

Economics of Inequality

(Master PPD & APE, Paris School of Economics)

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Lecture 1: Income, capital and growth

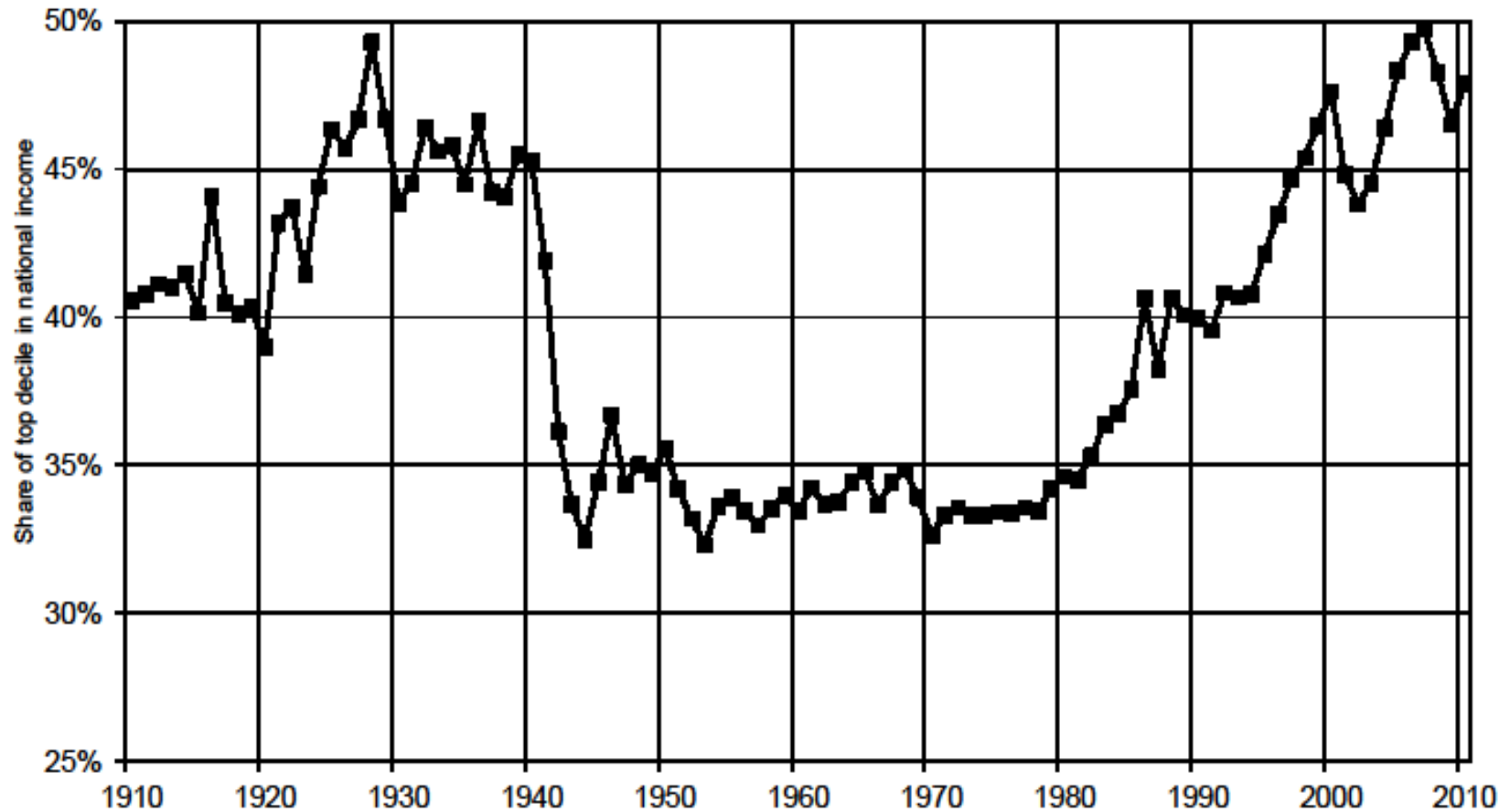
(Tuesday September 23rd 2014)

(check [on line](#) for updated versions)

Introduction: two U-shaped curves

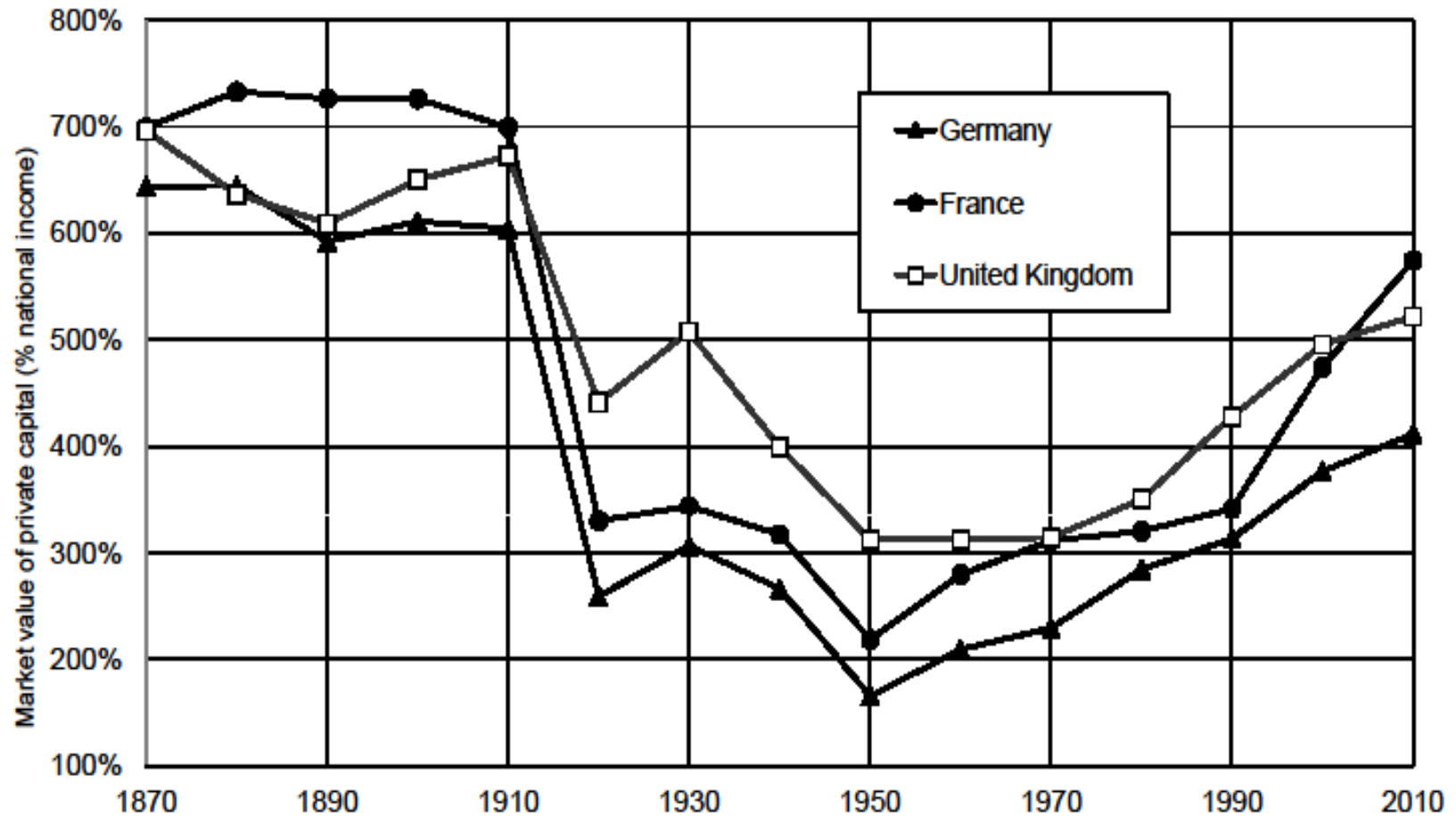
- (1) In the US, income inequality is now back to the levels observed in early 20^c : i.e. about 50% of national income for the top 10%
- (2) In Europe (and Japan), capital/income ratio is almost back to the level observed in early 20^c : i.e. about 500-600% for K/Y
- At this stage, these two U-shaped curves are mostly unrelated and involve different economic mechanisms; (1) = mostly US; (2) mostly Europe and Japan
- But both could happen everywhere in the future (or not)
- The central objective of this course is to better understand this kind of long-run evolution

Figure I.1. Income inequality in the United States, 1910-2010



The top decile share in U.S. national income dropped from 45-50% in the 1910s-1920s to less than 35% in the 1950s (this is the fall documented by Kuznets); it then rose from less than 35% in the 1970s to 45-50% in the 2000s-2010s. Sources and series: see piketty.pse.ens.fr/capital21c.

