



# HEALTH AND ENDOGENOUS GROWTH

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Adriaan van Zon

Joan Muysken

MERIT, Maastricht University



# Motivation for model

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- Policy situation in Netherlands:
  - Health benefits difficult to measure/value
  - 'Evidence Based Medicine' => (policy-) emphasis on controlling health costs , instead of maximizing societal welfare (including measure of health of population)
  - Under-allocation of (public) funds to health generation from welfare point of view?



# Economic features of model

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- Specification health benefits:
  - Contribution to welfare (directly, longevity);
  - Impact on supply of labour measured in **healthy hours** => increase in health => increase productive base economy;
- Specification health costs:
  - Resources (human capital) used for health production have alternative uses (opportunity costs);
  - Health depreciates => maintenance costs health state;



# Health features of model

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- Embodiment of health in people (cf. disembodied health stock Barro '95);
- Being healthy is necessary for being (fully) productive  $\Rightarrow$  health loss  $\Rightarrow$  productivity loss;
- Health per person cannot grow without limit  $\Rightarrow$  focus on sustainable steady state health **level** not **growth-rate**;



# Questions addressed by model

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- How big must health-sector be from welfare perspective given health costs AND benefits?
- How instrumental is health sector for growth?
  - Drag on growth (health resources have alternative/growth uses) ?
  - Necessary for growth because healthy work hours embodied in people => no health no productive activity (including human capital accumulation)?
- Parameter sensitivity + policy entry points?



# Is there a model available?

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- Lucas (1988) with following extensions:
  - Labour inputs measured as healthy hours in efficiency units;
  - Healthy hours used for 3 purposes:
    - 1) final output (as in Lucas);
    - 2) human capital formation (as in Lucas);
    - 3) health production under decreasing returns (Baumol's law)
  - CIES with health and consumption per head in CD-sub-nesting



# Limitations Lucas +,++ model

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- Same as Lucas (highly stylised, aggregate approach)
- Focus on steady states rather than transitions between them (epidemiology  $\Leftrightarrow$  transitional dynamics, AIDS)
- No explicit epidemiology with differential rates of mortality for different health states
- Stable population in steady state by assumption

# Outline Lucas +,++ models

- Human capital formation

- Lucas:  $\hat{e} = \delta . u$  , Lucas+,++:  $\hat{e} = \delta . u . h$

- Per capita production function

- Lucas:  $y = ((1 - u) . e)^\alpha . k^{1-\alpha}$
- Lucas+,++:  $y = ((1 - u - v) . e . h)^\alpha . k^{1-\alpha}$

- Steady state health production function Lucas+,++

$$dh/dt = \delta_h (v . h)^\beta - \zeta . h \Rightarrow h = (\delta_h / \zeta)^{1/(1-\beta)} . v^{\beta/(1-\beta)} = z_0 . v^{z_1}$$

- Utility function:  $u = (h^\gamma c^{1-\gamma})^{1-\theta} / (1 - \theta)$

- Lucas, Lucas+ :  $\gamma = 0$  , Lucas ++:  $\gamma > 0$



# The Lucas +, ++ results

- Steady state growth rate:

- Lucas:  $\hat{c} = (\delta - \rho) / \theta$

- Lucas+:  $\hat{c} = (\delta \cdot h(v) \cdot (1 - v) - \rho) / \theta$

- Allocation human capital:

- Lucas:  $u = \hat{c} / \delta = (\delta - \rho) / (\delta \theta)$

- Lucas+: -  $v = \beta \Rightarrow$

- $u = (\delta \cdot h(\beta) \cdot (1 - \beta) - \rho) / (\delta \theta \cdot h(\beta))$

