

Crowding Out Prevention: How Income Uncertainty Shapes Health Investment

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- ▶ Chronic, work-limiting health conditions have large and persistent effects on lifetime earnings.
- ▶ Investment in prevention of acute health shocks varies dramatically across individuals.
- ▶ Standard explanations: differences in information, preferences, or access.
- ▶ This paper: interaction between health risk and **income risk** shapes prevention decisions.

1. **Framework:** Continuous-time lifecycle model with three sources of risk: mortality, morbidity, and income uncertainty.
2. **Main finding:** Willingness-to-pay (WTP) varies dramatically across the state space. Highest for young, asset-poor individuals. Income uncertainty can either *crowd out* or *amplify* the value of prevention, depending on the agent's income uncertainty and accumulated wealth.

Continuous time, partial equilibrium. Agents live from age 0 to T .

Three sources of risk:

Mortality

- ▶ Hazard $\lambda_m(t)$
- ▶ Age-dependent

Morbidity

- ▶ Hazard $\lambda_s(t)$
- ▶ Transition to absorbing sick state

Income

- ▶ Stochastic productivity z_t
- ▶ Persistent shocks

Markets: Incomplete. Single risk-free asset a with return r . No borrowing.

Agents have preferences over consumption c and labor supply l :

$$u(c, l) = \frac{c^{1-\gamma}}{1-\gamma} - \frac{l^{1+1/\eta}}{1+1/\eta}$$

- ▶ $\gamma > 1$: coefficient of relative risk aversion
- ▶ $\eta > 0$: Frisch elasticity of labor supply
- ▶ $\rho > 0$: pure time preference rate

Agents choose consumption and labor to maximize expected discounted lifetime utility.

Effective labor productivity combines three components:

$$e(h, z_t, t) = \underbrace{p(t)}_{\text{Age profile}} \cdot \underbrace{z_t}_{\text{Stochastic}} \cdot \underbrace{\mathbb{I}_h}_{\text{Health}}$$

Stochastic component: Mean-reverting Ornstein-Uhlenbeck process

$$d \log(z_t) = -\theta \log(z_t) dt + \sigma dW_t$$

Health multiplier:

$$\mathbb{I}_h = \begin{cases} 1 & \text{if Healthy} \\ \psi \in (0, 1) & \text{if Sick} \end{cases}$$

Sickness permanently reduces labor productivity.

Model: Budget Constraint

State: (a, z, h, t) assets, productivity, health, age.

Flow budget constraint:

$$\dot{a}_t = (1 - \tau)(ra_t + e(h, z_t, t) \cdot l_t) - c_t$$

Borrowing constraint:

$$a_t \geq 0$$

Agents self-insure against mortality, morbidity, and income risk by accumulating assets.

The value function for a healthy agent satisfies:

$$\underbrace{(\rho + \lambda_m + \lambda_s)}_{\text{Effective discount}} V^H = \max_{c,l} \left\{ u(c, l) + V_t^H + V_a^H \dot{a}^H + \mathcal{A}V^H + \lambda_s V^S \right\}$$

where the generator for the productivity process is:

$$\mathcal{A}V = \left(-\theta z \log z + \frac{1}{2} \sigma^2 z \right) V_z + \frac{1}{2} \sigma^2 z^2 V_{zz}$$

The term $\lambda_s V^S$ captures the expected loss from transitioning to sickness.

The value function for a sick agent satisfies:

$$(\rho + \lambda_m)V^S = \max_{c,l} \left\{ u(c, l) + V_t^S + V_a^S \dot{a}^S + \mathcal{A}V^S \right\}$$

Key differences from healthy:

- ▶ No sickness hazard λ_s state is absorbing
- ▶ Lower effective productivity: $e^S = p(t) \cdot z_t \cdot \psi$
- ▶ Same stochastic income process continues

Terminal condition: $V(a, z, h, T) = u(a, 0)$ consume remaining assets.

Method: Finite difference approximation on discrete grid (a, z) .