Figure I.2. The capital/income ratio in Europe, 1870-2010



Aggregate private wealth was worth about 6-7 years of national income in Europe in 1910, between 2 and 3 years in 1950, and between 4 and 6 years in 2010. Sources and series: see piketty.pse.ens.fr/capital21c.

Basic concepts: income and capital

- National income Y = domestic output Y_d (NDP)
+ net foreign factor income
- Domestic output Y_d (NDP = Net domestic product)
= GDP (Gross domestic product) – capital depreciation
- Typically Y and Y_d = about 85-90% GDP in rich countries today
- I.e. capital depreciation = about 10-15% GDP
(but can be <5% in agrarian societies: low land depreciation rates
as compared to buildings, equipment, computers, etc.)
- Net foreign factor income can be >0 (typically in countries with net
foreign asset position > 0), or <0 (typically in countries with net
foreign asset position < 0)

- Net foreign asset position (NFA) = gross foreign assets (gross assets owned by the residents of a country in the rest of world) – gross foreign liabilities (debt) (gross assets owned by rest of the world in the country)
- Net foreign capital income = close to 0% of Y_d in most rich countries (between +1-2% & -1-2% Y_d) : right now, rich countries own approximately as much foreign assets in rest of the world as ROW owns in home assets, so that national income \approx domestic output
- But this has not always been like this (colonial times); and it could change again: Germany and Japan – and China and oil producing countries – are currently accumulating large foreign assets position
- **At the world level, net foreign income flows cancel out, so that national income $Y =$ domestic output Y_d**

- National income $Y = Y_d + r \text{ NFA}$
- Private capital (or private wealth) $W = \text{non-financial assets (real estate, family firms,..)} + \text{financial assets (equity, bonds, life insurance, deposits, cash, pension funds,..)} - \text{financial liabilities (debt) held by private individuals (households) (+non-profit inst.)}$
- Public capital (or public wealth) $W_g = \text{non-fin} + \text{fin assets} - \text{liabilities held by the government (all levels)}$
- National capital (or national wealth) $W_n = W + W_g$
- National wealth $W_n = \text{domestic capital } K + \text{net foreign assets NFA}$
- Domestic capital $K = \text{agricultural land} + \text{housing} + \text{other domestic capital (=structures, equipment, patents,.. used by firms \& govt)}$
- Note that firms are valued at market prices through equity
- Private wealth/national income ratio $\beta = W/Y$
- National wealth/national income ratio $\beta_n = W_n/Y$
- Domestic capital/output ratio $\beta_k = K/Y_d$
- **At the world level, national wealth/national income ratio = domestic capital/output ratio; but at the country level, it can differ**

- Basic orders of magnitude in rich countries today
 - National wealth $W_n \approx$ private wealth W
(i.e. public wealth $W_g \approx 0$) (or $<0..$)
 - National wealth $W_n \approx$ domestic capital K
(i.e. net foreign asset $NFA \approx 0$) (but large gross foreign positions)
 - National wealth $W_n \approx 500\text{-}600\%$ of national income Y
 \approx residential housing + other domestic capital ($\approx 50\text{-}50$)
 - Typically, in France, UK, Germany, Italy, US, Japan:
Per capita average income $Y \approx 30\ 000\text{€}$ (= national income/population)
Per capita average wealth $W \approx 150\ 000\text{-}180\ 000\text{€}$ (=private wealth/pop)
 - I.e. $\beta = W/Y \approx 5\text{-}6$
 - $Y_K =$ capital income = rent, dividend, interest, profits,..
 - $\alpha = Y_K/Y =$ capital share in national income $\approx 25\text{-}30\%$
 - I.e. average rate of return $r = \alpha/\beta = 4\text{-}5\%$
 - **Basic accounting law: $\alpha = r \times \beta$**
- see Lectures 2-3 on the dynamics of β , and Lecture 4 on α

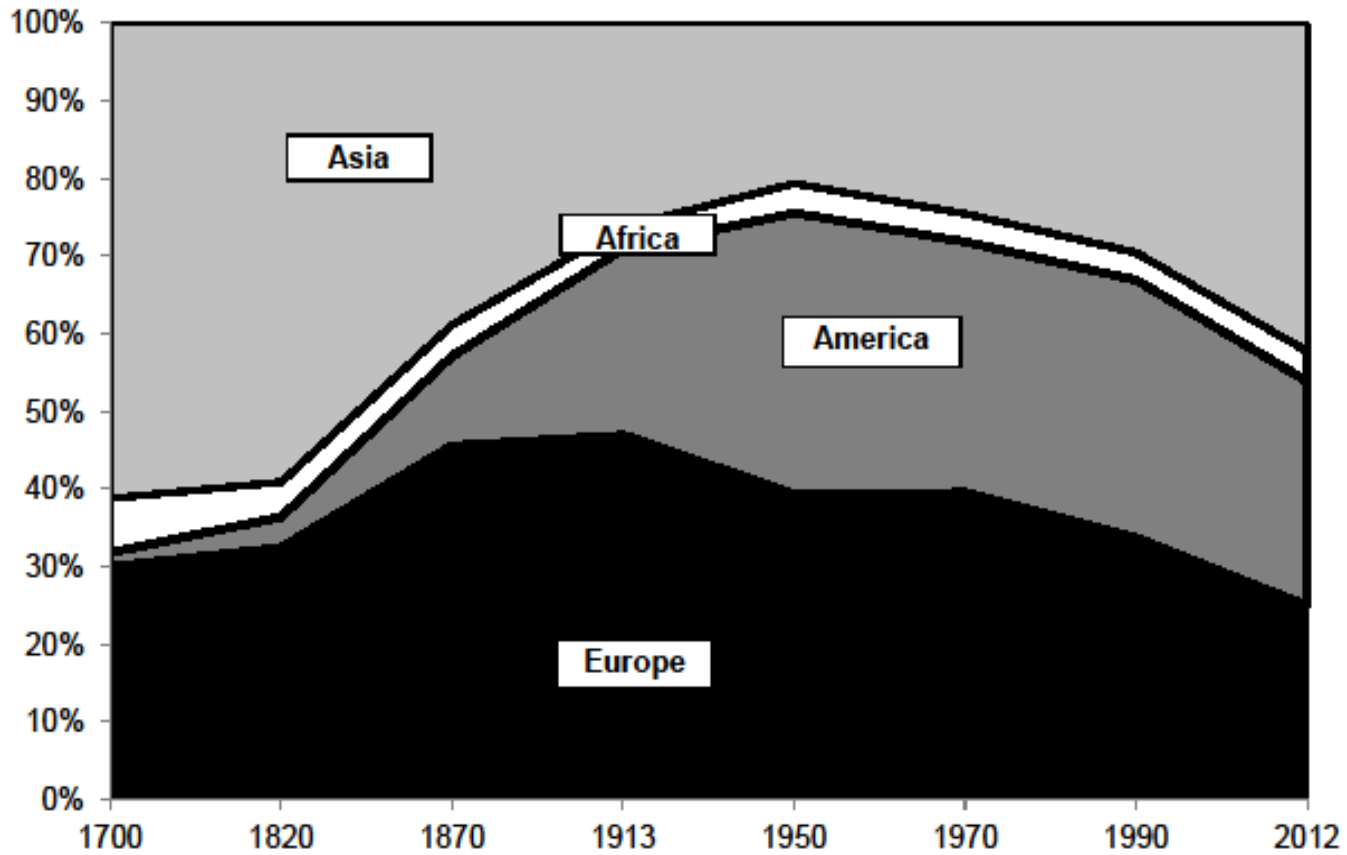
Facts & questions about long-run growth

- Long run national accounts: see [Maddison 2008](#) (and official series for recent decades)
- **Fact 1: Convergence**
- Convergence between poor and rich countries now seems well under way; but not over yet (?)
- **Fact 2: Global growth slowdown in 21^c**
- Productivity growth is always slow for countries at the world technological frontier; once global catch-up process is over, growth might be low everywhere (?)
- Population growth seems to be $\rightarrow 0$ (or < 0) (?)

