DETERMINANTS OF ECONOMIC GROWTH AND INSTITUTIONS

CONTENT AND INTRODUCTION

David de la Croix, http://www.de-la-croix.be

Main question

- Since 1800, take-off, growth of income per capita and development in certain countries:
- See the video here

http://www.youtube.com/watch?v=jbkSRLYSojo

Summary of growth and development experience, in 5 minutes, with thousands of data

Some numbers

- Income per capita 2008 vs 1820
  - Western Europe
    22246 / 1234 = 18
    real growth was large
  - Africa
    1780 / 420 = 4
- Gap between Western Europe and Africa:
  1234 / 420 = 3 in 1820
  22246 / 1780 = 12 in 2008
- Source: Maddison data
  those numbers are in 1990 International Geary-Khamis dollars, i.e. corrected for inflation

Two aspects of development

- Income differences today reflect different timing of the take-off
- Big question: Why did some countries take-off before the others?
- Two sides of the same question:
  - *Chronological:* How can we understand the growth of the « rich » countries over a long period of time
  - *Cross-section*: How can we understand the income gap between rich and poor countries

Institutional development

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Together with income growth, change in institutional set-up:

- Rise of democracy
- Rise of gender equality
- "Growing public" : rise of the welfare state
- Change in family institutions (divorce etc.)
- Rise of markets and free trade
- …

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- Part I – The world before 1800
  - Chap 2 - The model of Malthus
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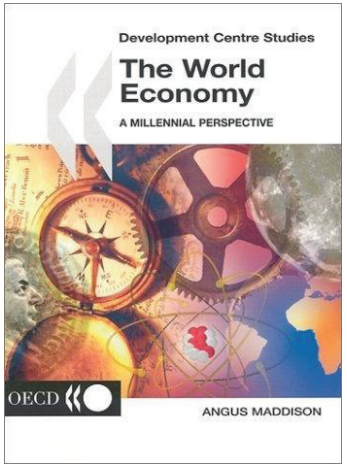
- Part III – The Transition from Stagnation to Growth
  - Chap 8 – Exogenous take-offs
  - Chap 9 – The rise in education
  - Chap 10 – The drop in fertility
  - Chap 11 – Endogenous take-offs

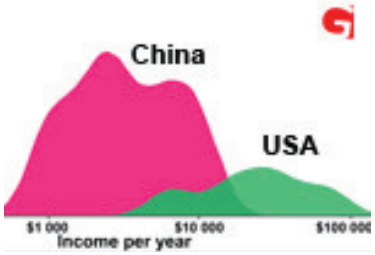
References - data



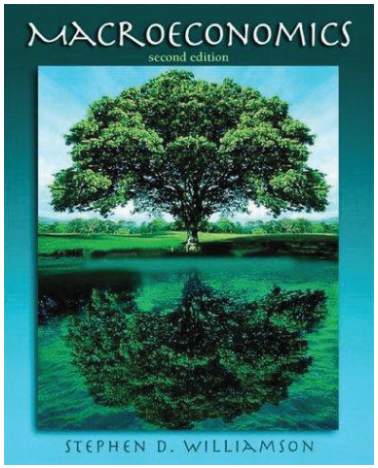
- Income and population in the world since the year 1000
- "Full of useful information and striking estimates. No better place to get a genuine feel for the economic history of the last millennia" (Amazon customer)
- Website: http://www.ggdc.net/MADDISON/oriindex.htm

References – data (2)

- A nice way of presenting tons of data: http://www.gapminder.org/downloads/
- Interactive presentations
- Videos http://www.gapminder.org/videos/

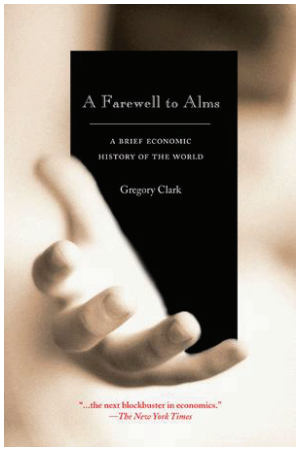


Models



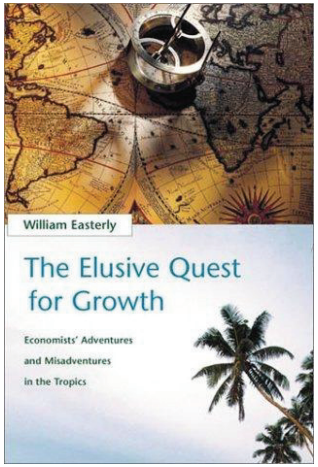
- macro book. Chapters 6 and 7 on growth.
- "Explains all the important intermediate macro concepts in an engaging, easy to follow, yet thorough way." (Amazon customer)

Models and data



- A Farewell to Alms asks the right questions and it is full of fascinating details. Clark's combination of passion and erudition makes his account engaging. (Bowles review in Science)
- The first part is the most complete analysis of the Malthusian world logic.

Nice applications



- Review of the factors and policies implemented to foster development: investment, education, control of population, etc…
- Both theory and practice

CHAPTER 1
ECONOMIC GROWTH AND DEVELOPMENT IN THE LONG-RUN

Growth over the very long run

- Additional readings
  - Jared Diamond "Guns, Germs, and Steel: The Fates of Human Societies"
  - David Landes "The Wealth and Poverty of Nations: Why Are Some So Rich and Others So Poor?"
  - Daniel Cohen, "La prospérité du vice"

- Homepages of economists working on long-run growth:
- Oded Galor, http://www.econ.brown.edu/fac/Oded_Galor/
- Gregory Clark, http://www.econ.ucdavis.edu/faculty/gclark/
- Samuel Bowles, http://tuvalu.santafe.edu/~bowles/
- Daron Acemoglu, http://econ-www.mit.edu/faculty/acemoglu/

In this introductory chapter

1. The take-off
2. The demographic transition
3. Welfare

1. The take-off

Income per capita: measures standard of living

Global data - very long term

J. Bradford DeLong, Estimating World GDP, One Million B.C. – Present, Department of Economics, U.C. Berkeley

Country data

A. Maddison, The World Economy – a Millennial Perspective, OECD

Real wages in England over more than 600 years !

Growth measurement

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- Real GDP per capita = Value added per inhabitant per year
  =average productivity per capita
  = average income per capita

Survival threshold: 400 dollars or euros per person per year (Maddison)

Other possible measures: stature, size of cities, calories intake, …

World GDP

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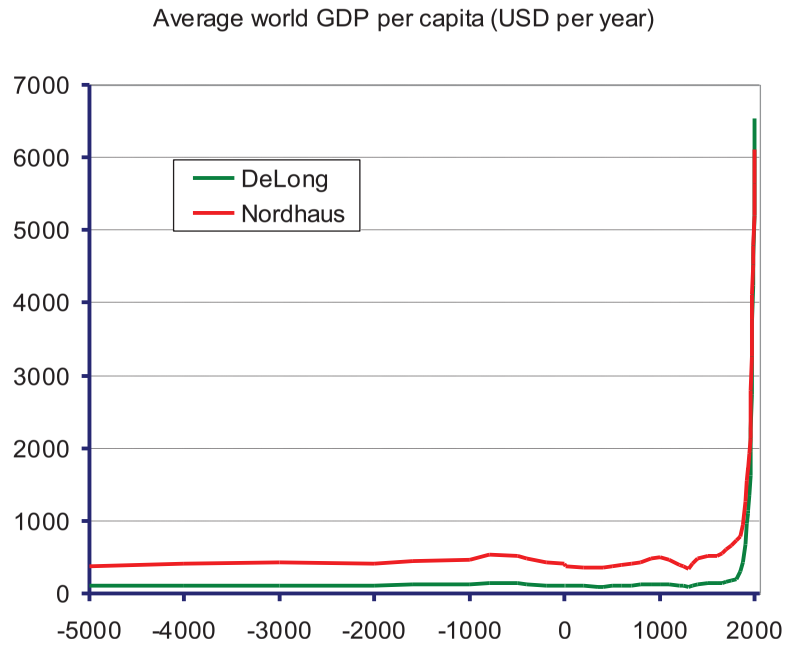
- Many sources: see **Estimating World GDP, One Million B.C. – Present**

http://www.j-bradford-delong.net/TCEH/1998_Draft/World_GDP/Estimating_World_GDP.html

- Methods
  - Start from today and backcast GDP assuming growth rates
  - Check using historical sources to compare standard of livings across time
- Example of difficulty
  - how to account for the invention / discovery of new goods ?
  - Delong put more weight on these goods and get a stronger growth



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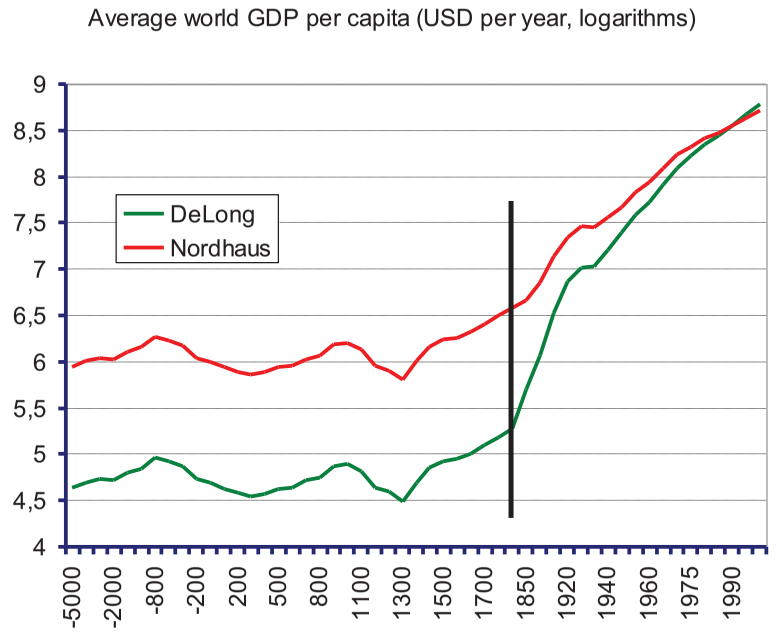

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Observations

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- Long stagnation of income per capital, close tu survival level, then growth during the last 2 centuries
- In 1800 the level of income per capita (and hence of productivity) was at best twice the level in the year 1.
- Even if the elite was living well, the huge majority of people was close to survival level.

Question

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- Do we believe into this stagnation ?
- We will provide more evidence
  - stagnation of height
  - historians estimates of wages in terms of wheat
  - wages in England over 800 years
  - infant mortality same for hunter gatherers as in 1800

Another measure of income!

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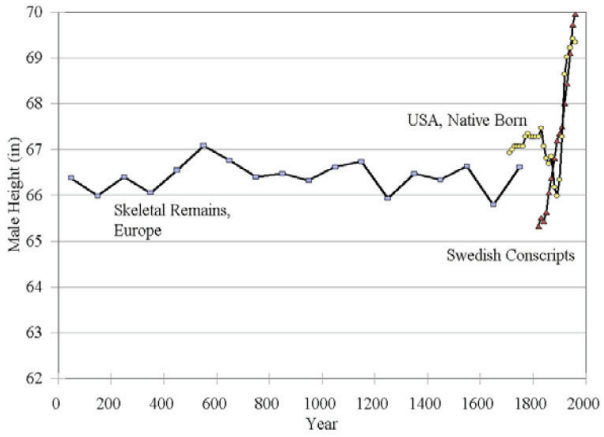

Source: Clark, Farewell To Alms

Figure 6 Male heights from skeletons in Europe, 1 AD to 2000[18]

Data from Maddison

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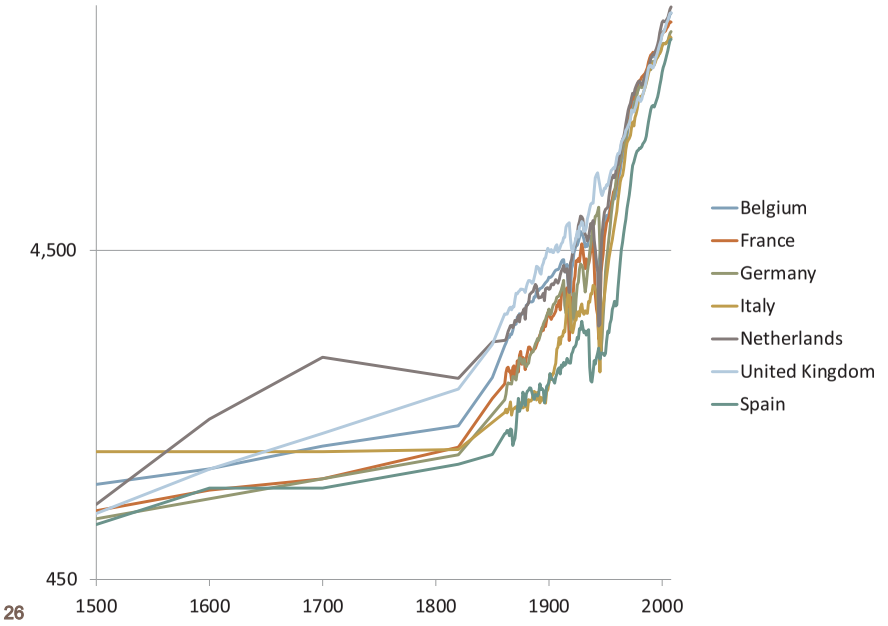
- By country
- Starting in 1820 + estimations at several dates starting in 1 CE
- Maddison dies in April 2010, read The Economist:

Maddison counting
Apr 29th 2010
From The Economist print edition

A long, passionate affair with numbers has finally come to an end



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Growth inEurope

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- 1500: Italy is the « richest » country
- 1600: The Netherlands has primacy
- 1700-1820: England emerges as a leader
  - Grows faster than any other country
  - Urbanization rises rapidly
- 1820-: acceleration in growth + convergence between European countries

City sizes (in thousands)

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- We retrieve a similar pattern in city size

	1500	1600	1700	1800	1850
Liege	20	30	45	55	76
Lyon	50	35	97	109	177
Koeln	45	40	40	41	110
Venice	100	151	138	138	127
Amsterdam	15	54	200	217	225
London	50	200	575	948	2236
Barcelona	20	32	34	100	220

Source: Bairoch et al. La population des villes européennes

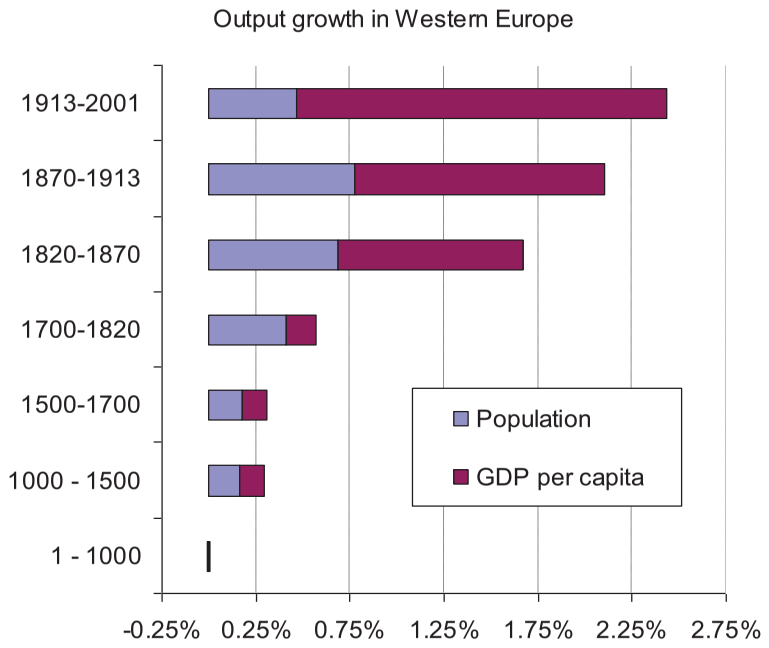
Population and GDP

- So far we have considered GDP per capita.
- But looking at extensive growth is also useful.
- GDP = GDP/pop x population
  Y = y N

Decomposition of GDP growth:

$\Delta Y/Y = \Delta y/y + \Delta N/N$

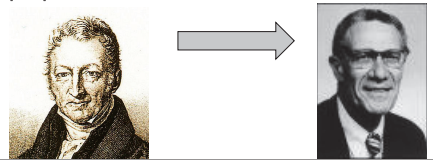
Two effects: Income per capita and population



Three « regimes »

- Until 1700: Malthusian stagnation
  - Income per capita constant
  - Slow growth of population
- Post-Malthusian regime:
  - Twin Acceleration: growth of population and growth of income per capita
- « Modern » growth:
  - Fast growth of income per capita
  - Deceleration in growth of population

From Malthus to Solow:



Real wage data

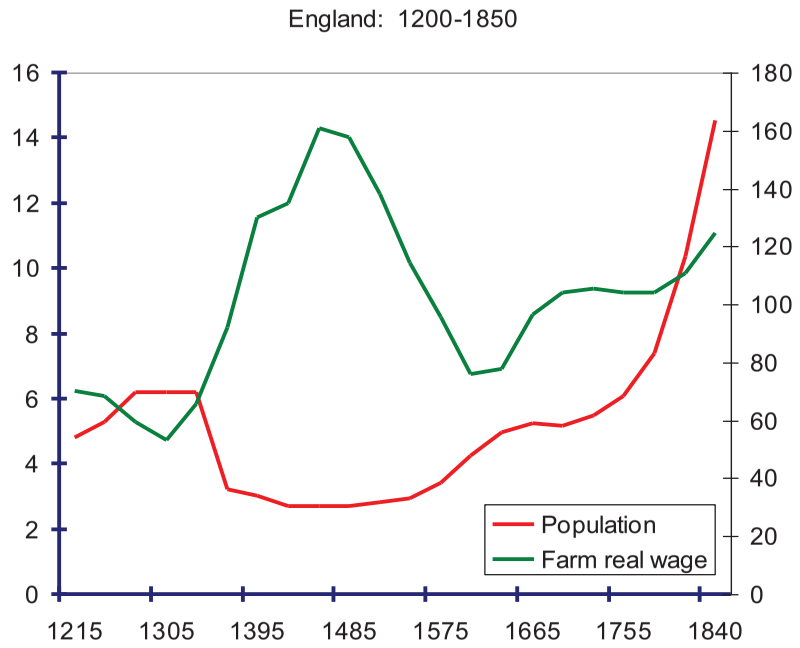
- Let us move to more micro data
- Gregory Clark computed daily real wages for farm laborers in England

G. Clark, **The Long March of History: Farm Laborers' Wages in England 1208-1850,** UC Davis

- With historical documents, Clark lists
  nominal daily wages
  prices for consumption goods
- He can deduce a real wage

Population data

- Population scientists have built a « population history of England »
- If age structure constant, number of laborers is proportional to population
- We can then compare real wages to labor input
- And see how England escaped from the « Malthusian » trap



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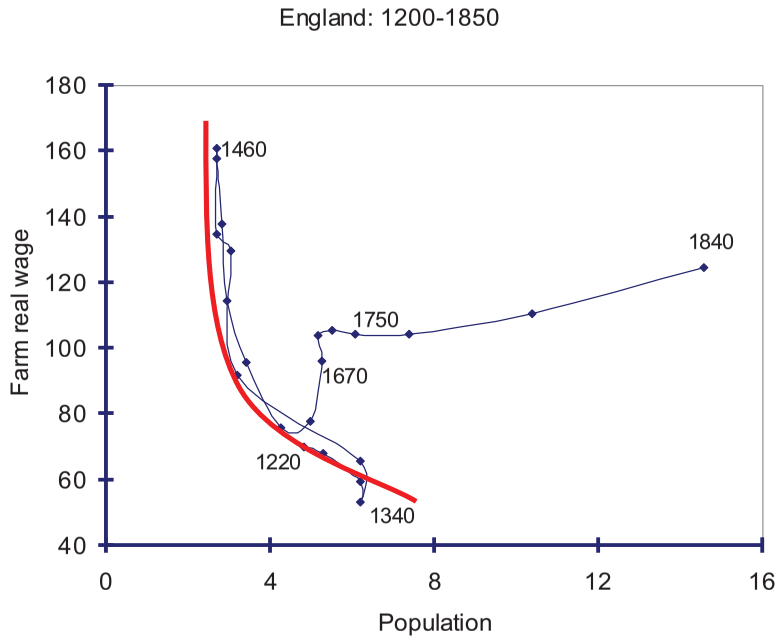

Observations

- Assuming workers are paid their productivity:

Red curve: law of marginal decreasing return.

- All observations from 1200 to 1650 are on the same curve - same production function.
- In 1700 real wages are 50% above the prediction of the red curve.
- After 1750, real wages continue to increase, despite increases in population size.

Back to econ 101

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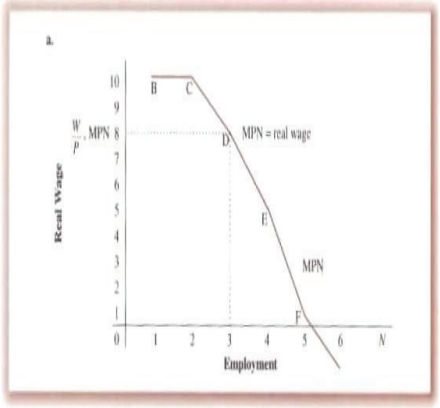
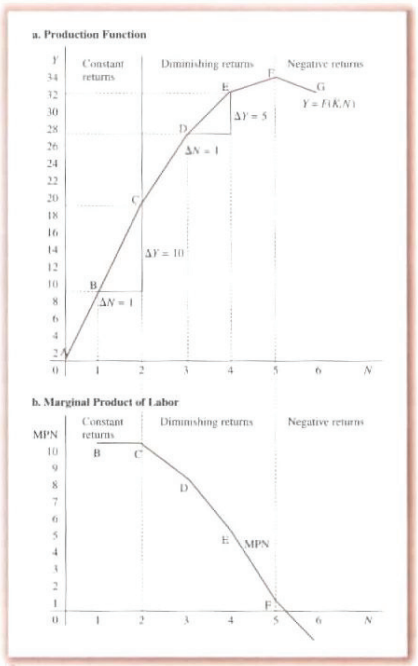
This is in line with the neo-classical labor demand curve





The labor market

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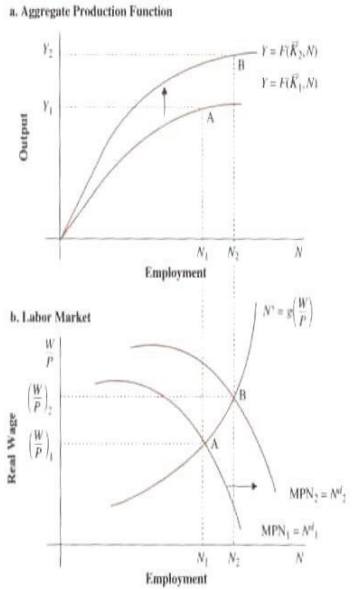
- Shifts in the curve are related to accumulation of capital or changes in technology
- While shifts along the curve occur when labor supply (population) changes



More from Clark …

- In his paper
  The Condition of the Working Class in England, 1209-2003
  (December, 2004)

- Clark proposes a real wage series for builders which extends up to 2003
- We retrieve the same picture as for world GDP: long stagnation (with the episode of the Black Death) then two centuries of growth

Figure 1: Real Builders Day Wages from 1200 to 2000

2. The demographic transition

- The transition from stagnation to growth is always followed by a « demographic transition »
- A shift from a situation

with stable population (or slightly increasing) with high fertility and high mortality

To a situation
with stable population
with low fertility and low mortality

Final question

- Income per capita (=productivity per capita) did not increase much before 1800
- Hard to understand given all the important inventions prior to 1800
  - Neolithic revolution 8500 BCE
  - Pottery 7900 BCE
  - Metal 5600 BCE
  - Writing 3200 BCE
  - Money (coins) 600 BCE
  - Plow 300 BCE
  - Zero 628 CE
  - Compass1190 CE
  - Printing 1454 CE

Some definitions

- Population: P_t
- Population dynamics:

$$P_{t+1}=P_t+B_t-D_t + M_t$$

Number of births: B_t, birth rate: $b_t=B_t / P_t$
(fertility rate: children born/woman)

Number of deaths: D_t, death rate: $d_t=D_t / P_t$
Net migrations: M_t, migration rate: $m_t=M_t / P_t$

- Growth rate of population:

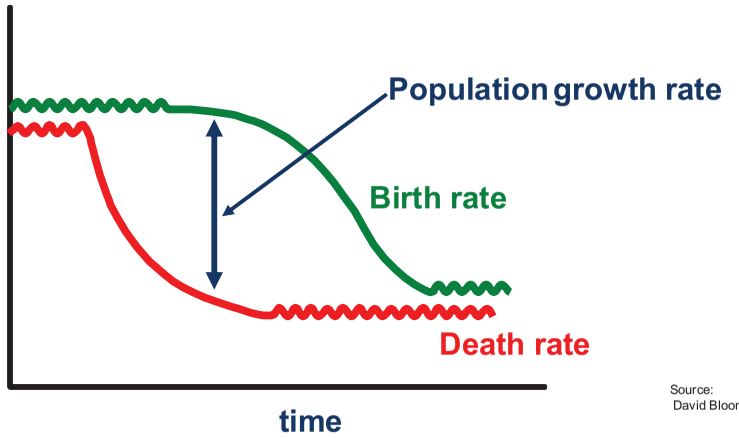
$P_{t+1} / P_t=1+n_t$ $\qquad$ $n_t = b_t - d_t + m_t$

Dynamics of the demographic transition

- mortality drops first,
- population increases during some time,
- until birth rates fell too

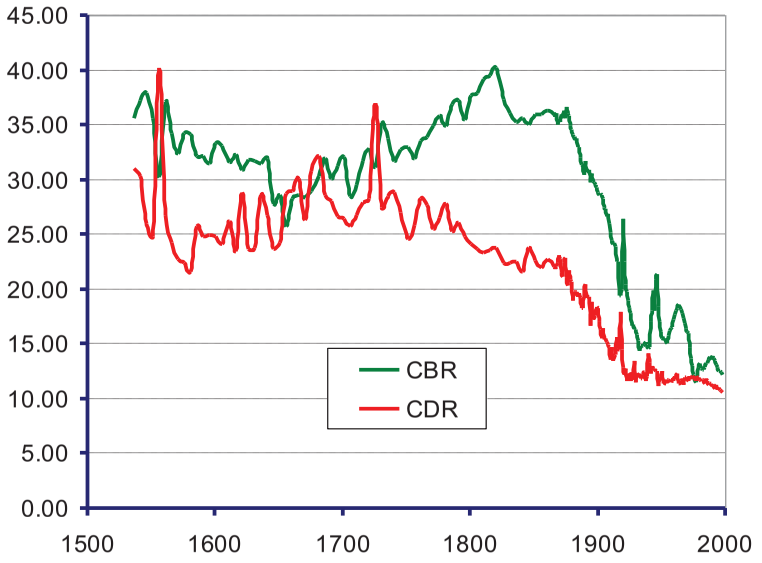
- Age structure effects of the transition:
  fewer children, more workers, more old later on

Schematic representation



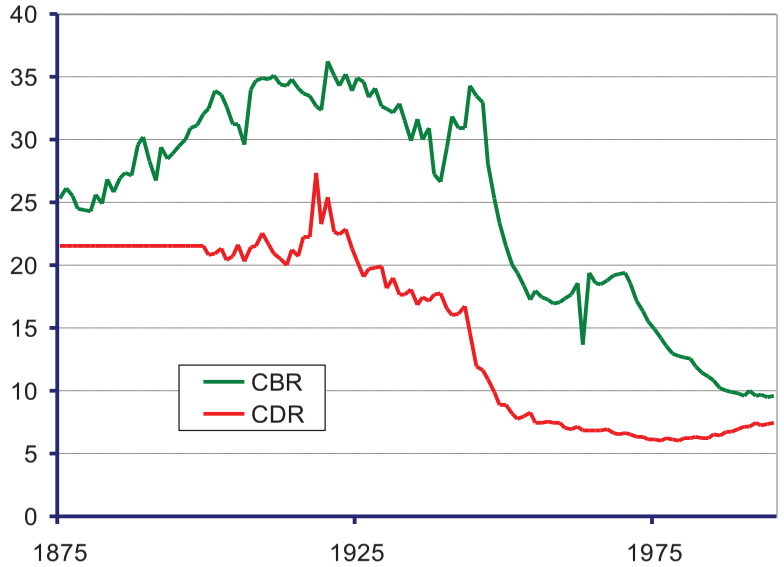
Source:
David Bloom

The English demographic transition



Source:
Wrigley et al. 1997
& Human mortality database

The Japanese demographic transition

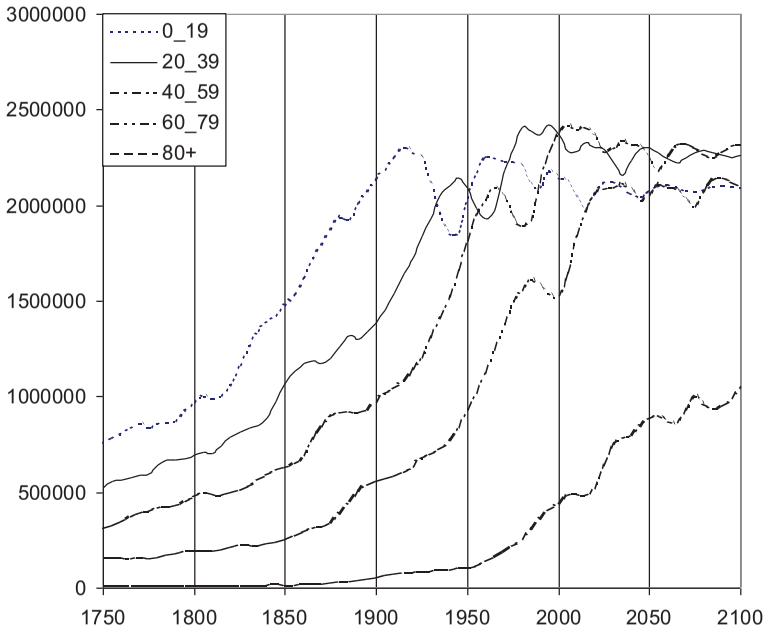


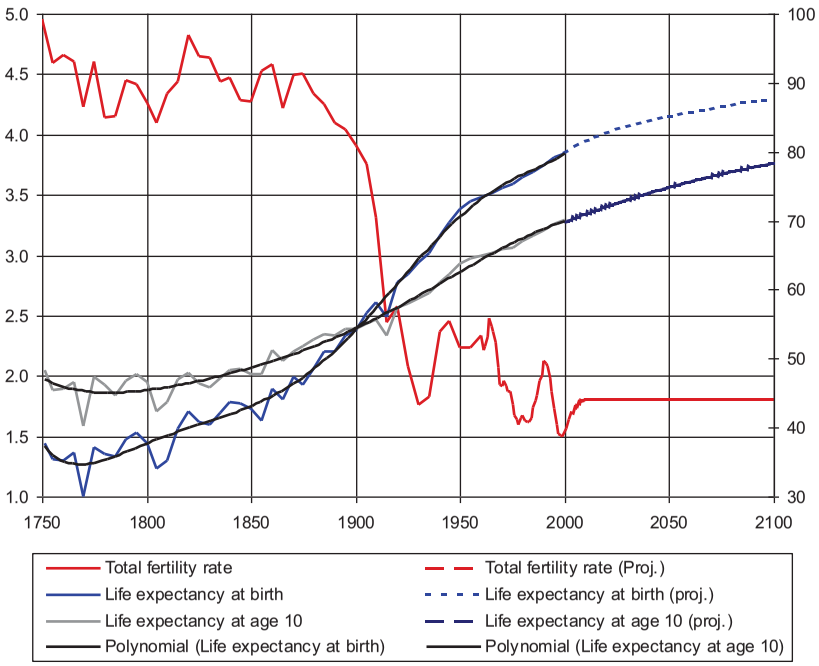
Length of the transition

- In England: two centuries
- In Japan: less than a century
- (sometimes even shorter, as in Taiwan)

- Demographic transition was first observed in Western Europe, then became generalized to the whole world. Sub-saharian Africa is next.

