A Life Insurance Deterrent to Risky Behavior in Africa

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AIDS Epidemic

- AIDS killed an estimated 2.1 million people worlwide in 2007.
- Between 30.6 and 36.1 million people worldwide currently live with HIV.
- About 2/3 of these people live in Sub-Saharran Africa.
- Worldwide, between 1.8 and 4.1 million new people become infected every year.

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HIV/AIDS Prevention Campaigns

- HIV/AIDS funding was around $10 billion in 2007.
  - Almost a 40 fold increase from the previous 10 years.
- Thailand and Cambodia: successful prevention campaigns focused on commercial sex workers.
  - Led to a 90% increase in condom use and 50% reduction in demand.
- Longer-term relationships:
  - Ku, Sonenstein, and Pleck (1994): condom use declines with age and length of relationship.

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Reasons for Risky Behavior

- Oster (2007): risky sexual behavior is greater for those with
  - shorter life expectancies,
  - smaller life time incomes.
  - Find decisions of heterosexual males in Sub-Saharan Africa are consistent with homosexual males in United States.
- Becker (1993): Education may increase lifetime income and decrease risky behavior.
- Grossman (1972) and Kenkel (1991): Education may increase access to health information and facilities.
- Can life insurance (paid only if HIV negative) also replicate higher life expectancy and higher lifetime income?

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Model

- Model the behavior of adult males with dependents.
- Derive utility and make decisions about:
  1. Personal consumption.
  2. Family consumption.
  3. Number of risky sexual partners.
- Three period model:
  1) Ages 25-39 2) Ages 40-54 3) Ages 55-69
- Agents alive in period 1, possibly die before periods 2 and 3.
  - Exogenous factors with probability $\delta \in (0, 1)$
  - Contracting HIV in period t, die of AIDS between t and $t + 1$.

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Preferences

Period $t \in \{1, 2, 3\}$ utility function:

$$u(c_t, f_t, m_t) = v(c_t, f_t) + \gamma_t w(m_t)$$

- c_t: personal consumption
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- m_t: number of sexual partners
- γ_t measures relative preference for sexual partners.

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Preference for Consumption

Log utility over CES personal/family consumption bundle:

$$v(c_t, f_t) =$$

$$\log\left(\left[\alpha\left(c_t+\epsilon\right)^{\frac{\nu-1}{\nu}}+(1-\alpha)\left(f_t+\epsilon\right)^{\frac{\nu-1}{\nu}}\right]^{\frac{\nu}{\nu-1}}\right)-\log(\epsilon)$$

- α: preference for personal vs family consumption.
- ν: elasticity of substitution personal vs family consumption.
- Small value of ϵ forces $v(0,0) = 0$.
- If husband is alive, $c_t, f_t > 0$, $v(c_t, f_t) > 0$, $v_c(c_t, f_t) > 0$ $v_f(c_t, f_t) > 0$, $v_{cc}(c_t, f_t) < 0$, $v_{ff}(c_t, f_t) < 0$.
- If husband is dead, $c_t = 0$ but $f_t > 0$ and $v(0, f_t) > 0$, $v_f(0, f_t) > 0$, $v_{ff}(0, f_t) < 0$.

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Preference for Sexual Parnters

- Assume no sexual partners in final period (ages 55-79).
- Increases in number of sexual partners increases utility...
- Until reach a satation point m^* where $w'(m^*) = 0$.

$$w(m_t) = \log\left[-(m_t - m^*)^2 + (m^*)^2 + \epsilon\right] - \log(\epsilon)$$

- Small value of ϵ forces $w(0) = 0$ if agent is dead.
- If agent is alive and $m_t < m^*$, $w(m_t) > 0$, $w'(m_t) > 0$, $w''(m_t) < 0$
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HIV Transmission