Fact 1. Convergence

- Between 1900 and 1980, Europe + America \approx 70-80% world GDP
- In 2013: down to about 50% (as in 1860)
- At some point during 21^c: down to 20-30%, i.e. to the share of Europe + America in world population = convergence in per capita output and income
- But will convergence be over in 2030, 2060 or 2090? Nobody knows. Probably closer to 2030 in East Asia, and closer to 2090 in South Asia and Africa.
- Convergence occurred mostly through domestic investment (not so much through foreign investment: emerging countries are not owned by rich countries... except Africa)
- Economic openness had a critical impact on development via free trade (specialization effect) and via diffusion of technology and know-how; but maybe not so much via free capital flows

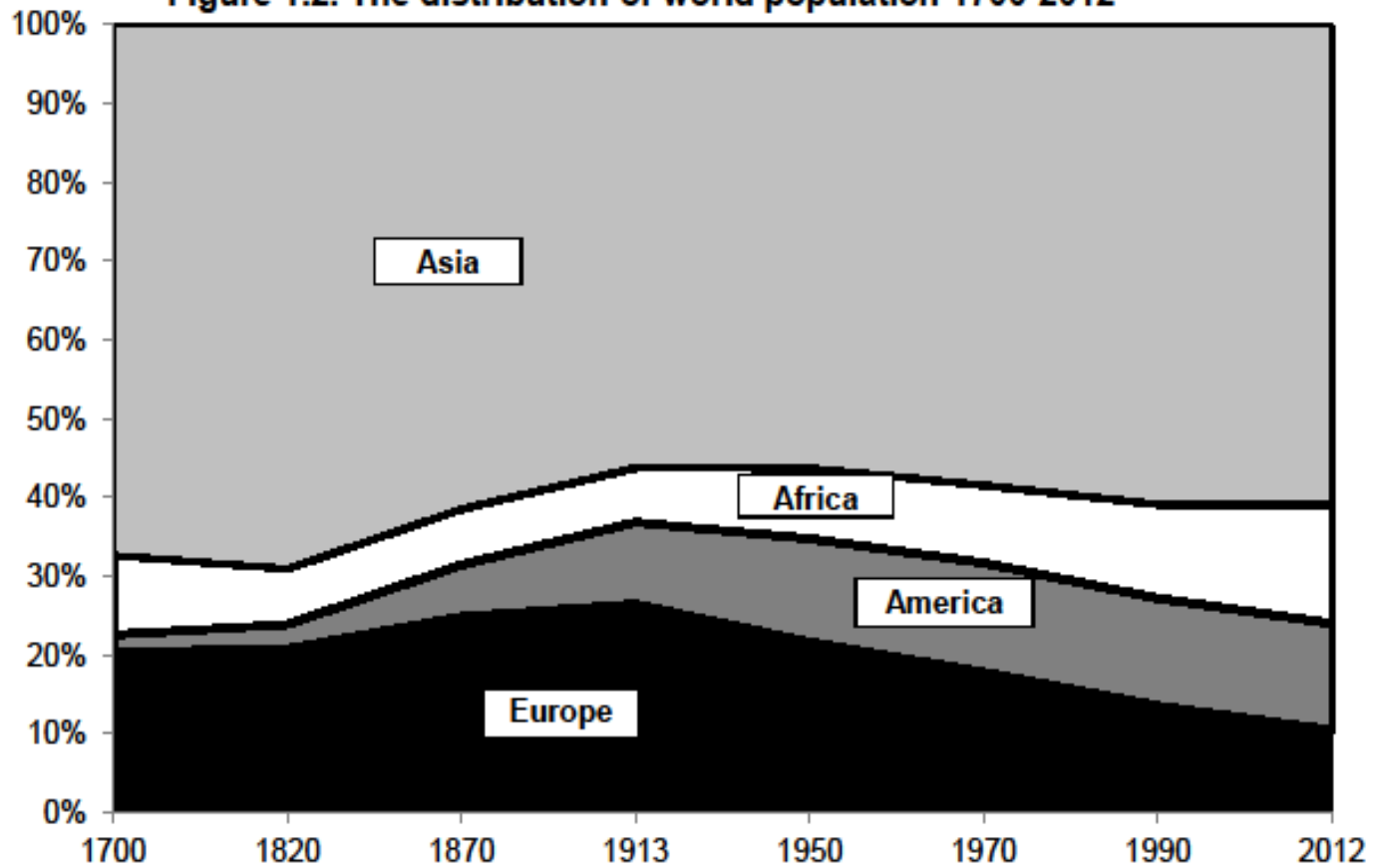
Figure 1.1. The distribution of world output 1700-2012



Europe's GDP made 47% of world GDP in 1913, down to 25% in 2012.

Sources and series: see piketty.pse.ens.fr/capital21c.

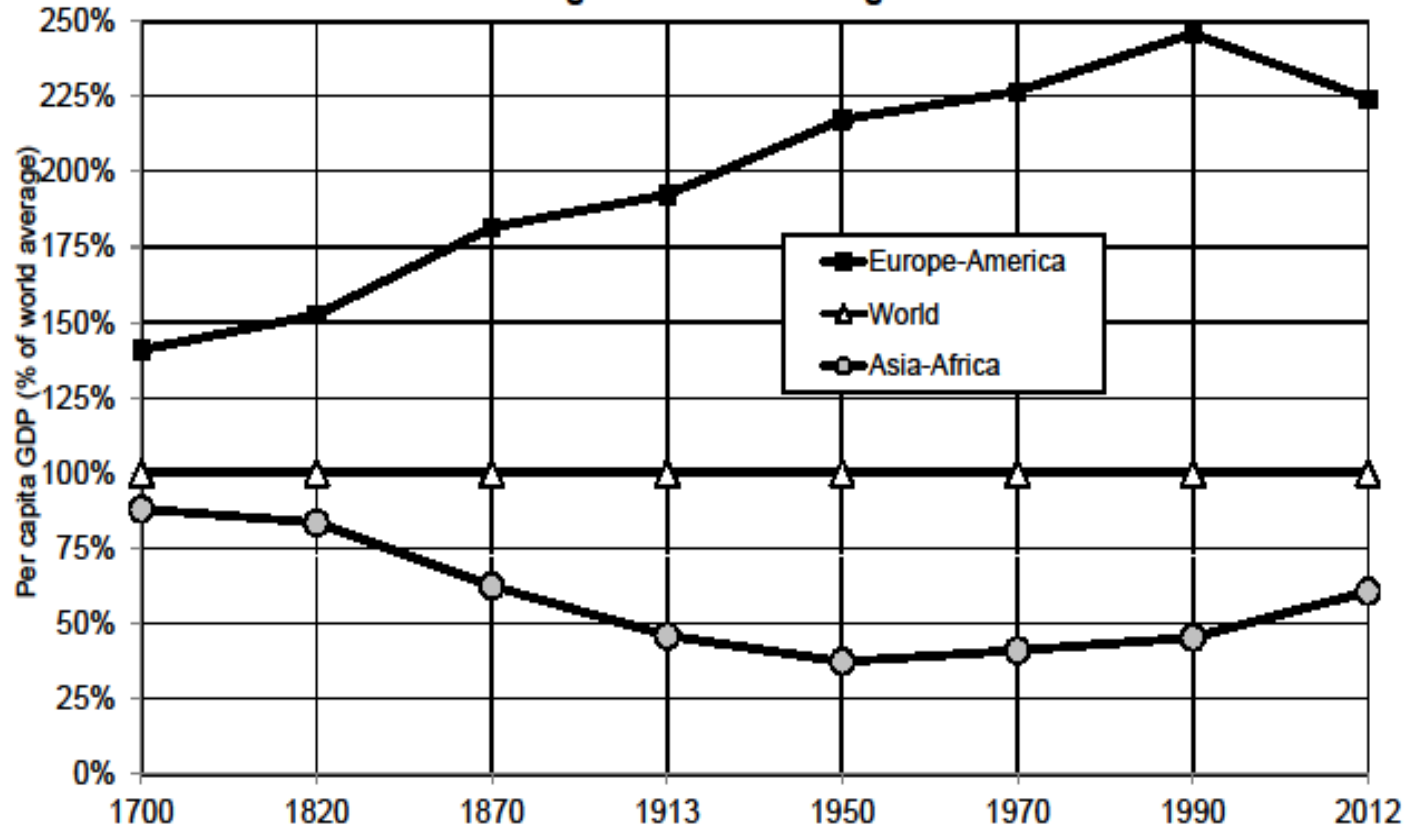
Figure 1.2. The distribution of world population 1700-2012