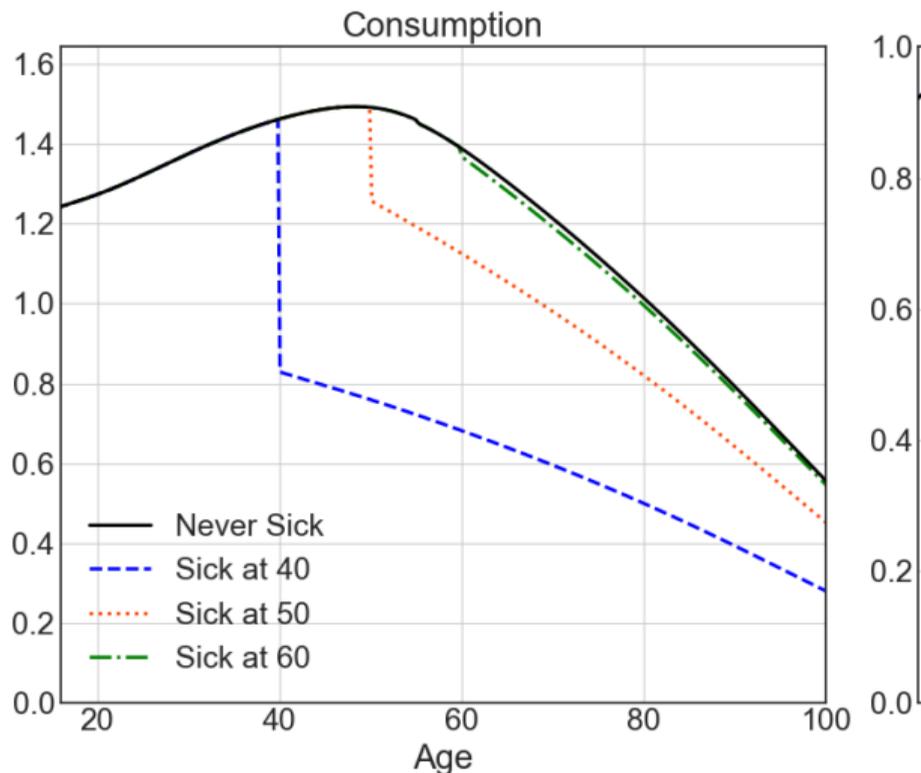
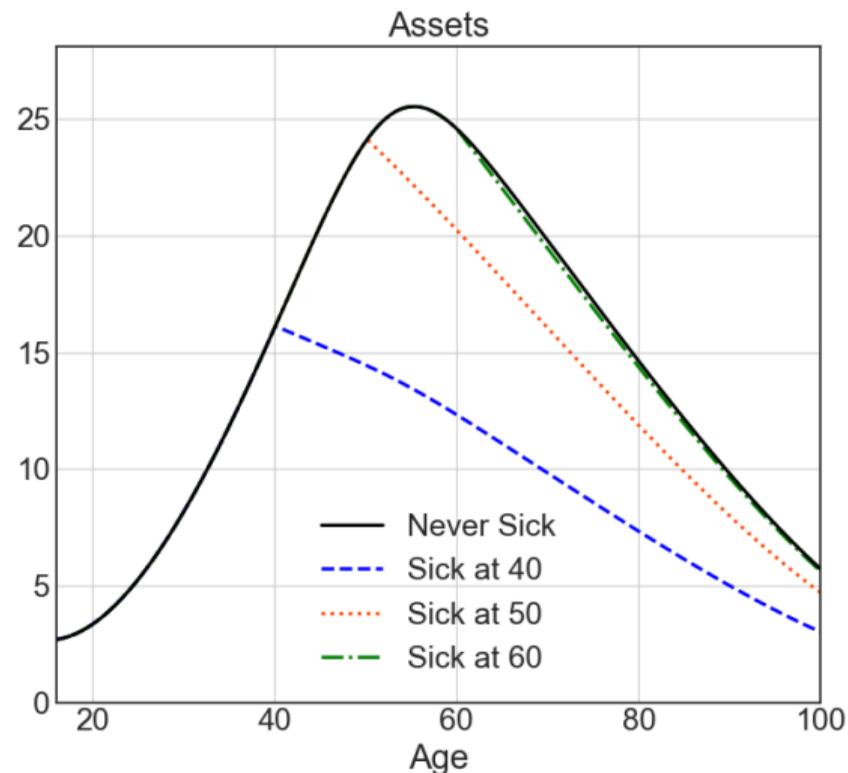
- ▶ Solve backwards from terminal age T
- ▶ Implicit time-discretization for stability
- ▶ Upwind scheme for asset derivative V_a to handle borrowing constraint
- ▶ Sparse matrix representation of finite difference operator