- Effet on age structure of population: example of Sweden.





Methods to compute life expectancy and fertility

- How do demographers calculate the mean length of life of a population, in other words its life expectancy, when all the people in the population are still alive and will not die until later?
  http://www.ined.fr/en/everything_about_population/animations/life_expectancy/
- Fertility refers to the average number of children born to women during their lifetime. How do we measure it for a given year in a country when we know the number of births in that year?
  http://www.ined.fr/en/everything_about_population/animations/fecondity/

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4. Welfare

Two additional – and broad - questions:

When did people realized that there was sustained growth ?

Does growth in income per capita means higher welfare?

Economic development: the concept exists since 1900

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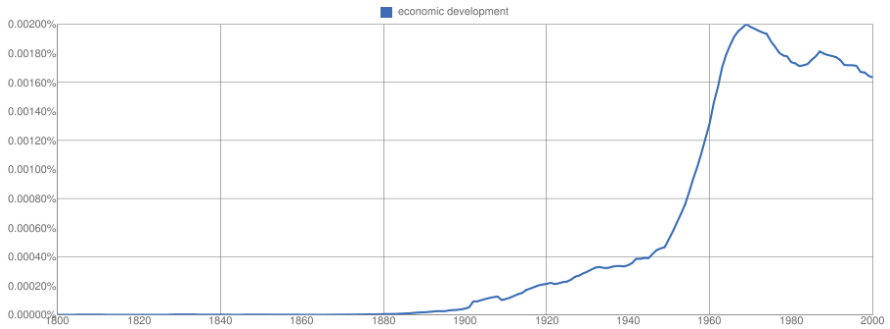

See how often phrases have occurred in the world's books over the years. Google Books has scanned over 10% of all books ever published, and now you can graph the occurrence of phrases up to five words in length from 1400 through the present day right in your browser.

Economic growth : a recent concept

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Growth and welfare

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- Some people think GDP per capita is a bad measure of welfare (or could even be negatively correlated with welfare)
- But, over le long-run, GDP per capita is correlated with many variables related to well-being
  - Life expectancy
  - 1/Infant mortality
  - Education
  - Leisure time
  - Gender equality
  - Democracy
  - Social protection systems

Income and happiness

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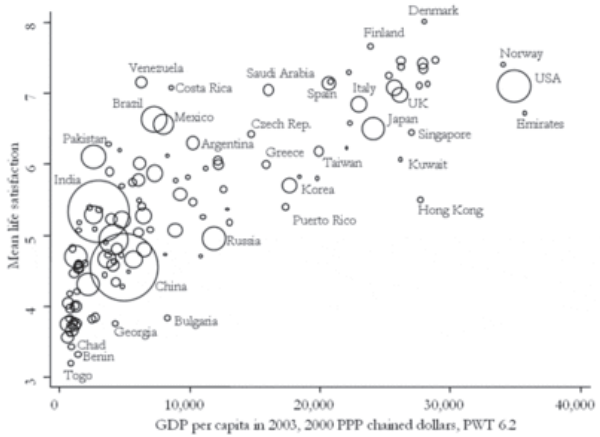

From http://economistsview.typepad.com/economistsview/2008/03/income-and-happ.html

PART I
THE WORLD BEFORE 1800

CHAPTER 2
THE MODEL OF MALTHUS

Malthus

- 1798
- No formal model but clear ideas - that we can express in a model - easier to understand
- *Essay on the Principle of Population*
- Paradox: THE Theoretician of stagnation comes just at the end of stagnation period

- Note: the model here is a very good example of how a simple set-up can be useful to answer questions

Malthus, outdated ? no

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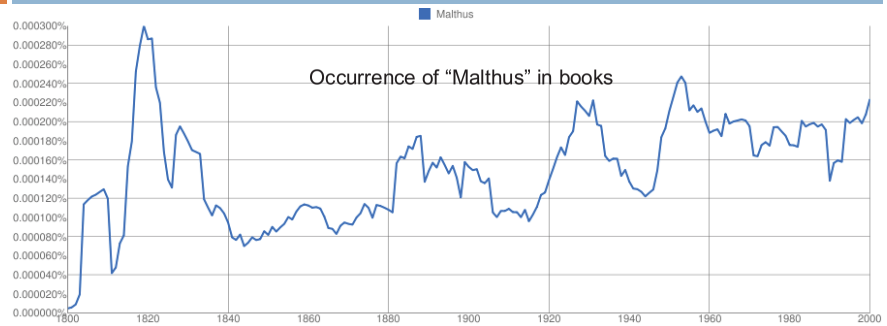


The Economist May 17th 2008: ``Malthus, the false prophet”
Could we understand the current rise in food price with Malthus approach ?
What are the limits to growth ?
Are the promotors of zero-growth Malthusian ?

Ideas

- Very pessimistic viewpoint:
  technical progress (in agriculture) always leads to population increase, never to rises in living standards (income per capita).
- To « force » gains in income per person, population control is necessary
- Consequences for institutions:
  - Institutions promoting productivity (e.g. good governance) will increase population in the long-run
  - Institutions promoting fertility and/or survival of children will deteriorate standard of living
  - High mortality will promote high standard of living. « The Three Horsemen of Riches: Plague, War and Urbanization in Early Modern Europe » (Voth &Voigtlander)

The model -Technology

- A representative firm
- Production function: $Y=z\,F(L, N^d)$
- L, land, is a fixed factor. The firm has to choose labor input N^d
- Total factor productivity (TFP) : z
- Marginal Productivity of labor:

$$z\,F_N(L,N^d)$$

TFP z

- The technological level z captures
  - the percentage of arable land,
  - soil quality, climate,
  - cultivation and irrigation methods,
- And, in a broader sense,
  - Public infrastructure (roads, rule of law,)
  - Access to markets
  - etc

Assumptions (1)

- Constant returns to scale:

$$z\,F(x\,L, x\,N^d) = x\,z\,F(L,N^d)$$

- F is increasing - more inputs gives more output:

$$z\,F_L(L,N^d)>0,\ z\,F_N(L,N^d)>0$$

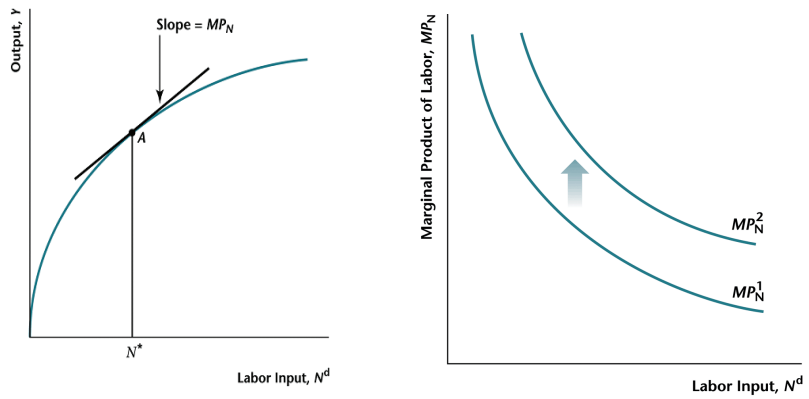
- Marginal returns are decreasing:

$$z\,F_{LL}(L,N^d)<0, \qquad z\,F_{NN}(L,N^d)<0$$

- The marginal productivity of one factor increases with the other factor:

$$z\,F_{LN}(L,N^d)>0$$

Figure



Firms' maximization

- If self employment, income is $Y/N = z\,F(L/N,1)$
- If landowner hire workers: Max $z\,F(L,N^d) - w\,N^d$

First order condition: $z\,F_N(L,N^d) = w$ (labor demand)

- Income for landowners:
  $Y - z\,F_N(L,N^d)\,N = z\,F_L(L,N^d)\,L$

Question: effect of population ++ on incomes ?

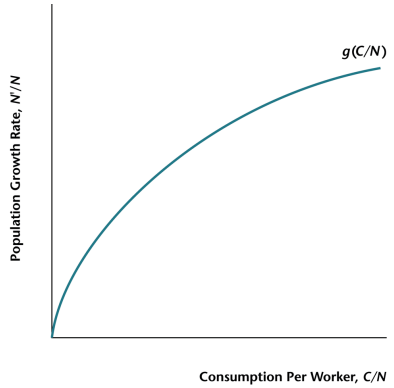
- - for self employed and workers,
- + for land owners
- - For the whole economy

Labor supply

- Each person supplies one unit of time inelastically
- Aggregate labor supply is equal to population (aged 15-65)
- Labor market clears: N^d = population

Fertility

- Ad-hoc modelling
- Population growth depends on consumption per capita: $N'/N = g(C/N)$
- Can be interpreted in terms of infant mortality (positive check)
- Can be interpreted in terms of fertility choice (preventive check)
- Function g() is concave, N'/N is bounded from above



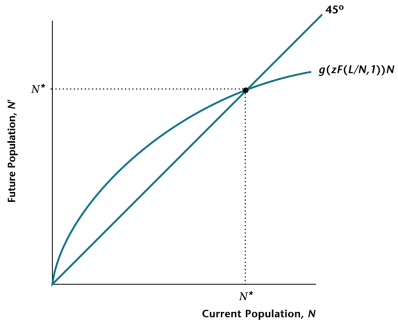
The equilibrium

- Goods market: Y=C, hence
- N'/N = g(z F(L,N)/N)
- Using constant returns to scale:

  z F(L,N)/N= z F(L/N,1)
- And hence N' = g(z F(L/N,1)) N
  This equation describes how population evolves as a function of the land / worker ratio

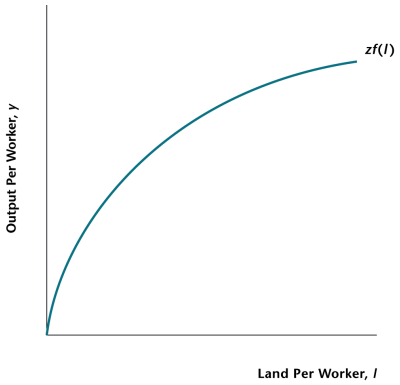
Steady state

- Steady state: when population is constant: N'=N= N^*
- N' = g(z F(L/N,1)) N
  N' concave function of N
- This steady state is globally stable
- Hence it is worthwhile to study its properties

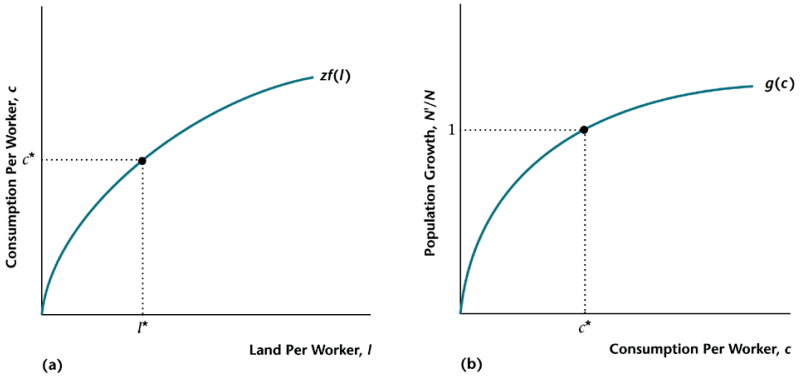


Steady state analysis

- variables per capita: y=Y/N, l=L/N, c=C/N
- Output per worker: y=z f(l)=z F(l,1)
- At equilibrium c=y, hence c=z f(l) and N'/N=g(c).
- The level c^* is the one corresponding to N'/N=1, N= N^*

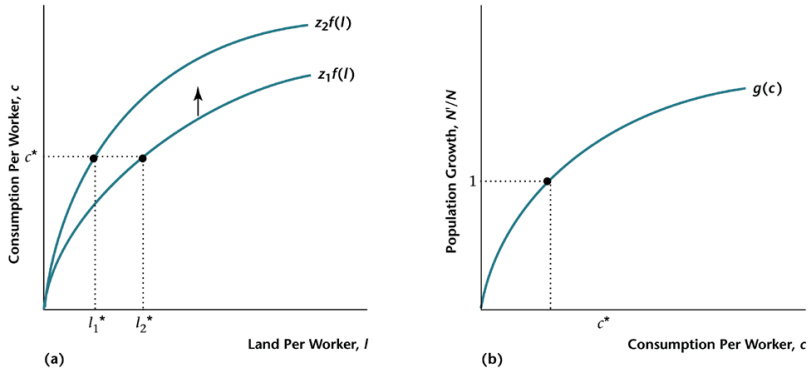


N'/N=1 → c^* → l^*



Key: panel (a) does not affect c^*

Increase in productivity - steady state

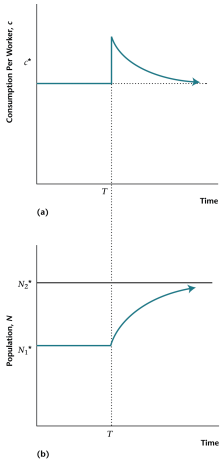


Increase in productivity (2)

- At steady state: Consumption per person stayed unchanged.
- Land per worker has diminished, which reflect that population is bigger
- All the increase in productivity has been « eaten » by an increase in population

Increase in productivity - dynamics

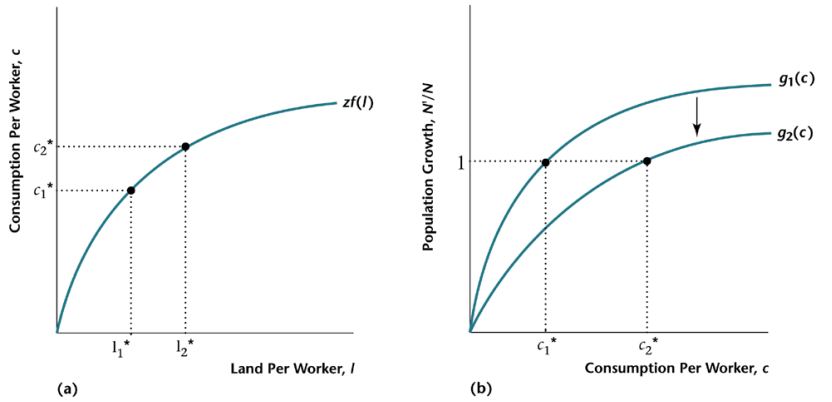
- A better technology first improves income, consumption and infant survival.
- Population increases, which reduces labor productivity and income (marginal decreasing returns)



Population control

- Reduce the growth rate of population for a given level of consumption per head (eg: one child policy in China)
- Shift in the function g()
- Consumption per head can increase in the long-run

Population control - steady state



Conclusion

- Technological improvements do not translate into growth in income per capita
- They generate a sustained (but slow) increase in population size
- There should be not much difference in income across countries; but difference in sizes (which reflects differences in mortality / fertility patterns)

Application: the world in 1500

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Source: Dynamics and Stagnation in the Malthusian Epoch: Theory and Evidence Ashraf and Galor

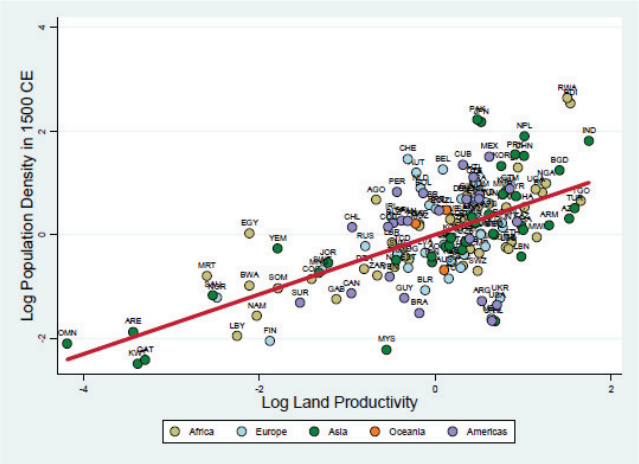
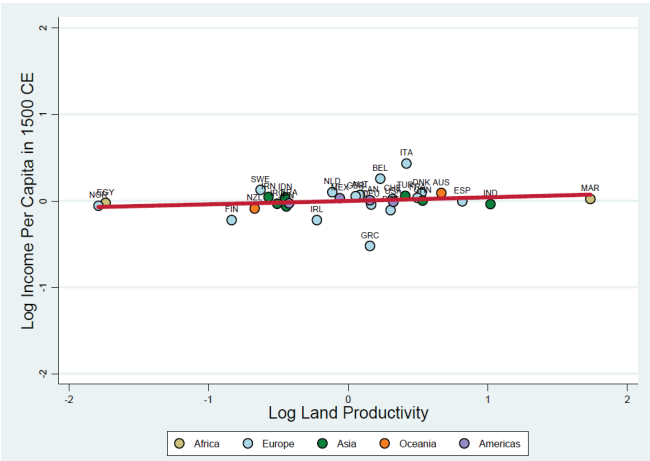


Figure 9b: Land Productivity and Population Density in 1500 CE

Ahraf et Galor - end

80



CHAP 3 – FACTS OF THE MALTHUSIAN ECONOMY

Map

- Living standards
- Fertility
- Mortality
- Technology
- Institutions

Test of the implications

- We show that the major implications of the Malthusian model hold true for the world in the years before 1800:
  - Slow growth of population
  - No trend in living standards
  - Living standards are determined by mortality and fertility
  - Good government cannot make countries rich except in the short run

Living standards

We have seen the picture of real wages in England from 1200 to 1800. Fluctuations are much more dramatic than long-run trends.

Stagnant material living standards does not mean low, neither the same everywhere.

Comparison between England and Malawi (poorest country?)

Table 3.2 Wages and Prices in Malawi, 2001–2002, and England, 1800

	England, 1800 (pence)	England, 1800 (units per day)	Malawi, 2001–02 (kwacha)	Malawi, 2001–02 (units per day)
Wage	23.9	—	69	—
Prices				
Flour (kilograms)	7.5	3.2	33	2.1
Bread (kilograms)	5.9	4.0	46	1.5
Potatoes (kilograms)	1.2	20.4	16	4.2
Beef (kilograms)	17.4	1.4	123	0.6
Eggs (dozen)	11.1	2.1	84	0.8
Milk (liters)	2.4	9.9	48	1.4
Sugar (kilograms)	26.3	0.9	42	1.7
Beer (liters)	4.1	5.8	93	0.7
Tea (kilograms)	219.5	0.1	248	0.3
Salt (kilograms)	9.1	2.6	24	2.8
Cost of English basket	23.9	1.0	178	0.4

Sources: England: Clark, 2007b. Malawi: International Labour Organization, Bureau of Statistics, 2006a.

Basket comparisons

- Columns (3) and (5) indicate how much good a worker can purchase with his/her day wage
- Cost of the food basket (only food but food 75% of whole basket).
- A Malawian can only afford 40% of the 1800 English worker basket

Table 3.1 Expenditure Shares of Laborers before 1800

Category of expenditure	Share (%)
Food and drink	75
Grains and starches	44
Dairy	10
Meat	9
Drink	8
Sugar and honey	3
Salt and pepper	1
Clothing and bedding	10
Housing	6
Heating	5
Light and soap	4

A cynical implication

- Reductions in mortality thanks to foreign aid in very poor countries since 1950
- Side effect: population is increasing fast, and in a Malthusian world this depresses standard of livings
- Aids: has reduced life expectancy, but could it generate higher living standards? (« the gift of the dying »)

Table 3.3 Comparative Incomes per Person, 2000

Country	Population, 2000 (millions)	Income per person (2005 $)	Relative income (%)	Population growth rate (%)	Life expectancy at birth, 2003
Tanzania	34	569	20	2.1	46
Burundi	7	717	25	2.9	44
Ethiopia	64	832	29	2.3	48
Sierra Leone	5	849	30	2.3	41
Malawi	10	935	33	2.4	40
Nigeria	127	956	34	2.4	43
Zambia	10	972	34	2.1	38
Madagascar	16	1,014	36	3.0	55
Rwanda	9	1,129	40	2.4	44
Burkina Faso	11	1,141	40	3.0	48
Mali	11	1,150	41	2.3	48
Benin	6	1,417	50	2.7	54
Kenya	30	1,525	54	2.6	47
Ghana	19	1,590	56	2.1	57
Nepal	23	1,809	64	2.2	62
Senegal	10	1,945	69	2.3	56
Bangladesh	131	2,052	73	2.2	63
Nicaragua	5	2,254	80	2.0	70
Côte d'Ivoire	16	2,345	83	2.0	46
Pakistan	138	2,497	88	2.2	63
Honduras	6	2,505	89	2.3	68
Moldova	4	2,559	90	0.3	68
Cameroon	15	2,662	94	2.0	46
England pre-1800	—	2,828	100	0.1	37
Zimbabwe	13	3,016	107	0.6	37
India	1,016	3,103	110	1.4	63
Bolivia	8	3,391	120	1.6	64
China	1,259	4,446	157	0.6	72

Sources: Income: Heston et al., 2006. Population: United Nations, 2006. Life expectancy: preindustrial England, table 5.2; others, United Nations, Development Program, 2005, 220–22.

No trend in living standard

- No improvement as we approach 1800
  - Look at Ancient societies
  - Look at societies around 1800
- No systematic difference in living standard as a function of time
- Additional ways to measure standards of living:
  - Calories and Protein: England 1820 compared to modern forager societies (hunter-gatherers)
  - Engel's law: share of income spent on basic food
  - Stature – height

=> Variability but no trend

Table 3.4 Laborers' Wages in Wheat Equivalents

Location	Period	Day wage (pounds of wheat)
Ancient Babylonia[a]	1800–1600 BC	15*
Assyria[b]	1500–1350 BC	10*
Neo-Babylonia[a]	900–400 BC	9*
Classical Athens[c]	408 BC	30
	328 BC	24
Roman Egypt[d]	c. AD 250	8*
England[e,f]	1780–1800	13
	1780–1800	11*

Sources: [a]Powell, 1990, 98; Farber, 1978, 50–51. [b]Zaccagnini, 1988, 48. [c]Jevons, 1895, 1896. [d]Rathbone, 1991, 156–58, 464–45. [e]Clark, 2005. [f]Clark, 2001b.
Note: * denotes farm wage.

Table 3.5 Laborer's Wages in Wheat Equivalents, circa 1800

Location	Period	Day wage (pounds of wheat)
Amsterdam[a]	1780–1800	21
Istanbul[b]	1780–1800	18
London[c]	1780–1800	16
Antwerp[a]	1780–1800	16
Cairo[b]	1780–1800	15
England[c]	1780–1800	13
Warsaw[a]	1780–96	13
Leipzig[a]	1780–1800	13
Danzig (Gdansk)[a]	1780–1800	11
England[d]	1780–1800	11*
Vienna[a]	1780–1800	10
Paris[c]	1780–1800	10
Madrid[a]	1780–99	9.0
Naples[a]	1780–1800	7.6
Valencia[a]	1780–85	6.8
China (Yangzi Delta)[f]	1750–1849	6.6*◊
Korea[g]	1780–99	6.0◊
Milan[a]	1780–1800	5.6
South India[f]	1750–90	5.1◊
Japan (Kyoto)[h]	1791–1800	4.5◊

Sources: [a]Allen, 2001, 411, note 1. [b]Pamuk, 2005, 224. [c]Clark, 2005. [d]Clark, 2001b. [e]Van Zanden, 1999, 181–85. [f]Broadberry and Gupta, 2006, 17, 19. [g]Ho and Lewis, 2006, 229. [h]Bassino and Ma, 2005, appendix table 1, assuming 45 pounds of wheat flour per 60 pounds of wheat.
Note: Silver wages in Europe 1780–1800 were deflated by the wheat prices in the Allen-Unger data set. * denotes farm wage. ◊ denotes the wheat equivalent of the rice wage, converting by the relative calorie content of wheat and rice.

Table 3.6 Calories and Protein per Capita

Group	Period	Kilocalories	Grams protein
England, farm laborers[a]	1787–96	1,508	27.9
England, all[a]	1787–96	2,322	48.2
Belgium, all[b]	1812	2,248	—
Ache, Paraguay[c]	1980s	3,827	—
Hadza, Tanzania[d]	—	3,300	—
Alyware, Australia[d]	1970s	3,000	—
Onge, Andaman Islands[d]	1970s	2,620	—
Aruni, New Guinea[e]	1966	2,390	—
!Kung, Botswana[c]	1960s	2,355	—
Bayano Cuna, Panama[f]	1960–61	2,325	49.7
Mbuti, Congo[d]	1970s	2,280	—
Anbarra, Australia[d]	1970s	2,050	—
Hiwi, Venezuela[c]	1980s	1,705	64.4
Shipibo, Peru[g]	1971	1,665	65.5
Yanomamo, Brazil[h]	1974	1,452	58.1

Sources: [a]Clark et al., 1995, 223–34. [b]Bekaert, 1991, 635. [c]Hurtado and Hill, 1987, 183; Hurtado and Hill, 1990, 316. [d]Jenike, 2001, 212. [e]Waddell, 1972, 126. [f]Bennett, 1962, 46. [g]Bergman, 1980, 205. [h]Lizot, 1977, 508–12.

