Health capital norms and intergenerational transmission of non-communicable chronic diseases

Catarina Goulão (Toulouse School of Economics, INRA)

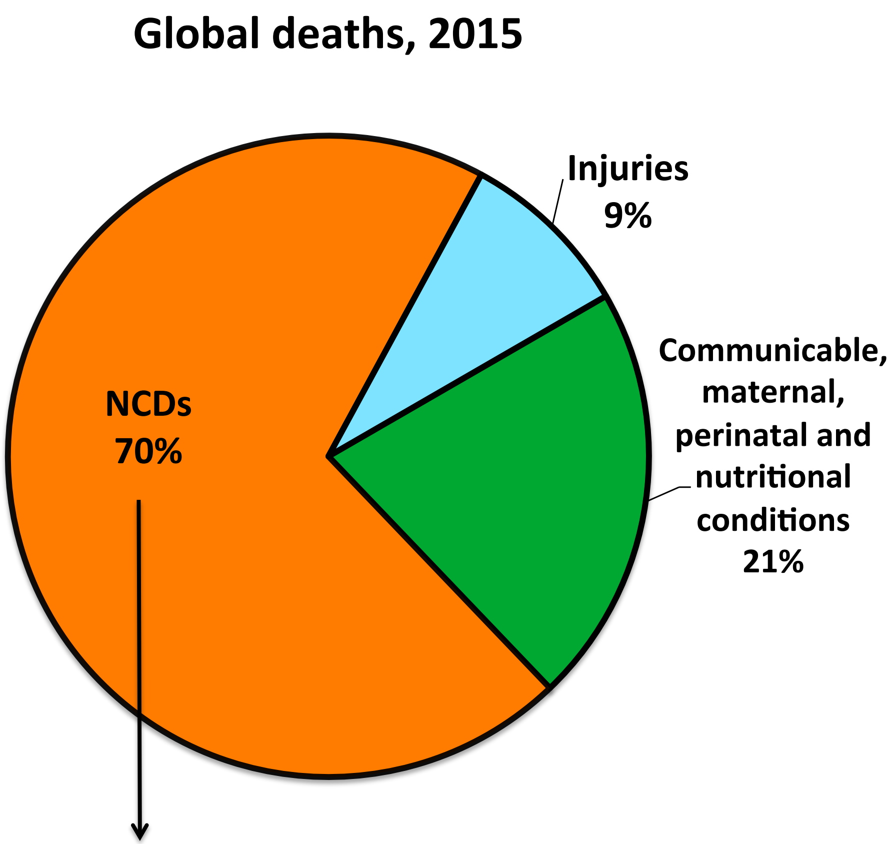
Agustín Pérez-Barahona (THEMA, Université de Cergy-Pontoise)

Workshop on Longevity and Dependence

Paris, SCOR, November 30, 2018

NCDs are the major cause of death worldwide,

and responsible for long periods of morbidity and dependency.



36% of these deaths were premature (30 to 70 years).

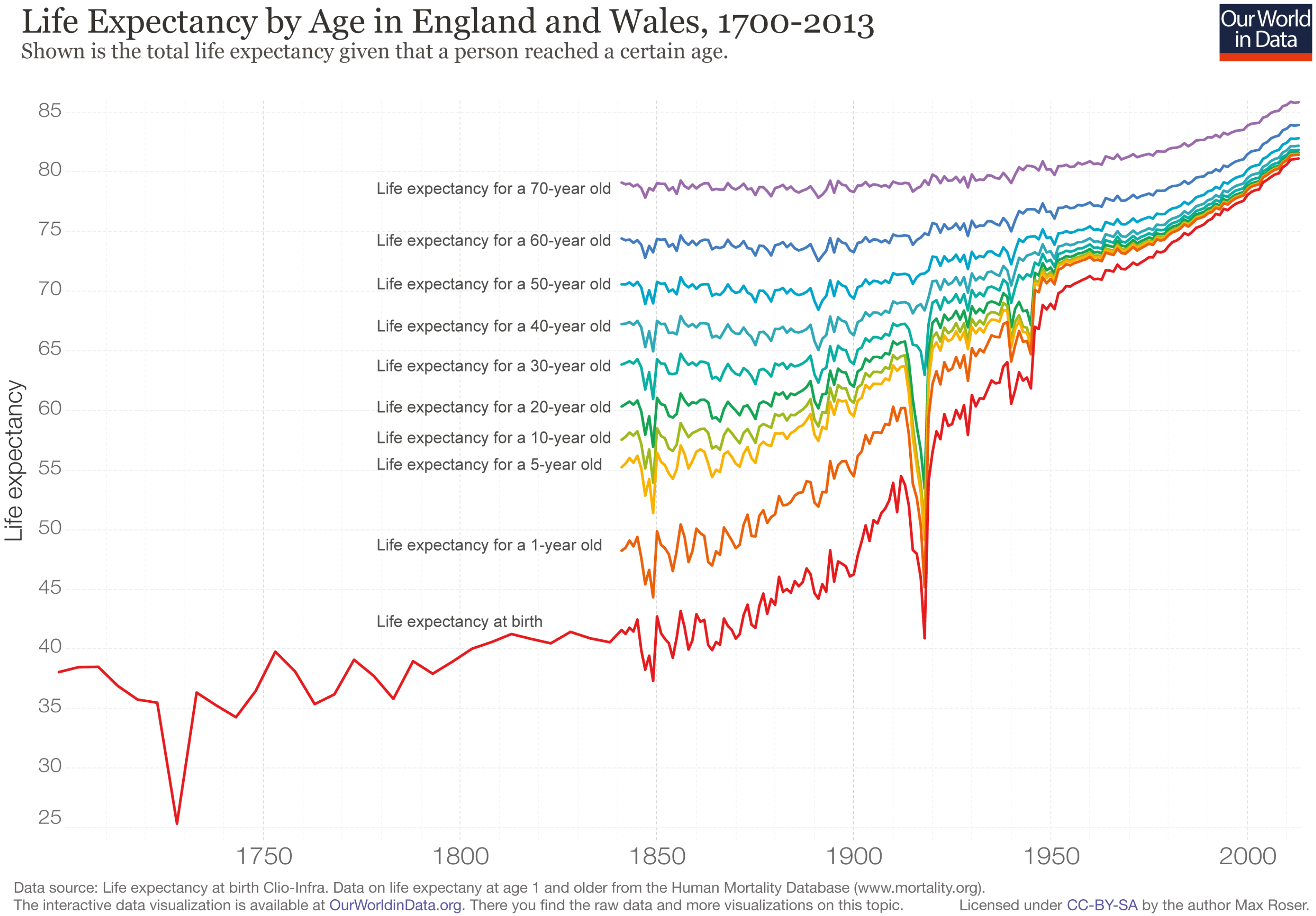
78% of Years lost due to disability (YLD): amputations, blindness, mobility, and speech impairments.