Europe's population made 26% of world population in 1913, down to 10% in 2012.

Sources and series: see piketty.pse.ens.fr/capital21c.

**Figure 1.3. Global inequality 1700-2012:
divergence then convergence?**



Per capita GDP in Asia-Africa went from 37% of world average in 1950 to 61% in 2012.

Sources and series: see piketty.pse.ens.fr/capital21c.

- Basic orders of magnitude to remember:
- World GDP 2012 = about 70 trillions €
(i.e. 70 000 billions €)
- World population = about 7 billions
- Per capital GDP = about 10 000€
- Per capital income = about 800€/month
- Rich countries = about 2000-3000€/month
- Poor countries = about 200-300€/month
- More inequality in income than in output, and in market exchange rates than in PPP

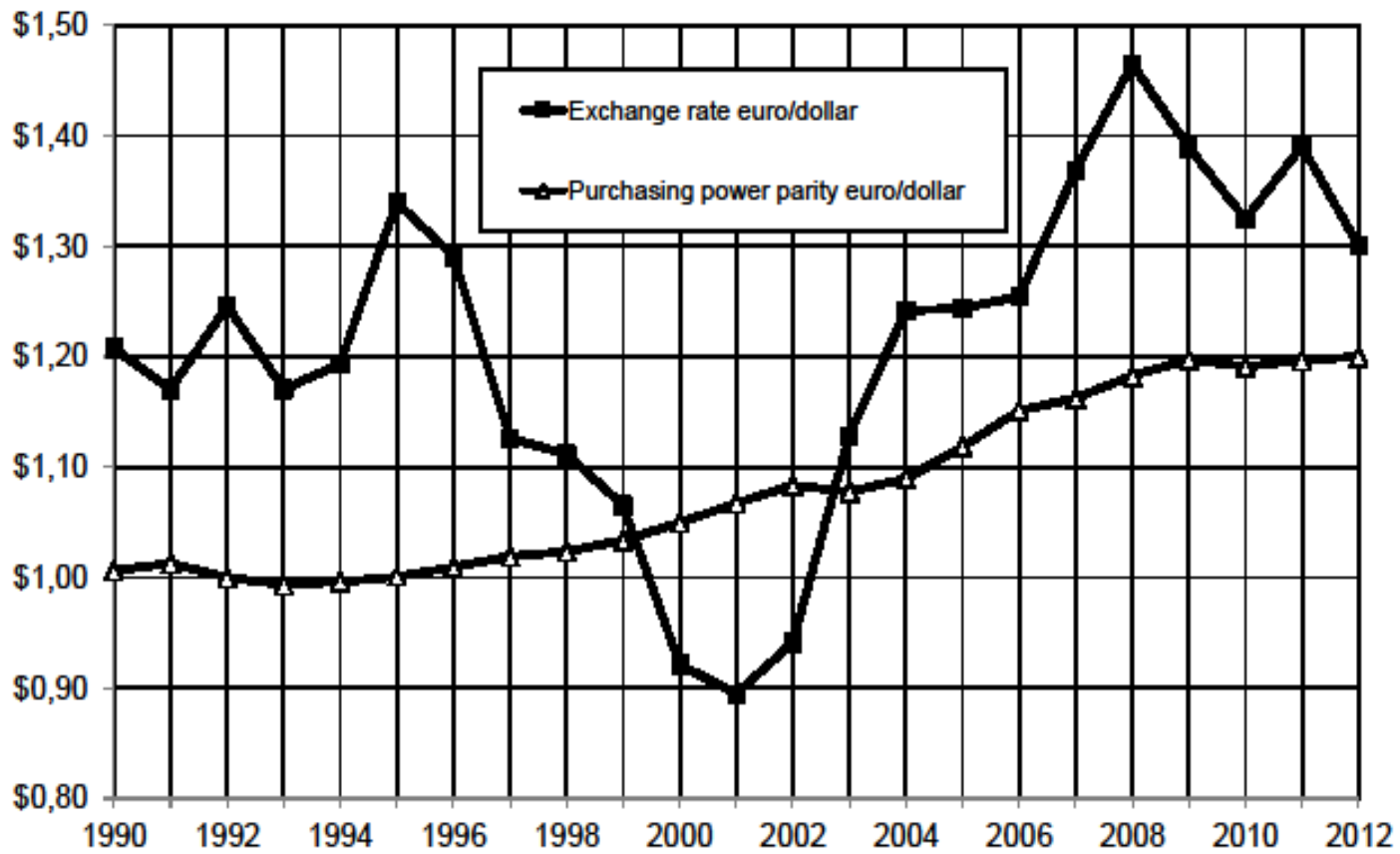
Table 1.1: Distribution of world GDP, 2012

	Population (millions inhabitants)		GDP (billions euros 2012)		Per capita GDP	Equivalent per capita monthly income
					(euros 2012)	
World	7 050	100%	71 200	100%	10 100 €	760 €
Europe	740	10%	17 800	25%	24 000 €	1 800 €
incl. European Union	540	8%	14 700	21%	27 300 €	2 040 €
incl. Russia/Ukraine	200	3%	3 100	4%	15 400 €	1 150 €
America	950	13%	20 600	29%	21 500 €	1 620 €
incl. United States/Canada	350	5%	14 300	20%	40 700 €	3 050 €
incl. Latin America	600	9%	6 300	9%	10 400 €	780 €
Africa	1 070	15%	2 800	4%	2 600 €	200 €
incl. North Africa	170	2%	1 000	1%	5 700 €	430 €
incl. Subsaharan Africa	900	13%	1 800	3%	2 000 €	150 €
Asia	4 290	61%	30 000	42%	7 000 €	520 €
incl. China	1 350	19%	10 400	15%	7 700 €	580 €
incl. India	1 260	18%	4 000	6%	3 200 €	240 €
incl. Japan	130	2%	3 800	5%	30 000 €	2 250 €
incl. Other	1 550	22%	11 800	17%	7 600 €	570 €

World GDP, estimated in purchasing power parity, was about 71 200 billions euros in 2012. World population was about 7.050 billions inhabitants, hence a per capital GDP of 10 100€ (equivalent to a monthly income of about 760€ per month). All numbers were rounded to the closed dozen or hundred