Table 3.7 Share of Different Products in Food Consumption of Farm Workers

Location	Period	Cereals and pulses (%)	Sugar (%)	Animal products, fats (%)	Alcohol (%)
England[a]	1250–99	48.0	0.0	40.2	11.8
	1300–49	39.7	0.0	43.0	17.0
	1350–99	20.8	0.0	55.3	24.0
	1400–49	18.3	0.0	46.4	34.3
England[b]	1787–96	60.6	4.7	28.4	1.3
Japan[c]	ca. 1750	95.4	0.0	4.6	0.0
India[d]	1950	83.3	1.6	5.4	0.8

Sources: [a]Dyer, 1988. [b]Clark et al., 1995. [c]Bassino and Ma, 2005. [d]Government of India, Ministry of Labour, 1954, 114, 118.

Table 3.8 Estimated Average Height of Adult Males in Preindustrial Societies

Period	Location	Type	Ages	Height (centimeters)
1830s	Sweden[a]	Soldiers	Adult	172
1710–59*	England[b]	Convicts	23–60	171
		Indentured servants	23–60	171
1830s	England[a]	Soldiers	Adult	169
	Northern Italy[a]	Soldiers	25–40	167
	Bavaria[a]	Soldiers	Adult	167
	France[a]	Soldiers	Adult	167
	Netherlands[a]	Soldiers	Adult	167
1770–1815	England[c]	Convicts	23–49	166
1830s	Hungary[a]	Soldiers	Adult	166
	Austria[a]	Soldiers	Adult	164
1819–39	West Africa (Yoruba)[d]	Slaves	25–40	167
	Mozambique[d]	Slaves	25–40	165
	West Africa (Igbo)[d]	Slaves	25–40	163
1800–29*	Southern China[e]	Convicts	23–59	164
1843	Southern India[f]	Indentured servants	24–40	163
1842–44	Northern India (Bihar)[f]	Indentured servants	24–40	161
1883–92	Japan[g]	Soldiers	20	159

Sources: [a]A'Hearn, 2003, table 3. Adjusted to adult heights. [b]Komlos, 1993, 775. [c]Brennan et al., 1997, 220. [d]Eltis, 1982, 459–60. Slaves freed from ships transporting them. [e]Morgan, 2006, table 4a. [f]Nicholas and Steckel, 1991, 946. [g]Yasuba, 1986, 223. Adjusted from age 20 to adult heights.
Note: * denotes birth years.

Note: An **indentured servant** is a laborer under contract of an employer for some period of time, usually three to seven years, in exchange for their transportation, food, drink, clothing, lodging and other necessities. Unlike a slave, an indentured servant was required to work only for a limited term specified in a signed contract.

Lessons from height

- Pre industrial Asia poorer than pre industrial Europe
- Africa: not far below Europe; way above Asia. high death rates from tropical diseases – high material living standards

Table 3.9 Heights of Adult Males in Modern Foraging and Subsistence Societies

Period	Group	Location	Ages	Height (centimeters)
1892	Plains Indians[a]	United States	23–49	172
1970s	Anbarra[b]	Australia	Adults	172*
	Rembarranga[c]	Australia	Adults	171*
1910	Alaskan Inuit[d]	United States	Adults	170*
1890	Northern Pacific Indians[e]	United States	Adults	167*
1944	Sandawe[f]	Tanzania	Adults	167*
1891	Shoshona[g]	United States	20–59	166
1970s	Fox Basin Inuit[c]	Canada	Adults	166*
1880s	Solomon Islanders[h]	Solomon Is.	Adults	165*
1906	Canadian Inuit[d]	Canada	Adults	164*
1969	!Kung[i]	Bostwana	21–40	163
1980s	Ache[j]	Paraguay	Adults	163*
1970s	Hadza[c]	Tanzania	Adults	163*
1985	Hiwi[j]	Venezuela	Adults	156*
1980s	Batak[c]	Philippines	Adults	155*
	Agta[c]	Philippines	Adults	155*
	Aka[c]	Central African Republic	Adults	155*

Sources: [a]Steckel and Prince, 2001. [b]Kelly, 1995, 102. [c]Jenike, 2001, 223. [d]Hawkes, 1916, 207. [e]Boaz, 1891, 327. [f]Trevor, 1947, 69. [g]Boaz, 1899, 751. [h]Guppy, 1886, 267. [i]Truswell and Hansen, 1976, 172. [j]Hurtado and Hill, 1987, 180–82.
Notes: * denotes heights adjusted to ages 21–40. The heights of all !Kung males averaged 2 centimeters less than those aged 21–40.

Table 3.10 Heights from Skeletal Remains by Period

Period	Location	Observations	Height (centimeters)
Mesolithic[a]	Europe	82	168
Neolithic[a,b]	Europe	190	167
	Denmark	103	173
1600–1800[c]	Holland	143	167
1700–1800[c]	Norway	1,956	165
1700–1850[c]	London	211	170
Pre-Dynastic[d]	Egypt	60	165
Dynastic[d]	Egypt	126	166
2500 BC[e]	Turkey	72	166
1700 BC[f]	Lerna, Greece	42	166
2000–1000 BC[g]	Harappa, India	—	169
300 BC–AD 250[h]	Japan (Yayoi)	151	161
1200–1600[h]	Japan (medieval)	20	159
1603–1867[h]	Japan (Edo)	36	158
1450[i]	Marianas, Taumako	70	174
1650[i]	Easter Island	14	173
1500–1750[i]	New Zealand	124	174
1400–1800[i]	Hawaii	—	173

Sources: [a]Meiklejohn and Zvelebil, 1991, 133. [b]Bennike, 1985, 51–52. [c]Steckel, 2001. [d]Masali, 1972. [e]Mellink and Angel, 1970. [f]Angel, 1971. [g]Houghton, 1996, 43–45. [h]Boix and Rosenbluth, 2004, table 6. [i]Dutta, 1984.

Polynesia

- Very low technology: e.g. no metal
- High stature
- Surprisingly not much diseases
- But high mortality from warfare and infanticide

Fertility

Fertility not at maximum

Why ?

There was some fertility control

Different across societies

<> View of the demographs according to which many births are non voluntary

Slow growth of population

- Maximum fertility per women ?? 12 and more
- Before 1800, surviving children was just about two
- World population:
  - 0.1 million in 130000 BCE
  - 770 million by 1800
  - This gives 2.005 surviving children per women

Surviving children

Table 2.1 Populations in Western Europe, 1300 and 1800

Location	Population ca. 1300	Population ca. 1800	Surviving children per woman
Norway[a]	0.40	0.88	2.095
Southern Italy[b]	4.75	7.9	2.061
France[c]	17.0	27.2	2.056
England[d]	5.8	8.7	2.049
Northern Italy[b]	7.75	10.2	2.033
Iceland[a]	0.084	0.047	1.930

Sources: [a]Tomasson, 1977, 406. [b]Federico and Malanima, 2004, table 4. [c]Le Roy Ladurie, 1981, 13. [d]Clark, 2007a, 120.

A benchmark

- The Hutterites, Anabaptists of German origin, now in Canada, with
  - Early marriage
  - No fertility limitation within marriage
  - Good health

Fertility in Europe

Table 4.1 Annual Birth Rate, Married Women, Europe before 1790

Country or group	Birth rate at age: *20–24*	*25–29*	*30–34*	*35–39*	*40–44*	All births (20–44)
Hutterites	0.55	0.50	0.45	0.41	0.22	10.6
Belgium	0.48	0.45	0.38	0.32	0.20	9.1
France	0.48	0.45	0.40	0.32	0.16	9.1
Germany	0.45	0.43	0.37	0.30	0.16	8.6
Switzerland	0.45	0.38	0.34	0.22	0.16	7.8
Scandinavia	0.43	0.39	0.32	0.26	0.14	7.7
England	0.43	0.39	0.32	0.24	0.15	7.6

Source: Flinn, 1981, 86.

Fertility control in Europe

- European marriage pattern
  - Late average age of first marriage for women
  - Many women never marry (10 to 25%)
  - Low illegitimacy rates (3 % of births)

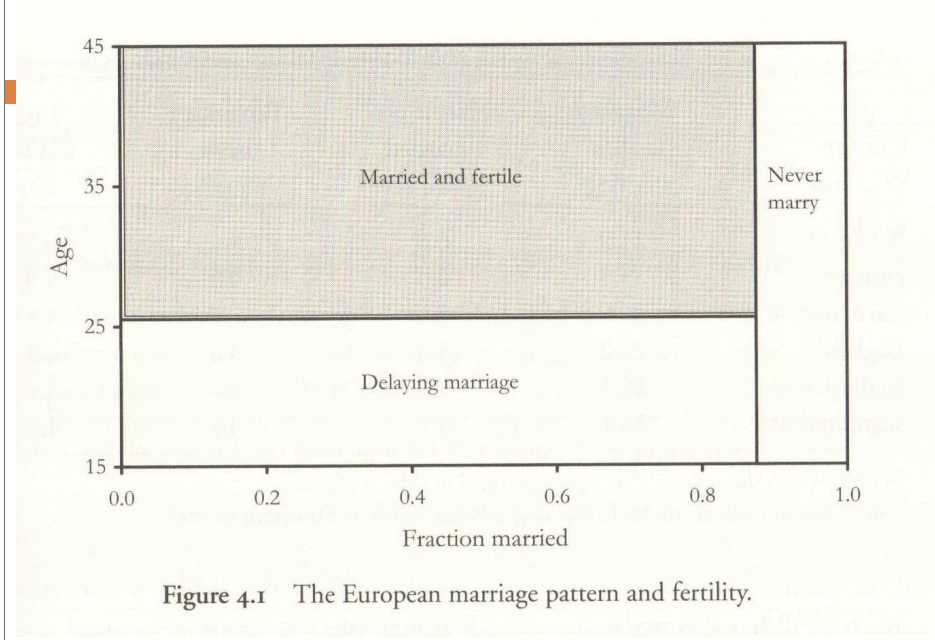


Figure 4.1 The European marriage pattern and fertility.

A possible reason for this scheme

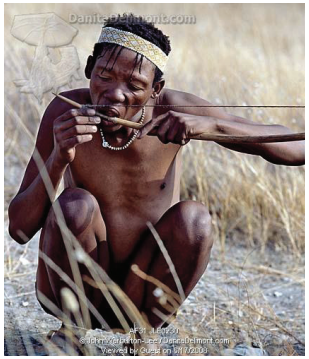
- 2 technologies: Grain and horn
- Women have a comparative advantage in the sector "horn"
- "horn" sector is more land intensive
- After the black death, L/N increases, horn sector becomes more profitable (and demand for luxury goods such as meet increases).
- There is an incentive for young women to work longer in the "horn" sector before getting married.

How the West 'Invented' Fertility Restriction

Nico Voigtländer Hans-Joachim Voth

Hunter gatherers

- So far, for all the settled agrarian societies before 1800, fertility rates were well below possibilities
- Let us look at non agricultural societies
- Also far below biological possibilities



A !Kung hunter-gatherer tightens his bow string with hands and teeth. The !Kung are a part of the San of Southern Africa who are often referred to as Bushmen.
Copyright © John Warburton-Lee

Table 4.4 Fertility in Modern Forager Societies

Group	Births woman per year	Mean age at first birth	Mean age at last birth	Total fertility rate
Ache[a]	0.32	20	42	8.0
Yanomamo[a]	0.34	18	38	6.9
James Bay Cree[b]	0.37	22	39	6.3*
Cuiva (Hiwi)[c]	—	—	—	5.1
Arnhem Land (monogamous)[b]	0.30	19	34	4.5*
Kutchin, pre-1900[b]	0.30	23	35	4.4
!Kung[b]	0.31	20	36	4.4
Batak[b]	0.44	18	26	3.8
Arnhem Land (polygamous)[b]	0.18	19	34	2.8*
Median	0.32	20	36	4.5

Sources: [a]Hill and Hurtado, 1996, 262. [b]Kelly, 1995, 246. [c]Hurtado and Hill, 1987, 180.
Note: * denotes values estimated from columns 2–4.

Birth rate and income

- Fertility of the rich <?> fertility of the poor
  - Data on England: look at wills (testaments in French) – in Suffolk, 1585-1638
  - Concerns mostly high income people
  - But also many at the bottom of the economic hierarchy (laborers, sailors, shepherds…)
  - From parish baptism record, we know the number of children for one fifth of the sample

Table 4.5 Testators by Social Rank, 1585–1638

Social group	Number of wills	Fraction of testators literate	Average value of bequests (£)	Maximum value of bequests (£)
Gentry	94	0.94	1,267	8,040
Merchants/ professionals	116	0.88	267	1,540
Farmers	824	0.53	376	6,352
Traders	116	0.46	124	1,226
Craftsmen	340	0.42	78	600
Husbandmen	377	0.26	82	1,898
Laborers	111	0.17	42	210

Source: Clark and Hamilton, 2006.

Husbandman: small farmer

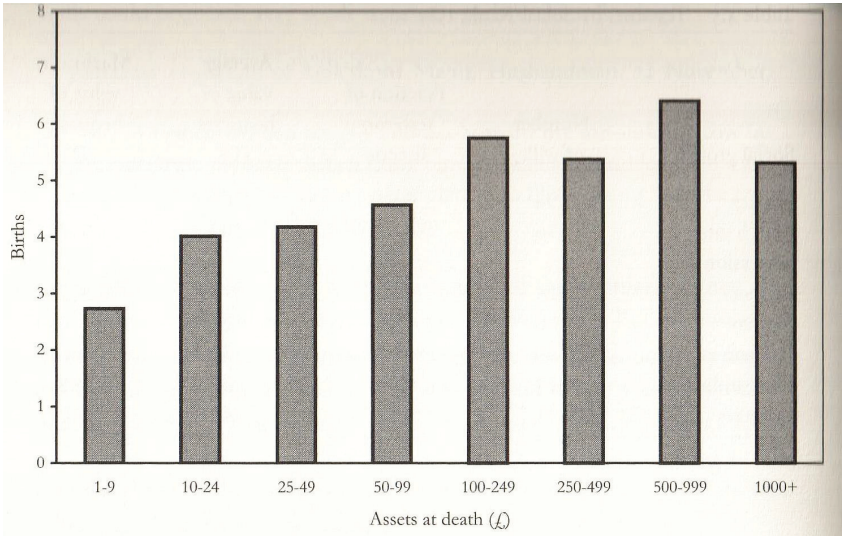


Figure 4.3 Births per man in England, by wealth at death.

Differential fertility

- The richest half fathered 40% more children than the poorest half
  - Richer are more likely to be married and live longer
  - But main reason: per year of marriage the rich had more children
- The rich of preindustrial england who married had as many children as the Hutterites

Table 4.6 Fertility and Wealth in England, 1620–1638

Variable	Number of observations	Poorer	Richer
Average births	642	4.2	5.8
Average bequest	642	£44	£534
Percent never married	642	9%	5%
Average age at death	499	53.6	56.1
Age at first marriage	128	27.5	27.4
Age of wife at marriage	51	25.0	23.6
Births, married 20+ years	304	6.4	9.2

Mortality – Life expectancy

- High mortality in the Malthusian world
- Typical life expectancy at birth – 35
- But very high infant mortality
- At age 20, same life expectancy as at age 0
- Mortality in town much higher than in countryside

Table 5.1 Life Expectancy for Modern Foragers

Group	Life expectancy at birth (e_0)	Life expectancy at age 20 (e_{20})	Infant mortality (%)	Deaths at ages 0–15 (%)
Ache, Paraguay[a]	37	37	12	34
Kutchin, Yukon[b]	35*	—	17	35
Hadza, Tanzania[b]	33	39	21	46
!Kung, Ngamiland, Botswana[b]	32*	—	12	42
!Kung, Dobe, Botswana[b]	30	40	26	44
Agta, Philippines[b]	24	47	37	49

Sources: [a]Hill and Hurtado, 1996, 196. [b]Pennington, 2001, 192.
Note: * denotes values estimated from share of population dying by age 15.

Table 5.2 Life Expectancy in Agrarian Economies

Group	Life expectancy at birth (e_0)	Life expectancy at age 20 (e_{20})	Infant mortality (%)	Deaths at ages 0–15 (%)
Western Europe				
Italy (medieval Pistoia)[a]	29	25	21	56
England, 1550–99[b]	38	33	18	30
England, 1650–99[b]	35	31	18	32
France, 1750–89[c]	28	—	21	—
England, 1750–99[b]	38	34	17	30
East Asia and Africa				
Egypt (rural), 11–257[d]	28	21	—	45
China (Anhui), 1300–1880[e]	28	33	—	—
China (Beijing), 1644–1739[e]	26	30	—	—
China (Liaoning), 1792–1867[e]	26	35	—	—
Rural Japan, 1776–1815[f]	33	37	25	50
Urban				
Egypt (urban), 11–257[d]	24	17	—	48
London, 1750–99[g]	23	—	30	—

Table 5.3 Preindustrial Life Expectancy at Age 20

Group	Age	Life expectancy at 20
Magistrates, Canusium, Italy, AD 223[a]	25	33
Ex-slaves, Italy, ca. AD 200[a]	22.5	28
England		
1300–48 (tenants)[b]	20+	28
1350–1400 (tenants)[b]	20+	32
1440–1540 (monks)[c]	20	27
1600–1638 (testators)	20	35
England, 1750–99[d]	20	34
Rural Japan, 1776–1815[d]	20	37
Rural China (Liaoning), 1792–1867[d]	20	35
Modern foragers[d]	20	40

Sources: [a]Duncan-Jones, 1990, 94–97. [b]Razi, 1980. [c]Harvey, 1993, 128. [d]Tables 5.1 and 5.2.

More on life expectancy

- From previous table: Stone Age life prospect at 20 were better than for the technological advanced places in 1800
- We have seen that low life expectancy (black death) in Europe in 1300-1600 was associated with high income
  - Drop in longevity did not last so much
  - But the effect on the stock of population is lasting
  - Black death was good for the future generations

Polynesia

- Healthy place (before Europeans arrived)
  - Look at troops mortality (next slide)
- This should be bad for standard of living
- But it was compensated by other practises
- According to missionaries in Tahiti, between 2/3 and ¾ of all children born were killed immediately.

Table 5.4 Healthy and Unhealthy Locations as Evidenced by Troop Mortality, circa 1800

Location	Troop nationality	Period	Death rate per thousand
New Zealand	British	1846–55	9
Tahiti	French	1845–49	10
Cape Colony	British	1818–36	16
Canada	British	1817–36	16
Gibraltar	British	1817–36	21
Bombay	British	1830–38	37
Bengal	British	1830–38	71
Martinique	French	1819–36	112
Jamaica	British	1817–36	130
Senegal	French	1819–38	165
East Indies	Dutch	1819–28	170
Sierra Leone	British	1819–36	483

Source: Curtin, 1989, table 1.1.

Technology

Technology is measured by z in the model

We can consider z increased slowly over time

But by how much compared to modern standards?

Measuring technology progress

- Production Function: $Y = z\, L^{a}\, N^{1-a}$
- Growth of output:
  $\gamma(Y) = \gamma(z) + a\,\gamma(L) + (1-a)\,\gamma(N)$
- Moreover, the model implies:
  - $\gamma(Y) - \gamma(N)=0$ (stagnation)
  - $\gamma(L)=0$ (land is in fixed supply)
- Hence

$$\gamma(z) = a\,\gamma(N)$$

Measuring technology progress (2)

- We need to know a
- Perfect competition implies that the return on land equals its marginal productivity : $r = z\, a\, L^{a-1}\, N^{1-a}$
  Hence $a = r\, L/Y$

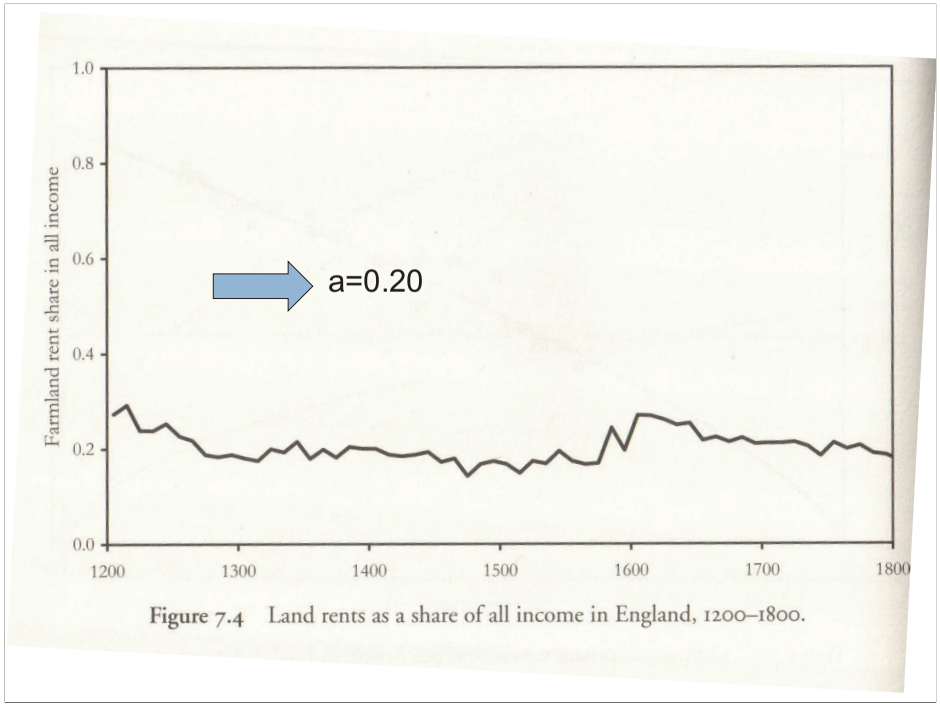


Figure 7.4 Land rents as a share of all income in England, 1200–1800.

Table 7.1 Population and Technological Advance, 130,000 BC to AD 1800

Year	Population (millions)	Population growth rate (%)	Technology growth rate (%)
130,000 BC	0.1	—	—
10,000 BC	7	0.004	0.001
AD 1	300	0.038	0.009
AD 1000	310	0.003	0.001
AD 1250	400	0.102	0.025
AD 1500	490	0.081	0.020
AD 1750	770	0.181	0.045

Source: Durand, 1977, 285.
Note: The estimate for 130,000 BC was made based on the idea that the range of animals man could hunt expanded greatly in this era. See Stiner, 2001, 2005.

Institutions

Question: was the take-off related to improvements in institutions?
(and is the lack of development of poor countries linked to bad institutions?)

Clark argues that Medieval England had relatively good institutions

Table 8.1 The Incentives of Medieval versus Modern England

Economic desiderata	1300	2000
Low tax rates	Yes	No
Modest social transfers	Yes	No
Stable money	Yes	No
Low public debt	Yes	No
Security of property	Yes	Yes
Security of the person	?	Yes
Social mobility	Yes	Yes
Free goods markets	Yes	Yes
Free labor markets	Yes	Yes
Free capital markets	Yes	Yes
Free land markets	Yes	No
Rewards for knowledge creation	?	Yes

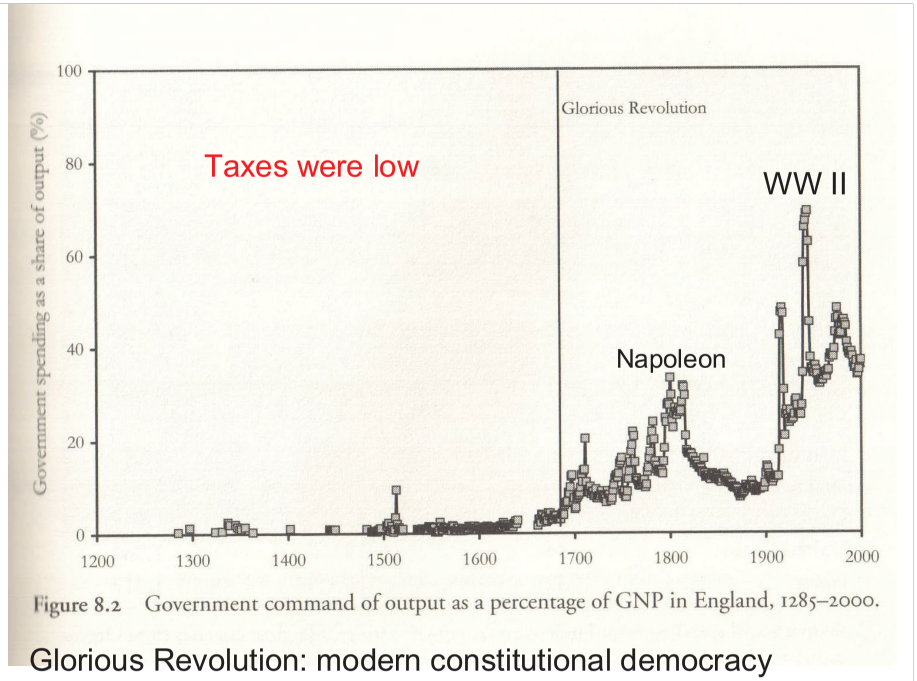


Figure 8.2 Government command of output as a percentage of GNP in England, 1285–2000.

Glorious Revolution: modern constitutional democracy

Table 8.3 Share of Preindustrial Income Collected in Taxes

Country	Period	All taxes (including church) (%)
England	1285–1688	6
	1689–1800	14
China[a]	Ming, ca. 1550	6–8
	Qing, ca. 1650	4–8
	Qing, ca. 1750	8
Ottoman Empire[b]	1500–99	3.5
	1600–99	3.5
	1700–99	4.5

Sources: [a]Feuerwerker, 1984. [b]Pamuk, 2005, graph 1, central government only.

Why were taxes so low?

- The ruling class had a rich source of income: land (20% of total output)
- Another sort of tax: inflation
  By printing money and creating inflation, government get resources at the expense of cash holders – inflation tax

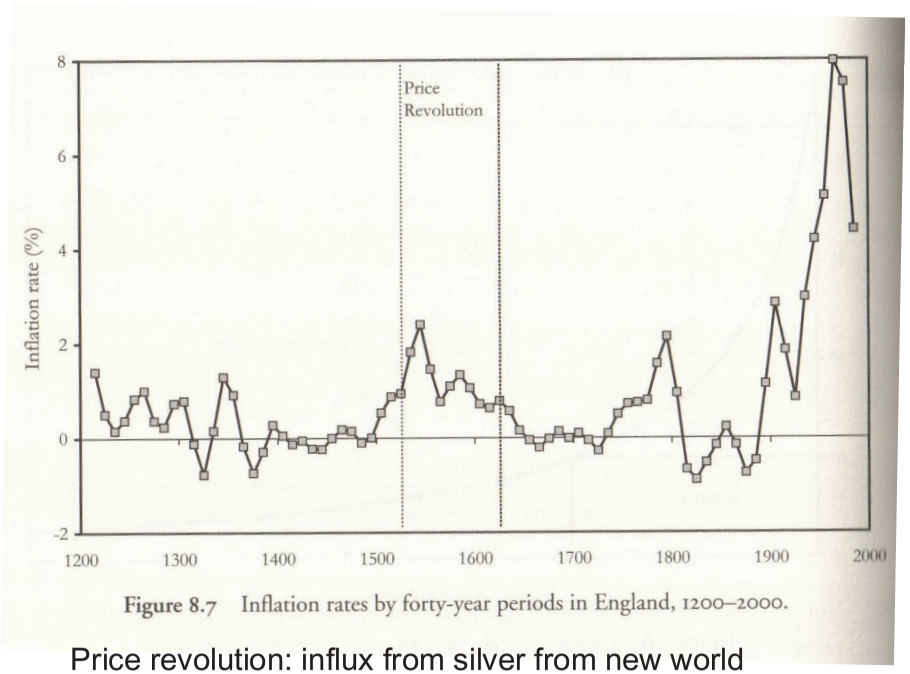


Figure 8.7 Inflation rates by forty-year periods in England, 1200–2000.