- Let $h \in (0,1)$ be the HIV prevalence among potential partners.
- Let $t \in (0,1)$ be the female-to-male transmission rate (per partnership).
- For a given partner, probability of not contracting HIV: $(1 - ht)$.
- For m_t partners: $(1 - ht)^{m_t}$.
- Probability of contracting HIV in period t, die before $t+1$:

$$\pi(m_t) = 1 - (1 - ht)^{m_t}$$

= HIV prevalence among age group t

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Expected Life-Cycle Utility

Expected utility over three periods:

$$U = u(c_1, f_1, m_1) + \beta(1-\delta)\left[1-\pi(m_1)\right] u(c_2, f_2, m_2)$$

$$+ \beta \left\{1 - (1-\delta)\left[1-\pi(m_1)\right]\right\} u(0, f_2, 0)$$

$$+ \beta^2 (1-\delta)^2 \left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right] u(c_3, f_3, 0)$$

$$+ \beta^2 \left\{1 - (1-\delta)^2 \left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right]\right\} u(0, f_3, 0)$$

Each compontent of utility function:

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$$+ \beta\left\{1-(1-\delta)\left[1-\pi(m_1)\right]\right\} u(0, f_2, 0)$$

$$+ \beta^2(1-\delta)^2\left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right] u(c_3, f_3, 0)$$

$$+ \beta^2\left\{1-(1-\delta)^2\left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right]\right\} u(0, f_3, 0)$$

Utility from everything in period 1 – definitely alive.

Expected Life-Cycle Utility

Expected utility over three periods:

$$U = u(c_1, f_1, m_1) + \beta(1-\delta)\left[1-\pi(m_1)\right] u(c_2, f_2, m_2)$$

$$+ \beta \left\{1 - (1-\delta)\left[1-\pi(m_1)\right]\right\} u(0, f_2, 0)$$

$$+ \beta^2 (1-\delta)^2 \left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right] u(c_3, f_3, 0)$$

$$+ \beta^2 \left\{1 - (1-\delta)^2 \left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right]\right\} u(0, f_3, 0)$$

(Utility from everything in period 2) x (Prob alive).

Expected Life-Cycle Utility

Expected utility over three periods:

$$U = u(c_1, f_1, m_1) + \beta(1-\delta)\left[1-\pi(m_1)\right] u(c_2, f_2, m_2)$$

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$$+ \beta^2\left\{1-(1-\delta)^2\left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right]\right\} u(0, f_3, 0)$$

(Utility from only family cons in period 2) x (Prob dead).

Expected Life-Cycle Utility

Expected utility over three periods:

$$U = u(c_1, f_1, m_1) + \beta(1-\delta)\left[1-\pi(m_1)\right] u(c_2, f_2, m_2)$$

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$$+ \beta^2\left\{1 - (1-\delta)^2\left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right]\right\} u(0, f_3, 0)$$

(Utility from family/personal cons in period 3) x (Prob alive).

Expected Life-Cycle Utility

Expected utility over three periods:

$$U = u(c_1, f_1, m_1) + \beta(1-\delta)\left[1-\pi(m_1)\right] u(c_2, f_2, m_2)$$

$$+ \beta\left\{1-(1-\delta)\left[1-\pi(m_1)\right]\right\} u(0, f_2, 0)$$

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(Utility from only family cons in period 3) x (Prob alive).

Expected Life-Cycle Budget Constraint

Expected budget constraint over three periods:

$$p_1(c_1 + f_1) + (1-\delta)\left[1-\pi(m_1)\right]\frac{p_2 c_2}{1+r} + \frac{p_2 f_2}{1+r}$$

$$+ (1-\delta)^2\left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right]\frac{p_3 c_3}{(1+r)^2} + \frac{p_3 f_3}{(1+r)^2}$$

$$= w_1 + (1-\delta)\left[1-\pi(m_1)\right]\frac{w_2}{1+r} + \delta\left[1-\pi(m_1)\right]\frac{b_2}{1+r}$$

$$+ \delta(1-\delta)\left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right]\frac{b_3}{(1+r)^2}$$

Each compontent of budget constraint:

Expected Life-Cycle Budget Constraint

Expected budget constraint over three periods:

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$$+ \delta(1-\delta)\left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right]\frac{b_3}{(1+r)^2}$$

Income and personal and family cons period 1 – definitely alive.

