When is a digging stick better than a plow? Boserup's Theory of Population and Technology

econ/demog 175
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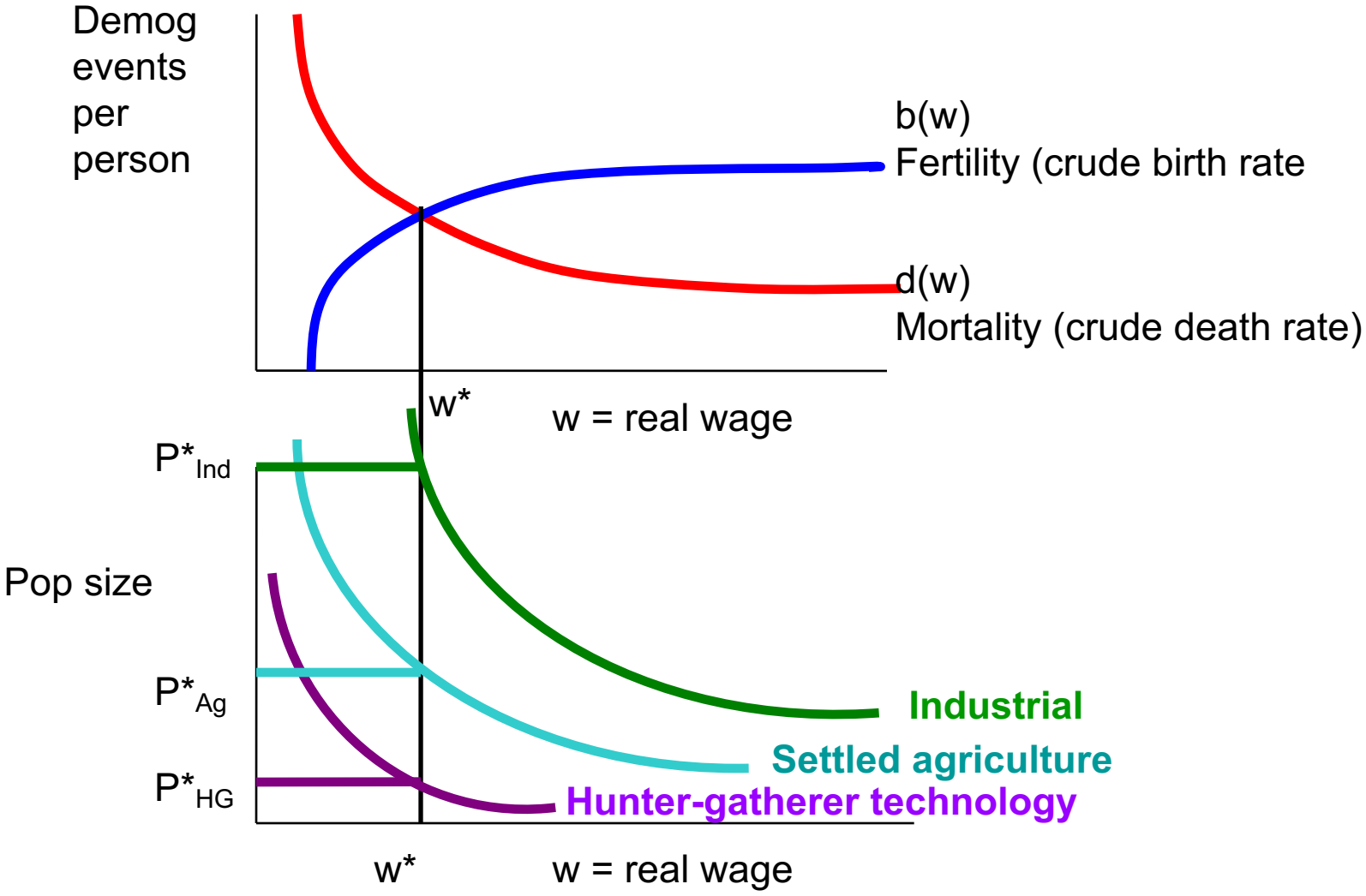
Agenda

- Two kinds of technological change (“new ideas” and “new uses of old ideas”)
- Agricultural Intensification (with pictures!)
- Agglomeration effects
- An ideal path of population growth?