Price revolution: influx from silver from new world

Public debt

- High public debt means high future taxes, and crowding out of private activities. Bad for growth.
- Before the glorious revolution: public debt less than 10 % of gdp
- Very small with respect to current standards

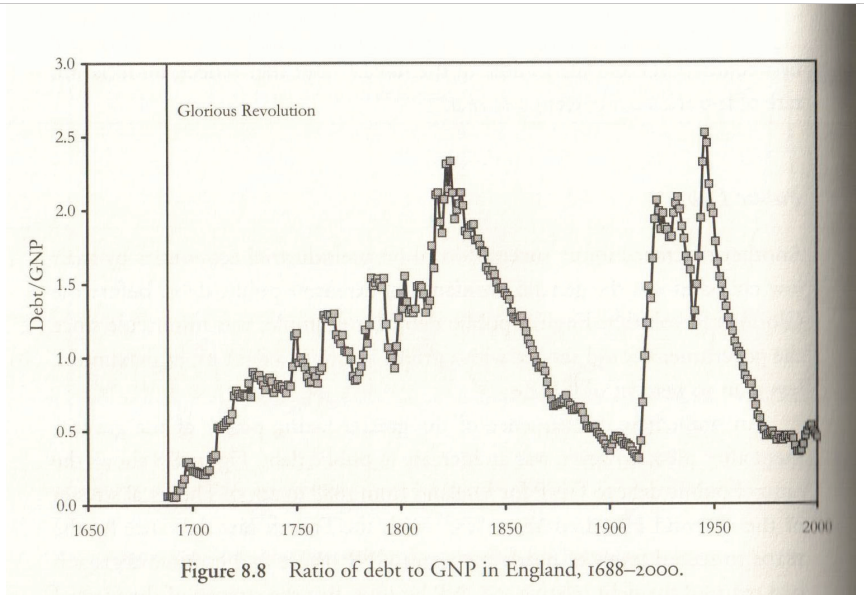


Figure 8.8 Ratio of debt to GNP in England, 1688–2000.

Glorious revolution: Bill of Rights circumscribing the monarch's powers. He or she could no longer suspend laws, levy taxes, make royal appointments, etc.

PART II – THE MODERN WORLD

CHAP 4 -THE MODEL OF SOLOW

Map

- The model
- Application 1 – measuring technical progress
- Application 2 – aid policy in developing countries (from Easterly)

The model

- Neo-classical growth model
- More optimistic view than Malthus
- Technical progress (z) increases income per capita

Production function

- One representative firm
- $Y=z\,F(K, N^d)$
- K, the stock of capital, will be equal to savings
- The firm chooses the labor input N^d
- Total factor productivity: z
- Marginal labor productivity:

$$z\,F_N(K,N^d)$$

A neo-classical production function

- Constant return to scale:

$$z\,F(x\,K, x\,N^d) = x\,z\,F(K,N^d)$$

big difference with malthus: now the two factors of production are variable

- More input implies more output:

$$z\,F_K(K,N^d)>0,\ z\,F_N(K,N^d)>0$$

- Marginal returns are decreasing:

$$z\,F_{KK}(K,N^d)<0, \qquad z\,F_{NN}(K,N^d)<0$$

- Marginal productivity of one factor increases with the other factor:

$$z\,F_{KN}(K,N^d)>0$$

Intensive production function

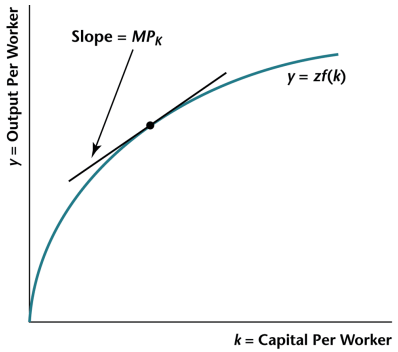
- With constant return to scale, one has:
- $Y = z\,F\,(K,N^d) \rightarrow \dfrac{Y}{N^d} = zF\left(\dfrac{K}{N^d}, 1\right)$
- Which can be rewritten in intensive terms as:

$y = z\,f(k)$

with $y=Y/N^d$, $k=K/N^d$ and $f(k)=F(k,1)$

Intensive production function (2)

- Income per capita (y) depends on the capital/labor ratio (k) and on total factor productivity (z)
- The slope of z f(k) is the marginal productivity of capital - which is decreasing



Households

- Exogenous fertility and mortality:
  N'=(1+n) N
- N is also the supply of labor (everybody works)
- Consumption: C = (1-s) Y
- Saving: S = s Y
- Saving rate (propensity to save): s
  exogenous

The equilibrium

- Capital accumulation:
  K'=(1-d) K + I
  Depreciation rate: d
  constant and exogenous
- Equilibrium on the labor market:
  $N = N^d$
- Equilibrium on the capital market
  S=I

  As a consequence: Y = C+I (since S=Y-C)
  to be seen as a physical good equilibrium
  note: here, no government, no international trade

Dynamics

- Start from K'=(1-d) K + I
- Use equilibrium condition S=I
  K'=(1-d) K + S
- Use S= s Y (saving « behavior »)
  K' = s Y + (1-d) K
- Finally use the production function:
  K' = s z F(K,N) + (1-d) K
  which describes capital dynamics

Dynamics of capital / labor ratio

$$\frac{K'}{N} = sz\frac{F(K,N)}{N} + (1-d)\frac{K}{N}$$

$$\frac{K'}{N}\frac{N'}{N'} = sz\frac{F(K,N)}{N} + (1-d)\frac{K}{N}$$

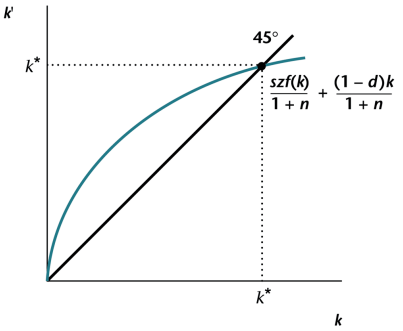
$$k'(1+n) = szf(k) + (1-d)k$$

Dynamics of k (2)

- Dynamics of k thus follow:

$$k' = \frac{szf(k)}{1+n} + \frac{(1-d)k}{1+n}$$

- The function k' =g(k) is concave since f(.) is concave.
- It cuts the 45° line at a point k^*



Dynamics

- If $k<k^*$, $k'>k$
  If $k>k^*$, $k'<k$
  If $k=k^*$, $k'=k$ (steady state)
- Hence k tends towards k^* as time passes
- Consequently, y tends towards z f(k^*)

Long run growth

- Result:
  For z, s, n and d given, income per capita converges to some long-run level
- Hence, sustained growth is impossible for z, s and d given
- Why ? Because marginal productivity of capital is decreasing: to keep k growing, we need more and more investment, and, finally, investment is just able to cover the depreciation of capital [replacement investment]

Long run growth (2)

- In the long run:
- $k=k^*$ and $y=z\, f(k^*)$ [steady state]
- K and Y grow in line with N, that is at rate n. Same for C, I, and S.
- Exogenous growth: Y grows at rate n, which is exogenous - not explained.

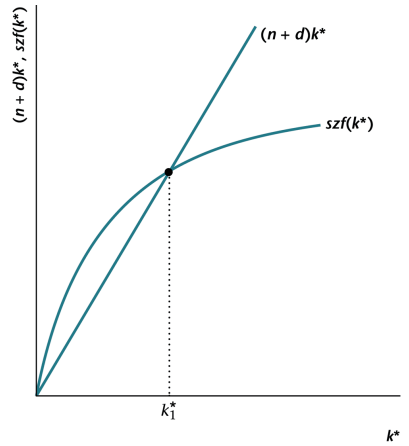
Steady state

- Capital at Steady state:

$$k^\star = \frac{szf(k^\star)}{1+n} + \frac{(1-d)k^\star}{1+n}$$

- Which amounts to

  $(n+d)\, k^* = s\, z\, f(k^*)$

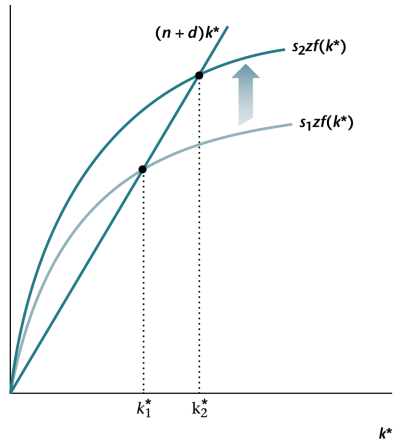


Comparative statics

- see the effect of changes in parameters
  - Saving rate
  - Population growth n
  - Productivity z

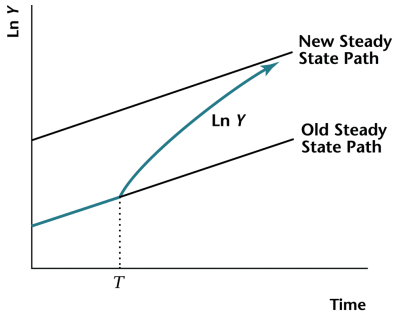
Increase in the saving rate

- Consumers save more (for example because they live longer)
- Output per capita increases and reaches a new steady state. Long-term growth is unchanged.



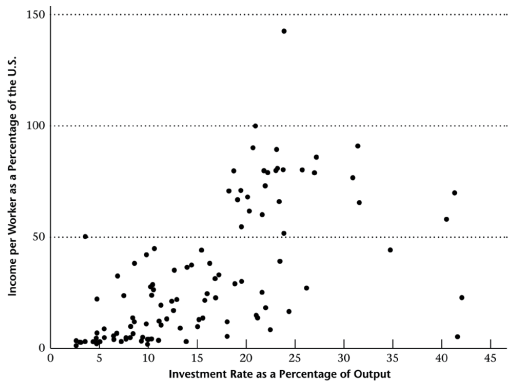
Increase in the saving rate (2)

- There is thus an effect on the level of Y but not on its long-run growth rate.



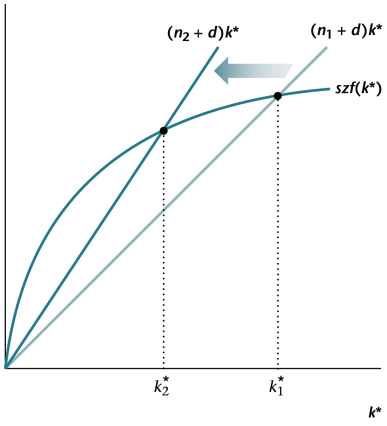
Empirical consequence 1

- Income per capita is positively correlated with the saving rate & the investment rate
- Source: Penn World Table



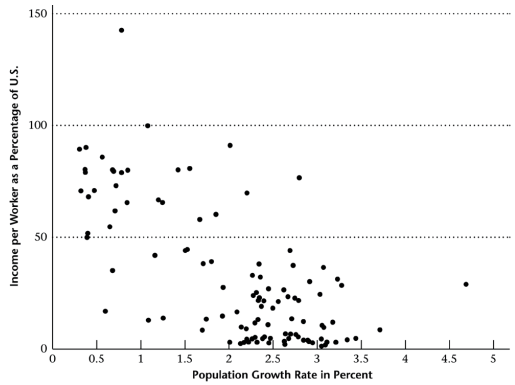
Increase in n

- If n increases from n_1 to n_2, capital per worker in the long-run goes from k_1^* to k_2^*.
- Idea: with n large, it is more difficult to increases future capital per worker because the number of workers increases fast



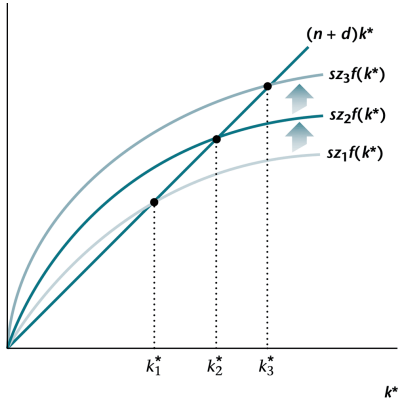
Empirical consequence 2

- Income per capita is negatively correlated with population growth rate n
- Source: Penn World Table



What about the source of growth ?

- Only sustained increases in z can lead to a sustained increase in income per capita.



Source of growth

- Hence: Increases in s or drops in n affect positively income per capita, but neither s nor n can change at every date
- The only possible source of growth in per capita variables is z (≠ Malthus)

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Application 1

- Measurement of z (tfp)
- Decomposing growth into its factors according to the production function

Application: estimation of z

- Question: how can we compute z ?
- If we know the production function, easy:

Suppose $F=K^a N^{1-a}$ and $a = 1/3$

We can then measure z as a « residual »:

$z = Y / [K^a N^{1-a}]$

Note: 1-a is the share of labor in value-added

- Total factor productivity is called « Solow residual »

Decomposition of growth in the USA 1950-

Year	$\hat{Y}$ (billions of 1996 dollars)	$\hat{K}$ (billions of 1996 dollars)	$\hat{N}$ (millions)	$\hat{z}$
1950	1686.6	5553.1	58.89	5.574
1960	2376.7	7920.9	65.78	6.439
1970	3578.0	11547.1	78.67	7.548
1980	4900.9	15922.3	99.30	7.934
1990	6707.9	20871.1	118.80	8.784
2000	9191.4	26993.8	136.90	10.027

Growth rate

Years	$\hat{Y}$	$\hat{K}$	$\hat{N}$	$\hat{z}$
1950–1960	3.49	3.62	1.11	1.45
1960–1970	4.18	3.84	1.81	1.60
1970–1980	3.20	3.27	2.36	0.50
1980–1990	3.19	2.74	1.81	1.02
1990–2000	3.20	2.61	1.43	1.33

- Computed from the levels of the previous slide.
- strong migration into the USA
- Effect of z in the 90s (new economy)

Growth of Asian « tigers »1960-1990

	Output	Capital	Labor	Total Factor Productivity
Hong Kong (1966–1991)	7.3%	7.7%	2.6%	2.3%
Singapore (1966–1990)	8.7%	10.8%	4.5%	0.2%
South Korea (1966–1990)*	10.3%	12.9%	5.4%	1.7%
Taiwan (1966–1990)*	9.4%	11.8%	4.6%	2.6%
United States (1966–1990)	3.0%	3.2%	2.0%	0.6%

Important role of physical capital
+ increase in the participation rate of women
+ TFP growth is not huge

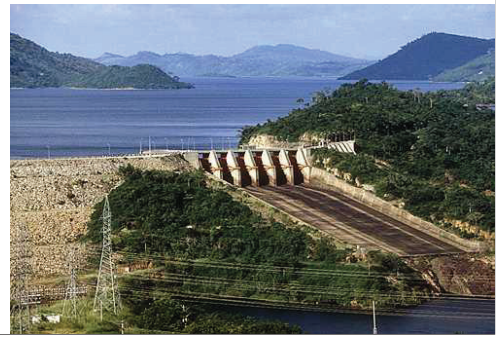
Application 2

Aid to investment

1. Investment aid

- Idea: help funding investment in infrastructure (dams, roads) and/or in equipment

◆Many examples: Akosombo dam in Ghana



Underlying model: Harrod-Domar

- Domar (1946): labor is in surplus ($N^s > N^d$), but available capital is a binding constraint
  - Historical context: great depression in the US, industrialization in the former Soviet Union
- Growth will be proportional to the share of investment in GDP
- Contradicts the decreasing returns to capital of Solow

Domar

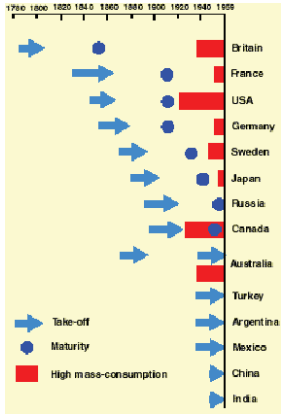
- **Evsey D. Domar, 1914-1997**
- In 1957 Domar acknowledged that his model was not a growth model (but one for business cycle analysis), accepting Solow's set-up.
- His approach still remains largerly used by policy makers

Implication

- There is a « needed » rate of investment to attain a given target in terms of growth.
- Between this rate and the domestic saving rate, there is a *financing gap* to be filled => External Aid, donors

The « stages of economic growth »

- The'idea that investment is key to trigger the take-off in reinforced by the book by Rostow (1960) « stages in economic growth »
- During phase 1, investment should go from 5 to 10% of GDP



The Soviet Union experience

- During the years 1950, the Soviet Union is seen as growing very fast thanks to a fast industrialization driven by investment
- To develop industries thanks to domestic accumulation (Staline)
- This reinforces the idea that investment is the prime source of growth

http://geohistech.free.fr/Staline/5_Stalin_1.html

The size of aid

- Massive aid invoquing the « financing gap approach »
- Between 1950 and 1995, Western countries gave 1 billion $ in aid (1985 dollars).
- Harrod-Domar is the most expensive economic theory in history
- Following Rostow, investment aid will foster the take-off of poor countries, and, 10 to 15 years later, domestic savings will increase enough so that external aid can be interrupted.

Tests of the theory

- 2 links tested by Easterly:
  - Aid goes to investment
  - Investment fosters growth

Aid goes to investment (1)

- Test 1: aid and investment should be positively correlated over time

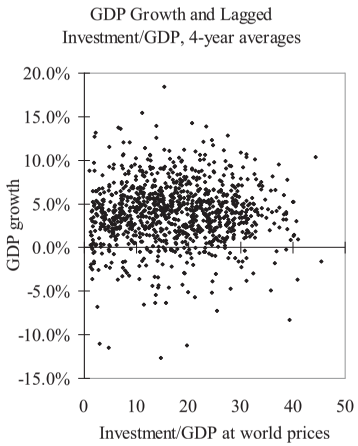
  Over 88 countries, taking data from 1965 to1995, Easterly finds a positive correlation in 17 countries
- Test 2: 1$ aid should at least gives 1$ investment, hopefully more.
  It is true in 6 countries among the 17 countries passing test 1

Aid goes to investment (2)

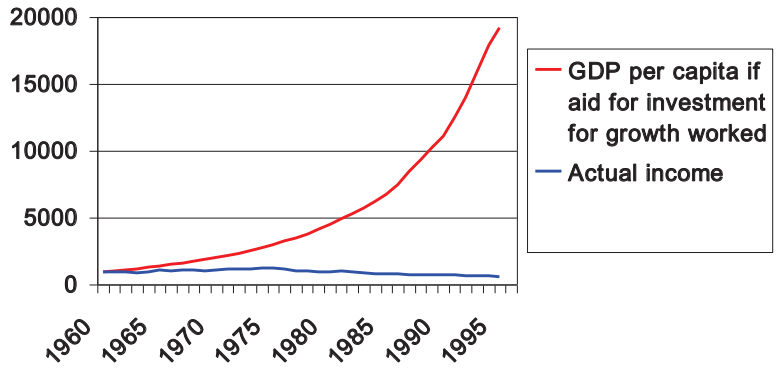
- Why is aid not invested ?
  - Easterly's Reason: Because agents react to economic incentives
  - Explanation:
    - If the return to investment is low, (imagine a Solow steady state with low z), or highly uncertain,
    - Investment is not profitable,
    - And aid will be consumed instead of being invested. (and it is individually optimal to do so)

Investment fosters growth

- In countries with a low productivity z (unstable institutions, low skilled labor force), the effect of investment on growth is weak



Test of the joined hypothesis (case of Zambia)



Applications of models seen previously

- If at the steady state of a Solow model, aid does not help
- If converging to a steady state, aid makes convergence faster
- If poverty trap, aid could help

Map

- Objectives
- The model
- Application: role of economic policy and institutions

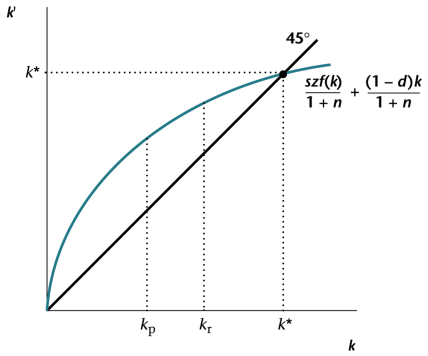
CHAP 5 - ENDOGENOUS GROWTH MODELS

Objectives

- Starting point: properties of the Solow model in terms of convergence across countries
- Introduction of a new model said to be of « endogenous growth »

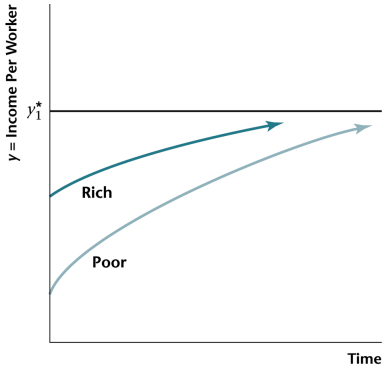
Convergence

- Properties of Solow model: Countries with similar caracteristics (s, n and z) converge to the same level of income per capita, even if they start from different level of capital per person (here k_p et k_r)



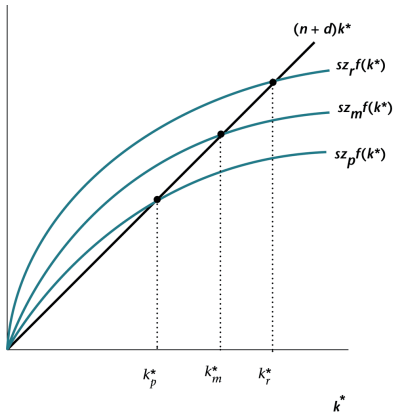
Convergence (2)

- Those who start with less capital grow faster and catch-up.
- This is absolute convergence



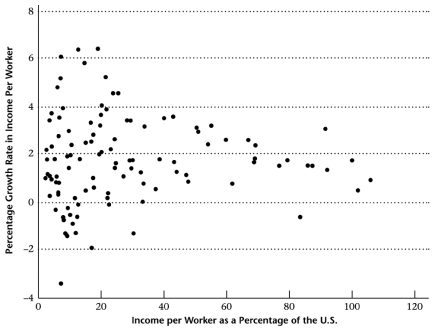
Conditional convergence

- Countries with different levels of z converge towards different income level
- Disparities between countries
- Conditional convergence: conditionally on the steady state, the poorest country still grows faster than the richest
(poorest = away from ss)



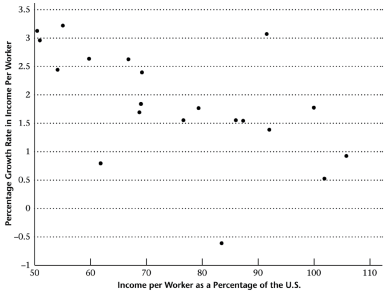
Convergence data

- Those who start with less capital grow faster and catch-up. True ?
- One should see a negative relationship between growth rates and initial income levels
- At the world level, we don't see it



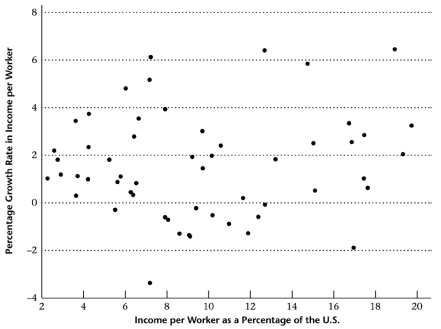
For rich countries

- One observes this negative correlation in the set of rich countries: catching-up (ex: Spain)



For poor countries

- Among developing countries, we do not observe this relation
- Even if we condition on productivity differences among countries
- Need for another model



A model with human capital

Important factor behind technology: human capital

Human capital determines the productivity of a worker:

Education, experience, health

Human capital accumulation

- Human capital accumulates as physical capital
- But it is embodied in human beings

- Its accumulation is perhaps not subject to marginal decreasing returns:
  - Non rival good: knowledge acquisition by somebody does not prevent the other persons to acquire se same knowledge
  - Externalities
    - Effect on peers,
    - On society as a whole
    - On his/her children (inter-generational externality)

A simple model with human capital

- At each date, households allocate their time between education and work. Time spent at work is written u.
- Wages depend on accumulated human capital. It equals the product w H^s
  - Wage per unit of efficient labor w
  - Human capital = efficient labor H^s
- To simplify, no saving, no other income. Consumption is

$$C = w\ u\ H^s$$

Accumulation

- Accumulated human capital depends on time spent at education 1-u and on past level of human capital H^s:
  $H^{s\prime} = b\ (1-u)\ H^s$
- Parameter b represents the « productivity » of the education system

Firms

- Technology simply uses efficient labor E (no land, no capital) and there is constant marginal return:
  $Y = z\ E$
- Firms maximize profits:
  $profit = Y - w\ E = (z-w)\ E$

Labor demand

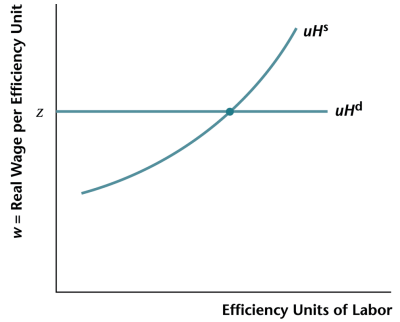
- How is labor demand E^d determined ? (as a function of wage) ?
  - If w>z, profits are negative, firms do not hire
  - If w<z, profits are positive, firms want to hire an infinite quantity of efficient labor
  - With w=z, profits are nil, firms are indifferent to the number of workers
- Hence, labor demand is infinitely elastic at w=z (horizontal demand)

Labor supply

- Main trade-off: if one person increases his/her labor supply now:
  - Income now is increased – gain depends on wage today
  - Human capital tomorrow may decrease, as there is less education today – loss depends on future wages
- Wages play a double role: opportunity cost today and return to human capital tomorrow

Equilibrium on the labor market determines education investment

- At equilibrium, supply and demand coincide : u H^s=E^d (=u H^d)
- Whathever the shape of labor supply (that we have not analyzed), there will always be an equilibrium point with w=z
- Here labor supply is supposed to be increasing

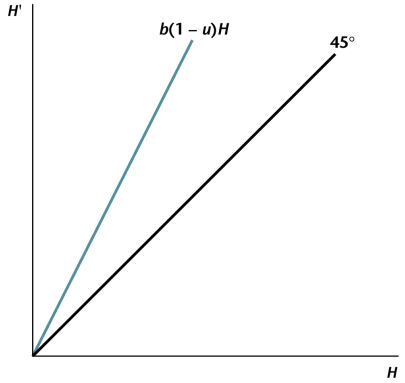


Human capital dynamics

- hence, at equilibrium, C= z u H and H'=b(1-u) H
- Growth rate of human capital is:
  $$H' / H - 1 = b(1-u) - 1$$
- The economy grows if b(1-u)>1

Human capital dynamics (2)

- Blue line represents future human capital as a function od today's human capital
- With a slope larger than one (b(1-u)>1), H'>H for all H, and the economy grows forever



Growth

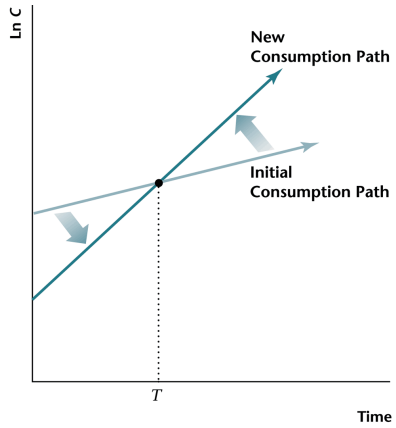
- Moreover, since C = zuH = Y, consumption, production and human capital grow at the same rate
- Here, even without technical progress and with constant population, the economy grows by itself: this is endogenous growth
- Key assumption: no decreasing returns

Policy

- If the government has the power to change b or u, it can affect the growth rate of the economy
- Hence, a focus on education policy, as well as on-the-job training/research policy in general

Policy(2)

- Enforce higher 1-u, More education
- Less work, u diminishes
- C= z u H
- C' / C -1 = b(1-u) -1

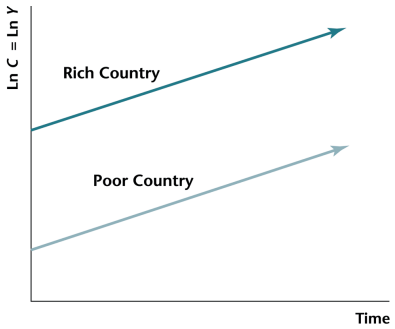


Short-term vs long term

- Stronger growth at the expense of today's consumption
- Is it better ?
  - Depends on patience
  - Arguments in terms of future generations (against current generations)