There is the common believe that we should be at least as healthy as the previous generation.

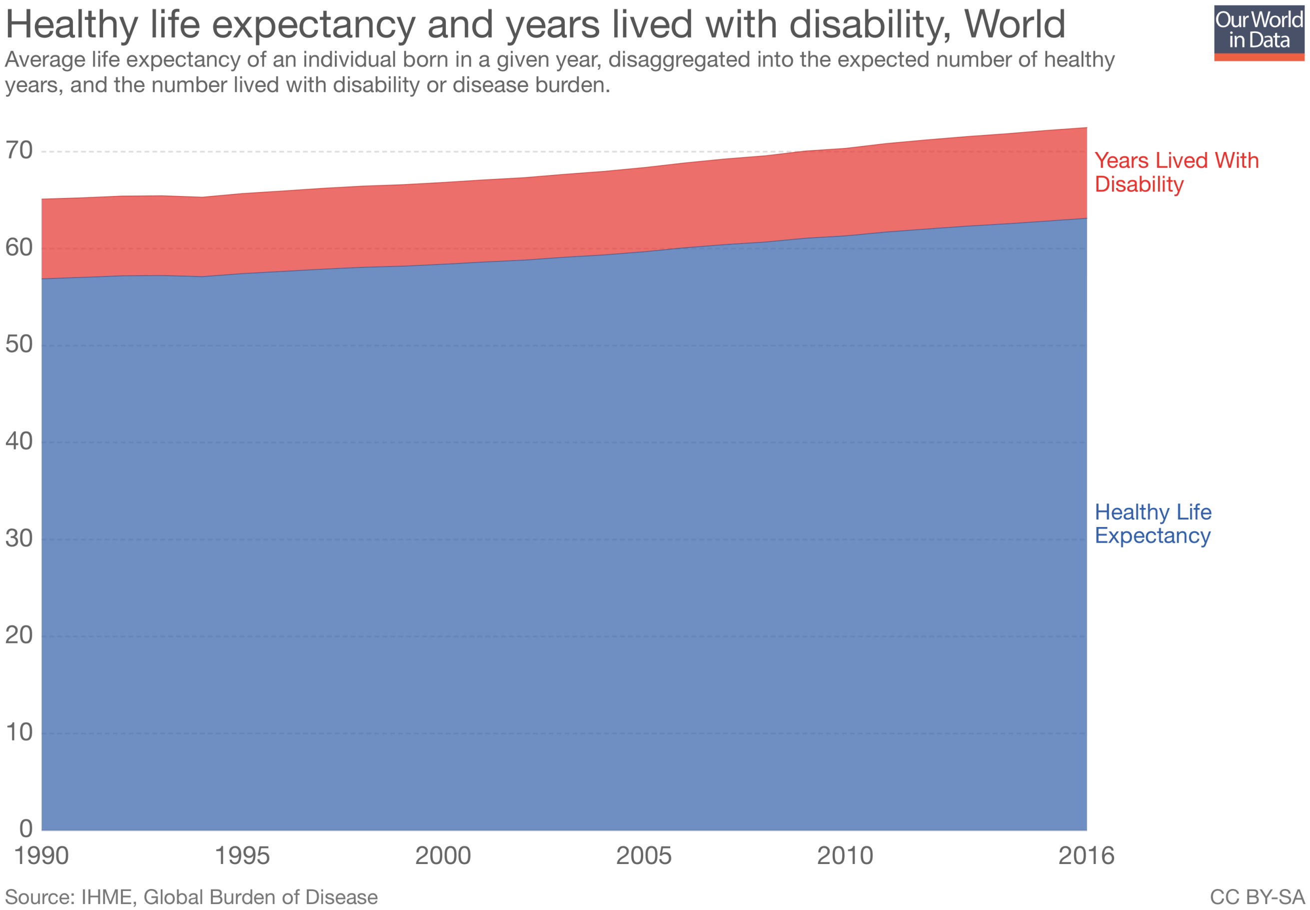
Increasing life expectancy.