Stationary distribution: Solve Kolmogorov Forward Equation forward in time.

$$\frac{\partial g^H}{\partial t} + \frac{\partial(\dot{a}^H g^H)}{\partial a} + \mathcal{A}^* g^H = -(\lambda_m + \lambda_s)g^H$$

The KFE operator is the transpose of the HJB operator.

The Cost of Chronic Illness



Earlier shocks \Rightarrow larger lifetime costs. Assets and consumption diverge permanently.

Definition: WTP is the income-equivalent value of a marginal reduction in the sickness hazard $\lambda_s(t)$.

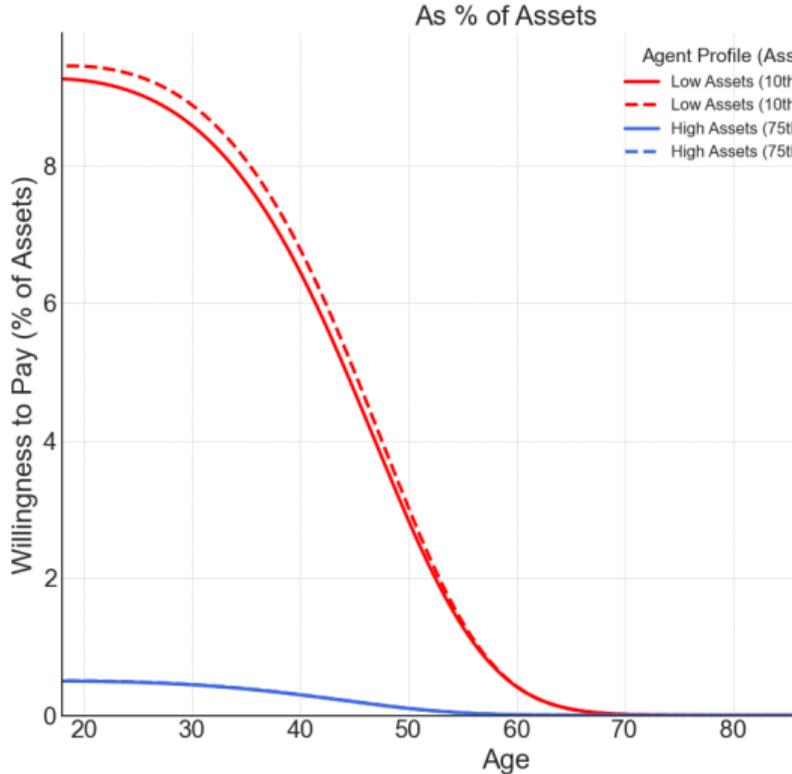
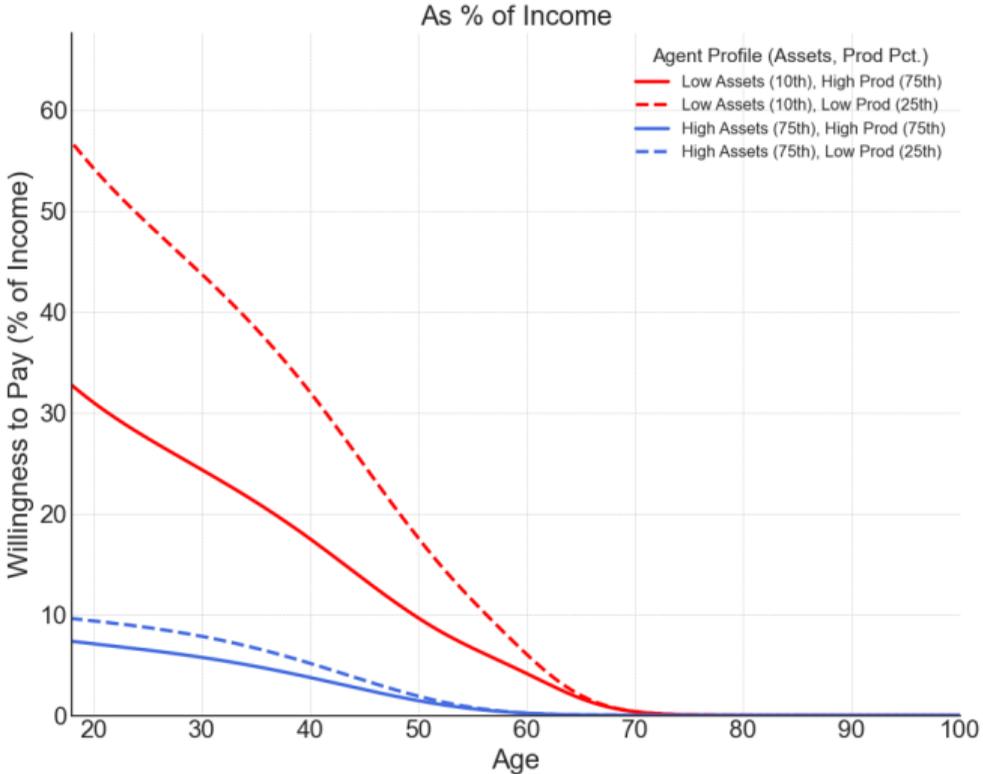
Computed from the value function:

$$\text{WTP}(a, z, t) = -\frac{\partial V^H / \partial \lambda_s}{\partial V^H / \partial \text{income}}$$

Interpretation: How much income would an agent sacrifice to reduce the probability of becoming sick?

WTP depends on the agent's entire state: age, assets, and productivity.

WTP: Heterogeneity by Assets and Productivity



WTP highest for young, asset-poor. Declines sharply with age and wealth.

Agents allocate resources between two margins:

Self-Insurance

- ▶ Accumulate assets a
- ▶ Buffer consumption across *all* future states

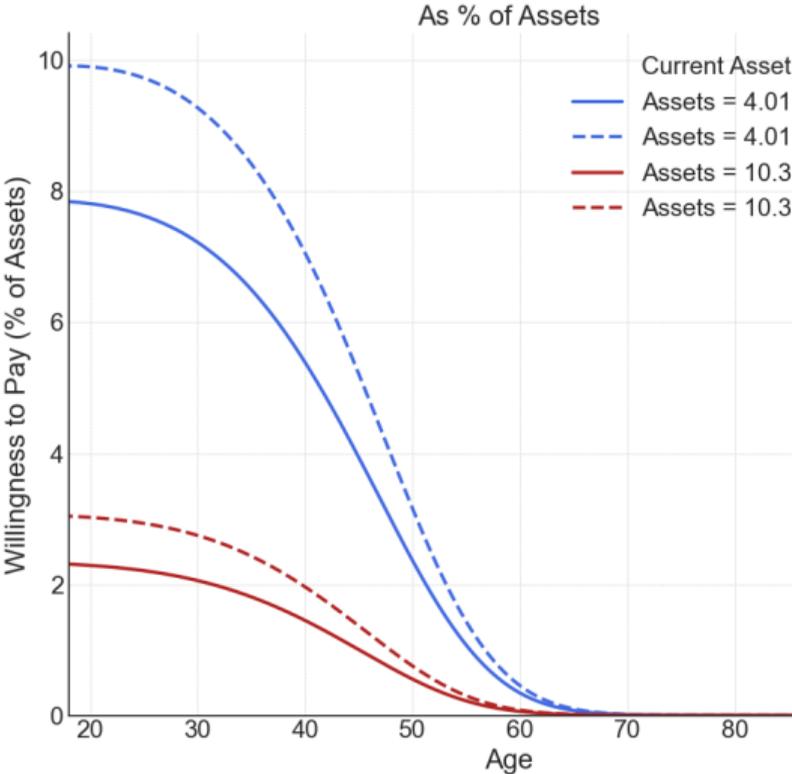
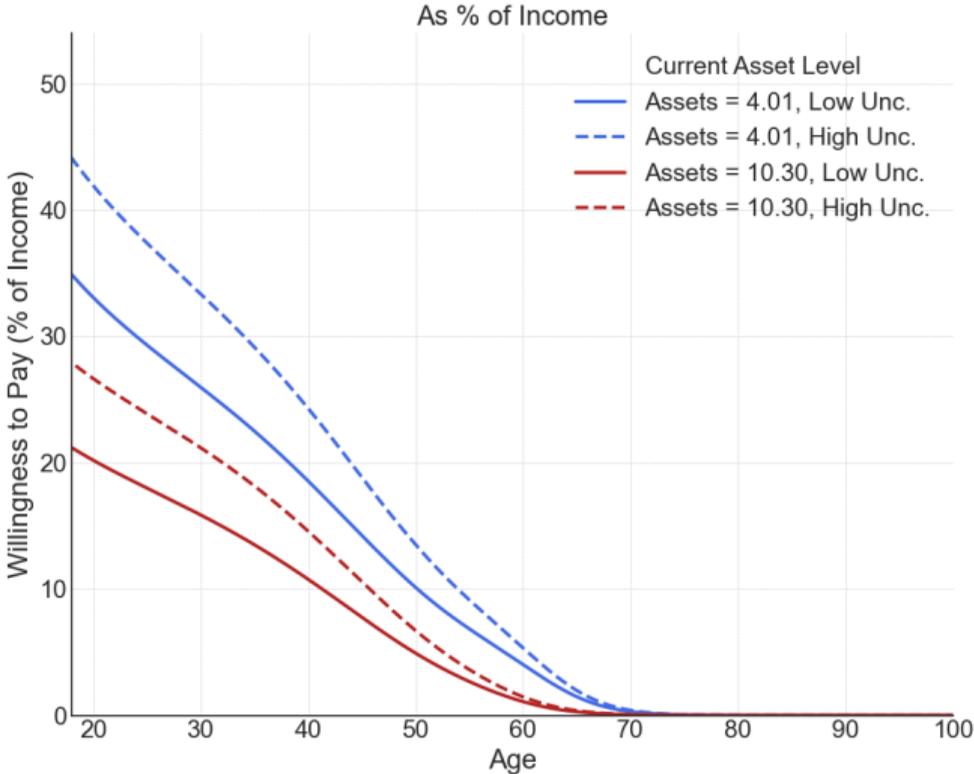
Prevention

- ▶ Reduce sickness hazard λ_s
- ▶ Avoid one *specific* bad state

Two competing effects of income uncertainty:

- ▶ **Crowd-out:** Higher uncertainty \Rightarrow stronger precautionary motive \Rightarrow agents prioritize liquid assets over prevention.
- ▶ **Amplification:** Higher uncertainty \Rightarrow harder to self-insure against compounding risks \Rightarrow prevention becomes more valuable.

Which Effect Dominates?



Here, amplification dominates: higher uncertainty \Rightarrow higher WTP.

- ▶ WTP for prevention varies dramatically across the state space: highest for young, asset-poor individuals who face the largest expected losses from chronic illness.
- ▶ Income uncertainty has ambiguous effects: it can crowd out prevention (precautionary motive) or amplify its value (compounding risks are harder to insure).
- ▶ Which effect dominates depends on the agent's state—a micro-foundation for heterogeneous health behaviors.