Implications for convergence

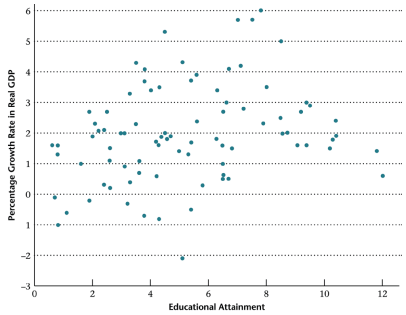
- Two countries with the same b and u and with different initial levels of human capital do not converge



To sum up

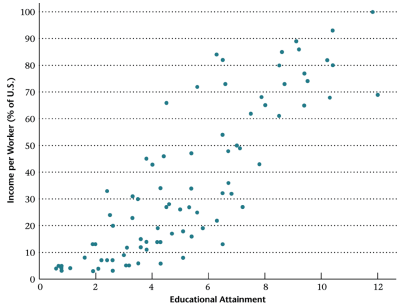
- Endogenous growth
  - Unbounded growth, depends on behaviors (incentives)
  - Policy affects growth permanently
  - No convergence across countries

Application: education and growth



- According to the model, growth rates should be positively correlated with 1-u, the time spent on education
- We retrieve this correlation in the data
- But question of causality

Education and income



- We also find a positive correlation between education and income, see equation $H^{s'}=b\,(1-u)\,H^{s}$

Application: role of policy and institutions

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- With exogenous growth, economic policy cannot modify the long term growth rate (=n), but only the level of income (by playing for example on the level of z)
- With endogenous growth, policy can change the growth path (by modifying b, for example)
- Let us consider some pairs of countries starting from similar initial conditions to check whether different policies lead to different growth paths

Inspired from

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Gylfason, Principles of Economic Growth, out of print at Oxford Univ. Press

Slides available from

http://www.hi.is/~gylfason/slides.htm

Case 1: Burma and Thailand

207

- Burma: Military dictatorship, centralized economy, centrally planned investments, low openess to trade, policy control of economic matters
- Thailand: Increasing openess to trade, investment in education, high level of savings

Case 1

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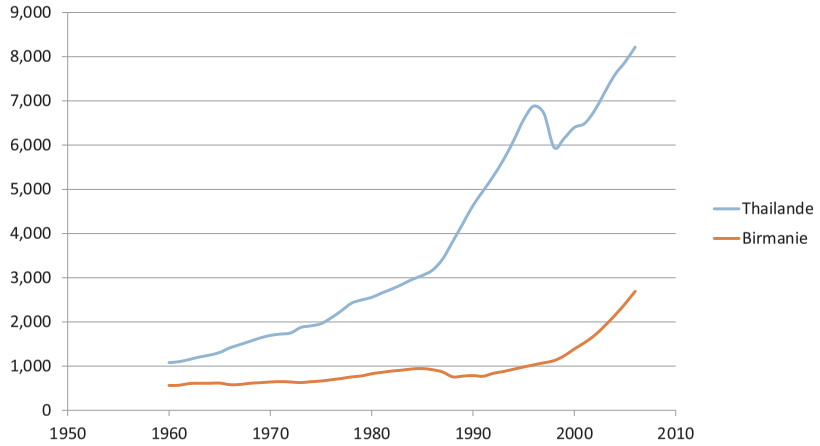

Different paths ? Not so true in logs

Case 2: Botswana and Nigeria

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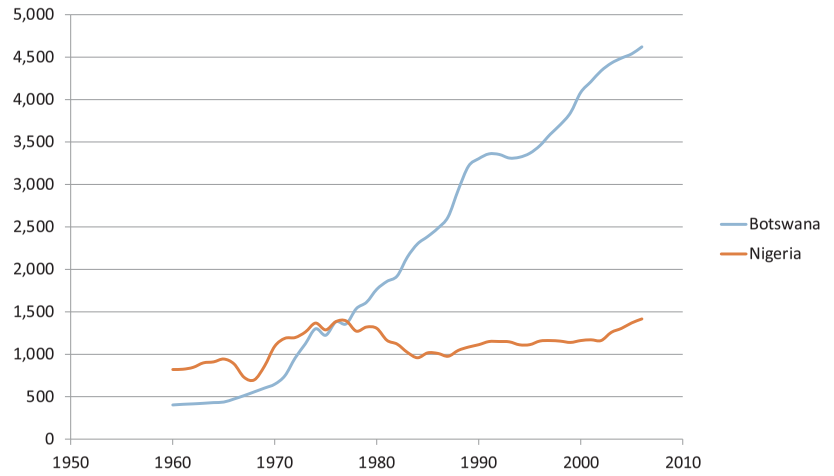
- Botswana: producer of diamonds, democracy, investment in education, stable economic policy
- Nigeria: oil producer, political instability (military coups), poor investment if the oil incomes
- Natural ressources: “a mixed blessing”

Case 2

210



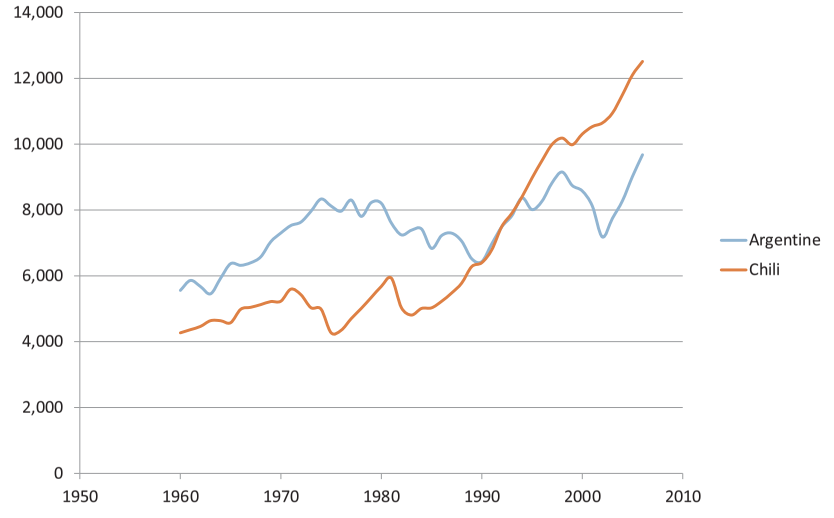
Case 3: Chile and Argentina

211

- Chile: 1974-1990, right wing dictatorship. Since 1990 democratic regime, free trade promotion (ARENA), rise of social policies to reduce income inequality in the most market friendly country of South America
- Argentine: Dictatorship followed by democracy, less open to international trade, corruption, unstable economic policy

Case 3

212



Case 4: Ireland and Greece

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- Two countries who benefitted from EU transfers
- Ireland is much more open to international trade

Case 4

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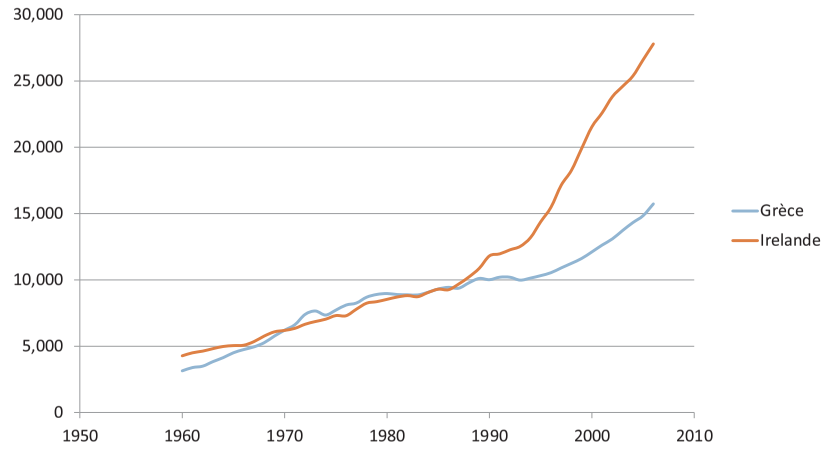
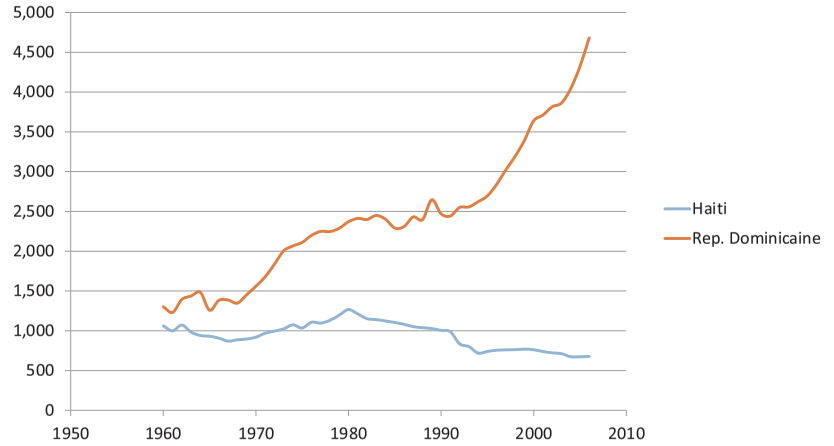


Case 5: Haiti and Dominican Rep

- Share the same island, so some technology in common (climate etc)
- How can one explain that gap except by differences in institutions ?

Case 5



Conclusion

Country comparisons are not to be taken literally
- intended to highlight some aspects of economic growth

What do the examples have in common?
- All point to economic factors rather than exogenous technology
  - economic system
  - institutions
  - orientation of economic policy

Key distinction: Endogenous growth vs. exogenous growth

This is the fundamental message of the theory of endogenous growth

CHAP 6 - POVERTY TRAPS

Convergence

- With Solow, marginal decreasing return implies convergence
  - Source graph: Galor, convergence ?

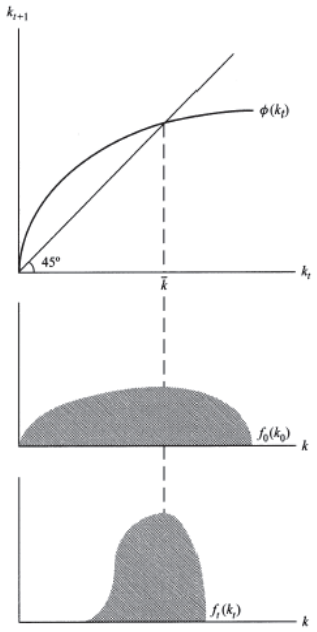


Fig. 1. Conditional convergence.

Convergence facts

- (1) No convergence at the world level
- (2) But convergence between the developed countries
- Endogenous growth accounts for (1) but not for (2)
- Need for a third approach
  - Exogenous growth: convergence
  - Endogenous growth: no convergence
  - How can we understand club convergence ?

Club convergence

- Key assumption: returns are increasing over some range
- Multiple steady states
- « club convergence »
- Poverty trap

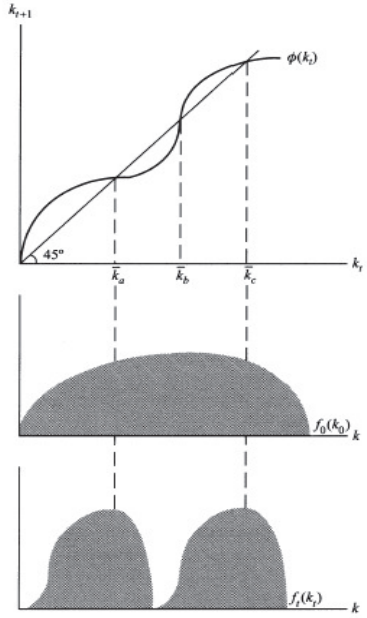


Fig. 2. Club convergence.

Empirical study of club convergence

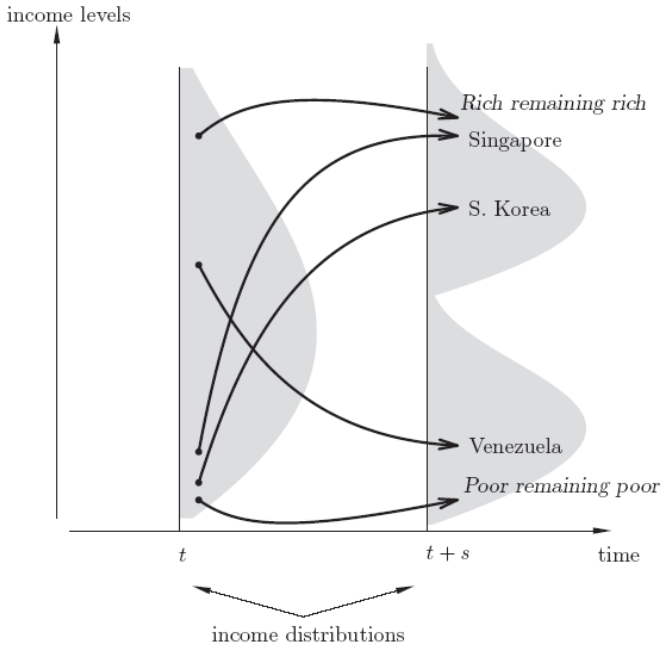
- Poverty traps are confirmed by empirical studies 1960-1990

- For an empirical study, we need to add some stochastic elements to our deterministic models: the possibility to go to another club

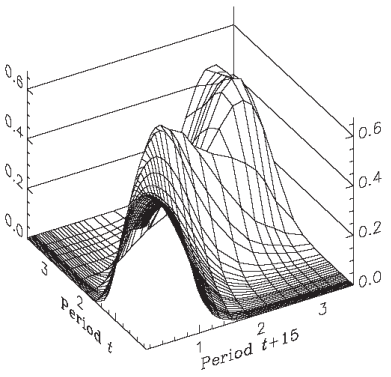
The New Empirics of Economic Growth

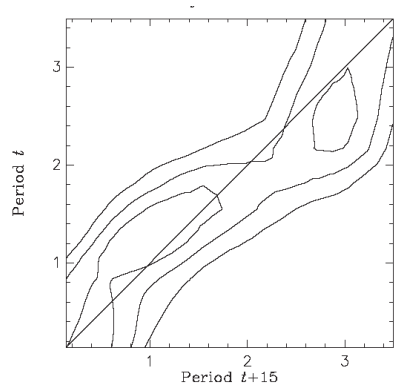
by

Steven N. Durlauf and Danny T. Quah*



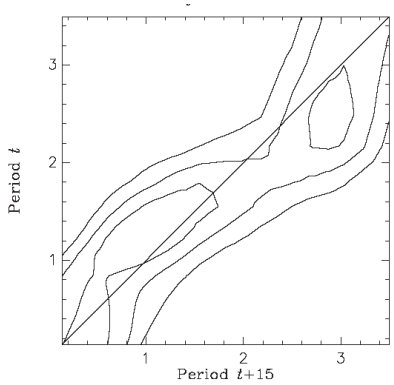
Estimation of transition probabilities





Twin peaks

- Riches have a high probability of being rich 15 years later
- Poors have a high probability of remaining poor
- Riches grow, poors don't



Escape from the trap

We can escape from the poverty trap if the function moves upward

Increase in productivity

More efficient institutions

Drop in n

Story for the 21th century? (china, India)

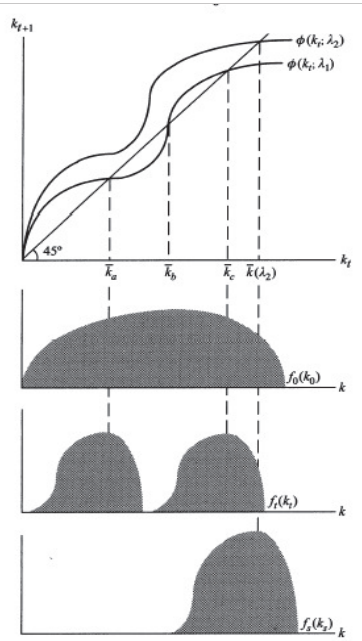


Fig. 3. Club convergence in the medium run.

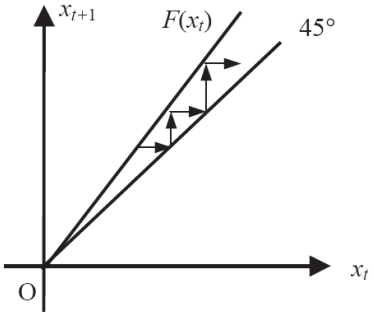
Generalization

« Poverty Traps », appeared in *the New Palgrave Dictionary of Economics*, 2nd Edition, McMillan

By varying the shape of the function linking k_{t+1} to k_t we obtain a list of possible dynamics.

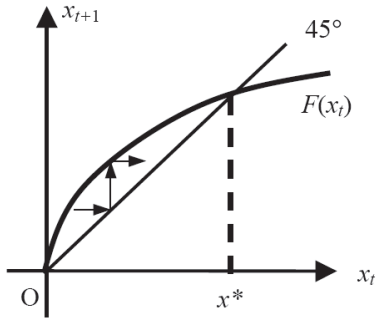
Endogenous growth

- See model with human capital



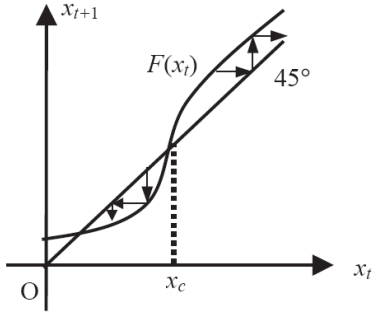
Convergence

- For any initial condition, the economy converges to x^*
- Solow



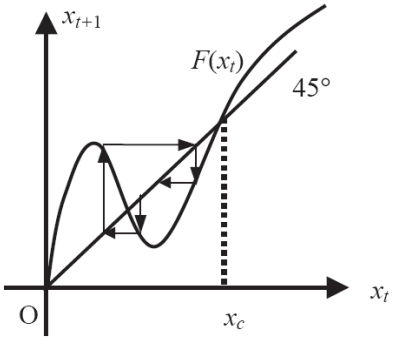
Inescapable trap - 1

- Long term outcome depends on the starting point:
- If initially: $x<x_c$, convergence towards low income level
- If initially: $x>x_c$, sustained growth



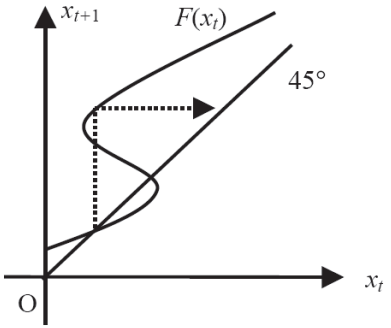
Inescapable trap - 2

- If initially: $x<x_c$, oscillations at a low level of income - volatility
- Shows a case where there is no convergence to a steady state
- Endogenous fluctuations: no need for exogenous shocks



Coordination problems

- The economy can stay in a poverty trap is she remains on the low curve
- Reach the upper curve allows to escape from the trap
- Here, the selection of the curve (lower or upper) is a coordination problem

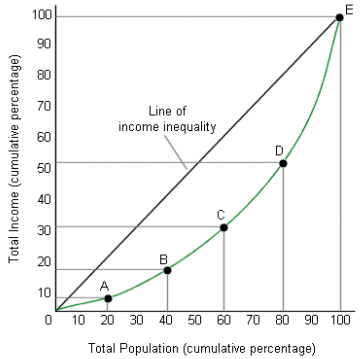


Underlying mechanisms

- Need for a vicious circle to model a trap
  - Human capital externalities: when human capital is low, the education sector (teachers) is bad, etc…
  - Example with corruption
  - Example with brain drain

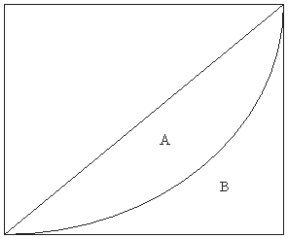
CHAP 7 - INEQUALITY AND GROWTH

Methods - The Lorenz curve



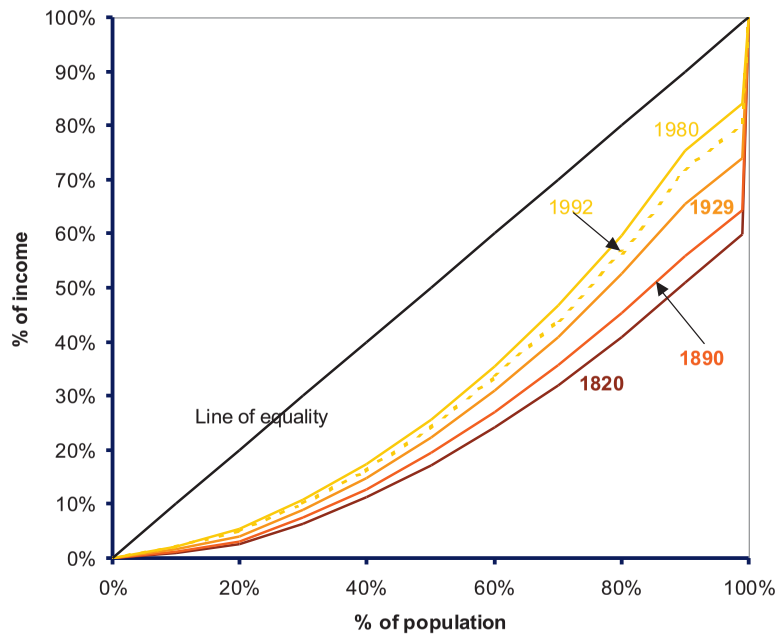
The Gini coefficient

- Gini = A/ (A+B)
- Between 0 and 1
- 0: perfect equality
- 1: one household has all income



Global data

- Bourguignon and Morrison estimate the distribution of income for large geographical zones over the period 1820-1992
- Let us draw global Lorenz curves
- We observe a steady reduction of inequalities over the period 1980-1992



Difficulties when looking at income and wealth inequality

- Income vs wealth
- Before tax, after tax
- Households or individuals
- At one point in time or over the life-cycle ?
  - Life-cycle inequality depends on mortality
  - Some agents die young, some others die when old -> source of inequality.
  - Reductions in infant and adult mortality reduce inequalities.

Transmission of wealth inequality

- Wealth w_i of individual i depends on that of his parents w_{ip}, on a constant term and on a random component λ_i:

$$w_i = \beta w_{ip} + (1-\beta)\underline{w} + \lambda_i$$

Coefficient β represents the rate of inter-generational transmission of wealth

- The variance of wealth (a measure of inequality) is:

$$\mathrm{var}(w_{it}) \equiv \mu_t = \beta^2 \mu_{t-1} + \sigma_\lambda^2$$

- In the long-run, at steady state, inequality depends positively on β

$$\mathrm{var}(w_i) \equiv \mu = \sigma_\lambda^2/(1-\beta^2)$$

Factors affecting β?

Intergenerational Wealth Transmission and the Dynamics of Inequality in Small-Scale Societies
Monique Borgerhoff Mulder, *et al.*
Science **326**, 682 (2009);

- Kind of wealth
  - "Embodied": physical strength, ability, …
  - "Relational": social links, friends networks, …
  - "Material": land, capital, …
- Societies with more material wealth have a larger inequality

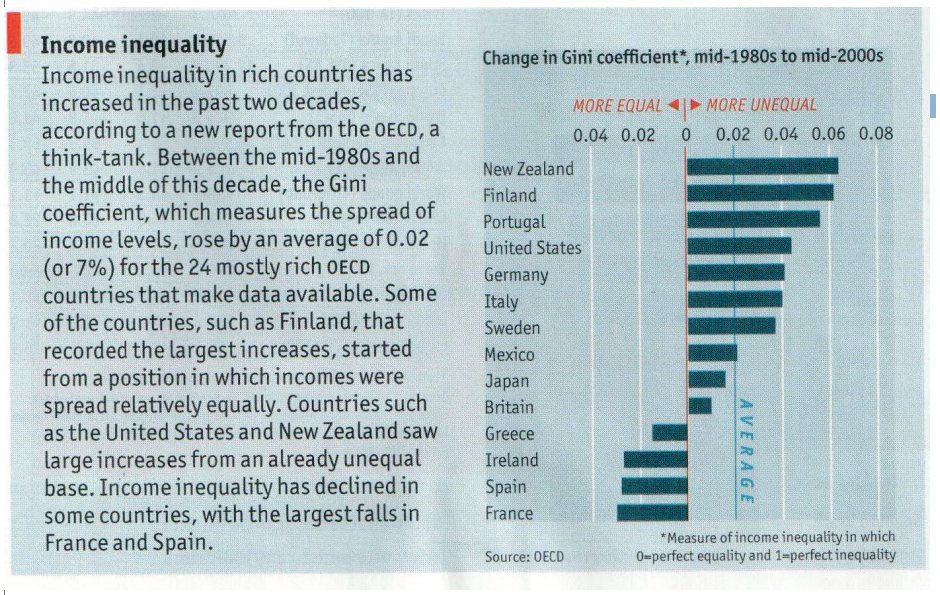
Economic systems		Wealth classes: Embodied	Wealth classes: Relational	Wealth classes: Material	α-weighted average of β values	α-weighted average of Ginis
Hunter-gatherer	α	0.46	0.39	0.15		
	β	0.16 ± 0.06	0.23 ± 0.11	0.17 ± 0.011	0.19 ± 0.05	0.25 ± 0.04
Agricultural	α	0.27	0.14	0.59		
	β	0.10 ± 0.07	0.08 ± 0.11	0.55 ± 0.07	0.36 ± 0.05	0.48 ± 0.04

β today

- These inequalities can be corrected by redistributive policy. β varies across developed nations:
  - β=0.18 in Denmark, Sweden, Norway
  - β=0.43 in the USA and Italy

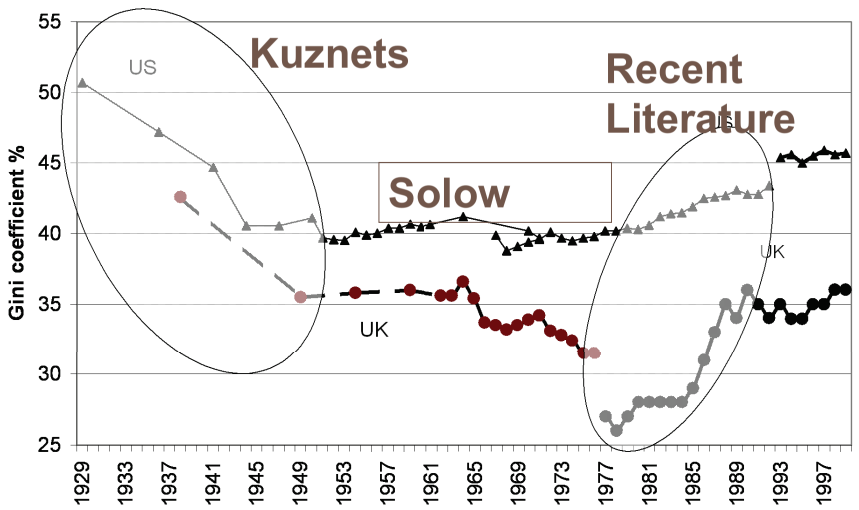
Facts - Traditional view

- Kuznets : in the first phase of development, income inequality increases, then decreases at later stages
- Evidence
  - England
  - We know for sure: very high inequality in both income and wealth around 1870.
  - Both have diminished in the 20th century
  - Did inequality rise between 1750 and 1870 ? (validating the Kuznet curve): May be. Not proven yet.
  - And inequality is rising since 1980.