Increasing the length of healthy life.

Increasing life expectancy.



Increasing the length of a healthy life.



The number of years with disability has increased as well: from 8.22 to 9.36 years.

This common believe can be seen as a social norm.

The social norm being "be as healthy as the previous generation".

Being healthy understood as having a good stock of health capital (Grossman 1972).

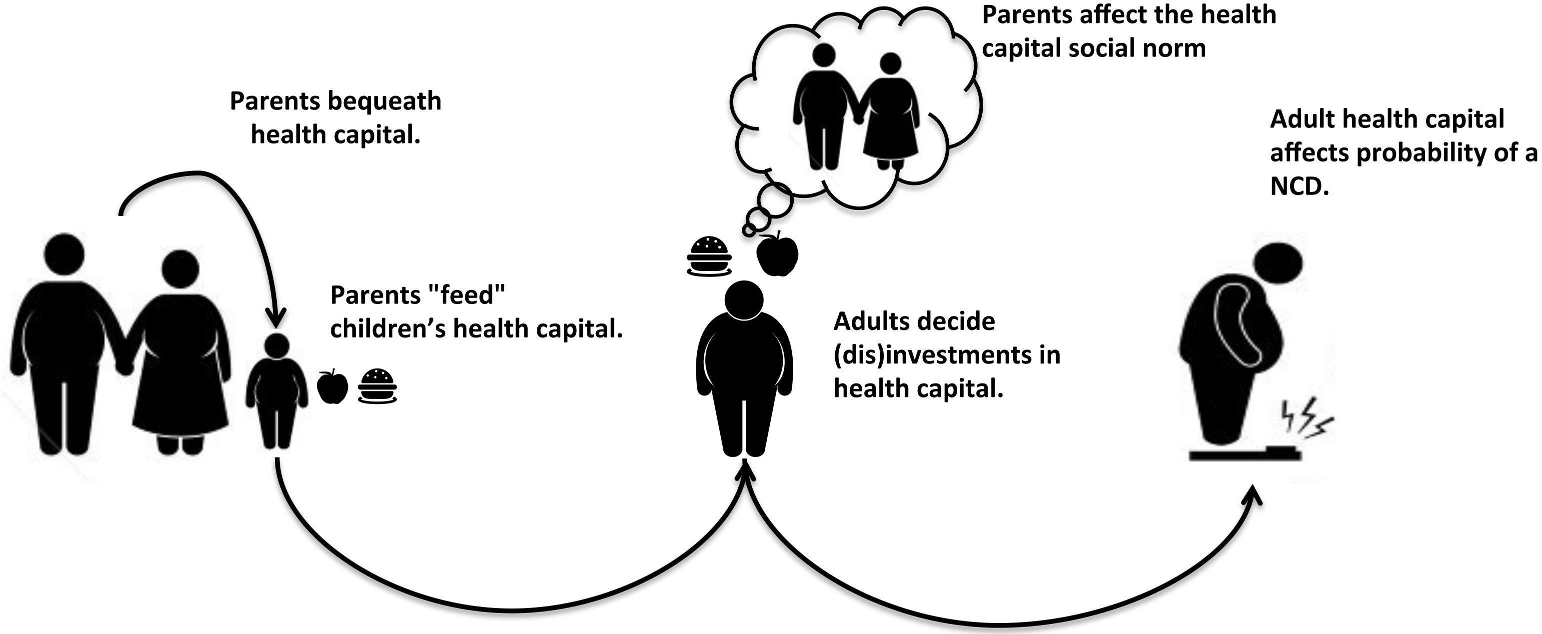
Common proxies for health capital are Height and BMI.

Modeling of a social norm

$$\downarrow$$

Disutility for not being as healthy as the previous generation.

Infinite-horizon economy.
3 periods OLG: childhood, adulthood and old age.