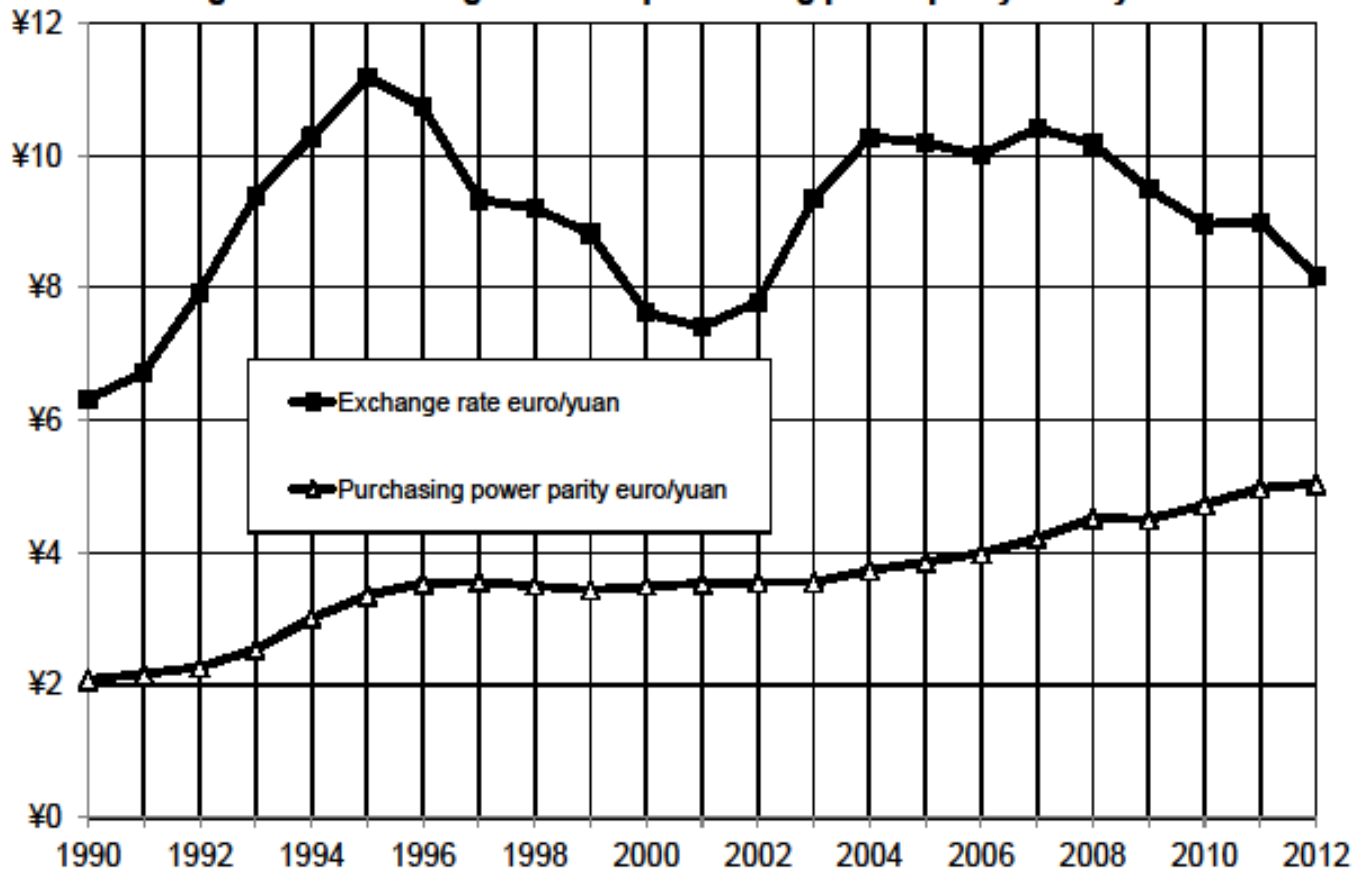
Sources: see piketty.pse.ens.fr/capital21c.

Figure 1.4. Exchange rate and purchasing power parity: euro/dollar



In 2012, 1 euro was worth 1,30 dollars according to current exchange rate, but 1,20 dollars in purchasing power parity. Sources and series: see piketty.pse.ens.fr/capital21c.

Figure 1.5. Exchange rate and purchasing power parity: euro/yuan



In 2012, 1 euro was worth 8 yuans according to current exchange rate, but 5 yuans in purchasing power parity. Sources and series: see piketty.pse.ens.fr/capital21c.

Fact 2. Growth slowdown

- Productivity growth is always slow for countries at the world technological frontier; once global catch-up process is over, growth might be low everywhere
- Population growth seems to be $\rightarrow 0$ (or < 0)
- Average world growth 1700-2012: $g=1,6\%$, including $n=0,8\%$ for population and $h=0,8\%$ for per capita output
- But $0,8\%$ per year was enough to multiply world population (and average income) by a factor of 10
- $g = n + h$ with $n =$ population growth
and $h =$ productivity growth
- In the very long run, maybe $n \approx 0\%$ and $h \approx 1-1,5\%$, so that $g=n+h \approx 1-1,5\%$
- Some economists are even less optimistic: long-run $g < 1\%$ according to [Gordon 2012](#)

Table 2.1: World growth since the industrial revolution

Average annual growth rate	World output	World population	Per capita output
0-1700	0,1%	0,1%	0,0%
1700-2012	1,6%	0,8%	0,8%
<i>incl.: 1700-1820</i>	0,5%	0,4%	0,1%
<i>1820-1913</i>	1,5%	0,6%	0,9%
<i>1913-2012</i>	3,0%	1,4%	1,6%

Between 1913 and 2012, the growth rate of world GDP was 3,0% per year on average. This growth rate can be broken down between 1,4% for world population and 1,6% for per capita GDP.

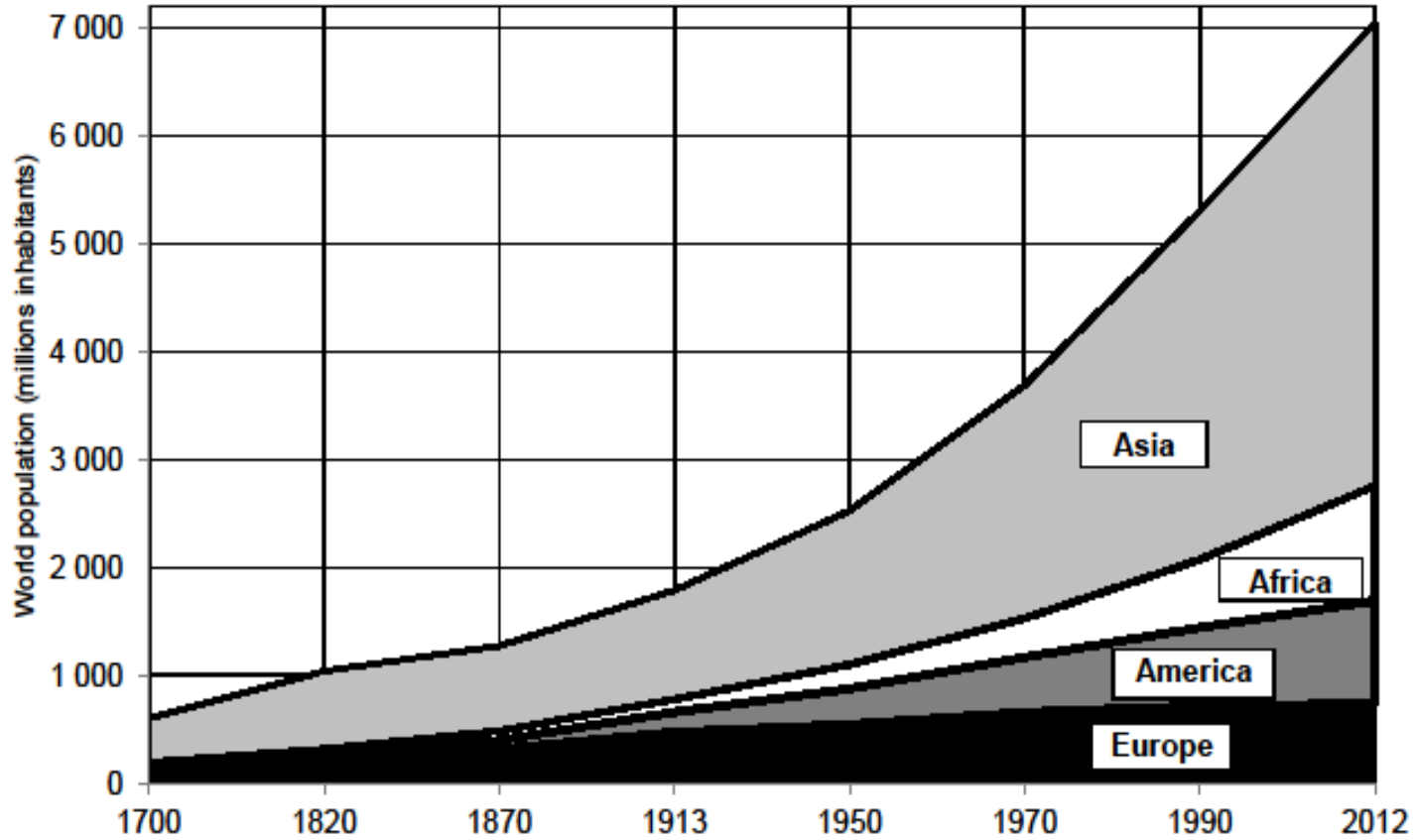
Sources: see piketty.pse.ens.fr/capital21c.