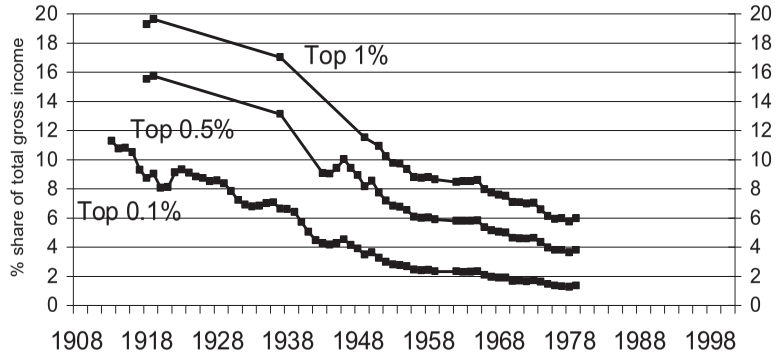
The Economist, nov 1 2008

Figure 3 Gini Coefficients for US and UK: Different Foci



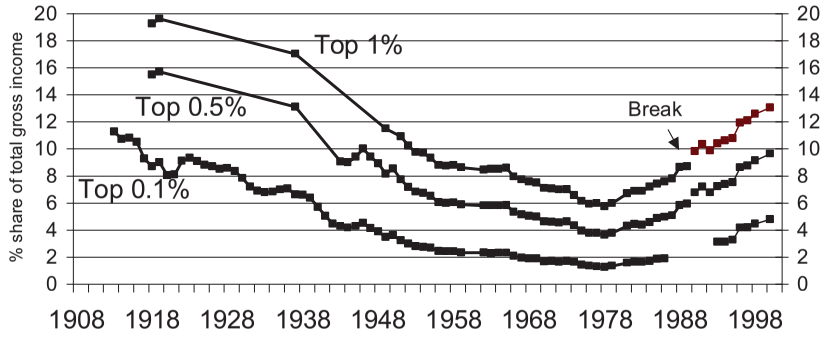
The decline in inequality in the UK

Figure 8 Shares of top income groups in total gross income in UK



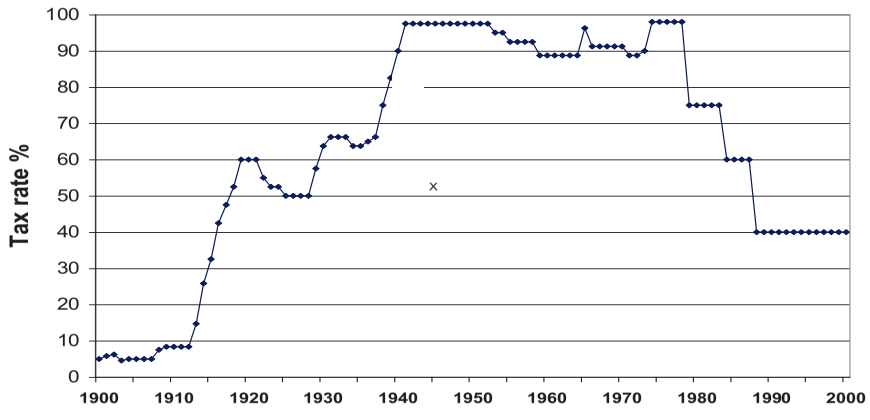
The rise in inequality in the UK

Figure 8 Shares of top income groups in total gross income in UK 1913-2000



A fiscal reason ?

Figure 4 Top tax rate on investment income in the UK



Why did inequality increase recently?

- Pro rich fiscal policy
- Skilled-biased technical progress
- Globalisation (unskilled are in competition with e.g. Chinese workers)
- Better markets ? (e.g. credit)
  - more opportunities for able persons
  - But poor have more access to credit

Effect of inequality on institutions

- If policy is determined by voting, more inequality increases the need for redistribution (what we observe today?)
- Effect on education policy: more inequality implies more private schooling and less public spending
  - But more public spending per child if democracy (de la Croix – Doepke)

PART III – THE TRANSITION FROM STAGNATION TO GROWTH

CHAPTER 8 EXOGENOUS TAKEOFFS

Map

- Typology of explanations of the takeoff
- Technical progress
- Institutions
- Application: are institutions really exogenous?

Typology of explanations

Different types of explanations, depending on their exogenous character

Endogenous variable: Dependent variable generated within a model and, therefore, a variable whose value is changed (determined) by one of the functional relationships in that model. (n in Malthus, growth in endogenous growth models)

Exogenous variable: Independent variable that affects a model without being affected by it, and whose qualitative characteristics and method of generation are not specified by the model builder. (z in Solow, n in Solow)

Exogenous shocks

- What are the possible exogenous shocks?
- Candidate 1: technology
  - Can be technical progress
  - Can be broader – a new vision of the world – the enlightenment
- Candidate 2: institutions
  - Democratisation
  - Public schools

Models of the take-off

- Exogenous shock: something external changed and is responsible for the take-off
  - Shock which modifies the growth rate of an exogenous process (z) – this chapter
  - Multiple equilibrium theories – some shock led the economy from a stagnant equilibrium to one with sustained growth
  - Exogenous shock but propagation mechanism: : an exogenous shock which keeps having effects through endogenous growth mechanism (chap 9 & 10)
- Pure endogenous explanations (no shocks) –we do not need any shock to generate the take-off. Everything was predetermined as the beginning of time. We will see two examples in chap 11:
  - Population-induced technical progress
  - Natural selection

Technical progress

Where does technical progress comes from?

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- Ref: The Rational Optimist, Matt Ridley, 2010
- There is no technical progress for animals. Evolution comes from that some species are replaced by more efficient ones.
- Mankind did not experienced technical progress before homo sapiens. The biface (hand axe) used by homo erectus to cut meet did not change over 10000 centuries.

Trade and Progress

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- Without trade there is no innovation.
- Homo sapiens is open to trade -> he can then specialize -> when specialized, innovate becomes productive
- Hence progress is rooted in trade
- Trade also allows to diffuse innovations an give them a cumulative character

  "Exchange is to technology as sex is to evolution."

Two tools for the hand

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- To be produced:
  - The biface only requires the knowledge of one person
  - The mouse requires knowledge from hundreds of persons ; collective knowledge

From Malthus to Solow with technical progress

- In the last 100000 years, there has been technical progress
- Bur growth only came in the last 200 years
- Which model could account for these facts?
  - Malthus no-growth model - pre-industrial period
  - Solow growth model – last 200 years
- Objective: to model in a single framework the whole history

Main engine ? Technical progress

- A steady technical progress in a single model will not be able to explain both stagnation and growth
- Solution: model with one good, but two technologies (sectors) and two « z »
  - Technology « Malthus » : $z^M F^M(L,N,K)$
  - Technology « Solow » : $z^S F^S(N,K)$

(Hansen Prescott, **Malthus to Solow**, American Economic Review, 2002.)

The Malthus technology

- Land is fixed
- Marginal returns to labor are decreasing
- Physical Capital is included
- But returns to scale with respect to accumulable factors are decreasing (K and N)

The Solow technology

- Uses capital and labor (no land)
- Constant return to scale
  → doubling K and N doubles Y

Sectoral allocation of resources

- Capital and labor are mobile across sectors and go where returns are higher
- Equilibrium conditions:
  equalization of marginal productivities:

$$z^M \partial F^M(L,N,K)/\partial K = z^S \partial F^S(N,K)/\partial K$$

$$z^M \partial F^M(L,N,K)/\partial N = z^S \partial F^S(N,K)/\partial N$$

The Malthus sector is always profitable (land)

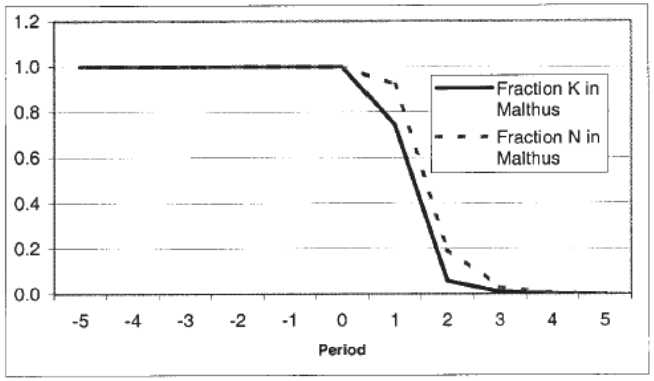
If initially, z^S is very low, there is a corner regime where all the resources are in Malthus sector

Technical progress

- Each sector has its own technical progress which drives TFP:

$$z^M = z_0^M (1+g_M)^t \quad z^S = z_0^S (1+g_S)^t$$

- $z_0^M > z_0^S$
- If technical progress is stronger in the Solow sector ($g_S > g_M$), this sector will inevitably become profitable



Shifting in the allocation of resources from one sector to the other.

Storyline

- Initially all K and N are located in the Malthus sector. The Solow sector does not produce yet.
- Technical progress is stronger in the Solow sector
- At one point, Solow sector becomes profitable; labor and capital start to switch from Malthus to Solow
- In the end, almost all capital and labor are in the new sector - the transition is achieved

Two models in one

- In a single framework we have the two models we have seen
- When M dominates, the model has the properties of the Malthus model
- When S dominates, it is like the Solow model

Discovery and profitability

- At the time of the transition, the modern sector is not suddenly discovered, but starts to be profitable, and this is why its share will start to grow in the economy.
  - Idea of Mokyr: « much growth is deployed from previously available information rather than the generation of altogether new knowledge. »

Weaknesses of the approach

- A constant rate of technological progress is necessary in the model to trigger the transition. This displaces the charge of the proof a little bit further: where do technological improvements come from ?
- And why in 1820 or not before, for example during the Renaissance ?
- The actual transition comes too late to explain the early rise in literacy and the early drop in adult mortality.

Institutions

Institutional progress can also underlies the changes in z

Looking beyond

- Beyond technical progress, 4 intellectual and institutional change (Maddison)
  1. Development of secular knowledge and science
  2. Protection of property rights (financial development, accountancy)
  3. Changes in Family, Marriage, Inheritance (promoted individualism vs clan)
  4. Emergence of a system of nation-states (fragmentation stimulates competition)

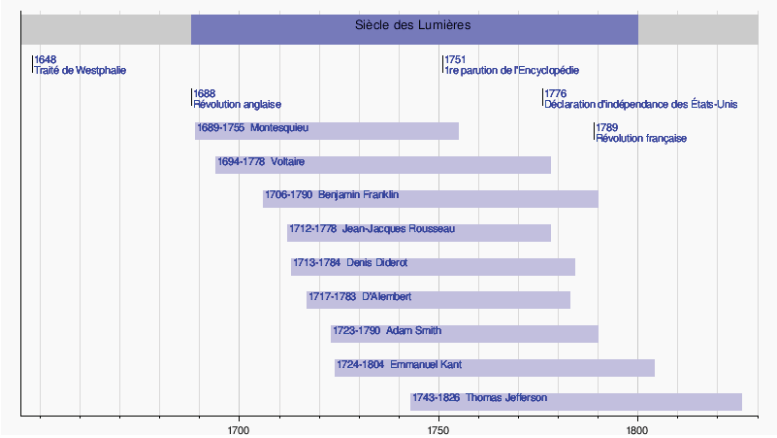
The possible role of Protestantism

- Protestant work ethic (Weber):
  self-confidence took the place of priestly assurance of God's grace
- Less redistribution than catholics (charity encouraging beggary)
- Importance of learning to read (the Bible)
  (next slide: The Bible weights more than the symbols of catholicism (tiara, keys, reliquary + monk)

The possible role of the enlightenment

- *The Enlightenment* advocates reason as the primary basis of authority
  - eighteenth century
  - France, Britain, Germany
  - Experimental attitude in sciences
  - => Decline of tradition, irrationality, superstition, and tyranny
  - Both technological and institutional shock

Timeline



A representative text (FR)

- From « l'Esquisse d'un tableau historique des progrès de l'esprit humain », written by Condorcet just before his death, and published just after in an III:
- Il arrivera donc, ce moment où le soleil n'éclairera plus, sur la terre, que des hommes libres, et ne reconnoissant d'autre maître que leur raison; où les tyrans et les esclaves, les prêtres et leurs stupides ou hypocrites instrumens n'existeront plus que dans l'histoire et sur les théâtres; où l'on ne s'en occupera plus que pour plaindre leurs victimes et leurs dupes, pour s'entretenir, par l'horreur de leurs excès, dans une utile vigilance, pour savoir reconnoître et étouffer, sous le poids de la raison, les premiers germes de la superstition et de la tyrannie, si jamais ils osoient reparaître.

Application: are institutions exogenous ?

Easterly gives the menu of bad policies held in Africa since 1960.

Quality of institutions is low. Why ?

Bad policy

- Recipe to kill growth (following Easterly):
  - Create inflation
  - Create an exchange rate premium on the black market
  - Create public deficits
  - Close the economy
  - Do not provide basic services
  - Do not fight corruption

Inflation

- Increases with money creation
  For example to fund a war (Israel after 1974),
- Creates bad incentives:
  - Inflation = tax on cash holdings;
    When inflation is high, agents avoid holding cash (incl. bank accounts), transactions - exchanges are more difficult - can be captured roughly by a negative productivity shock (drop in z)
  - Resources are used (diverted from productive activities) to protect against inflation

Governance: general assessment

- According to Easterly, governance explains a large share of the difference between Africa and Asia
- If policy in Africa was of the same quality as the one in Asia over the period 1960-1990, income per capita would be greater by 2000$ in Africa
- But what determines the quality of governance?

Why to kill growth ?

- A government, even kleptocratic and corrupted, has no interest in killing growth, since this would limit its future tax basis
- Key: a government, it is a coalition of different groups
- Polarization: by income (cf inequality), by ethnic group, by religion …
- In very polarized societies
  - Compromise at the government
  - Each group acts on its own
  - Non cooperative behavior kills growth

Ethnic diversity - 1

Ethnic diversity, violence, and public services, 1960–1989

	Average, quarter of sample least ethnically diverse	Average, quarter of sample most ethnically diverse
Ethnic diversity (probability of two people speaking different languages)	5%	80%
Violence		
Probability of civil war	7%	18%
Probability of genocide	5%	16%
Public services		
Average years of schooling of labor force	5.3	2.6
Percentage of roads paved	53.9	24.2
Percentage of power system losses	12.4	22.8
Telephones per 1,000 workers	92.8	7.4

Ethnic diversity - 2

Ethnic diversity and its consequences for policies, 1960–1989

	Average, quarter of sample least ethnically diverse (%)	Average, quarter of sample most ethnically diverse (%)
Ethnic diversity (probability of two people speaking different languages)	5	80
Per capita growth rate per annum	3.0	0.9
Policies		
Black market premium	10	30
Financial depth (broad money[a]/GDP)	47	22

a. Total assets of the banking system

Ethnic diversity and income inequalities

- Different types of polarization are bad for growth:
  - ethnic
  - High income inequality
- The combination of both is particularly bad

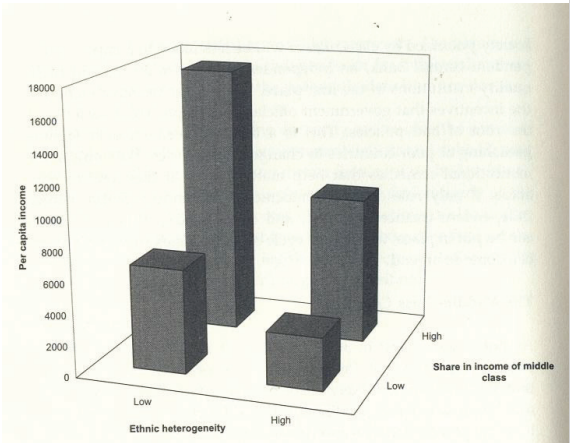


Figure 13.1
Economic development and social polarization

Geography

- Another determinant of policy: geography
- Acemoglu at al (QJE, 2002): geography and institutions are related.
- « Extractive » institutions introduced in naturally rich countries.
- In poor areas, no plundering incentives.
  Nothing prevented the building of investment-friendly institutions.

The most upstream explanation

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- Guns Germs and Steel (J. Diamond)
- Eurasia's large landmass provided it with more plant and animal species suitable for domestication, and allowed its people to exchange both innovations and diseases.
- Its East-West orientation allowed breeds domesticated in one part of the continent to be used elsewhere through similarities in climate and the cycle of seasons.
- The Americas had difficulty adapting crops domesticated at one latitude for use at other latitudes. + barriers to diffusion of knowledge
- Africa was fragmented by its extreme variations in climate from North to South: plants and animals that flourished in one area never reached other areas where they could have flourished.
- Europe was the ultimate beneficiary of Eurasia's East-West orientation:

Guns, Germs, and Steel

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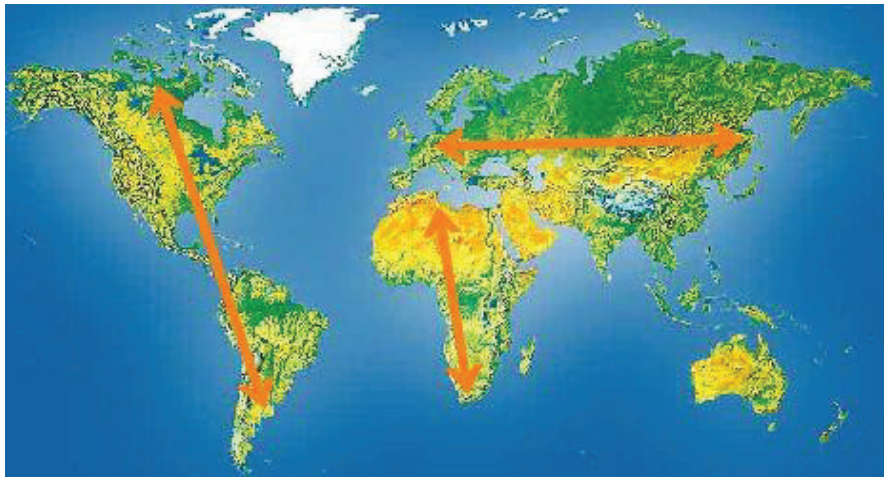


CHAP 9 -THE RISE OF EDUCATION

Map

- Question
  - The transition from stagnation to growth was accompanied by a rise in education
  - Previous approaches neglect this fact
  - An exogenous shock having permanent effects through human capital accumulation?

Map

1. Facts
2. The role of institutions
3. A possible role for mortality
4. Application: Education policy

1. Facts - Literacy

Link between the rise in literacy in the pre-industrial era and the process leading to the Industrial Revolution?

(Cipolla, Literacy and development in the West)

Literacy may favor the Industrial Revolution in more than one way:

- Avoids shortages of literate workers in fields where such workers are specifically required
- made people more adaptable to new circumstances and receptive to new ideas.

Literacy - general picture

- The general picture:
  - little education in the population around 1600,
  - then continous improvements,
  - until compulsory education was decided around 1870 (England).

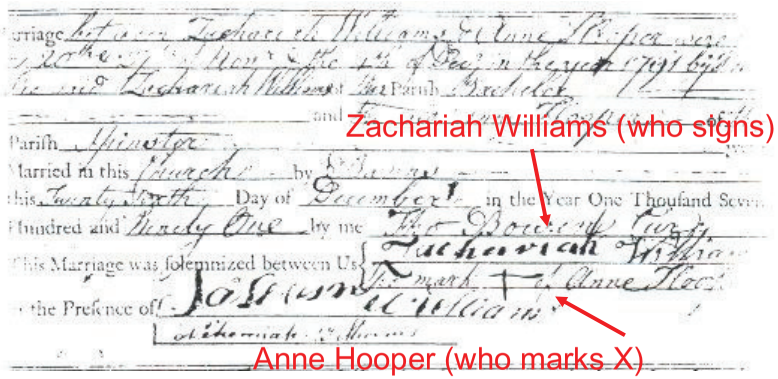
Literacy en 1600

Population was largely illiterate in 1600.

- Anecdotes:
  « In 1607 the Venetian government appointed a commission of four naval officers to decide upon the kind of ships to be used in a war against the pirates. They must have been officers of quality to be chosen for such a purpose; among the four officers, three of them signed their names with a cross. » (Cipolla)
- Parish registers

Parish registers

Marriage register, Notgrove, 1791



France

- Survey in 1877 by Maggiolo.

  15,928 teachers counted the signatures in marriage registers. They examined 219,047 documents over the period 1686–1690 and 344,220 documents over 1786–1790.

- % newly married people signing with marks:

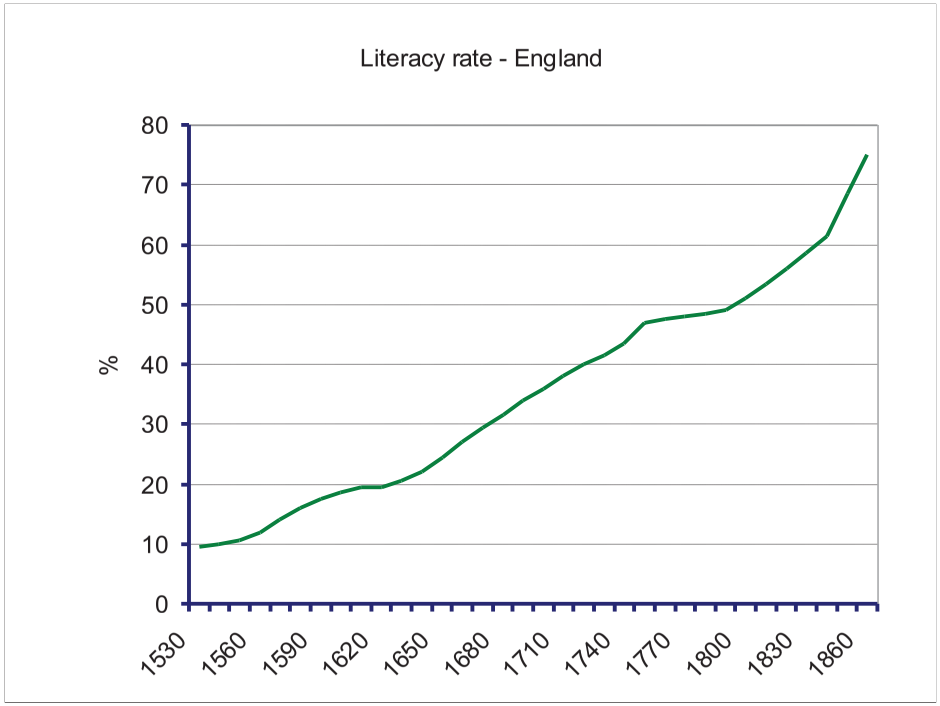
1686-90	1786-90
79	63

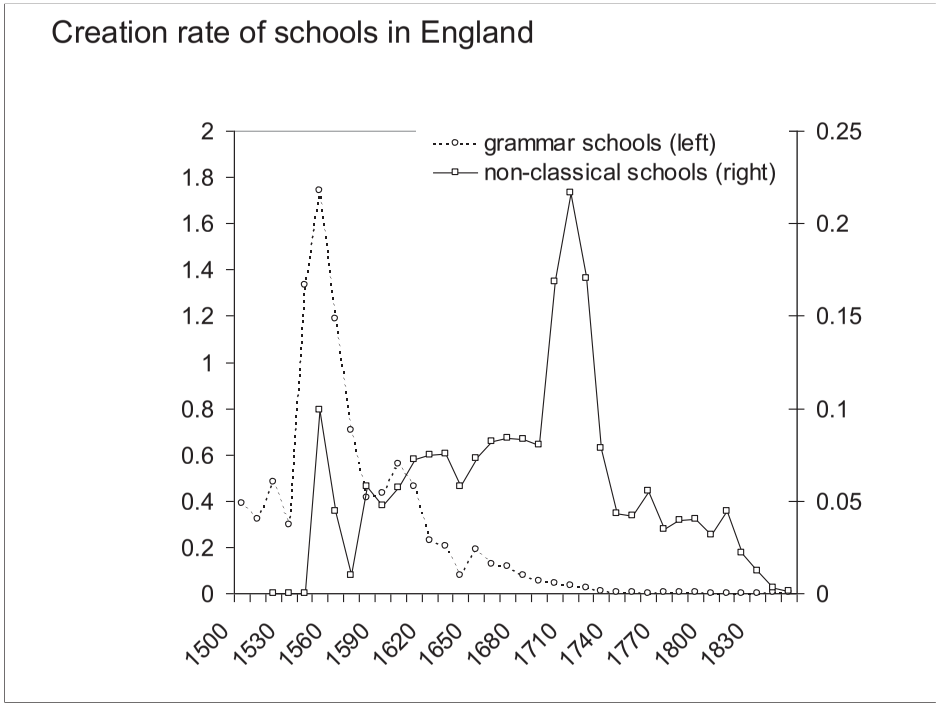
England

- Following Cressy, improvements in literacy started as early as in 1500.
- Significant achievements much before any compulsory schooling

Source: Cressy, Literacy and the social order, CUP

Establishement of many schools as soon as in the 16th century
Protestantism ?
Density of population ?





Provisory conclusion

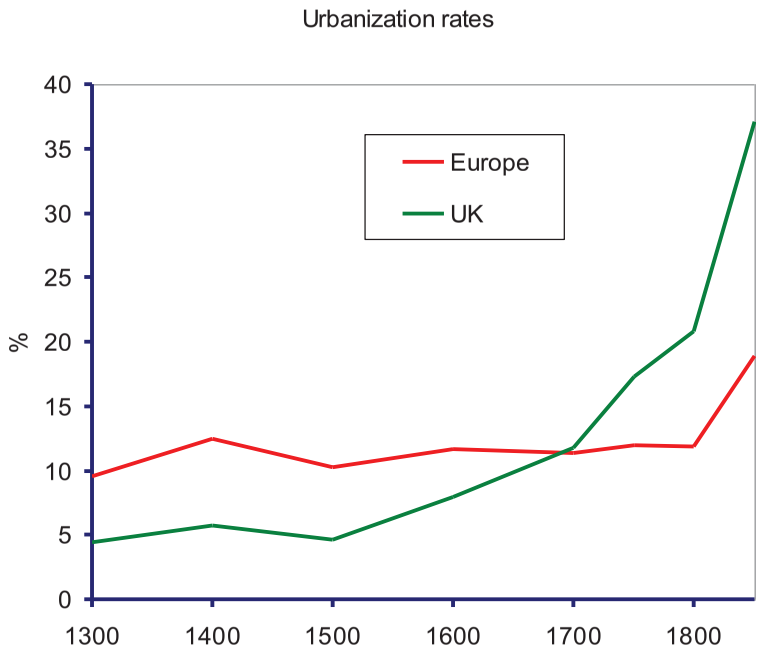
- The two data set we have seen - France and England - agree:
- There has been large improvements in literacy right before the industrial revolution.
- Two additional indications
  - Size of cities
  - Heaping in birth dates

Literacy and cities

- Cities are important places to acquire education.
- Population of London:

1500	1600	1700	1800
50	200	575	948

Bairoch, Batou, Chèvre, The Population of European Cities from 800 to 1850



Heaping in birth dates

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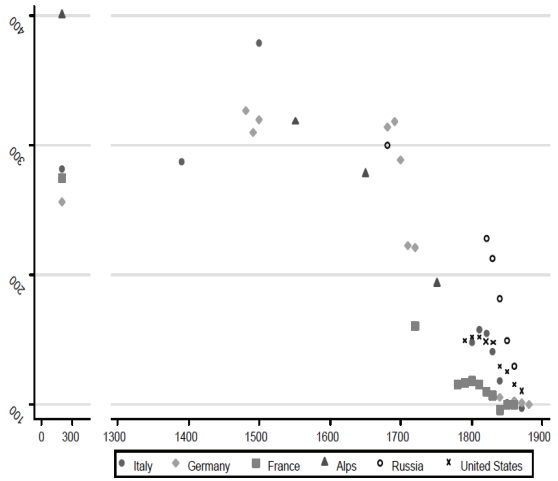


When one does not know one's date of birth, one usuallly report a multiple of 5: 1980, 1985, 1990...

There is therefore a heaping phenomenon (accumulation of reported birth at these dates)

This heaping is a measure of the absence of human capital

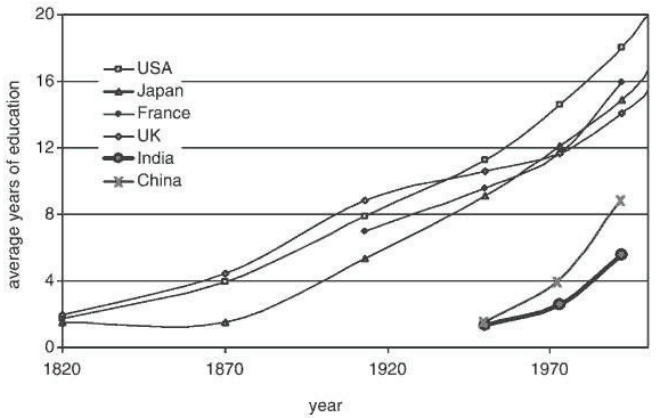
Seehomepage Joerg Baten

19th and 20th centuries

- Average years of schooling (maddison)

	1820	1870	1913	1950	1973	1992
England	2.00	4.44	8.82	10.60	11.66	14.09
France			6.99	9.58	11.69	15.96
Germany			8.37	10.40	11.55	12.17
Belgium				9.83	11.99	15.24

Figure 2.16
YEARS OF EDUCATION PER PERSON, 1820–2001



SOURCES: Angus Maddison, *Monitoring the World Economy, 1820–1992* (Paris: OECD, 1995); Angus Maddison, *Chinese Economic Performance in the Long Run* (Paris: OECD, 1998); Angus Maddison, *The World Economy: Historical Statistics* (Paris: OECD, 2003), http://ggdc.net/~maddison (accessed July 1, 2005).