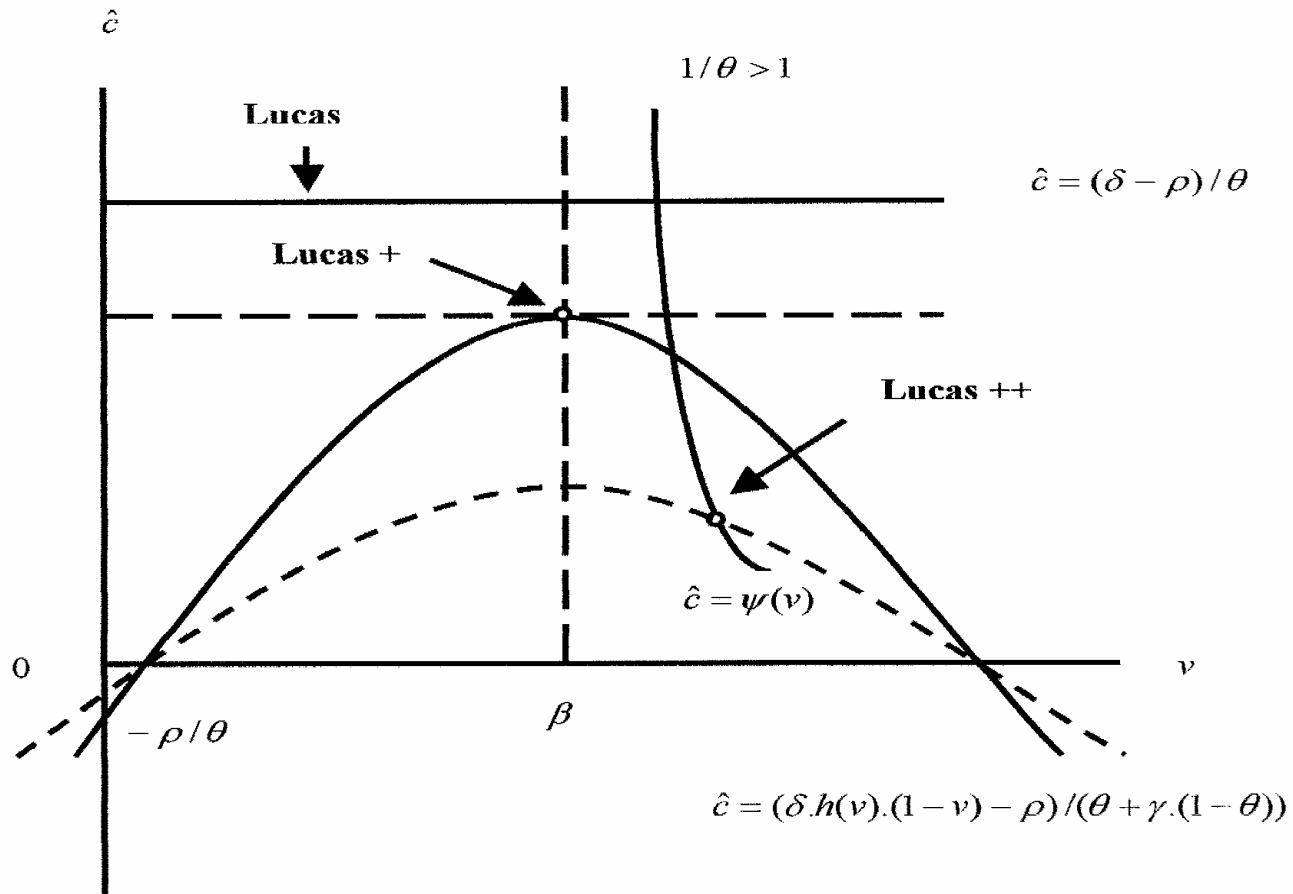
- $\partial \hat{c} / \partial v \big|_{v=\beta} = 0$

- Lucas++ : -  $\hat{c} = (\delta \cdot h(v) \cdot (1 - v) - \rho) / (\theta + \gamma \cdot (1 - \theta)) \} \Rightarrow v = v^*$

- $\hat{c} = \psi(v)$

- $u = (\delta \cdot h(v^*) \cdot (1 - v^*) - \rho) / (\delta \cdot (\theta + \gamma \cdot (1 - \theta)) \cdot h(v^*))$

# Lucas +, ++ in a graph



# Lucas++ in a table

Param	$c=C/Y$	$\hat{c}$	u	v	h
$\theta$	+	-	-	+	+
$\rho$	+	-	-	+	+
$\left\{ \begin{array}{l} \delta e \\ \delta h \end{array} \right.$	-	+	+	-	-
	-	+	+	-	+
$\zeta$	+	-	-	+	-
$\gamma$	+	-	-	+	+
$\beta$	?	?	?	+	+



# Lucas++: conclusions

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- Reactions to  $\delta e$  ,  $\delta h$  very similar  $\Leftrightarrow$  underlines health as complement to growth
- $\gamma'(y) > 0 \Rightarrow$  slowing down of productivity growth
- Longevity up through income per head up  $\Rightarrow$  wedge between health consumption and health production  $\Rightarrow$  slow down productivity growth, but not necessarily in growth welfare
- High rate of decay health  $\Rightarrow$ ? high discount rate, low IES  $\Rightarrow$  there might be a 'no growth, low health' trap?  $\Rightarrow$  role (foreign) aid in lowering rate of decay health, or increasing  $\delta e$  ,  $\delta h$  ?

# Under construction Lucas++++

## Main Features

- Epidemiology with differential rates of mortality sick/healthy people =>
  - Incidence depends negatively on **prevention activities**
  - Prevalence diseases => (prioritised) **care activities**
  - **2 health uses** + final output + human capital formation
- Endogenous growth rate population (depends on distribution sick/healthy + differential mortality rates)
- Lucas +++ = Lucas+ AND epidemiology AND 2 health activities (NB Lucas++++ = Lucas+++ AND  $\gamma > 0$  )
- Results Lucas +++ are similar to Lucas ++, but 'productivity' parameters of health sector are now linked explicitly to epidemiological parameters

# Under construction Lucas++++

## Some Preliminary results

- NB Results below pertain to Lucas +++ !
- 1) If incidence diseases down =>
  - Higher: growth population, consumption per head, health level, preventive activities
  - Lower: care, marginal propensity to consume
- 2) Average mortality sick down =>
  - Higher: growth population, prevention, care
  - Lower: growth consumption per head, health level, human capital formation
- 3) Care intensity up =>
  - Higher: demand for care
  - Lower: growth population, consumption per head, health level
- 4) Higher productivity human capital formation =>
  - Higher: growth population, consumption per head, health
  - Lower: care, marginal propensity to consume
- Effectiveness mix of 4) and 1) in countering 3) and 2) ?