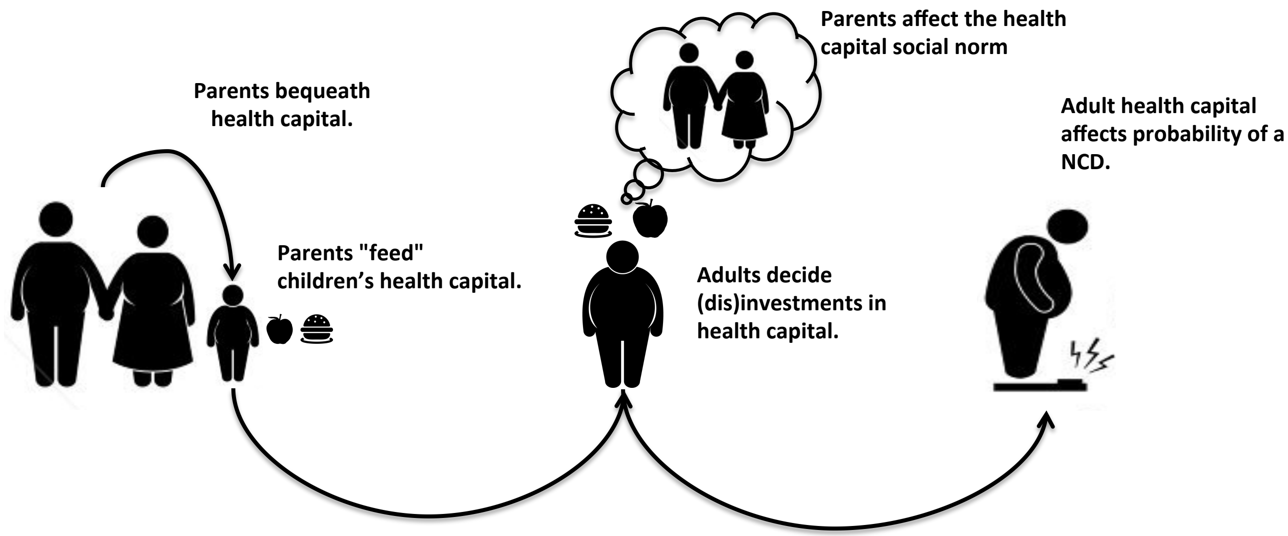


All decisions are made at adulthood.

Individuals might suffer from a NCD at old age.

Preferences:

$$U(c_t, v_t, \eta_t, h_{t+1}) = \ln(c_t) + \lambda \ln(v_t) + (1-\pi_t)\gamma \ln(h_{t+1} - \eta_t) + \pi_t \gamma (1-\phi) \ln(h_{t+1} - \eta_t)$$



$v_t \equiv$ modifiable risk factors: unhealthy eating, drinking, smoking.

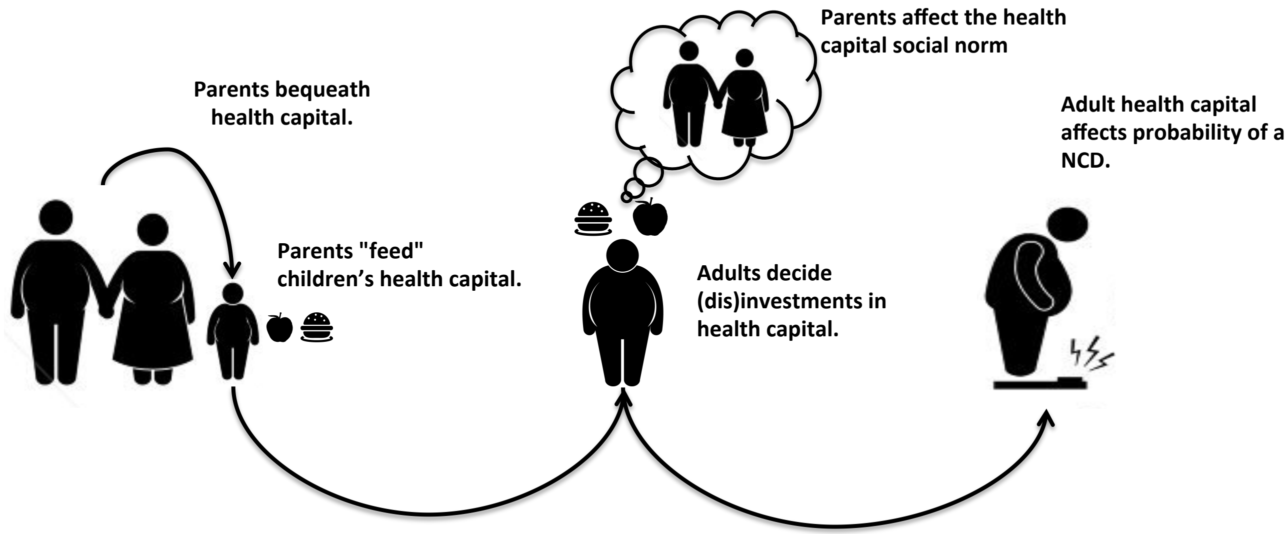
$h_{t+1} \equiv$ health capital when old.

$\phi \equiv$ disutility of suffering from a NCD ($0 \leq \phi \leq 1$).

$\eta_t = \epsilon h_t \equiv$ social norm.

Probability of suffering from a NCD at old age $\pi_t = \pi(h_{t+1})$:
Depends on adult health capital.

