- Health (H) - a resource, a ”good thing”
  - direct utility in consumption $u'_H > 0$
  - increase production opportunities
    – higher productivity in work, e.g. more energy
    – fewer days sick (more healthy time)
    In the Grossman model, there is only the latter effect.

- Health (H) - a resource, a ”good thing”
  - direct utility in consumption
  - increase production opportunities
    – higher productivity in work, e.g. more energy
    – fewer days sick (more healthy time)

- Health - capital
  - The stock of health (H) gives utility and/or production opportunities. Health lasts over several periods, but time wears (depreciation).
  - Measures to improve health – *investments* in health

The Grossman model

- The application of consumption (and investment) theory to the analysis of individual health.
- Health, the result of rational choice.
- Demand for health *care* is derived from a (rational) demand for health.
- Health – capital
- Health brings direct utility, and increases production/earning opportunities.
- The individual is not only a consumer, but a **producer** of own health.

Note: Symbols are the same as in Grossman, chapter 7 in Handbook.

The derivation of the user cost of health

Then it is convenient to look at the optimal health stock in period t (H_t) rather than the gross investments.

The relation between H_t and $I_1, ..., I_n$:

$$\begin{aligned} I_{t-1} &= H_t - (1-\delta_{t-1}) H_{t-1}, \\ I_t &= H_{t+1} - (1-\delta_t) H_t \end{aligned}$$

while.H_t does not enter in the expression for I_{t-j},for $j \neq 0, 1$.
That is, $\partial I_{t-1}/\partial H_t = 1$, and $\partial I_t/\partial H_t = -(1-\delta_t)$
(and $\partial I_{t-j}/\partial H_t = 0$ for $j \neq 0, 1$).

$$\partial L_t/\partial H_t = \lambda \frac{1}{(1+r)^{t-1}} \left(-\underbrace{P_{t-1}\frac{\partial M_{t-1}}{\partial I_{t-1}}}_{\pi_{t-1}} \underbrace{\frac{\partial I_{t-1}}{\partial H_t}}_{=1} \right) +$$

$$+ uh_t G_t + \lambda \frac{1}{(1+r)^t} \left(G_t W_t - \underbrace{P_t \frac{\partial M_t}{\partial I_t}}_{\pi_t} \underbrace{\frac{\partial I_t}{\partial H_t}}_{=-(1-\delta_t)} \right) = 0$$

$$\frac{\lambda}{(1+r)^{t-1}} \pi_{t-1} = uh_t G_t + \frac{\lambda}{(1+r)^t} \left(G_t W_t + \pi_t (1-\delta_t) \right)$$

multiply by $(1+r)^t / \lambda$ and rearrange right hand side (RHS):

$$\pi_{t-1}(1+r) = G_t W_t + \frac{uh_t}{\lambda} G_t (1+r)^t + \pi_t (1-\delta_t)$$

$$\pi_{t-1}(1+r) - \pi_t (1-\delta_t) = G_t W_t + \frac{uh_t}{\lambda} G_t (1+r)^t$$

Rearrangeing the LHS: $\pi_{t-1}(1+r) - \pi_t(1-\delta_t) = \pi_{t-1}\left(1 + r - \frac{\pi_t}{\pi_{t-1}} + \frac{\pi_t}{\pi_{t-1}}\delta_t\right) =$
$\pi_{t-1}\left(\frac{\pi_{t-1}}{\pi_{t-1}} + r - \frac{\pi_t}{\pi_{t-1}} + \frac{\pi_t}{\pi_{t-1}}\delta_t\right) = \pi_{t-1}\left(r - \left(\frac{\pi_t}{\pi_{t-1}} - \frac{\pi_{t-1}}{\pi_{t-1}}\right) + \frac{\pi_t}{\pi_{t-1}}\delta_t\right) = \pi_{t-1}\left(r - \widetilde{\pi}_{t-1} + \frac{\pi_t}{\pi_{t-1}}\delta_t\right)$,
where $\widetilde{\pi}_{t-1} = \frac{\pi_t - \pi_{t-1}}{\pi_{t-1}}$.Grossman assumes that $\delta \widetilde{\pi}_{t-1}$ is very close to zero, then $\frac{\pi_t}{\pi_{t-1}}\delta_t \approx \delta_t$, and we arrive at equation (11):

$$\pi_{t-1}(r - \widetilde{\pi}_{t-1} + \delta_t) = G_t W_t + G_t \frac{uh_t}{\lambda}(1+r)^t \tag{11}$$

RHS: The gain from a marginal increase in health stock in period t.

The LHS: The cost of a marginal increase in H_t - can be thought of as a user cost of health capital.

In the next lecture, we will interpret this condition, and use the equation for graphical analysis I will place some notes on the course web site before that lecture, and no later than Monday the 14th in the morning.

Kari