Productivity trends from 1890 to 2012 in advanced countries

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Antonin Bergeaud – Banque de France and Polytechnique
Gilbert Cette – Banque de France and AMSE
Rémy Lecat - Banque de France
Current debates on productivity

- **Information and communication technology**
  - R. Gordon: ICT revolution does not match the industrial revolutions and is now over
  - vs Byrne, Oliner and Sichel, 2013, among others

- **US-Europe and Japan divergence**
  - End of a decade-long convergence process
  - Role of education and institutions?

- **A new deal with the Great Crisis**
Literature

- **Technological progress**
  - Aghion and Howitt, 1998, 2009
  - Crafts and O’Rourke, 2013
  - Ferguson and Washer, 2004

- **Convergence**
  - Barro and Sala-i-Martin, 1997
  - La Porta, Lopez-De-Silanes and Shleifer, 2008
  - Algan and Cahuc, 2010

- **Productivity in the long run**
  - Islam, 2003
  - Madsen, 2010
  - Crafts and O’Rourke, 2013
What we do

- Productivity over the period 1890-2012
  - Using annual and quarterly data
  - From 1890 to the Great Crisis

- 13 advanced countries
  - G7: US, UK, Japan, France, Germany, Italy, Canada
  - Spain, The Netherlands, Finland
  - Australia, Sweden, Norway
  - +reconstituted Euro area

- Labor Productivity and TFP
  - Filtering
  - Breaks
Computing productivity

- Labor productivity per hour
  \[ LP_{i,t} = \frac{Y_{i,t}}{H_{i,t}} \]
  with \( H \) total number of hours worked

- Total factor productivity
  \[ TFP_{i,t} = \frac{Y_{i,t}}{H_{i,t}^{1-\alpha} K_{i,t-1}^\alpha} \]
  \( \alpha = 0, 3 \)

- The capital stock:
  - Permanent inventory method \( \delta = 10\% \) (equipment)/2.5\% (building)
  - Distinguishing building and equipment
  - Taking into account war/earthquake damages

- Productivity level: 2005 PPP USD from Penn world tables
Data sources

For annual data
- Starting from Cette, Kocoglu and Mairesse (2009) for US, UK, JP, FR
- The basis: Maddison, 2001, 2003…
- …updated by Bolt et alii (2013)…
- and complemented for specific countries by Baffigi/Broadberry et alii for Italy, Prados for Spain, Villa for France, Smits et alii/Groote et alii for the Netherlands…
- Particular weakness for Hours worked per employee

For quarterly data
- From 1960 to 2012 Q4
- National accounts, Eurostat, OECD and specific national sources
Filtering and breaks

- **Filtering**
  - Hodrick-Prescott filtering
  - 30-years cycles ($\lambda = 500$)

- **Breaks**
  - Bai and Perron (1998): optimal number and datation of breaks+trends
  - Minimum gap between 2 breaks: 7 years for annual data; 5 years for quarterly data
  - After 1960: breaks on quarterly data reported on annual data
  - Dealing with wars:
    - major disruptions and unreliable data
    - Testing breaks in trend and intercept through dummies
What we find

1. Two productivity growth waves
2. In the US, smaller and shorter-lived ICT productivity wave
3. In other countries, delayed productivity growth waves (if any)
4. Two main productivity leadership changes
5. No global and permanent convergence process
6. Global productivity breaks due to global shocks
7. Country-specific breaks due to idiosyncratic shocks
1. Two productivity growth waves

United States:
HP filtering of Productivity growth with $\lambda=500$

Trend of productivity growth rate

- Total factor Productivity
- Labor Productivity
2. A smaller and shorter-lived ICT wave

United States

Labor productivity

TFP

US$ PPP of 2005 (log scale)
Areas in grey: war periods
3. Delayed productivity growth waves in other countries

HP filtering of Labor Productivity growth with $\lambda=500$

- United States
- Japan
- Euro Area
- United Kingdom

Introduction  Data & Methodology  **Technology**  Convergence  Robustness
4. Leadership changes

Labor Productivity per hour:
- Level relative to the current US level
- Non-Euro Area countries, 1890-2012, $2005 PPP, US level = 100

Labor Productivity per hour:
- Level of relative to the current US level
- Euro Area countries, 1890-2012, $2005 PPP
5. Convergence process

United Kingdom

Labor productivity

TFP

Areas in grey: war periods

Distance to US level, %

Introduction Data & Methodology Technology Convergence Robustness
5. Convergence process

Euro area

Labor productivity

Distance to US level, %
Areas in grey: war periods

TFP

Introduction ➔ Data & Methodology ➔ Technology ➔ **Convergence** ➔ Robustness
5. Convergence process

Japan

Labor productivity

Distances to US level, %

Areas in grey: war periods

Introduction  Data & Methodology  Technology  Convergence  Robustness
6. Productivity breaks: global shocks