Health capital law of motion: $h_{t+1} = (1-\delta)h_t + \sigma m_t - \alpha v_t$

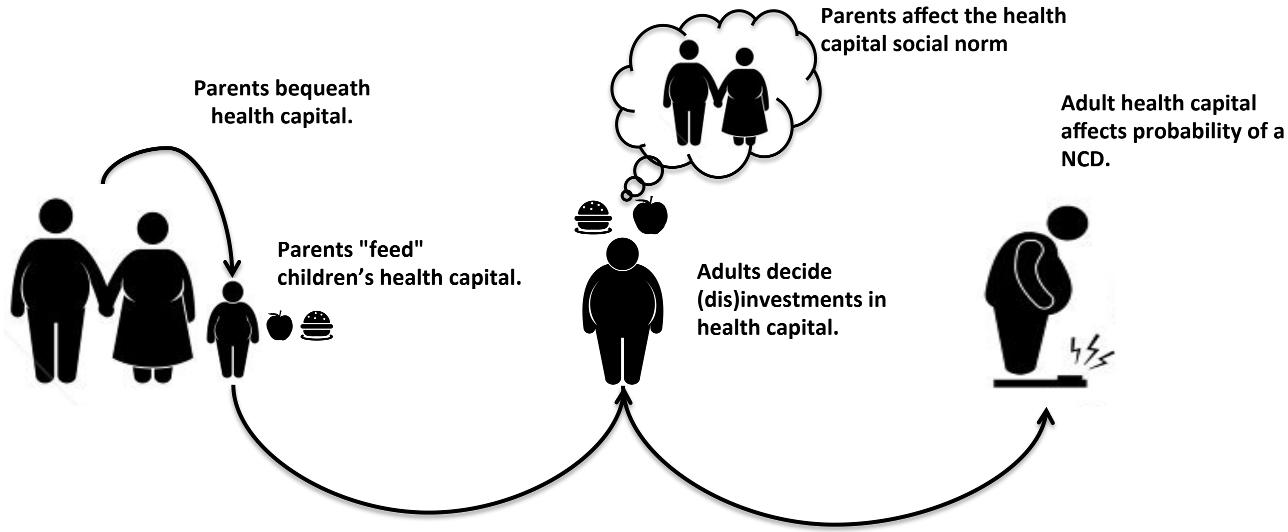


Budget constraint: $w_t = c_t + m_t + v_t$

$w_t \equiv$ exogenous income.
$m_t \equiv$ investment in health capital (medical care, physical activity).
with $0 < \delta < 1$, $\sigma > 0$, $\alpha > 0$.

Individual behavior

Max $U(c_t, v_t, \eta_t, h_{t+1}) = \ln(c_t) + \lambda \ln(v_t) + (1-\pi_t)\gamma \ln(h_{t+1}-\eta_t) + \pi_t\gamma(1-\phi)\ln(h_{t+1}-\eta_t)$



subject to:

$h_{t+1} = (1-\delta)h_t + \sigma m_t - \alpha v_t$

$w_t = c_t + m_t + v_t$

$\eta_t = \epsilon h_t$

w_t, h_t **taken as given.**

$c_t > 0$, $v_t > 0$, $m_t > 0$, $h_t > 0$, $0 < \epsilon < 1$.

Full-fledge forward-looking planner

Maximize $\beta^{-1}U_{-1} + \sum_{t=0}^{\infty} \beta^t U_t\left(c_t, v_t, \eta_t, h_{t+1}\right)$

subject to:

$h_{t+1} = (1-\delta)h_t + \sigma m_t - \alpha v_t$

$w_t = c_t + m_t + v_t$

$\eta_t = \epsilon h_t$

w_t, h_t taken as given.

$c_t > 0$, $v_t > 0$, $m_t > 0$, $h_t > 0$.

$$\mathcal{L} = \beta^{-1}U_{-1} + \sum_{t=0}^{\infty} \beta^t \left[U_t\left(c_t, v_t, \eta_t, h_{t+1}, \pi_t\right) + \xi_{t+1}\left[(1-\delta)h_t + \sigma w - (\sigma+\alpha)v_t - \sigma c_t - h_{t+1}\right]\right]$$

The decentralized solution is not optimal.

Foc Full-fledge forward-looking planner:

$$\frac{\partial U_t}{\partial v_t} = \frac{\partial U_t}{\partial c_t} + \alpha \left(\frac{\partial U_t}{\partial h_{t+1}} + \frac{\partial U_t}{\partial \pi_t} \frac{\partial \pi_t}{\partial h_{t+1}} \right) + \alpha\beta \left(\xi_{t+2}(1-\delta) + \frac{\partial U_t}{\partial n_t} \frac{\partial n_t}{\partial h_t} \right)$$

Foc decentralized:

$$\frac{\partial U_t}{\partial v_t} = \frac{\partial U_t}{\partial c_t} + \alpha \left(\frac{\partial U_t}{\partial h_{t+1}} + \frac{\partial U_t}{\partial \pi_t} \frac{\partial \pi_t}{\partial h_{t+1}} \right)$$

A tax on unhealthy goods (v_t) that finances a subsidy on healthy activities m_t can implement the optimal solution.

$$w = c_t + (1 - s_t)m_t + (1 + \tau_t)v_t$$

The decentralized FOC becomes

$$\frac{\partial U_t}{\partial v_t} = \frac{\partial U_t}{\partial c_t} + \left(\alpha + \sigma \frac{\tau_t}{1 - s_t}\right)\left(\frac{\partial U_t}{\partial h_{t+1}} + \frac{\partial U_t}{\partial \pi_t}\frac{\partial \pi_t}{\partial h_{t+1}}\right)$$

Foc Full-fledge forward-looking planner:

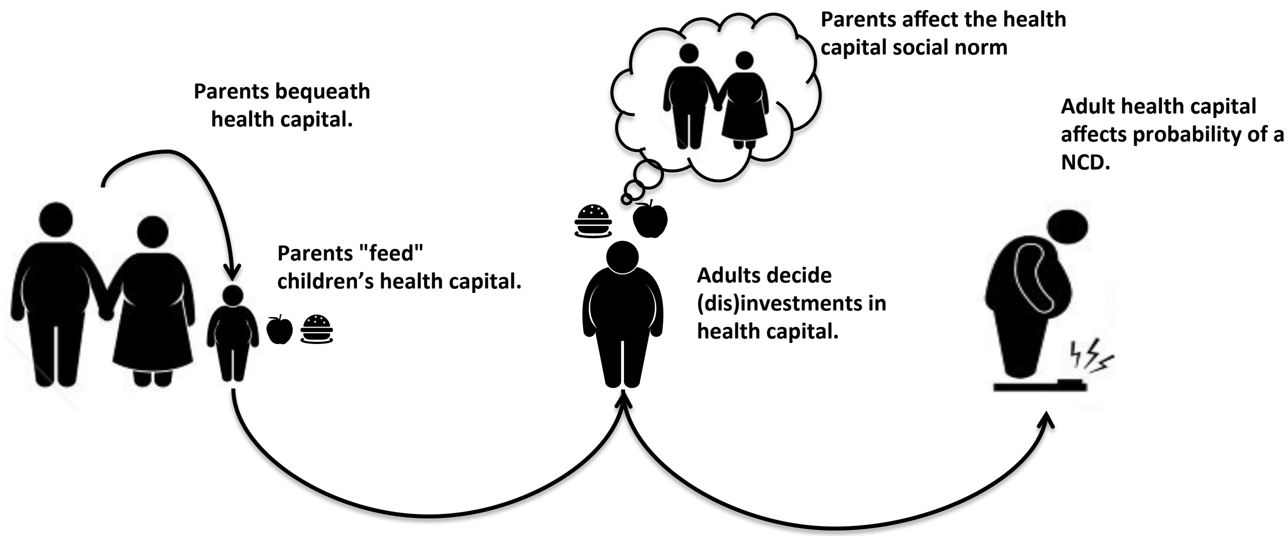
$$\frac{\partial U_t}{\partial v_t} = \frac{\partial U_t}{\partial c_t} + \alpha\left(\frac{\partial U_t}{\partial h_{t+1}} + \frac{\partial U_t}{\partial \pi_t}\frac{\partial \pi_t}{\partial h_{t+1}}\right) + \alpha\beta\left(\xi_{t+2}(1 - \delta) + \frac{\partial U_t}{\partial n_t}\frac{\partial n_t}{\partial h_t}\right)$$

The trajectory of taxes corrects the intergenerational transmission of health capital not accounted for individuals.

$$\frac{\tau_t}{1-s_t} = \frac{\alpha\beta}{\sigma}\frac{\xi_{t+2}(1-\delta) + \frac{\partial U_t}{\partial n_t}\frac{\partial n_t}{\partial h_t}}{\frac{\partial U_t}{\partial h_{t+1}} + \frac{\partial U_t}{\partial \pi_t}\frac{\partial \pi_t}{\partial h_{t+1}}}$$

If $\delta \to 1$ and $\frac{\partial U_t}{\partial n_t}\frac{\partial n_t}{\partial h_t} \to 0$, the tax vanishes to zero.

Suppose $\pi_t(h_t)$. At adulthood π_t is given.



Agents' problem:

Max $U(c_t, v_t, \eta_t, h_{t+1}) = \ln(c_t) + \lambda \ln(v_t) + (1-\pi_t)\gamma \ln(h_{t+1} - \eta_t) + \pi_t \gamma (1-\phi) \ln(h_{t+1} - \eta_t)$

subject to:

$w_t = c_t + m_t + v_t$

$h_{t+1} = (1-\delta)h_t + \sigma m_t - \alpha v_t$

$c_t, v_t, m_t, h_t > 0, \quad h_0$ **initial condition.**

FOC

$$m_t = \frac{\sigma[\gamma(\sigma+\alpha)(1-\phi\pi_t) + \lambda\alpha]w_t - (1-\delta-\epsilon)[(\lambda+1)\sigma+\alpha]h_t}{\sigma(\sigma+\alpha)[\lambda+1+\gamma(1-\phi\pi_t)]}$$

$$v_t = \frac{\lambda[(1-\delta-\epsilon)h_t + \sigma w_t]}{(\sigma+\alpha)[\lambda+1+\gamma(1-\phi\pi_t)]}$$

$$c_t = \frac{(1-\delta-\epsilon)h_t + \sigma w_t}{\sigma[\lambda+1+\gamma(1-\phi\pi_t)}$$

Inherited health capital and social norms work on opposite directions

$\partial m_t/\partial \pi_t < 0$	$\partial m_t/\partial w_t > 0$	$\partial m_t/\partial h_t < 0$	$\partial m_t/\partial \epsilon > 0$
$\partial c_t/\partial \pi_t > 0$	$\partial c_t/\partial w_t > 0$	$\partial c_t/\partial h_t > 0$	$\partial c_t/\partial \epsilon < 0$
$\partial v_t/\partial \pi_t > 0$	$\partial v_t/\partial w_t > 0$	$\partial v_t/\partial h_t > 0$	$\partial v_t/\partial \epsilon < 0$

Higher probability of disease (π_t), lower value of old age:

Lower health investments, higher consumption and unhealthy consumption.

