Economics of Inequality
(Master PPD & APE, Paris School of Economics)
Thomas Piketty
Academic year 2014-2015

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 20c: 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 20c: 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
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 $Y = \text{domestic output } Y_d (\text{NDP})$
  $+ \text{net foreign factor income}$

• Domestic output $Y_d (\text{NDP} = \text{Net domestic product})$
  $= \text{GDP (Gross domestic product)} - \text{capital depreciation}$

• Typically $Y$ and $Y_d = \text{about 85-90\% GDP in rich countries today}$

• I.e. capital depreciation $= \text{about 10-15\% GDP}$
  (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 $Y = \text{domestic output } Y_d$
• National income $Y = Y_d + r \text{ NFA}$
• Private capital (or private wealth) $W = \text{non-financial assets (real estate, family firms,..) + financial assets (equity, bonds, life insurance, deposits, cash, pension funds,..) – financial liabilities (debt) held by private individuals (households) (+non-profit inst.)}$
• Public capital (or public wealth) $W_g = \text{non-fin + fin assets – liabilities held by the government (all levels)}$
• 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 $K = \text{agricultural land + housing + other domestic capital (=structures, equipment, patents,.. used by firms & govt)}$
• 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 $W_n \approx 500-600\%$ of national income $Y$
  $\approx$ residential housing + other domestic capital ($\approx 50-50$)

• Typically, in France, UK, Germany, Italy, US, Japan:
  Per capita average income $Y \approx 30\,000\,€$ (= national income/population)
  Per capita average wealth $W \approx 150\,000-180\,000\,€$ (=private wealth/pop)

  i.e. $\beta = W/Y \approx 5-6$

  $Y_K$ = capital income = rent, dividend, interest, profits,..

  $\alpha = Y_K/Y$ = capital share in national income $\approx 25-30\%$

  i.e. average rate of return $r = \alpha/\beta = 4-5\%$

• Basic accounting law: $\alpha = r \times \beta$

→ see Lectures 2-3 on the dynamics of $\beta$, and Lecture 4 on $\alpha$
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 21c**
  • 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 ≈ 70-80% world GDP
- In 2013: down to about 50% (as in 1860)
- At some point during 21\textsuperscript{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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>7,050</td>
<td>71,200</td>
<td>10,100</td>
<td>760 €</td>
</tr>
<tr>
<td>Europe</td>
<td>740</td>
<td>17,800</td>
<td>24,000</td>
<td>1,800 €</td>
</tr>
<tr>
<td>incl. European Union</td>
<td>540</td>
<td>14,700</td>
<td>27,300</td>
<td>2,040 €</td>
</tr>
<tr>
<td>incl. Russia/Ukraine</td>
<td>200</td>
<td>3,100</td>
<td>15,400</td>
<td>1,150 €</td>
</tr>
<tr>
<td>America</td>
<td>950</td>
<td>20,600</td>
<td>21,500</td>
<td>1,620 €</td>
</tr>
<tr>
<td>incl. United States/Canada</td>
<td>350</td>
<td>14,300</td>
<td>40,700</td>
<td>3,050 €</td>
</tr>
<tr>
<td>incl. Latin America</td>
<td>600</td>
<td>6,300</td>
<td>10,400</td>
<td>780 €</td>
</tr>
<tr>
<td>Africa</td>
<td>1,070</td>
<td>2,800</td>
<td>2,600</td>
<td>200 €</td>
</tr>
<tr>
<td>incl. North Africa</td>
<td>170</td>
<td>1,000</td>
<td>5,700</td>
<td>430 €</td>
</tr>
<tr>
<td>incl. Subsaharan Africa</td>
<td>900</td>
<td>1,800</td>
<td>2,000</td>
<td>150 €</td>
</tr>
<tr>
<td>Asia</td>
<td>4,290</td>
<td>30,000</td>
<td>7,000</td>
<td>520 €</td>
</tr>
<tr>
<td>incl. China</td>
<td>1,350</td>
<td>10,400</td>
<td>7,700</td>
<td>580 €</td>
</tr>
<tr>
<td>incl. India</td>
<td>1,260</td>
<td>4,000</td>
<td>3,200</td>
<td>240 €</td>
</tr>
<tr>
<td>incl. Japan</td>
<td>130</td>
<td>3,800</td>
<td>30,000</td>
<td>2,250 €</td>
</tr>
<tr>
<td>incl. Other</td>
<td>1,550</td>
<td>11,800</td>
<td>7,600</td>
<td>570 €</td>
</tr>
</tbody>
</table>