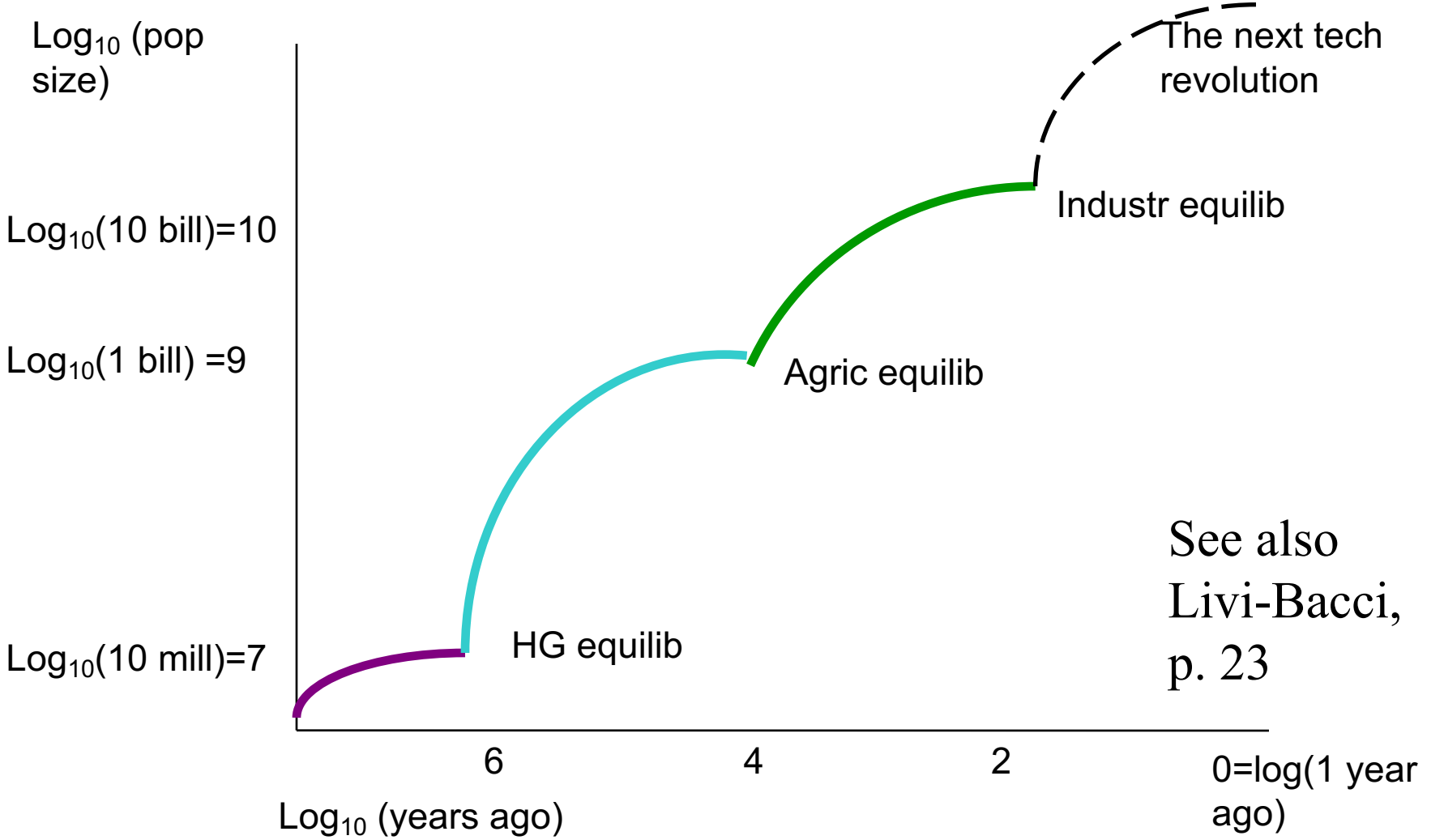
Technological Pull
and
Population Push

The "Technology-Pull" theory of population history (Malthus)



Courtesy of Ronald Lee, UC Berkeley, 2013

Technology-Pull interpretation unfolding in real historical time (Deevey diagram)



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The Boserup'ian alternative

- Not *Technology Pull*
  Techological change → Pop growth
- Rather, *Population Push*
  Pop growth → Technological change

A technology-population model typology

POPULATION	TECHNOLOGY: exogenous	TECHNOLOGY: endogeous
exogenous	(2) Solow	(3) Boserup
endogeous	(1) Malthus	Endogenous growth (e.g., Kremer, 1993; Galor & Weil 2000)

Note: A more complete typology would include "ECONOMY" (a good HW)

Boserup basics

- Population change is exogenous. A tendency for growth.
- Hardship in historical Europe the result of war, plague, and natural disaster (not over-population)
- Population increase drives agricultural and non-agricultural technological change
- A distinction between short-term and long-term technological change

How does population size drive technology?

