,t}, \epsilon_t^h).$$

Model: Credit Constraints ...

- Borrowing limit:

$$s_{t+1} \geq \underline{s}(\theta, h_t, e_t, t).$$

- Parental transfers:

$$\text{tr}_{p,t} = \text{tr}_p(e_p, s_p, d_{e,t}, d_{k,t}).$$

- Time discount factor:

$$\rho(\theta, h_t) = \frac{\exp(\rho_0 + \rho_c \theta_c + \rho_n \theta_n + \rho_h h)}{1 + \exp(\rho_0 + \rho_c \theta_c + \rho_n \theta_n + \rho_h h)}.$$

Model: Health effects

- The model allows for a very rich pattern of channels through which health can affect individuals' decisions and state variables. Health enters in into:
 - direct effect on the level of utility;
 - marginal utility of consumption;
 - utility from unhealthy activities;
 - utility from going to school;
 - disutility of working;
 - time discount factor;
 - production function of health;
 - wage equation;
 - borrowing constraint.

Model: Factor Model

- The authors take into account that "Health", "Cognitive Skill", and "Non-Cognitive Skill" are measured with error.
- They consider a **factor model** where the dependent variables are the observable Health status, BMI, Asthma, Scores at ASVAB, Non-cognitive variables, and the explanatory variables are the unobserved factors "Health", "Cognitive Skill", and "Non-Cognitive Skill".
- The estimation of this factor model (together with Bayes rule) provides the distribution of an individual's "Health", "Cognitive Skill", and "Non-Cognitive Skill" conditional on his observable variables.

Identification

- **Conditional independent assumptions.** The unobserved shocks in the primitive functions are i.i.d. and independent of the predetermined observable state variables, and of the unobserved factors.
- **Exclusion Restrictions.** Some state variables do not enter in some of the structural functions.
- **Stock of unhealthy behavior** does not enter into Disutility of going to school, Disutility of working, Wage equation, Credit constraint, Discount factor.
- **Wealth** does not enter in the production function of health.

Estimation

- **Two step method:** (Step 1) Estimation of factor model; (Step 2) Estimation of Structural model using Full Solution - Simulated MM.
- **Full Solution - Simulated MM.**
 - For each individual we take a random draw from the posterior distribution of skills.
 - Given a vector of structural parameters, we solve using backwards induction the DP problem of each individual.
 - We use the solution to simulate life cycle paths of decisions and state variables for each individual.
 - We use the simulated paths to construct moments.
 - Estimator minimizes a weighted sum of the deviation between empirical moments and predicted moments from the model.

Fit of Age Profiles of Choice Probs

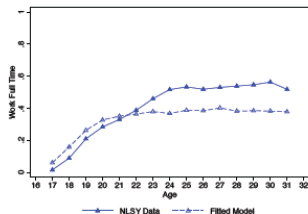
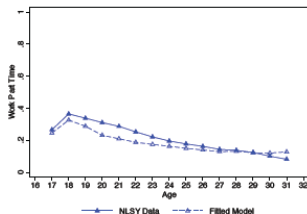
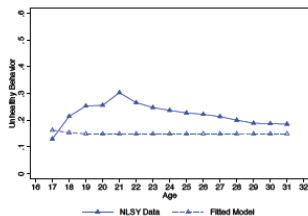
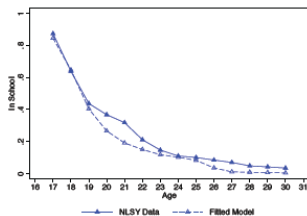
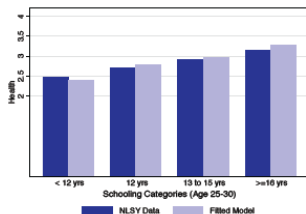
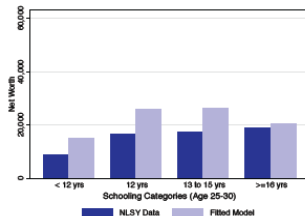


Figure 4: Model Fit on Choice Probability Over Age

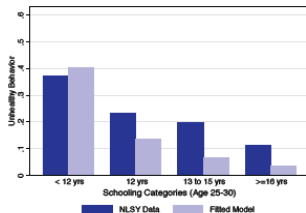
Fit of Correlations



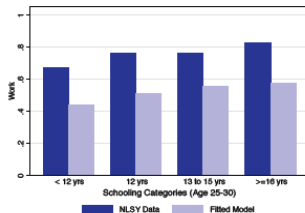
(a) Health



(b) Net Worth



(c) Unhealthy Behavior



(d) Work (Full-time or Part-time)

Figure 6: Conditional Model Fit By Education Groups (Age 25 to 30)

Counterfactuals: Removing Credit Constraints

- Schooling increases substantially (as in Lochner's work).
- Large negative effect on Wealth at age 30 (perhaps not surprising).
- Very small effect of health.
- Minor effect on the correlation between health and education. Credit constraints can explain very little, if any, of this correlation.
- No effect on unhealthy behavior.

Counterfactuals: Removing Addiction

- Negligible effect on practically any prediction of the model except that it reduces unhealthy behavior uniformly across every age.
- This could be because the model does not perform well in explaining unhealthy behavior.

Counterfactuals: Skill Endowments

- Strong selection on cognitive and non-cognitive skills for schooling. Very interestingly, selection seems stronger for non-cognitive skills than for cognitive skills.
- Some selection effect in health with respect to non-cognitive skills. The selection with respect to cognitive skills seems small.
- Strong selection on cognitive and non-cognitive skills for wealth.

My comments and suggestions

- **Comment #1:** I miss additional counterfactual experiments that evaluate more explicitly the role of the causal effects of schooling on education and of education of schooling play.
 - A counterfactual experiment that shuts-down the effect of education on the production function of health.
 - A counterfactual experiment that shuts-down the effect of health on the disutility of schooling.
- **Comment #2:** Some exclusion restrictions should be better motivated.

My comments and suggestions

- **Comment #3:** Measurement of “Non-cognitive skills” and assumption that all individuals have the same level of the stock of “unhealthy behavior” at each 17.
- Measures of NC Skills: (a) record of violent behavior; (b) smoked cigarette before age 17; (c) drank alcohol before age 17; and (d) tried marijuana before aged 17.
- I find more plausible to include these measures in the initial conditions of unhealthy behavior. This might matter:
- Estimated effect of NC skills on health PF and wage equation could be partly effect of the (omitted) initial conditions unhealthy behavior
- Selection on NC skills could be partly effect of unhealthy behavior
- Effect of non-cognitive skills on unhealthy choices could be capturing state dependence in this decision, i.e., addiction

My comments and suggestions

- **Comment #4:** No positive investments in health.
- Other than “unhealthy behavior” there is not any other endogenous decision affecting health status.
- “Doing exercise” ... that represent investment in health.
- Some improvements in health (or no reduction despite unhealthy behavior) could be endogenous decisions.

My comments and suggestions

- **Comment #5:** School performance, school PF and the effect of health (and stock of unhealthy behavior) in this function.
- In the current version of the model this effect is only captured by the effect of health on the disutility of schooling.
- **Comment #6:** Serially correlated unobservables.
- Given that the sample period has 14 years per individual, it seems restrictive to assume that all the persistence generated by the unobservables comes from the time invariant unobserved skills while the rest of the unobserved shocks in the structural functions are not serially correlated.