Table 2.2. The law of cumulated growth

An annual growth rate equal to...	.. is equivalent to a generational growth rate (30 years) of...	...i.e. a multiplication by a coefficient equal to...	...and a multiplication after 100 years by a coefficient equal to...	...and a multiplication after 1000 years by a coefficient equal to...
0,1%	3%	1,03	1,11	2,72
0,2%	6%	1,06	1,22	7,37
0,5%	16%	1,16	1,65	147
1,0%	35%	1,35	2,70	20 959
1,5%	56%	1,56	4,43	2 924 437
2,0%	81%	1,81	7,24	398 264 652
2,5%	110%	2,10	11,8	52 949 930 179
3,5%	181%	2,81	31,2	...
5,0%	332%	4,32	131,5	...

An annual growth rate of 1% is equivalent to an annual growth rate of 35% per generation (30 years), a multiplication by 2,7 every 100 years, and by over 20 000 every 1000 years.

Figure 2.1. The growth of world population 1700-2012



World population rose from 800 millions inhabitants in 1700 to 7 billions in 2012.

Sources and series: see piketty.pse.ens.fr/capital21c.

The standard growth model (1)

- Output $Y = F(K,L)$, with K = capital input (=non-human capital: buildings, equipment, robots, patents, etc.)
and L = labor input (=human capital)
- Constant-returns-to-scale production function: $F(\mu K, \mu L) = \mu F(K,L)$
→ $F(K,L) = L f(k)$, with $k = K/L$ = capital per labor unit
and $f(k) = F(K,L)/L = F(K/L, 1)$ = output per labor unit
- Exemple: Cobb-Douglas production function: $F(K,L) = K^\alpha L^{1-\alpha}$, i.e. $f(k) = k^\alpha$
- As $k \rightarrow \infty$, marginal product of capital $f'(k) \rightarrow 0$: capital accumulation is not sufficient in itself to generate long-run growth; one also needs long-run population and/or productivity growth; see [Solow 1956](#)
- Steady-state growth path = everything grows at rate g
- $Y_t = F(K_t, L_t) = Y_0 e^{gt}$ with $K_t = K_0 e^{gt}$ and $L_t = L_0 e^{gt}$ (all ratios are constant)
- The growth of labor input $L_t = N_t \times P_t$ can be decomposed into the growth of (employed) population $N_t = N_0 e^{nt}$ and the growth of productivity $P_t = P_0 e^{ht}$
- I.e. $g = n + h$ with n = population growth
and h = productivity growth

The standard growth model (2)

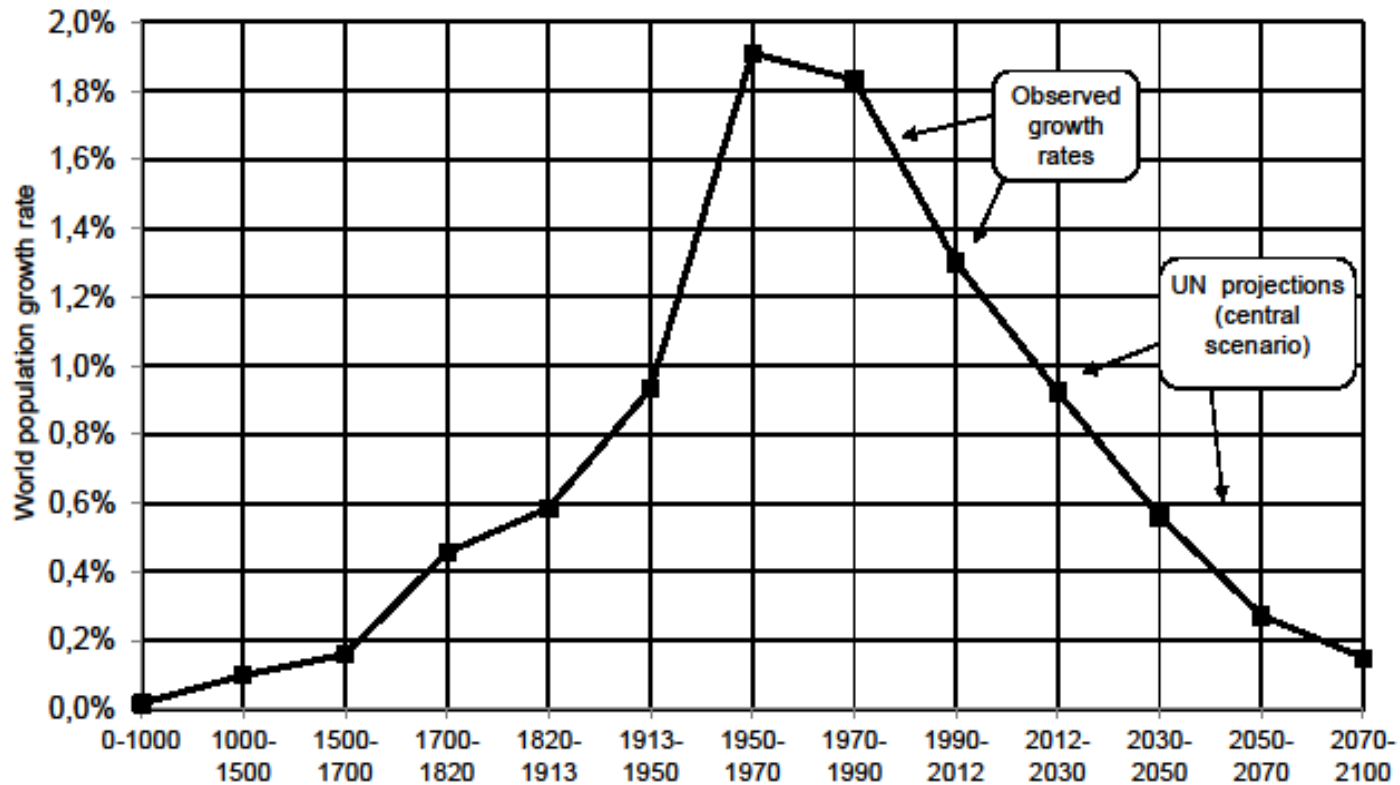
- Where does population growth rate n come from? Fertility decisions, health conditions, etc.
- Where does productivity growth rate h come from? Human capital accumulation, educational institutions, innovations, etc.
- Endogenous growth literature = endogenizing $g=n+h$; see e.g. [Jones-Romer 2010](#) for a brief survey
- Steady-state capital-output ratio $\beta=K/Y$ matters for output level, but not for output growth; same thing for employment rates
- Note: annual growth rates ($Y_t = Y_0 (1+g_a)^t$) do not perfectly coincide with instantaneous growth rates ($Y_t = Y_0 e^{gt}$):

$$1+g_a = e^g, \text{ i.e. } g_a \approx g \text{ only if } g_a \text{ and } g \text{ are small}$$

The advantage of instantaneous growth rates is additivity: $g=n+h$

With annual growth rates, $1+g_a = (1+n_a) \times (1+h_a)$

Figure 2.2. The growth rate of world population from Antiquity to 2100



The growth rate of world population was above 1% per year from 1950 to 2012 and should return toward 0% by the end of the 21st century. Sources and series: see piketty.pse.ens.fr/capital21c.