1. **Intensification**
   - "No new ideas, just new applications"
   - Productivity per hour of work falls, so given same need for calories, must work harder.
   - Is a plow better than a digging stick?

     (Depends on density)
   - Dismal and Malthusian

Deeper technological change

2. **Invention**
   - "Some sticks better than others, some plows better than others"
   - Cumulative infrastructure (roads, metal industries, etc.)
   - A *virtuous* circle

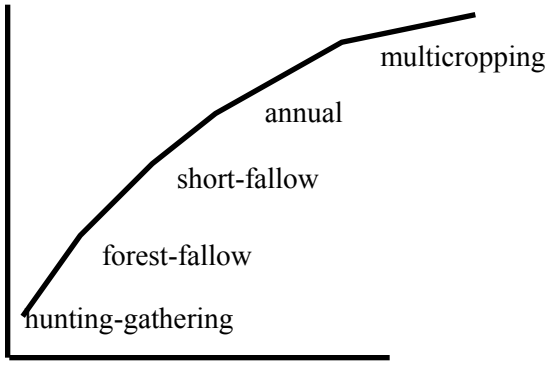
     (increasing density → better tech → increases surplus → increasing density → better tech → increases surplus → increasing density → → …)

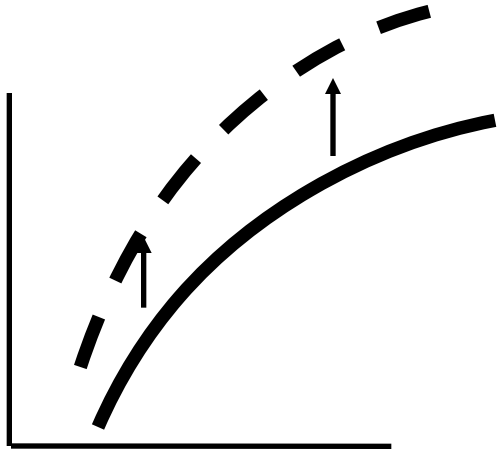
A picture distinguishes between the two

Intensification

Deeper invention

total output per acre





available labor (population)

Note: Smoothness of curve:
because can combine intensities
AND because declining marginal returns within technologies

iClicker

Which of the following are exogenous to Malthus's model?

A. wages

B. productivity-improving technology

C. agricultural intensification

D. population

E. More than 1 of the above

Intensification of vegetable food production

- Gathering — Wild plants, roots, fruits, and nuts
- Forest-fallow — 1 or 2 crops then 15-25 years fallow
- Bush-fallow — 2+ crops followed by 8-10 years fallow
- Short-fallow — 1 or 2 crops then 2 years fallow
- Annual cropping — 1 crop a year then few months fallow
- Multi-cropping — More than one crop per year, little or no fallow

Why FALLOW?
Regenerates soil nutrients
Can avoid weeding, just letting them grow
Burn weeds (providing nutrients)

Agricultural intensification slides (Photos courtesy of Ralph Coolman)

VERY LOW DENSITY …

- Extensive gardening, with easy access to forest for hunting and gathering

Brazil

SLASH AND BURN AGRICULTURE

Brazil

- A farmer planting tubers in a forest cleared by fire
- Minimize labor: Don't clear logs, let weeds and bushes grow.
- Clear more land when overgrown, or no longer productive

MULTICROPPING (AN EXPERIMENT)

- Rice and several other plants
- Can work same land year-round
- Multiple harvests
- Makes labor and capital investments more worthwhile: weeding, irrigation, fertilizing, etc.