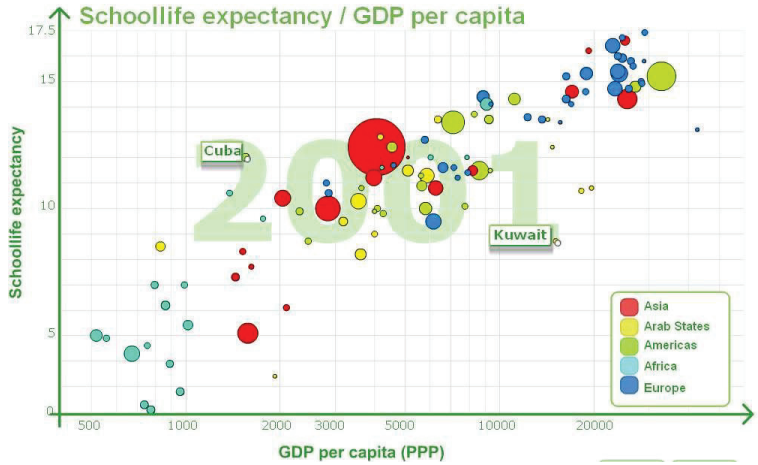
30 last years

- Interactive presentation
  http://www.gapminder.org/downloads/presentations/world-education-chart-2003.html

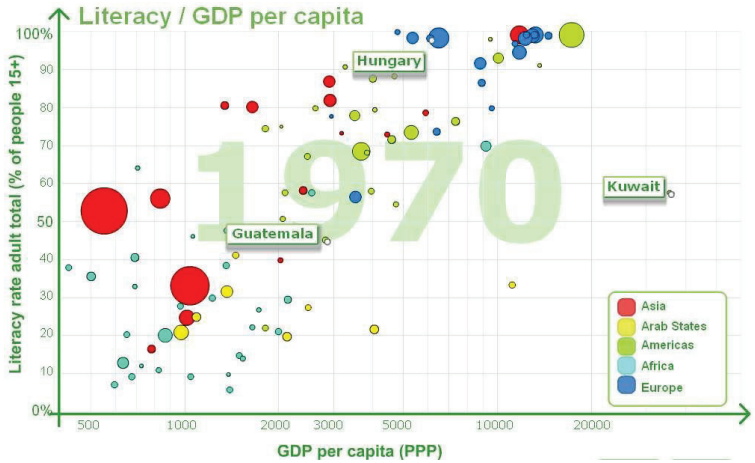
World Education Chart 2003 - Education data about the world 1970-2000

- Strong correlation between income per capita
  - Education
  - Gender equality
- Direction of causality ??
  (this is why we look at old data to show that education comes first)

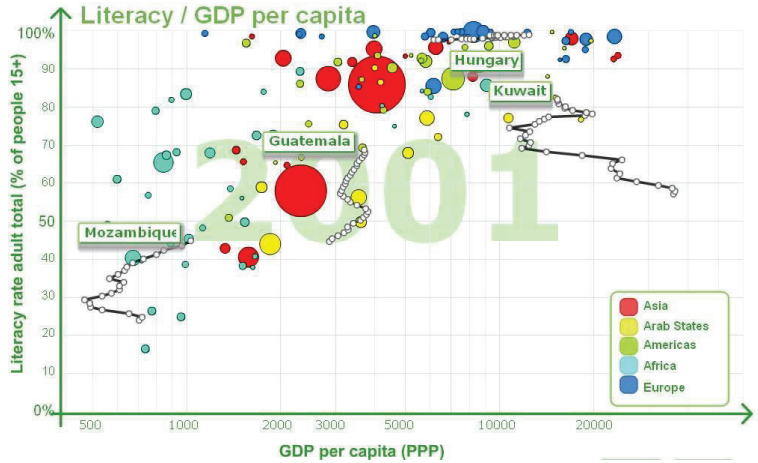
Correlation income -education



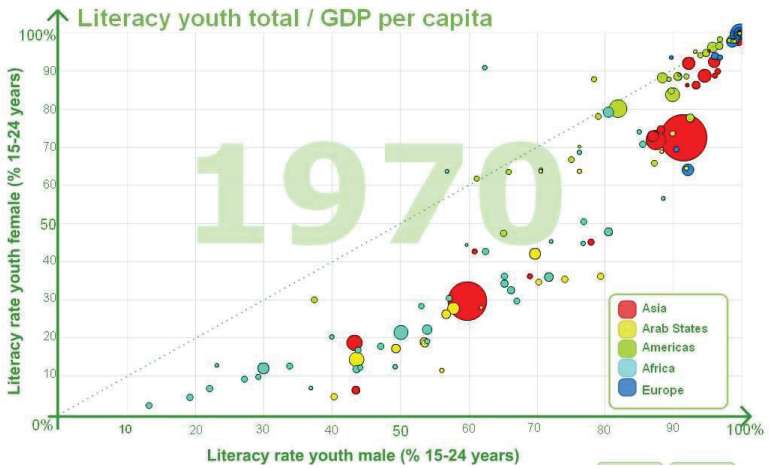
Literacy and income



Relation over time



Correlation income with gender equality



2. A possible role for institutions

Many institutions can be invoqued:

- Existence, accessibility and quality of public education
- Capacity of individuals to finance the cost of education (credit markets or intra-family transfers)
- Attitude of cultural and religious groups towards education (Weber on protestantism)
- Natural environment (e.g. tropical diseases) influencing health and capacity to follow some education

An example

- But institutions are not exogenous
- Recently: interesting data and models on the link between the introduction of *public schooling* and the distribution of land.
- Starting point: Why richer countries like Spain and Portugal were overtook by England ?
- Same question for their colonies: why was the gold-rich Mexico overtook by Northern-American colonies ?

Proportion of household heads who own land

Mexico, 1910	2.4
United States, 1900	74.5
Canada, 1901	87.1
Argentina, 1885	20

Engerman – Sokoloff, FACTOR ENDOWMENTS, INEQUALITY, AND PATHS OF DEVELOPMENT AMONG NEW WORLD ECONOMIES, NBER WP

Factor endowments and inequality

- Most of the New World economies developed extremely unequal distributions of wealth, and they maintained them after independence.
- The United States and Canada are exceptional in that right from the beginning, they were characterized by relative equality. It may not be coincidental that they began to industrialize much earlier ...

A model of conflict

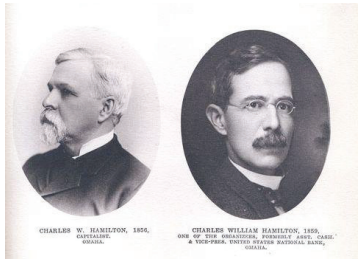
Two types of wealth: land and capital

- land is less complementary to human capital than physical capital
- Conflict of interest:
  - land-owners want cheap unskilled labor,
  - capitalists want more educated persons.

Galor, Moav and Vollrath: **Divergence and Overtaking: Land Abundance as a Hurdle for Education Reforms**

Conflicts between land-owners and capitalists

Dodson Foster (1730-92), Quaker merchant and Port Commissioner (1755-58) whose first investments were in slaving.



- The outcome of this conflict – and the support to education - depends on the distribution of wealth.
  In economies dominated by land owners, little public education

Land and education reforms

- Land and education reforms are often observed together:
  - Either land reform has reduced the incentives or the power of landowners to block education reform
  - Or land reform is just the witness of a reduction of power of land owners
- Examples:
  - Japan: redistribution de la terre vers les petits propriétaires en 1871-83 et éducation obligatoire en 1872
  - South Korea and Taiwan after WWII

3. A possible role for mortality

The return to education depends on how long the investment will be productive

It depends on longevity

Ben Porath effect

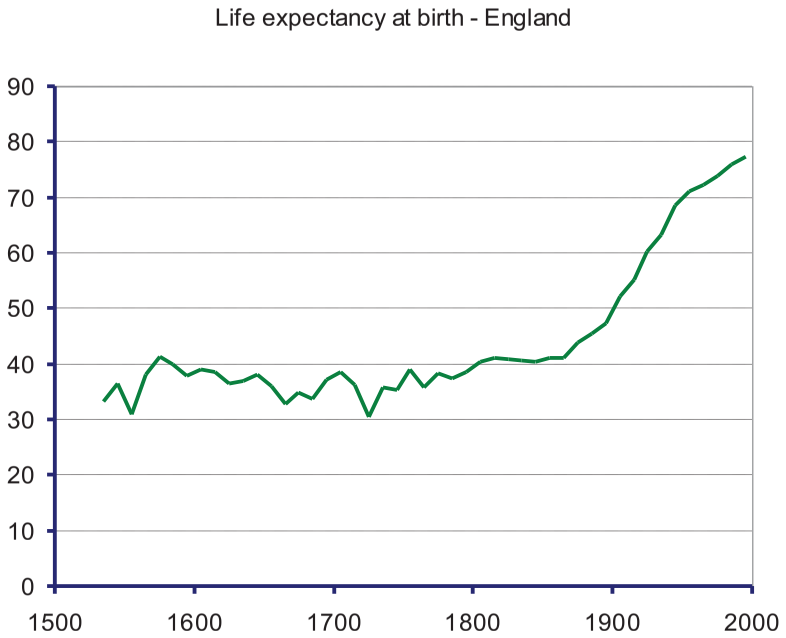
Idea: there was an exogenous improvement in longevity, which translated into more education and sustained accumulation of human capital

Little Model

- Length of life (certain): A
- Time spent at school: T, to be chosen
- Wage per unit of human capital: w
- Human capital function of time spent at school:$H=T^a$
- Parameter a measures the return to education
- Life cycle income: (A-T) w T^a
- First order condition implies: T = A a/(1+a)

Mortality

- Definition: Life expectancy at birth, or mean length of life, is the mean of the ages at death for one generation.
- Trends:
  - No improvement before 1800
  - But reduction in variability



Infant mortality

- Infant mortality
  - Fluctuates strongly as a function of economic and sanitary conditions
  - has a major influence on the estimation of life expectancy at birth.
  - improvements arose very late in the nineteenth century
    ! not surprising that life expectancy at birth shows little trend before that time.

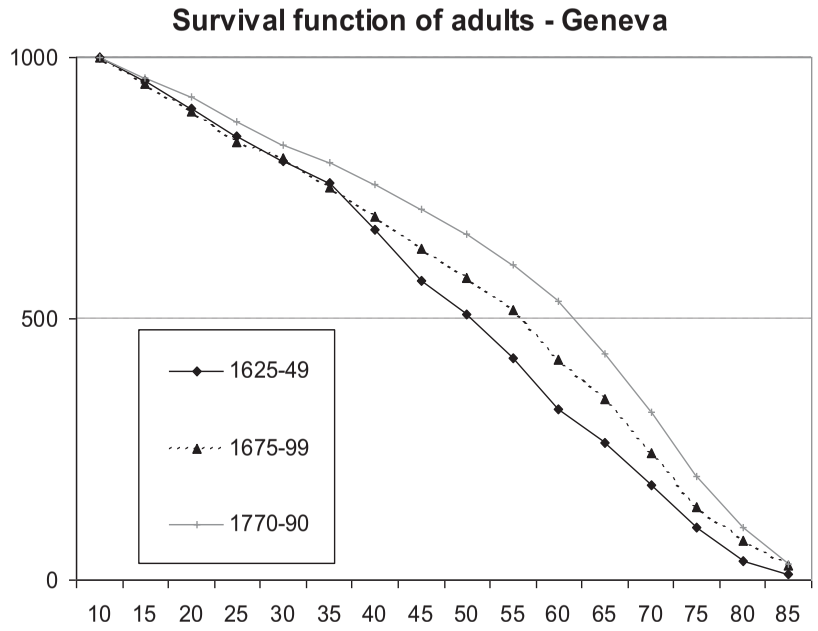
Adult mortality

To study how adult mortality evolved over time, we need cohort life tables.

- Pre-industrial data: Not easy to find
- Good data from Perrenoud (1978), who constructed life tables from 1625 to 1825 on the basis of a broad nominative study in Geneva (Switzerland).
- Long series available for some developed countries starting in 1800.

Lifetable

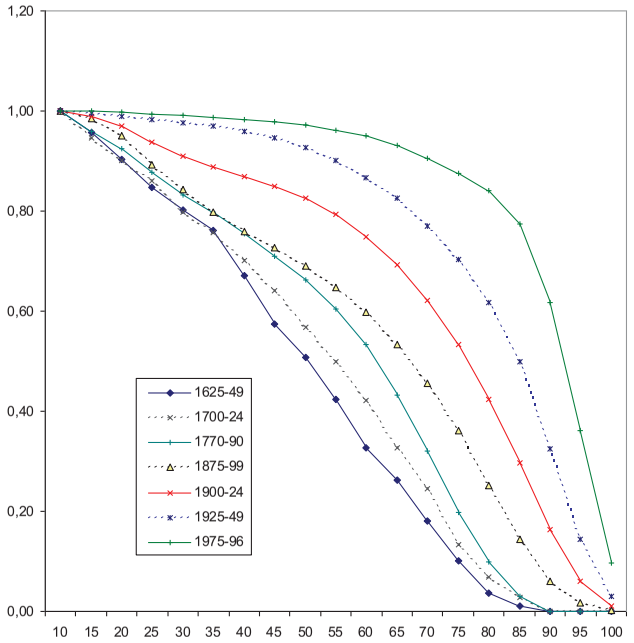
Age	Survivors	Deaths	Death rate	Survival function
0	1000	100	10%	1
10	900	45	5%	0.9
20	855	43	5%	0.855



Observations

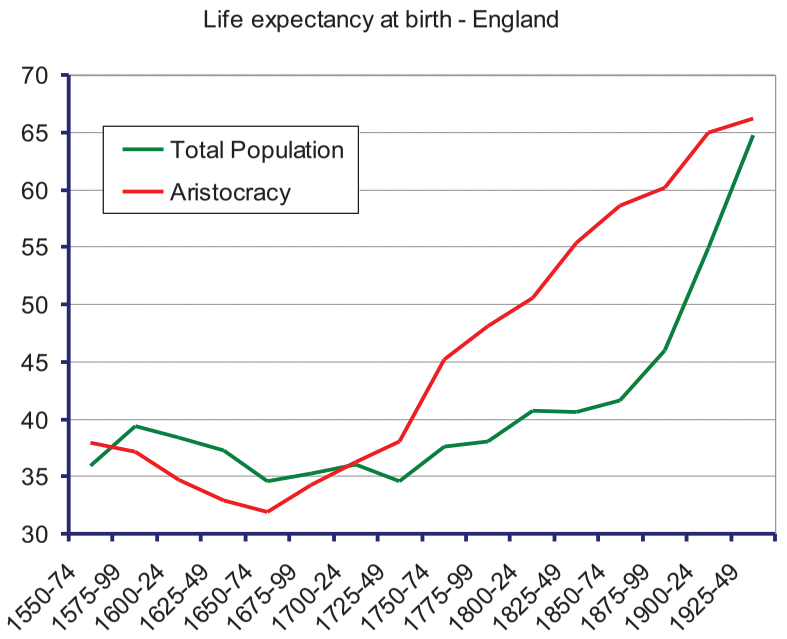
- Survival function normalized to 1,000 at age 10.
  - To eliminate the shifts generated by changes in infant mortality and concentrate on the mortality of adults.
- Observations
  - Upward shifts of the curve from one generation to the next.
  - Drop in death rates concerns those aged 40–65.
  - Gains in longevity do not translate into a rise in the maximum attainable age. Very few persons lived longer than 85.

Data for France (1800-)



Mortality by social class

- The various social classes are not « equal » in face of development: differential mortality
- English data.
  Total population from Parish data
  Aristocrats from genealogical data
  (Hollingsworth)
- A priori we expect aristocrats to live longer than ordinary people, become they have a higher income



Differential mortality

- History is full of surprises:

Before 1700, life expectancy at birth was not higher for upper social classes

Explanation: urban penalty ?

- After 1700, a gap appears, and already by 1800 elites rose their life expectancy from 35 years to 45-50 years.
- Thereafter, the gap is progressively filled.

Surgery in Bruges hospital, 18th century

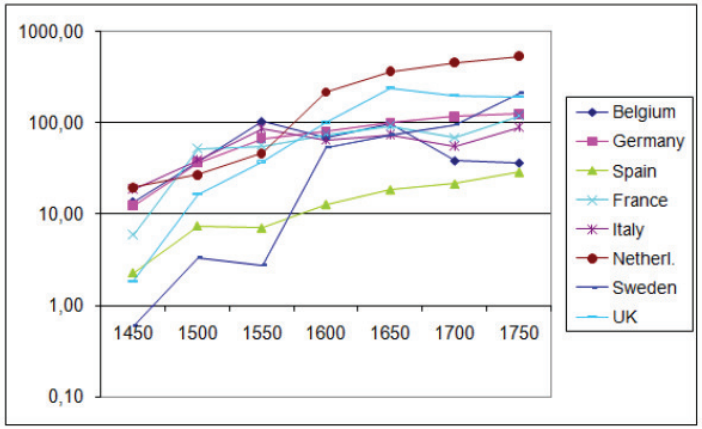
Medical knowledge

- Common view: The period 1500-1870 does not contain major technology changes in health that could have increased life expectancy
- But 3 arguments against this view

3 arguments

- 1500-1800: medicine showed an increasingly experimental attitude: no improvement on theory but advances on practice and empirical observations. (new drugs coming from the New World)
- 1829, Hawkins wrote *Elements of Medical Statistics*, in which he described a set of diseases which were leading causes of death but can now (in 1829) be treated effectively
- Number of books over the period 1750-1800.

number of new editions per million inhabitants



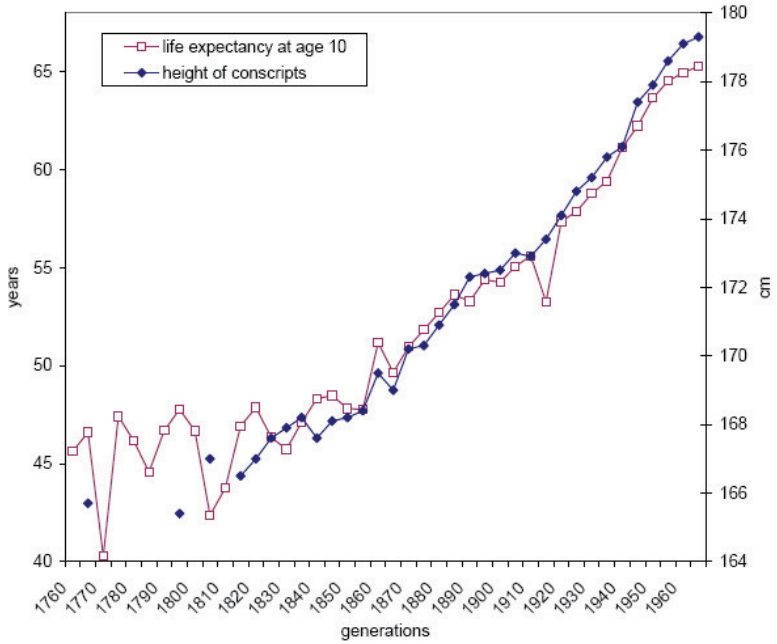
Baten en van Zanden (2007)

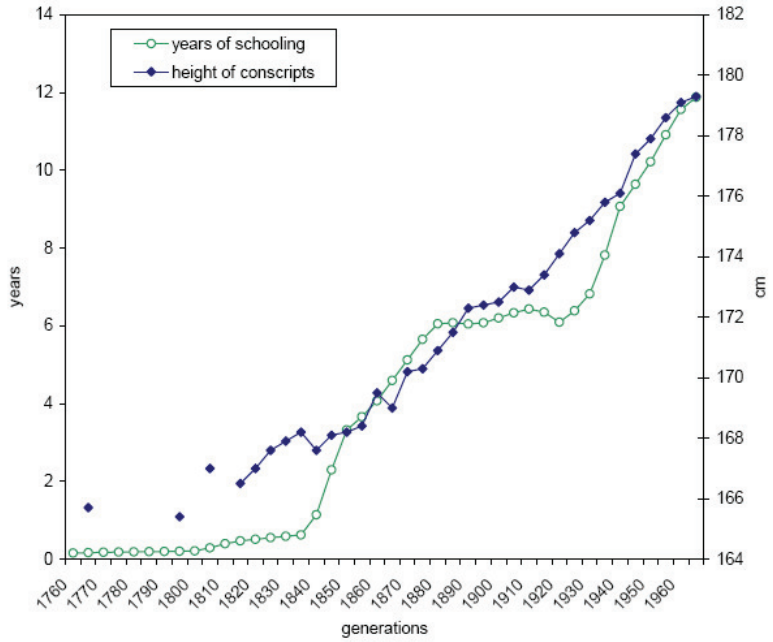
Number of new books on health published in England

Period	Number of books
1600-24	9
1625-49	16
1650-74	17
1675-99	25
1700-24	28
1725-49	34
1750-74	53
1775-1800	81

Mortality and Height

- A further indication that longevity improved before the industrial revolution: look at height
- Height: simple measure of childhood development
  - Role of nutrition and exposure to infection
- But is a very good predictor of old age longevity
- Look at Swedish data: height increases with life expectancy, before the rise in education





CHAPTER 10

THE DROP IN FERTILITY

To summarize

- Human capital accumulation is closely linked to growth
- It was made possible by
  - The adoption of new institutions
  - The rise in longevity (before the industrial revolution)
  - An attitude favorable to education (enlightenment, prev. chapter)

Map

- Objectives
- A model of fertility and education
- The tradeoff between quality and quantity
- Application: cash for condoms

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Objectives

- The transition « stagnation » -> « growth » has been accompanied by a drop in fertility

In all the models we have seen, this has a positive effect on the level of income (in Malthus, in Solow).

4. Fertility and Education : A model

Tradeoff between the quality and quantity of children
U[n ,e]
n: number of children (homogeneous),
e:education (quality) of each child

Constraint: (1-f n) w^m + w^p= e n
f: rearing time, w^m: mother's wage, w^p: father's wage

The tradeoff arises from the budget constraint: impossible to increase quality e at constant quantity n

Possible reasons of a drop in fertility

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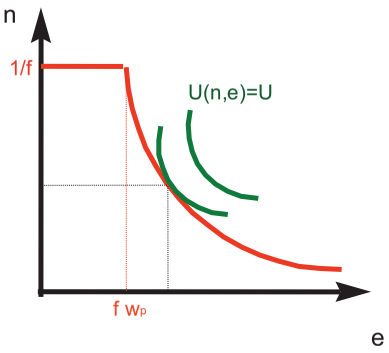
- Better contraception technology
- Drop in infant mortality (child replacement hypothesis)
- Introduction of social security systems. Children are no longer seen as an investment (old age support hypothesis)
- Ban on child labor
- Change in the values of the society (cultural explanation)
- Tradeoff between quality and quantity of children: higher income of the mother (opportunity cost), and/or rise in the return to education
  - Rise in income of the parents : education becomes less costly than number of children
  - Rise in the return to education

Quality and quantity

- Budget constraint in red
  for n=1/f, e= f w^p
  otherwise, n= (w^m+w^p)/(e +f w^m)
- Indifference curve in green
- Determination of quantity (n) and quality (e)

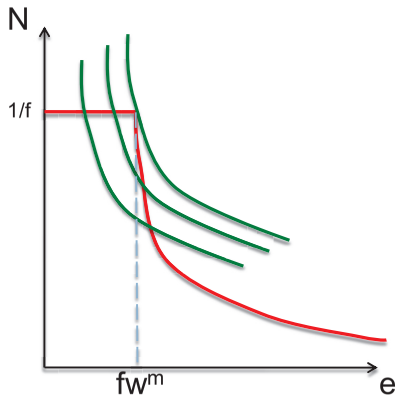


Maximum fertility

- Strong taste for the quantity of children and low w^m

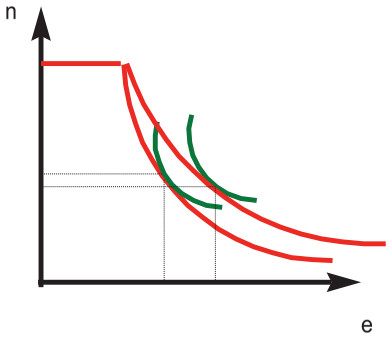
→

- It may be optimal to have the biological maximum 1/f. Then, women do not participate to the labor market



Increase in w^m

- Having children is more costly (opportunity cost) Education is cheaper
- Substitution quality / quantity
- Hypothesis: substitution effect dominates

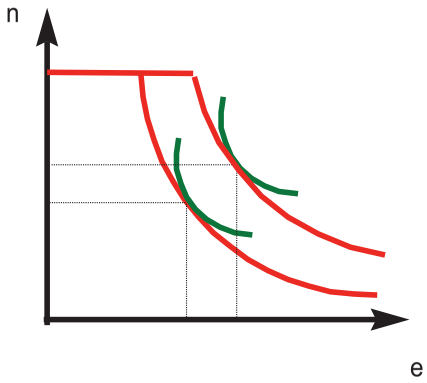


Interpretation

- w^m ?
- Importance of women education
- Gender equality both in the education system and on the labor market plays an important role (here channel: gender eq -> fertility -> growth)

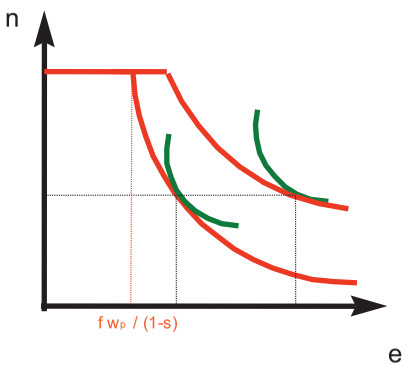
Increase in w^p

- Pure income effect
- Both quantity and quality increases (if normal goods)
- Same if there is a lump sum transfer to households



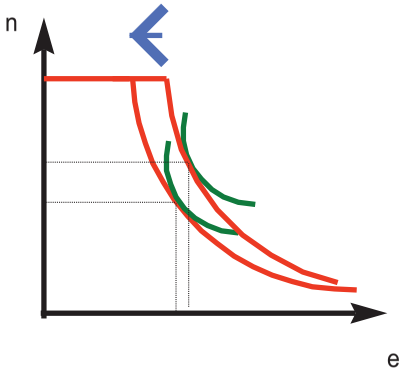
Subsidies to education e

- $(1\text{-}f\ n)\ w^m + w^p = (1\text{-}s)\ e\ n$
  Subsidy rate: s
- Positive effect on education,
  Uncertain effect on fertility



Child labor

- $(1\text{-}f\ n)\ w^m + w^p + p\ n = e\ n$
- With p: productivity of children
- To ban child labor has a negative effect on fertility
- Uncertain effect on education



Rise in the return of education

- Quality of children = their human capital h
- Human capital depends on education: h(e)
- The return of education is the derivative of h(e): h'(e)
- Parents maximize U(n, h(e))
- The return of education affects the marginal rate of substitution between quantity n and quality e
- If it increases, there is a pure substitution effect: more e and less n

Change in the composition of population

- Two types of people:
  1. like having many children and don't care too much about education
  2. put a lot of weight on quality of children
- Group 1 is in proportion p in the economy
- $U[n,e] = p\ U1[n,e] + (1\text{-}p)\ U2[n,e]$
- If p decreases, aggregate preferences U will reflect more those of type 2: education increases and fertility decreases (next chapter)

Cultural change

- Or, two groups of people:
  traditional (1)
  modern (2)
- As the share of traditional people decreases, fertility drops
- Need to model how the groups evolve over time

Empirical relevance of the model on modern data

- Not so many analysis. Here India, 1994
- 35000 households, 1765 villages

Estimating the Effect of Fertility Decisions on Child Labor and Schooling

P. Deb
F. Rosati

February, 2004

Marginal effects

- We estimate the effect of the various variables on fertility
- Effect of the education (income) of the father (+) and of the mother (-) are as predicted
- Reduce mortality by 1.00 increases the number of surviving children by 0.63

first child is male	-0.060*
	(0.013)
mother's age	0.085*
	(0.008)
father's age	0.048*
	(0.007)
mortality rate in village	-0.627+
	(0.371)
mother's education	-0.069*
	(0.009)
father's education	0.010*
	(0.005)

Marginal effects (2)

- The number of children increases with the cost of education
- Income effect: poor, livestock

primary school in village	-0.031
	(0.020)
secondary school in village	-0.018
	(0.020)
cost of education	0.017
	(0.011)
household is poor	-0.099*
	(0.012)
household owns land	0.002
	(0.013)
household owns livestock	0.047*
	(0.013)
number of appliances	-0.000
	(0.005)

Marginal effects (3)

- culture
- Reflects preferences (U function).

household is hindu	-0.094*
	(0.036)
household is muslim	0.140*
	(0.040)
household is christian	-0.265*
	(0.055)

Table 2: Ordered Probit Regression Model and OLS

	OProbit 1	OProbit 2	OProbit 3	OLS 1	OLS 2	OLS 3
Female Income	-0.089	-0.080	-0.080	-0.095	-0.085	-0.084
	(4.88)***	(4.38)***	(4.37)***	(5.14)***	(4.61)***	(4.60)***
Male Income	0.053	0.049	0.051	0.052	0.048	0.049
	(4.55)***	(4.25)***	(4.35)***	(4.42)***	(4.14)***	(4.22)***
Small Town	0.251	0.248	0.250	0.243	0.234	0.236
	(4.38)***	(4.32)***	(4.35)***	(4.09)***	(3.97)***	(3.99)***
Live In Paris	-0.374	-0.344	-0.350	-0.327	-0.299	-0.305
	(4.93)***	(4.51)***	(4.59)***	(4.35)***	(3.99)***	(4.06)***
Primary Education	0.340	0.318	0.321	0.514	0.487	0.489
	(3.47)***	(3.24)***	(3.27)***	(4.90)***	(4.68)***	(4.70)***
Never Married	-1.357	-1.363	-1.360	-1.053	-1.052	-1.048
	(16.00)***	(16.04)***	(15.95)***	(14.12)***	(14.22)***	(14.09)***
More Than 45	0.227	0.197	0.206	0.274	0.232	0.239
	(3.92)***	(3.36)***	(3.49)***	(4.54)***	(3.83)***	(3.92)***
Less Than 28	-1.422	-1.400	-1.410	-0.981	-0.949	-0.957
	(12.25)***	(12.04)***	(12.10)***	(10.17)***	(9.90)***	(9.96)***
Parental Fertility		0.060	0.060		0.059	0.058
		(3.02)***	(3.01)***		(2.87)***	(2.85)***
Family Values		0.143	0.145		0.132	0.134
		(4.10)***	(4.14)***		(3.73)***	(3.78)***
Office Frequency		0.039	0.040		0.060	0.062
		(2.00)**	(1.70)*		(3.00)***	(2.59)***
No Religion			0.143			0.122
			(1.59)			(1.49)
Believer			0.042			0.032
			(0.66)			(0.48)
Constant				1.604	1.138	1.089
				(15.89)***	(8.11)***	(7.56)***
Pseudo R2	0.144	0.149	0.15	0.295	0.31	0.312
(Adj R for OLS)						
BIC	-8482	-8492	-8480			

Observations 1793
Absolute value of z statistics in parentheses (t statistics for OLS)
* significant at 10%; ** significant at 5 %; * significant at 1 %

And in France:

- Dataset "Enquête Mode de Vie des Français" for the year 2007: 1799 French women aged between 18 and 93, total fertility rate equals 1,6 children.