Table 2.3: Demographic growth since the industrial revolution

Average annual growth rate	World population	Europe	America	Africa	Asia
0-1700	0,1%	0,1%	0,0%	0,1%	0,1%
1700-2012	0,8%	0,6%	1,4%	0,9%	0,8%
incl: 1700-1820	0,4%	0,5%	0,7%	0,2%	0,5%
1820-1913	0,6%	0,8%	1,9%	0,6%	0,4%
1913-2012	1,4%	0,4%	1,7%	2,2%	1,5%
<i>Projections 2012-2050</i>	0,7%	-0,1%	0,6%	1,9%	0,5%
<i>Projections 2050-2100</i>	0,2%	-0,1%	0,0%	1,0%	-0,2%

Between 1913 and 2012, the growth rate of world population was 1.4% per year, including 0.4% for Europe, 1.7% for America, etc.

Sources: see piketty.pse.ens.fr/capital21c. Projections for 2012-2100 correspond to the UN central scenario.

- Per capita growth was exceptionally high in Europe and Japan in the 1950-1980 period ($h=4-5\%$ per year) because of a catch-up process with the US; but since 1980, per capital growth rates have been low in all rich countries
- In the very long, $h=1\%$ is already quite fast and requires permanent reallocation of labor (about one third of the economy is being renewed at each generation)

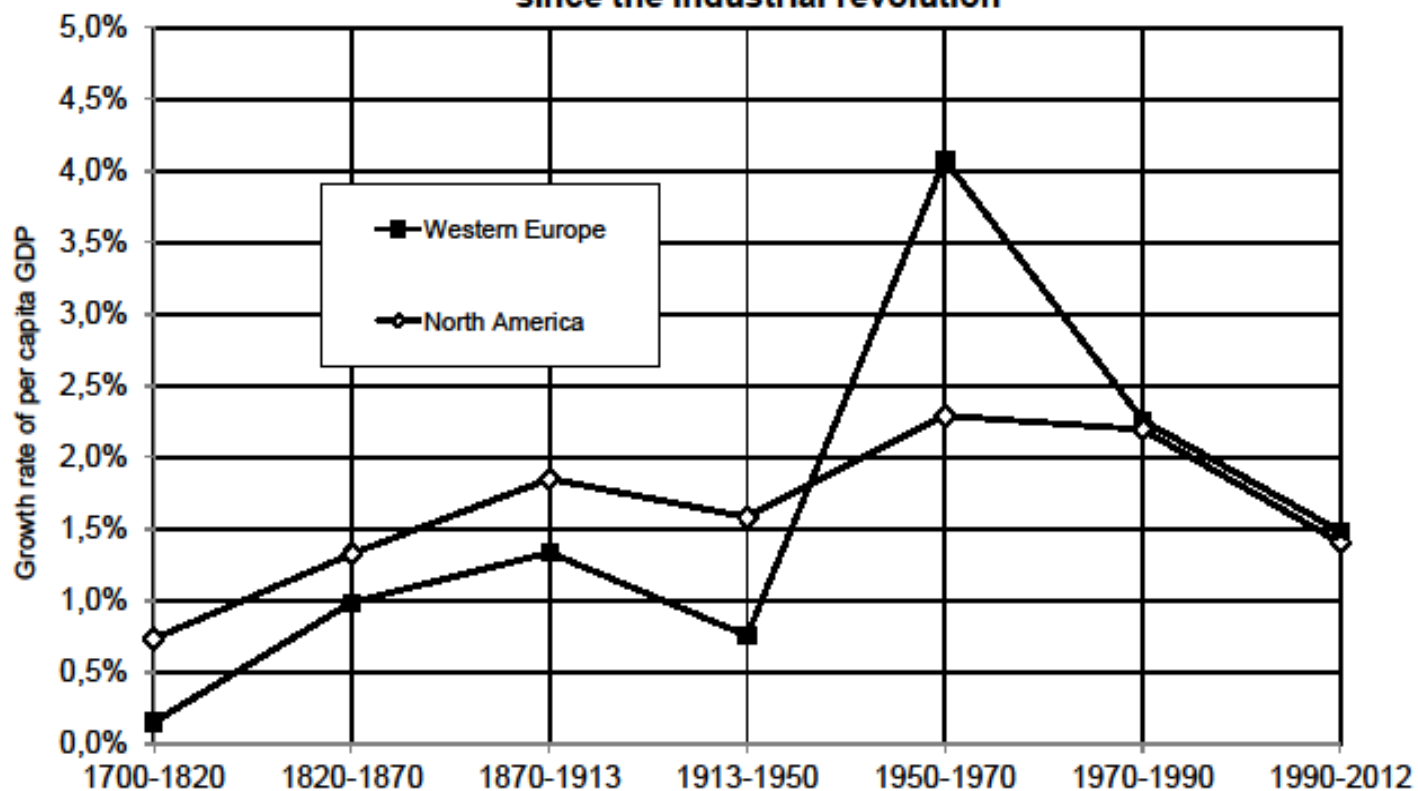
Table 2.5: Per capita output growth since the industrial revolution

Average annual growth rate	Per capita world output	Europe	America	Africa	Asia
0-1700	0,0%	0,0%	0,0%	0,0%	0,0%
1700-2012	0,8%	1,0%	1,1%	0,5%	0,7%
incl.: 1700-1820	0,1%	0,1%	0,4%	0,0%	0,0%
1820-1913	0,9%	1,0%	1,5%	0,4%	0,2%
1913-2012	1,6%	1,9%	1,5%	1,1%	2,0%
1913-1950	0,9%	0,9%	1,4%	0,9%	0,2%
1950-1970	2,8%	3,8%	1,9%	2,1%	3,5%
1970-1990	1,3%	1,9%	1,6%	0,3%	2,1%
1990-2012	2,1%	1,9%	1,5%	1,4%	3,8%
1950-1980	2,5%	3,4%	2,0%	1,8%	3,2%
1980-2012	1,7%	1,8%	1,3%	0,8%	3,1%

Between 1910 and 2012, the growth rate of per capita output was 1,7% per year on average at the world level, including 1,9% in Europe, 1,6% in America, etc.