Brazil

INTENSIVE RICE AGRICULTURE

- Huge investment in terraces
- Labor intensive planting
- Can get a lot from land
- Need very high density (or markets) to justify labor investments

Philippines

THE JOY OF GATHERING

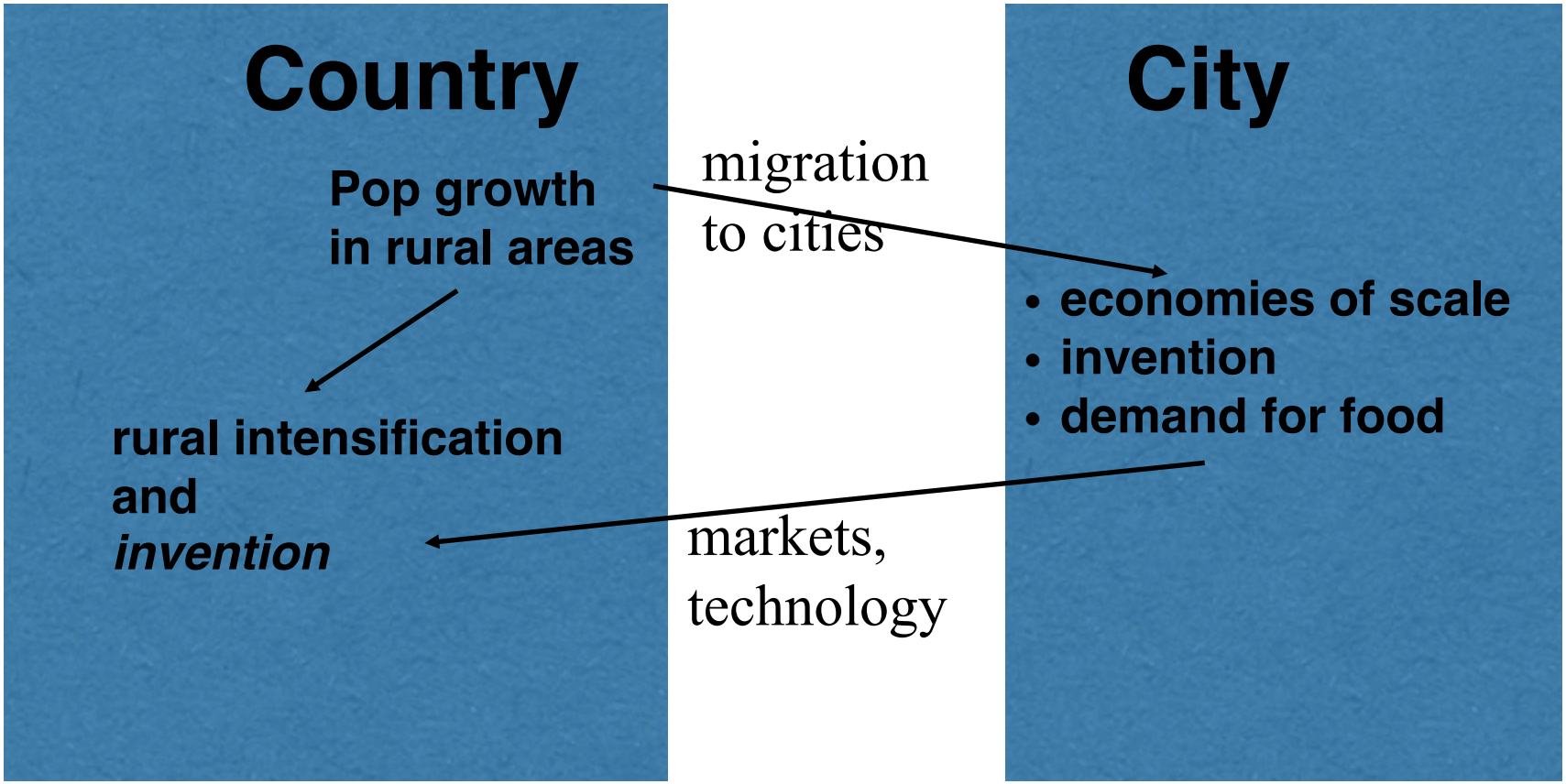
Does intensification mean more misery?

- Not in the Malthusian sense of higher mortality
- But yes, in our sense of having a lower amount of utility.
- Labor-leisure choice is simplified here (Leisure = Total_time – work_to_survive) you need to produce some amount of food, and work as much as you need to obtain it.