Richer economy (w_t):

Higher health investments, consumption and unhealthy consumption.

Higher inherited health conditions (h_t):

Lower health investments, higher consumption and unhealthy consumption.

Stronger social norm (ϵ):

Higher health investments, lower consumption and unhealthy consumption.

Myopic Social Planner that maximizes aggregate utility in each period.

(Green) Golden Rule.

Chichilnisky et al. (1995), Mariani et al.(2009).

$$
\begin{array}{rcl}
\max U(c, v, \eta, h) & & \\
\text{subject to:} & & \\
w & = & c + m + v \\
h & = & (1-\delta)h + \sigma m - \alpha v
\end{array}
$$

In our specification:

$$c^*_{\pi_i} = c_g + \frac{[(1-\delta) - \epsilon]h^*_{\pi_i}}{\delta[(1+\lambda) + \gamma(1-\phi\pi)]}$$

$$v^*_{\pi_i} = v_g + \frac{\lambda[(1-\delta) - \epsilon]h^*_{\pi_i}}{(\alpha+\sigma)[(1+\lambda) + \gamma(1-\phi\pi)]}$$

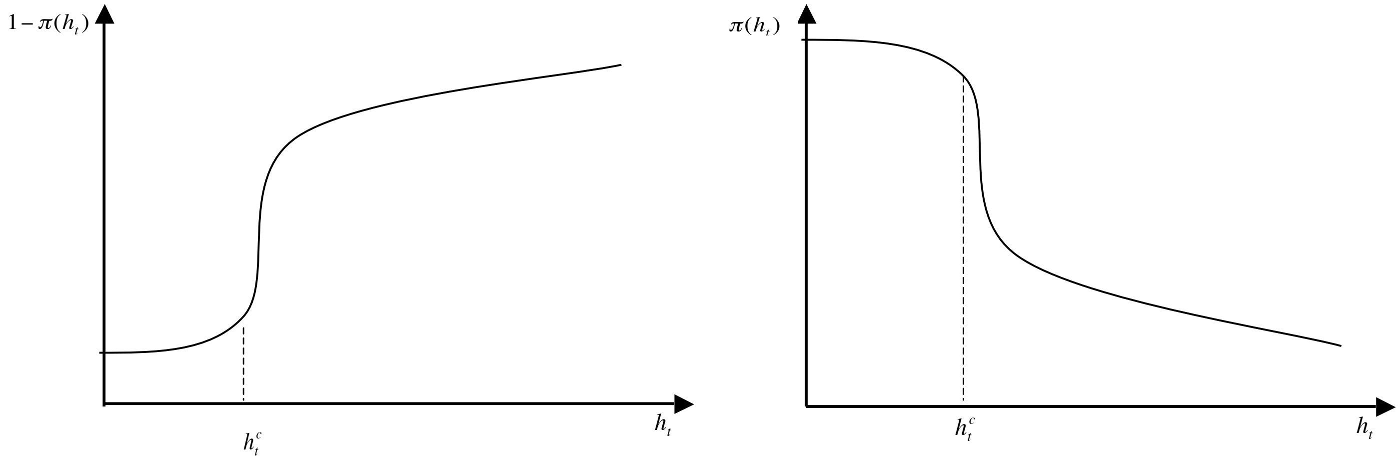
$$m^*_{\pi_i} = m_g - \frac{\lambda[(1-\delta) - \epsilon](\alpha + \delta(1+\lambda))h^*_{\pi_i}}{(\alpha+\sigma)[(1+\lambda) + \gamma(1-\phi\pi)]}$$

If $\epsilon = 1 - \delta$ the two solutions coincide.

The norm can be used to implement the golden rule.

Health capital trap

- If $1 - \pi(h_t)$ is convex-concave then the transition function $\varphi(h^*)$ is convex-concave (Balckburn and Cipriani, J Economic Dynamics and Control (2002)).