Labor productivity

US$ PPP of 2005 (log scale)
Areas in grey: war periods
6. Productivity breaks: global shocks

Wars

Labor productivity

United Kingdom

France

United States

Japan

US$ PPP of 2005 (log scale)
Areas in grey: war periods
6. Productivity breaks: global shocks

Global financial crisis

Labor productivity

US$ PPP of 2005 (log scale)
Areas in grey: war periods
6. Productivity breaks: global shocks

Global supply shocks

Labor productivity

US$ PPP of 2005 (log scale)
Areas in grey: war periods
7. Productivity breaks: country-specific shocks

Sweden

Labor productivity

Total Factor Productivity

US$ PPP of 2005 (log scale)
Areas in grey: war periods
7. Productivity breaks: country-specific shock

Japan

Labor productivity

Total Factor Productivity

US$ PPP of 2005 (log scale)
Areas in grey: war periods
7. Country-specific Productivity breaks

- Due to policy shocks / structural reforms
  - **The Netherlands**, following the Wassenaard agreement, 1982
    TFP growth: 1977-1983 0.5%, 1983-2002 1.5%
  - **Canada**, reforms from the early 1990s
    TFP growth: 1974-1990 0.3%, 1990-2000 1.1%
  - **Australia**, reforms from the early 1990s
    TFP growth: 1971-1990 0.4%, 1990-2002 1.4%
  - **Sweden**, reforms from the early 1990s
    TFP growth: 1976-1992 0.4%, 1992-2008 1.9%
Concluding remarks
Productivity and the long run

- Major contribution of long-run analysis:

  Technology
  - Long lags in innovation diffusion
  - « One big wave » staggered across countries
  - Small and short-lived ICT productivity wave so far

- Convergence
  - Erratic convergence process
  - Major role of wars, supply shocks, financial crisis and innovation clusters
  - Major role of specific shocks, and large impact of ambitious structural reform programs
Robustness checks:
Break dates significance

Break dates significance: Student test for the break coefficient (coefficient $\beta_k$ in equation 1, section 3.1)
*: less than 10%; **: less than 5%; ***: less than 1% significance

<table>
<thead>
<tr>
<th>Country</th>
<th>Total factor productivity (TFP)</th>
<th>Labor productivity (LP)</th>
</tr>
</thead>
</table>
**Robustness checks: Capital share**

*TFP* robustness test with respect to $\alpha$, the capital share – Break dates

--- $^+$ (resp. ---) stands for appearing (resp. disappearing) break date when changing coefficient to a higher or lower value.

<table>
<thead>
<tr>
<th>Country</th>
<th>Benchmark value $\alpha = 0.3$</th>
<th>High value $\alpha = 0.35$</th>
<th>Low value $\alpha = 0.25$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>1915, 1929, 1968, 1974, 1983, 1990</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1963, 1974, 1992, 2008</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Euro Area</td>
<td>1928, 1974, 1995, 2008</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Germany</td>
<td>1928, 1969, 1980, 1990, 2006</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Italy</td>
<td>1975, 1981, 1995, 2008</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Finland</td>
<td>1928, 1969, 1975, 1990, 2008</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Canada</td>
<td>1898, 1928, 1933, 1941, 1966, 1974, 1990, 2000</td>
<td>-</td>
<td>1933$^-$</td>
</tr>
<tr>
<td>Sweden</td>
<td>1971, 1976, 1992, 2008</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Norway</td>
<td>1902, 1980, 1988, 1998, 2005</td>
<td>-</td>
<td>-</td>
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</tbody>
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Robustness checks: Depreciation rate

TFP robustness test with respect to $\delta$, the depreciation rate of the capital – Break dates

- stands for appearing (resp disappearing) break date when changing coefficient to a higher or lower value

<table>
<thead>
<tr>
<th>Country</th>
<th>Benchmark value $\delta^E = 0.1$ and $\delta^B = 0.025$</th>
<th>High value $\delta^E = 0.15$ and $\delta^B = 0.05$</th>
<th>Low value $\delta^E = 0.05$ and $\delta^B = 0.015$</th>
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<td>1915, 1929, 1968, 1974, 1983, 1990</td>
<td>-</td>
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<tr>
<td>United Kingdom</td>
<td>1963, 1974, 1992, 2008</td>
<td>1987$^+$</td>
<td>-</td>
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<td>Germany</td>
<td>1928, 1969, 1980, 1990, 2006</td>
<td>-</td>
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<td>Australia</td>
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Complements: Leadership changes

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Non-Euro Area countries, 1890-2012, $2005 PPP, US level = 100

Total Factor Productivity:
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Complements: Country-specific shocks

United Kingdom

Labor productivity

Total Factor Productivity

US$ PPP of 2005 (log scale)
Areas in grey: war periods