Non-agriculture (the cities)

- Higher density creates economies of scale
  - human capital: itinerant craftsman becomes local specialist, universities, …
  - physical capital: water / animal milling instead of everyone milling at home by hand
  - infrastructure: roads, canals
- Cities increase need for food from country
  - increase returns on capital investments in agriculture
  - (a precarious system — bad times, high prices AND labor shortage in country)

Town and Country



What is exogenous in Boserup's framework?

- Population
- Gradual pop increase (limited by European marriage pattern)
- Plagues/wars/failed harvests are exogenous, NOT caused by over-population

Intensification is not necessarily "progress"

- Hunters and gatherers work less, eat more meat → "invention of agriculture 8000 BC" perhaps more out of necessity
- Capital investment (draft animals, plows, harnesses) only make sense if frequent cropping
- No ratchet on intensive technology (For example, Europeans used slash and burn in New World)

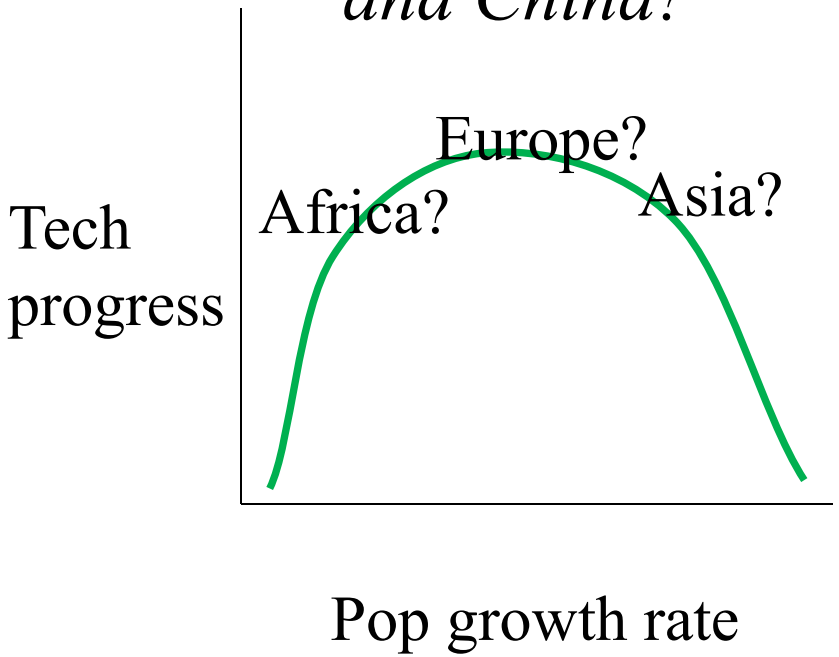
Invention leads to “progress”

- Better tools
- More infrastructure (saving of surpluses)
- Rising standards of living
- Know-how does ratchet

An ideal path of population growth?

- Grow too slowly and never achieve densities required for deeper technical progress
- Grow too quickly and are under constant Malthusian pressure (small surpluses, little capital)

Europe between Africa and China?



Boserup (and Malthus) causes of differential population density

- Positive check: Climate and disease?
- Preventive check: European marriage pattern, not in China?
- War and slavery: Boserup suggests that ”American slave raids” → African low population density “trap”

Homeostasis or path-dependence?

- We asked earlier if current population size was an *accident* resulted from a series of unpredictable events (wars, famines, discoveries, etc.)
- Or, if it was endogenously determined by demographic functions of population density (Malthus)
- From Malthus we got "homeostasis" (a self-regulating system in equilibrium)

Path-dependence

- By combining Boserup and Malthus, we get a 3rd possibility: *path-dependence*

$$\Delta pop \xrightarrow{\text{Boserup}} \Delta tech \xrightarrow{\text{Malthus}} \Delta pop \xrightarrow{\text{Boserup}} \Delta tech \xrightarrow{\text{Malthus}} \Delta pop \xrightarrow{\text{Boserup}} \Delta tech \xrightarrow{\text{Malthus}} \Delta pop \xrightarrow{\text{Boserup}} \ldots$$

- With Malthus the history is memory-less, but with Malthus and Boserup history remembers, and cumulates.

Boserup