Expected Life-Cycle Budget Constraint

Expected budget constraint over three periods:

$$p_1(c_1 + f_1) + (1-\delta)\left[1-\pi(m_1)\right]\frac{p_2 c_2}{1+r} + \frac{p_2 f_2}{1+r}$$

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$$+ \delta(1-\delta)\left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right]\frac{b_3}{(1+r)^2}$$

(Income and expenses from personal cons period 2) x (Prob alive).

Expected Life-Cycle Budget Constraint

Expected budget constraint over three periods:

$$p_1(c_1 + f_1) + (1-\delta)\left[1-\pi(m_1)\right]\frac{p_2 c_2}{1+r} + \frac{p_2 f_2}{1+r}$$

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Certain family consumption period 2.

Expected Life-Cycle Budget Constraint

Expected budget constraint over three periods:

$$p_1(c_1 + f_1) + (1-\delta)\left[1-\pi(m_1)\right]\frac{p_2 c_2}{1+r} + \frac{p_2 f_2}{1+r}$$

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$$+ \delta(1-\delta)\left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right]\frac{b_3}{(1+r)^2}$$

(Expenses from personal cons period 3) x (Prob alive).

Expected Life-Cycle Budget Constraint

Expected budget constraint over three periods:

$$p_1(c_1 + f_1) + (1-\delta)\left[1-\pi(m_1)\right]\frac{p_2 c_2}{1+r} + \frac{p_2 f_2}{1+r}$$

$$+ (1-\delta)^2\left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right]\frac{p_3 c_3}{(1+r)^2} + \frac{p_3 f_3}{(1+r)^2}$$

$$= w_1 + (1-\delta)\left[1-\pi(m_1)\right]\frac{w_2}{1+r} + \delta\left[1-\pi(m_1)\right]\frac{b_2}{1+r}$$

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Certain expense on family consumption in period 3.

Expected Life-Cycle Budget Constraint

Expected budget constraint over three periods:

$$p_1(c_1 + f_1) + (1-\delta)\left[1-\pi(m_1)\right]\frac{p_2 c_2}{1+r} + \frac{p_2 f_2}{1+r}$$

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b_2 : Life insurance if dead in period 2, but not from HIV.

Expected Life-Cycle Budget Constraint

Expected budget constraint over three periods:

$$p_1(c_1 + f_1) + (1-\delta)\left[1-\pi(m_1)\right]\frac{p_2 c_2}{1+r} + \frac{p_2 f_2}{1+r}$$

$$+ (1-\delta)^2\left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right]\frac{p_3 c_3}{(1+r)^2} + \frac{p_3 f_3}{(1+r)^2}$$

$$= w_1 + (1-\delta)\left[1-\pi(m_1)\right]\frac{w_2}{1+r} + \delta\left[1-\pi(m_1)\right]\frac{b_2}{1+r}$$

$$+ \delta(1-\delta)\left[1-\pi(m_1)\right]\left[1-\pi(m_2)\right]\frac{b_3}{(1+r)^2}$$

b_3 : Life insurance if alive in period 2, dead in 3, not from HIV.

Baseline Parameters

- HIV Prevalence among potential parnters: $h = 0.119$.
- Transmission rate: $t = 0.15$.
- Exogenous probability of dying: $\delta = 0.382$
  matches a 55 year life expectancy.
- Interest rate / Discount rate (15 year period):
  $r = 0.82$, $\beta = 0.547$.
- Income: $w_1 = w_2 = 328.0$,
  roughly real GDP per person Uganda (U.S. dollars).
- Prices: $p_1 = p_2 = p_3 = 1$.

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Baseline Preference Parameters

- Satiation point: $m^* = 50$.
- Personal consumption preference parameter: $\alpha = 0.5$.
- Elastcity of sub personal/family consumption: $\nu = 1.0$.
- Sexual partner preference parameters $\gamma_1 = 1.23$
  (chosen to yield $\pi(m_1) = 0.119$).
- Sexual partner preference parameters $\gamma_2 = 51$
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