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 →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 ≈ 0% and h ≈ 1-1.5%, so that g=n+h≈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

<table>
<thead>
<tr>
<th>Average annual growth rate</th>
<th>World output</th>
<th>World population</th>
<th>Per capita output</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1700</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>1700-2012</td>
<td>1.6%</td>
<td>0.8%</td>
<td>0.8%</td>
</tr>
<tr>
<td>incl.: 1700-1820</td>
<td>0.5%</td>
<td>0.4%</td>
<td>0.1%</td>
</tr>
<tr>
<td>1820-1913</td>
<td>1.5%</td>
<td>0.6%</td>
<td>0.9%</td>
</tr>
<tr>
<td>1913-2012</td>
<td>3.0%</td>
<td>1.4%</td>
<td>1.6%</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>An annual growth rate equal to...</th>
<th>.. is equivalent to a generational growth rate (30 years) of...</th>
<th>...i.e. a multiplication by a coefficient equal to...</th>
<th>...and a multiplication after 100 years by a coefficient equal to...</th>
<th>...and a multiplication after 1000 years by a coefficient equal to...</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1%</td>
<td>3%</td>
<td>1.03</td>
<td>1.11</td>
<td>2.72</td>
</tr>
<tr>
<td>0.2%</td>
<td>6%</td>
<td>1.06</td>
<td>1.22</td>
<td>7.37</td>
</tr>
<tr>
<td>0.5%</td>
<td>16%</td>
<td>1.16</td>
<td>1.65</td>
<td>147</td>
</tr>
<tr>
<td>1.0%</td>
<td>35%</td>
<td>1.35</td>
<td>2.70</td>
<td>20 959</td>
</tr>
<tr>
<td>1.5%</td>
<td>56%</td>
<td>1.56</td>
<td>4.43</td>
<td>2 924 437</td>
</tr>
<tr>
<td>2.0%</td>
<td>81%</td>
<td>1.81</td>
<td>7.24</td>
<td>398 264 652</td>
</tr>
<tr>
<td>2.5%</td>
<td>110%</td>
<td>2.10</td>
<td>11.8</td>
<td>52 949 930 179</td>
</tr>
<tr>
<td>3.5%</td>
<td>181%</td>
<td>2.81</td>
<td>31.2</td>
<td>...</td>
</tr>
<tr>
<td>5.0%</td>
<td>332%</td>
<td>4.32</td>
<td>131.5</td>
<td>...</td>
</tr>
</tbody>
</table>

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 600 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: \( F(\mu K,\mu L) = \mu F(K,L) \)
  \( \rightarrow F(K,L) = L \ f(k) \), 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 \( k \to \infty \), marginal product of capital \( f'(k) \to 0 \) : 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 \( g \)
  \( Y_t = F(K_t,L_t) = Y_0 \ e^{gt} \quad \) with \( K_t = K_0 \ e^{gt} \) and \( L_t = L_0 \ e^{gt} \) (all ratios are constant)
- The growth of labor input \( L_t = N_t x P_t \) 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 pikety.pse.ens.fr/capital21c.
### Table 2.3: Demographic growth since the industrial revolution