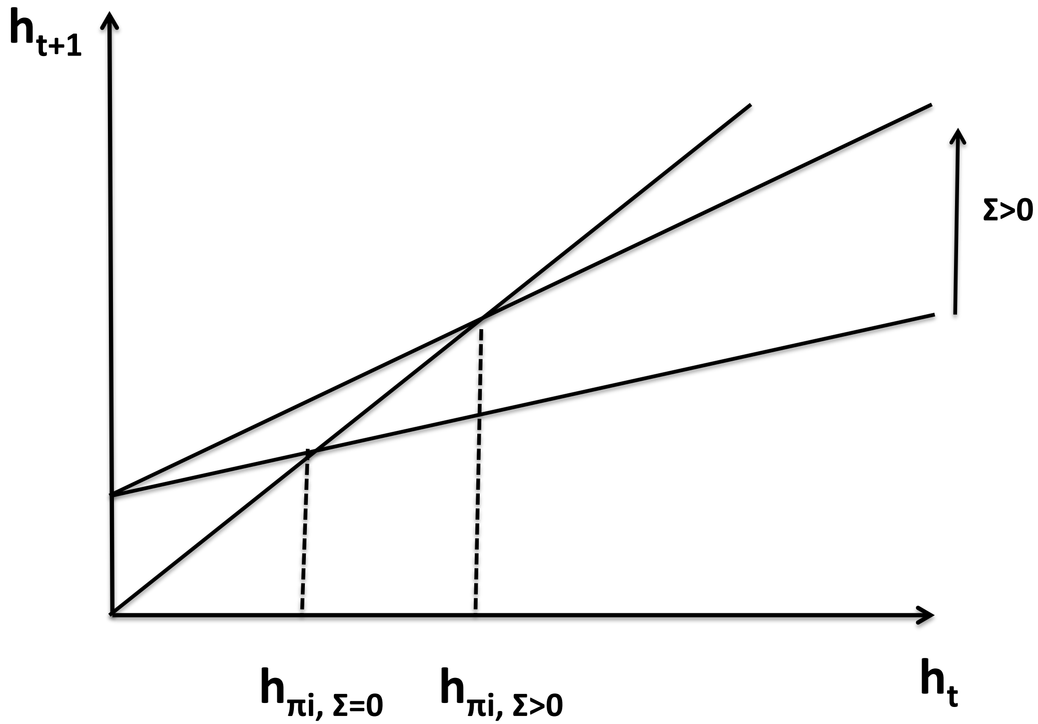
- When h_t is low, a small increase of h_t leads to just a small increases of $1 - \pi$.

- After a threshold h_t^c, a small increase of h_t leads to a huge increase of $1 - \pi$.

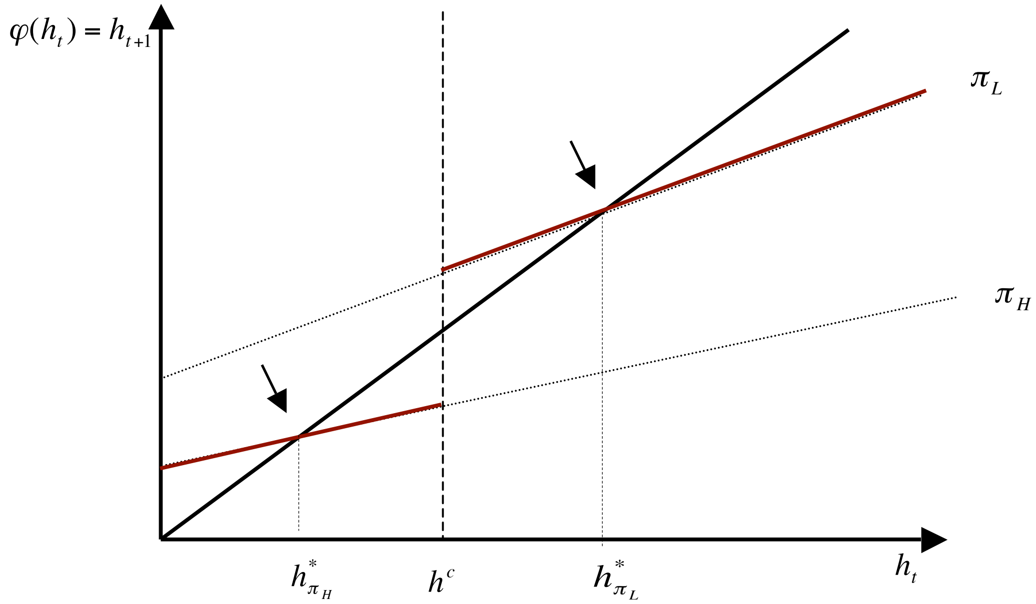
- Examples: Thresholds for diabetes, blood pressure, etc...

$$\pi(h_t) = \begin{cases} \pi_H & \textbf{if} \quad h_t < h^c \\ \pi_L & \textbf{if} \quad h_t \geq h^c \end{cases}$$

$$\varphi(h_t) = \begin{cases} \frac{(1+\lambda)h_t}{\gamma(1-\phi\pi_H)+\lambda+1}\epsilon + \frac{\gamma(1-\phi\pi_H)[(1-\delta)h_t+\sigma w]}{\gamma(1-\phi\pi_H)+\lambda+1} & \textbf{if} \quad h_t < h^c \\ \frac{(1+\lambda)h_t}{\gamma(1-\phi\pi_L)+\lambda+1}\epsilon + \frac{\gamma(1-\phi\pi_L)[(1-\delta)h_t+\sigma w]}{\gamma(1-\phi\pi_L)+\lambda+1} & \textbf{if} \quad h_t \geq h^c \end{cases}$$


h_{t+1}
Σ>0
$h_{\pi i,\, \Sigma=0}$
$h_{\pi i,\, \Sigma>0}$
h_t

The dynamic equation admits two stable steady states



Exogenous value of h^c.
The norm can be used to avoid the health trap.

Decentralized solution is not optimal because there is an intergenerational externality:
–Health capital passes from one generation to the other.
–The social norm.

The optimal solution can be reached with
–The appropriate taxes.
–By changing the social norm.

The social norm can be used to escape health traps.

Discuss exogenous threshold h^c.