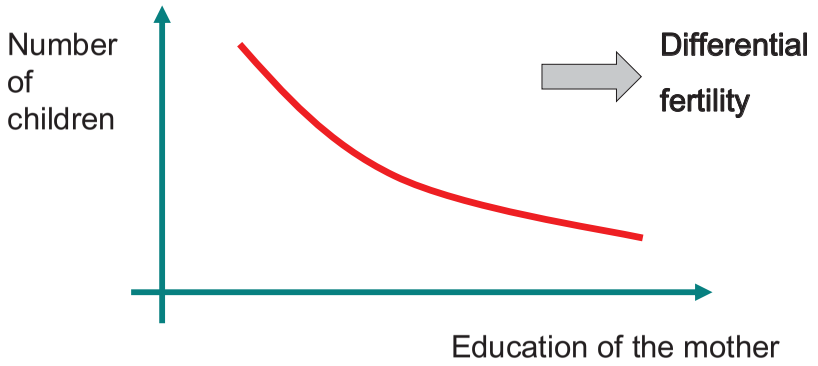
  from Baudin [2009] "Religion and Fertility: The French Connection"
- Positive impact of men's income and negative impact of female's income
- Effect of female's education preserved for low educated agents

5. Additional facts on the quality/quantity tradeoff

More educated mothers should have fewer children. Do we observe such a relationship between fertility and education across countries ?

Fertility and education

Today across the world:



Fertility per level of education

Total fertility rates by education

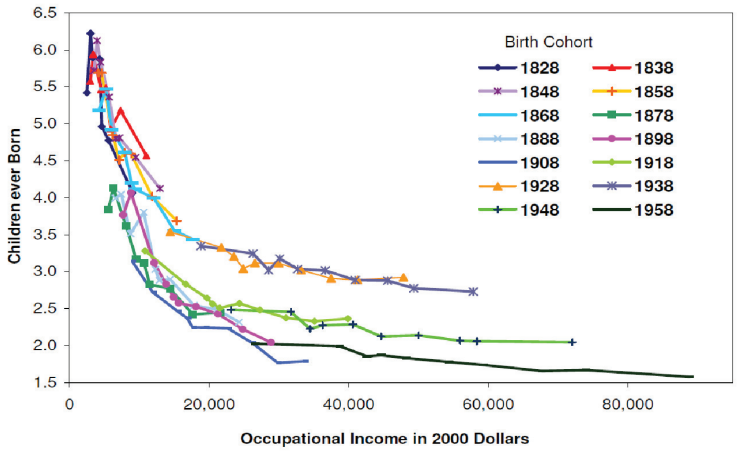
Survey	No. of countries	Total fertility rate		
		<Elementary	Elementary	Secondary+
WFS, 1975–1979	13 EUR/US	2.40	2.17	1.79
WFS, 1974–1982	30 DC	6.5	5.5	4.0
DHS, 1985–1989	26 DC	5.7	4.9	3.6
DHS, 1990–1994	27 DC	5.29	4.72	3.29

Source: Kremer and Chen (2000). WFS: World Fertility Survey. DHS: Demographic and Health Survey. "Secondary+" is the average of low secondary, high secondary, and post-secondary, where appropriate.

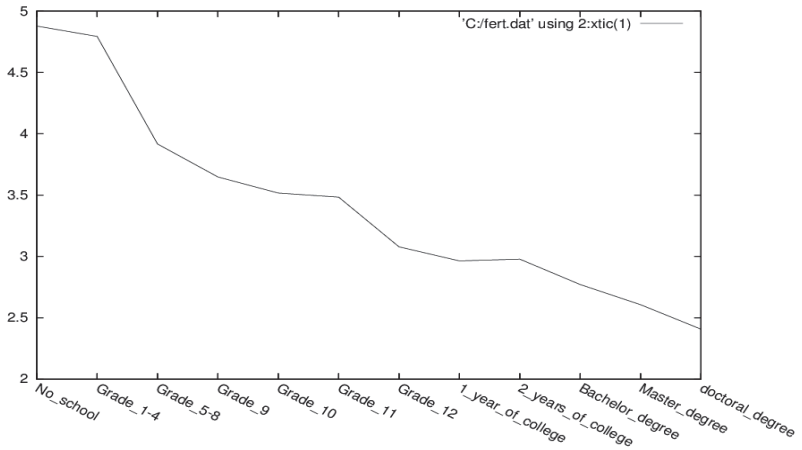
Quality/quantity tradeoff

- For educated women (high wage): the opportunity cost of child-rearing time is high -> small number of children and high quality.
- For less-educated women (low wage): providing education is expensive relative to their income -> many children.

US: cross section and time series (from Jones – Tertilt)



In the US: children ever born from married mothers 45+, in 1990



Fertility control

« Cash for condoms »

Motivations to control population

- Malthus and Solow
- Demographic dividend
- Sustainability for the environment

≠

- Density of population good for technical progress
- Density of population helps to cover the cost of infrastructure

Malthus and Solow

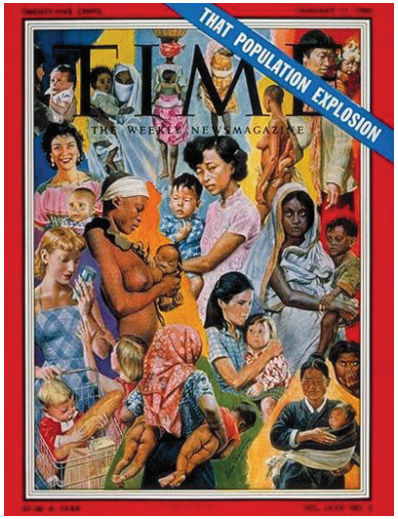
- According to Malthus, to control population is the only way to increase the income per capita
- According to Solow, Long term per capita income depends negatively on population growth:
  when population grows fast, it is difficult to maintain a rise in physical capital per worker

Demographic dividend

- If fertility drops fast, there will be, 15 years later:
  - A high share of active population in total pop
  - A low share of dependent population (young and old)
  - « demographic dividend », a period during which a country has to seize its chance to develop (« a window of opportunity »), … which lasts as long as the last large generation is on the labor market

The fear of the 70s

- Moreover…
- Fear that the explosion of population on earth could not be sustainable (food production, natural resources)
- Too pessimistic as far as food is concerned: Since then, food production grows faster than population



Still today

- August 17, 2005 - Philippines' parlement
-

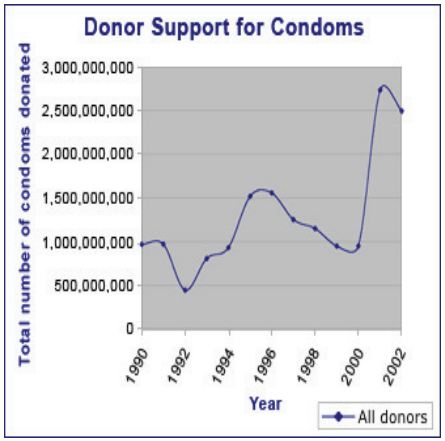
Legislators urge stronger population control measures

Together with visiting officials from the United Nations Population Fund (UNFPA), the members of the Special Committee discussed ways to control the country's ballooning population.

Rep. Marcoleta also asked the UN representatives for an update on the UNFPA's commitment to supply $20,000 worth of condoms through the Philippine Legislators Committee on Population and Development (PLCPD).

Policy recommandation

- Help poor populations to control their size
- cash for condoms - donate condoms to these countries
- Note: recently, such policy is also targeted at AIDS - which is a different question



The myth of undesired birth

(following Easterly)

- Hard to believe that condoms are not affordable or simply unavailable
- We already have seen that the population in Rouen managed to reduce fertility as early as in the 18th century
- Comparing desired fertility with observed fertility (with surveys) one conclude that 90% of the variation in observed fertility is accounded for by variations in desired fertility

The best condom

- The high rates of fertility result most often from choices, not from contraception mistakes
- The best condom: to develop incentives to have fewer children
  - reduce gender inequality on labor market (wages, education)
  - Increase the return to education

Objective

- In these theories, the take-off will appear inevitably at some time
  - Given some initial conditions
  - Without any external shock
- Two theories
  - Population driven technical progress
  - Natural selection

CHAPTER 11

ENDOGENOUS TAKE-OFFS

1. Population driven technical progress

Unified growth theory

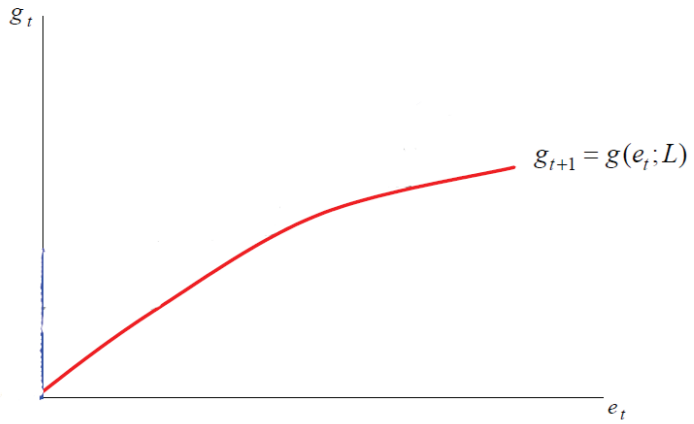
Galor and coauthors

http://www.econ.brown.edu/fac/Oded_Galor/UGT.htm

In short

- For Galor and Weil, there is an impact of population size on the rate of technological progress
  causes the Malthusian state to vanish in the long-run
- This raises the return to human capital sufficiently so as to induce parents to provide their children with some human capital.
- At this point a virtuous circle develops and the transition starts.

Technical progress as a function of e and L



Population induced technical progress

- We adopt Galor notation: L = population, g= growth of technical progress $((z_{t+1}-z_t)/z_t)$
- Key element 1: g depends on population size and education per capita: g(e,L)
- In the Malthusian epoch, parents do not invest in education, only in quantity of children. Any increase in income is translated into more children (function g() of Malthusian theory (which has nothing to do with the g here))
- With no education, everything is as in the Malthusian model except that g is endogenous and increases with L (population). Population increases is the only engine of technical progress

Justifications

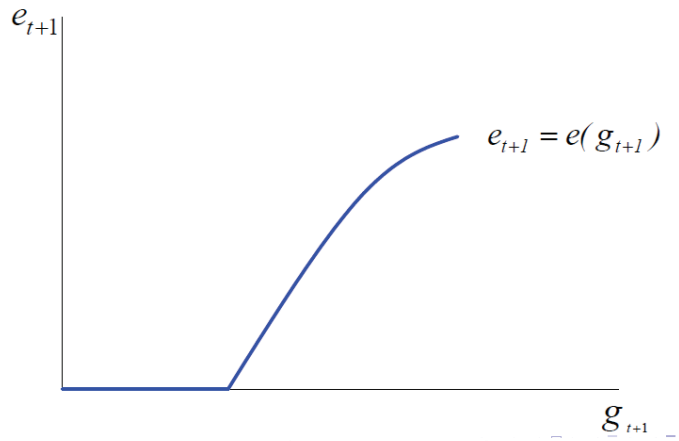
- the transmision of knowledge is easier in regions with shorther geographical distance between people, i.e. cities.etc…
- greater urbanization promotes exchange of ideas.
- More population allows for specialization of tasks

→ density speeds up the accumulation of knowledge.

Technical progress and human capital

- Key element 2: at some point, technical progress requires educated individuals to be implemented.
- Educated individuals now have a comparative advantage (skill premium)
- Increases the return to education and leads parents to reduce quantity of children to enhance their quality
- Hence, spending on education depends on g: e(g).

Optimal education as a function of growth



Notice the corner regime (no education for low g) and the interior regime with e>0

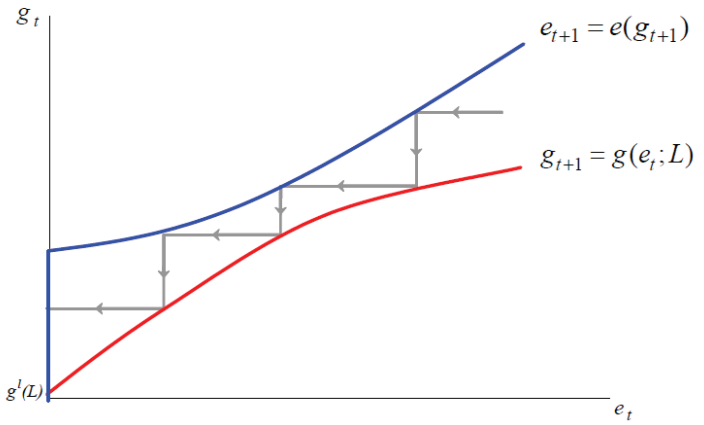
Production function

- Key element 3: human capital also enters into the production function. It is like this:

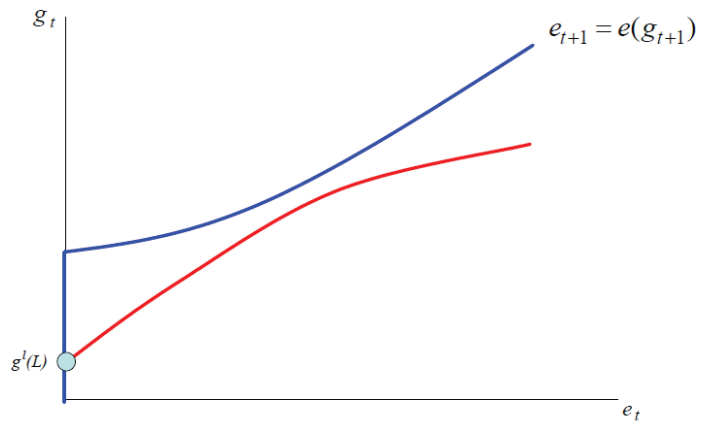
$$Y_t = H_t^a (z_t \text{ Land})^{1-a}$$

- H_t is the total human capital in the society.
- In the Malthusian regime, H_t is just population
- As soon as human capital accumulates, unbounded growth is possible: H_t and z_t would grow at the same rate in the modern regime

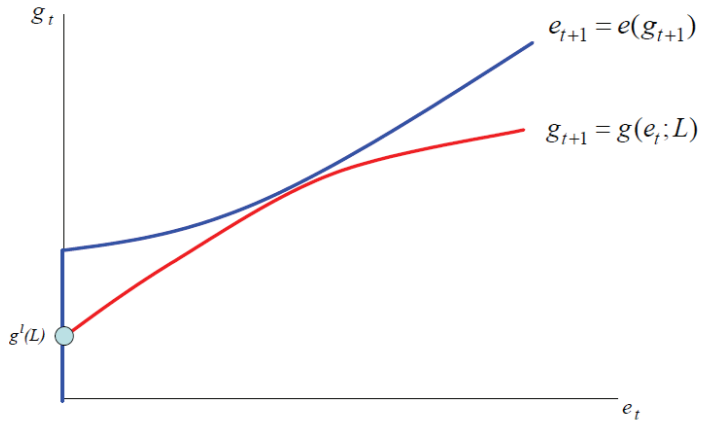
In the Malthusian regime



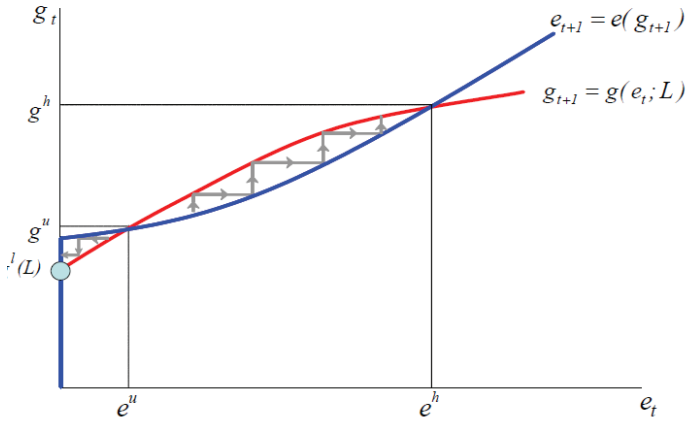
Population increases



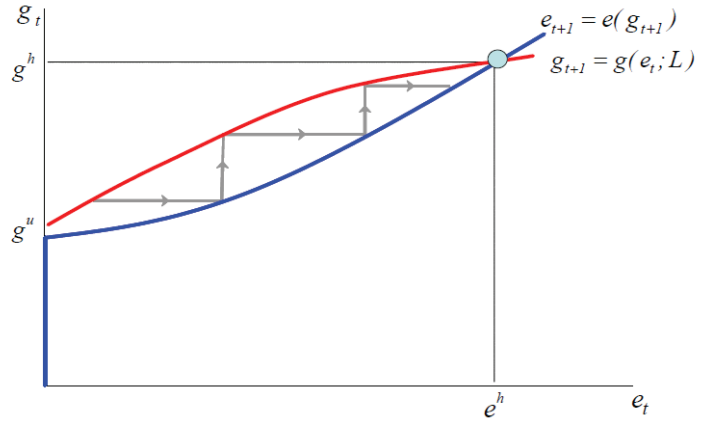
further



Some countries take off



Modern growth regime



Timing of the take-off

- The location of the e() curve may depend on institutions and other characteristics promoting educational investment
- The location of the g() curve may depend on institutions promoting research and development
- Hence, the timing of the take off may depend on some parameters but the take-off itself inevitable

Stochastic version (2)

- as it escapes, the economy first experiences population and human capital growing simultaneously, which is the Post-Malthusian regime we have seen

→ Industrial revolution is inevitable at some stage, that is if the time horizon is long enough, but its timing is very random

Here, what explains différences in the timing of take-offs: natural environment, luck !

Stochastic version (Lagerlof)

- Population is hit by epidemics.
- Novelty of the approach here: epidemics are stochastics.
- severeness of epidemics falls with human capital (medical skills).

- To escape from the malthusian regime the economy must be spared from epidemic shocks long enough, allowing population to grow enough to foster g.
- and once transition has started, growth of human capital make it safe from further shocks.

International version (Galor-Mountford)

- Rise of international trade in 19th century
- enhanced the specialization of industrial economies in the production of industrial, skilled intensive, goods -> rise in the return to education-> investment in the quality of the population
  -> demographic transition
  -> accumulation of physical capital, further improvements in industry
- In non-industrial economies, incentive to specialize in the production of unskilled intensive, non-industrial, goods -> invest in the quantity of the population (income effect from the gains from trade) -> delay in the demographic transition

2. Natural selection

- Galor – Moav

Main hypothesis

- The epoch of stagnation led to a process of natural selection that transformed the characteristics of the human population
- It made them more complementary to the growth process.
- This evolutionary change is the trigger of the take-off from an epoch of stagnation to sustained economic growth
- Most of this evolutionary change occurred in the transition from the Neolithic Revolution to the Industrial Revolution (i.e. over about 10,000 years)

Evidence for Rapid Evolutionary Changes

The color change that *peppered moths underwent* during the 19th century.

- **Duration: 300-500 generations**

Malthusian elements

- Similar as model of Chapter 2, with different types of households
- For low level of income, the subsistence consumption constraint imposes a binding physiological constraint on the size of a family: *Fertility is increasing in income*

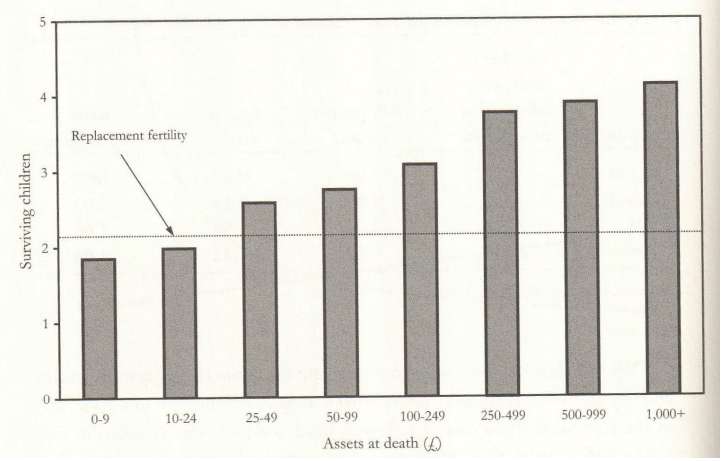
Darwinian elements

- Main ingredients of the Darwinian world : variety, natural selection, and evolution
- The weight households attach to quality of children *is transmitted* from generation to generation within a dynasty
- As is established in evolutionary biology (Lack, 1954), the allocation of resources between child caring and child bearing is subjected to evolutionary changes.

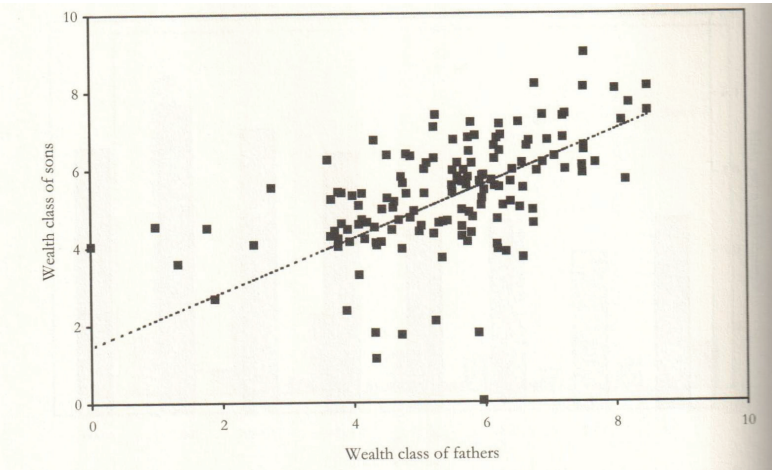
Main result

- As fertility rates are positively associated with income levels, the Malthusian pressure generates an evolutionary advantage to individuals whose preferences are biased towards child quality, increasing their representation in the population.
- At some point, the proportion of persons wanting high quality children is high enough and growth starts, propelled by human capital accumulation.

Some empirical evidence from Clark



Inheritability of traits- look at wealth correlation -



And before ?

Table 6.6 Survival of Landowners in Halesowen, 1270–1348

Family type in 1270–82	Numbers of families	Number with descendants holding land in 1348	Percentage with descendants holding land in 1348
Rich	40	40	100
Middling	64	58	91
Poor	70	25	36
All	174	123	—

Source: Razi, 1981, 5.

More on the inherited trait

- People with high weight on quality of children have an evolutionary advantage (galor-moav)
- Clark adds some additional characteristics (the emergence of the modern man) such as patience
- Increase in patient population should lower the interest rate

Interest rate

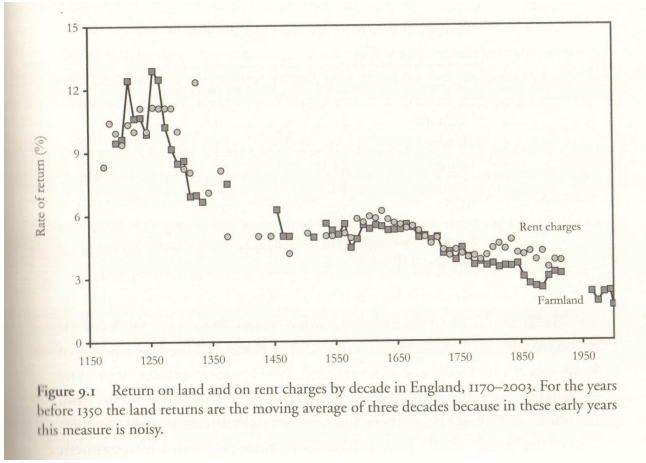


Figure 9.1 Return on land and on rent charges by decade in England, 1170–2003. For the years before 1350 the land returns are the moving average of three decades because in these early years this measure is noisy.

Criticism of the natural selection approach (i)

- Bowles (Science, vol 318)
- Reproductive success of wealthy Englishmen: ok. But not elsewhere in the world ? Why the industrial revolution in England?
- Parents transmit personality traits to their children, and there is good evidence that genetic transmission is involved for some social behaviors. *However,* none of this evidence concerns hard work, patience, or the other values that Clark stresses

Criticism (2)

- the correlations between parental and offspring measures of personality are strikingly low (0.1).
  => parental influence on descendent preferences is quickly dissipated across the generations.

Location and Timing

- If from 1250 or even earlier these “capitalistic” values were spreading as the surplus children of the rich cascaded down the social ladder, why do we not observe a gradual acceleration of the economy beginning in the 13th century rather than the abrupt take-off we observe?
- And why did the equally capitalistic Netherlands not also take off? The argument thus explains neither the location nor the timing of the first escape from the Malthusian trap.