<table>
<thead>
<tr>
<th>Average annual growth rate</th>
<th>World population</th>
<th>Europe</th>
<th>America</th>
<th>Africa</th>
<th>Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1700</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.0%</td>
<td>0.1%</td>
<td>0.1%</td>
</tr>
<tr>
<td>1700-2012</td>
<td>0.8%</td>
<td>0.6%</td>
<td>1.4%</td>
<td>0.9%</td>
<td>0.8%</td>
</tr>
<tr>
<td>incl: 1700-1820</td>
<td>0.4%</td>
<td>0.5%</td>
<td>0.7%</td>
<td>0.2%</td>
<td>0.5%</td>
</tr>
<tr>
<td>1820-1913</td>
<td>0.6%</td>
<td>0.8%</td>
<td>1.9%</td>
<td>0.6%</td>
<td>0.4%</td>
</tr>
<tr>
<td>1913-2012</td>
<td>1.4%</td>
<td>0.4%</td>
<td>1.7%</td>
<td>2.2%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Projections 2012-2050</td>
<td>0.7%</td>
<td>-0.1%</td>
<td>0.6%</td>
<td>1.9%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Projections 2050-2100</td>
<td>0.2%</td>
<td>-0.1%</td>
<td>0.0%</td>
<td>1.0%</td>
<td>-0.2%</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Average annual growth rate</th>
<th>Per capita world output</th>
<th>Europe</th>
<th>America</th>
<th>Africa</th>
<th>Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1700</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>1700-2012</td>
<td>0.8%</td>
<td>1.0%</td>
<td>1.1%</td>
<td>0.5%</td>
<td>0.7%</td>
</tr>
<tr>
<td>incl.: 1700-1820</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.4%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>1820-1913</td>
<td>0.9%</td>
<td>1.0%</td>
<td>1.5%</td>
<td>0.4%</td>
<td>0.2%</td>
</tr>
<tr>
<td>1913-2012</td>
<td>1.6%</td>
<td>1.9%</td>
<td>1.5%</td>
<td>1.1%</td>
<td>2.0%</td>
</tr>
<tr>
<td>1913-1950</td>
<td>0.9%</td>
<td>0.9%</td>
<td>1.4%</td>
<td>0.9%</td>
<td>0.2%</td>
</tr>
<tr>
<td>1950-1970</td>
<td>2.8%</td>
<td>3.8%</td>
<td>1.9%</td>
<td>2.1%</td>
<td>3.5%</td>
</tr>
<tr>
<td>1970-1990</td>
<td>1.3%</td>
<td>1.9%</td>
<td>1.6%</td>
<td>0.3%</td>
<td>2.1%</td>
</tr>
<tr>
<td>1990-2012</td>
<td>2.1%</td>
<td>1.9%</td>
<td>1.5%</td>
<td>1.4%</td>
<td>3.8%</td>
</tr>
<tr>
<td>1950-1980</td>
<td>2.5%</td>
<td>3.4%</td>
<td>2.0%</td>
<td>1.8%</td>
<td>3.2%</td>
</tr>
<tr>
<td>1980-2012</td>
<td>1.7%</td>
<td>1.8%</td>
<td>1.3%</td>
<td>0.8%</td>
<td>3.1%</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>(% of total employment)</th>
<th>France</th>
<th></th>
<th>United States</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agriculture</td>
<td>Manufacturing</td>
<td>Services</td>
<td>Agriculture</td>
</tr>
<tr>
<td>1800</td>
<td>64%</td>
<td>22%</td>
<td>14%</td>
<td>68%</td>
</tr>
<tr>
<td>1900</td>
<td>43%</td>
<td>29%</td>
<td>28%</td>
<td>41%</td>
</tr>
<tr>
<td>1950</td>
<td>32%</td>
<td>33%</td>
<td>35%</td>
<td>14%</td>
</tr>
<tr>
<td>2012</td>
<td>3%</td>
<td>21%</td>
<td>76%</td>
<td>2%</td>
</tr>
</tbody>
</table>

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.