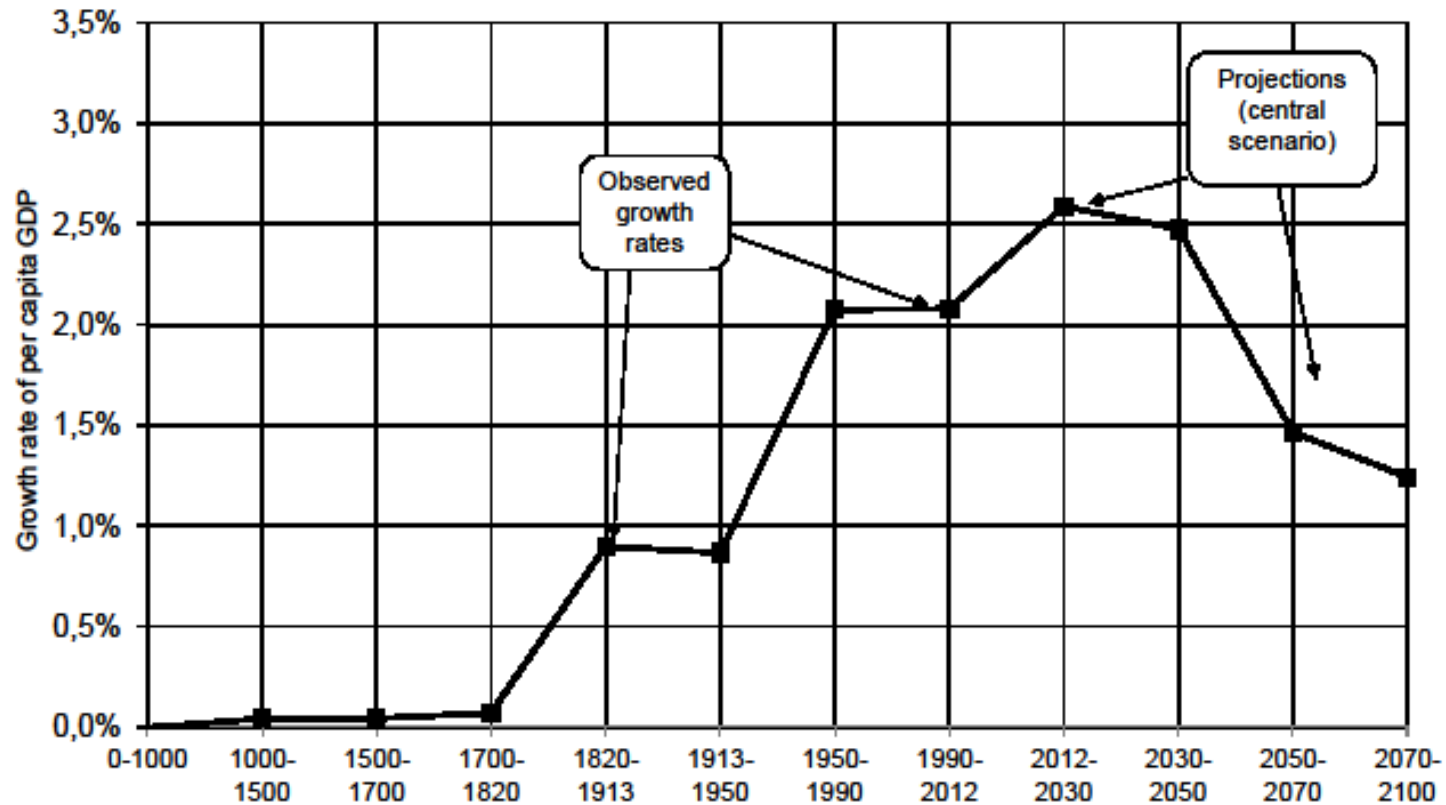
Sources: voir piketty.pse.ens.fr/capital21c

Figure 2.3. The growth rate of per capita output since the industrial revolution



The growth rate of per capita output surpassed 4% per year in Europe between 1950 and 1970, before returning to American levels. Sources and series: see piketty.pse.ens.fr/capital21c

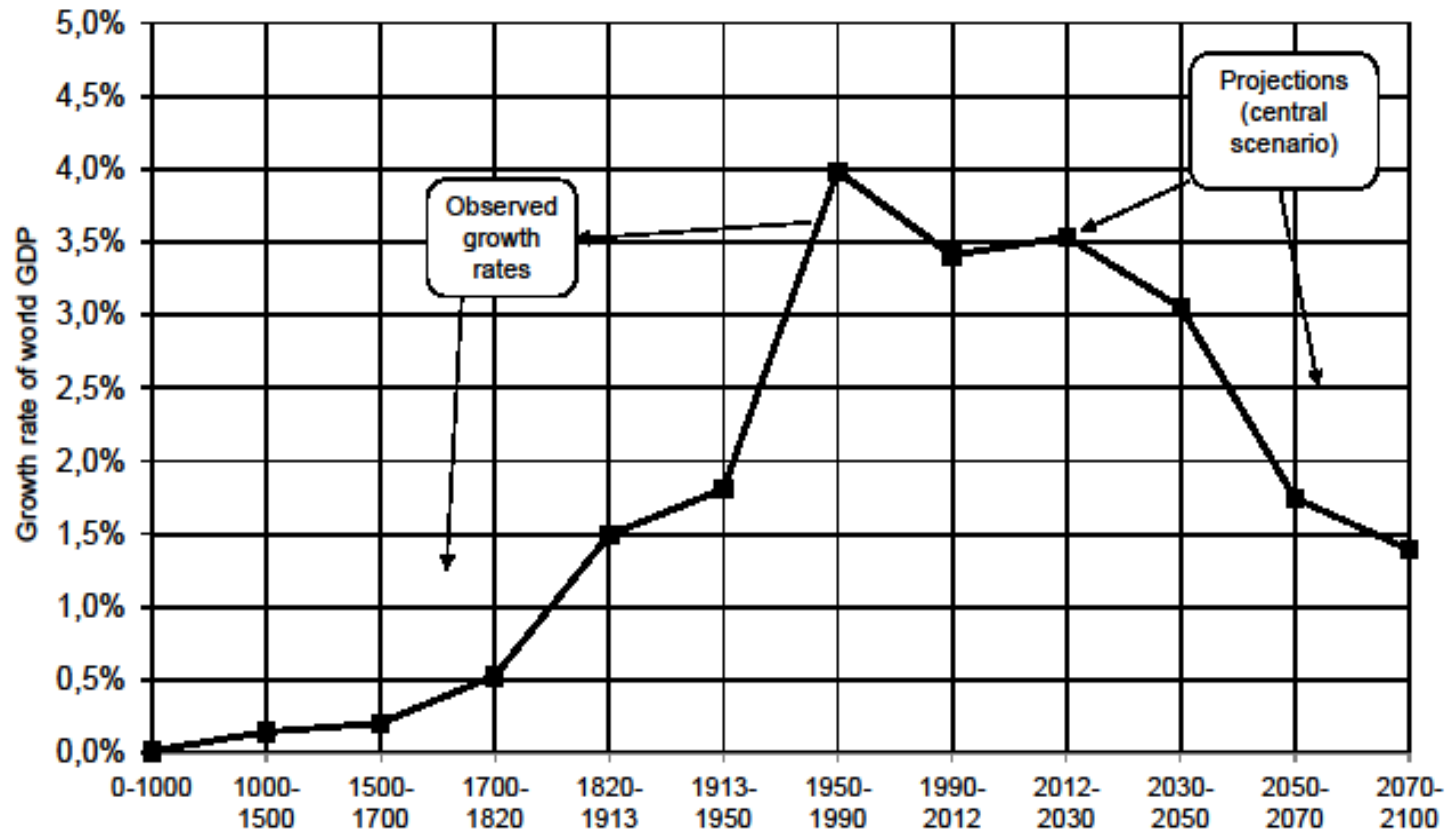
Figure 2.4. The growth rate of world per capita output since Antiquity until 2100



The growth rate of per capita output surpassed 2% from 1950 to 2012. If the convergence process goes on, it will surpass 2,5% from 2012 to 2050, and then will drop below 1,5%.

Sources and series : see piketty.pse.ens.fr/capital21c.

Figure 2.5. The growth rate of world output from Antiquity until 2100



The growth rate of world output surpassed 4% from 1950 to 1990. If the convergence process goes on it will drop below 2% by 2050. Sources and series: see piketty.pse.ens.fr/capital21c.

**Table 2.4: Employment by sector
in France and the United States, 1800-2012**

(% of total employment)	France			United States		
	Agriculture	Manufacturing	Services	Agriculture	Manufacturing	Services
1800	64%	22%	14%	68%	18%	13%
1900	43%	29%	28%	41%	28%	31%
1950	32%	33%	35%	14%	33%	50%
2012	3%	21%	76%	2%	18%	80%

In 2012, agriculture made 3% of total employment in France, vs. 21% in manufacturing and 76% in the services. Construction - 7% of employment in France and the U.S. in 2012 - was included in manufacturing.

Sources: see piketty.pse.ens.fr/capital21c.