The circular relationship between productivity growth and real interest rates

A Bergeaud  G Cette  R Lecat

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Motivation: a general productivity slowdown

Figure: Smoothed growth rate of total factor productivity in the Euro Area, USA, JP and UK. Source: Bergeaud, Cette and Lecat (2016) (www.longtermproductivity.com)
Motivation: a general productivity slowdown

Figure: Evolution of TFP growth rates for the median of our 17 OECD countries (and inter Q range). Source: Bergeaud et al. (2016)
A general productivity slowdown

Possible explanations for the slowdown (among others):

- Productivity growth is mismeasured (Aghion et al., 2018a, Byrne et al., 2016...)
- Ideas harder to get (Bloom et al., 2017)
- The age of great invention is over (Gordon)
- Rising Market power $\rightarrow$ reduced competition and increasing concentration (Aghion et al., 2019b; Akcigit and Ates, 2018, Liu et al. 2018...)

There exists a positive circular relationship between interest rates ($r$) and productivity growth ($g$)

$g \rightarrow r$: potential output key driver of return on capital and therefore long term interest rates

$r \rightarrow g$: interest rates are also a determinant of the minimum expected return from investment projects

Productivity level required for such an investment

Cleansing mechanism as in Aghion et al. (2019a, ABCLM)
A general productivity slowdown

Possible explanations for the slowdown (among others):

- Productivity growth is mismeasured (Aghion et al., 2018a, Byrne et al., 2016...)
- Ideas harder to get (Bloom et al., 2017)
- The age of great invention is over (Gordon)
- Rising Market power \(\rightarrow\) reduced competition and increasing concentration (Aghion et al., 2019b; Akcigit and Ates, 2018, Liu et al. 2018...)
- In this paper, we study another mechanism
  - There exists a positive circular relationship between interest rates \(r\) and productivity growth \(g\)
  - \(g \rightarrow r\): potential output key driver of return on capital and therefore long term interest rates
  - \(r \rightarrow g\): interest rates are also a determinant of the minimum expected return from investment projects
    - Productivity level required for such an investment
    - Cleansing mechanism as in Aghion et al. (2019a, ABCLM)
Declining interest rates

Figure: Evolution of real interest rates for the median of our 17 OECD countries (and inter Q range). Source: OECD
Positive effect of financial development and easing credit access on growth is well known. Shown empirically by e.g. Manaresi and Pierri (2017).

On the other hand, if credit is *too easy*, this may create a negative misallocation effect on growth (Gropp et al., 2016).

We combine these two approaches in a unifying framework.
Positive effect of financial development and easing credit access on growth is well known. Shown empirically by e.g. Manaresi and Pierri (2017). On the other hand, if credit is too easy, this may create a negative misallocation effect on growth (Gropp et al., 2016). We combine these two approaches in a unifying framework.

Which effect dominates depends on the level of credit constraints. Overall, the cleansing mechanism dominates.
What we do

- Country level analysis over the period 1950-2017
- Formal test of the circular relationship
  - Interest rate equation: \( r_{i,t} = f(r_{i,t-1}, g_{i,t}, X_{i,t}) \)
  - TFP equation: \( g_{i,t} = h(g_{i,t-1}, r_{i,t-1}, Z_{i,t}) \)
  - \( X \) measures financial conditions, \( Z \) contains catch-up, technology...
  - We show that \( \frac{\partial f}{\partial g} > 0 \) and \( \frac{\partial h}{\partial r} > 0 \)
- Without any technological shock, the economy converges to a model with low growth and low interest rates \( \rightarrow \) secular stagnation
- From reduced form coefficients, we simulate the effect of a technological shock in the US
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Dataset

- 17 OECD countries with yearly data from 1950
- Mostly western European countries (France, Germany, Spain, Italy) + USA, UK, Japan etc...
- TFP growth is taken from Bergeaud et al. (2016) → Solow Residual
- Real interest rates taken from Jorda et al. (2018)
- Other covariates taken from various sources: life expectancy, relative investment price, inflation volatility...
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Empirical model

We estimate a circular dynamic model

\[
\begin{align*}
    g_{i,t} &= ag_{i,t-1} + br_{i,t-1} + C'X_{i,t} + \varepsilon_{i,t} \\
    r_{i,t} &= \alpha g_{i,t} + \beta r_{i,t-1} + \Gamma'Z_{i,t} + \eta_{i,t}
\end{align*}
\]  

(1)

We are interested in the values of \( \alpha \) and \( b \) and their long-term counterparts: \( \alpha/(1 - \beta) \) and \( b/(1 - a) \)

\( \alpha \) corresponds to the marginal effect of a change in the growth rate of TFP on the contemporaneous change of interest rates

\( b \) corresponds to the marginal effect of a lagged change in interest rates on the productivity growth rate.

We expect both \( \alpha \) and \( b \) to be positive
Choice of covariates $X$ and $Z$

- In $X$ we want to capture the normal long-run dynamics of productivity growth (i.e. without any change in interest rates).
  - Relative price of investment at the frontier (and to countries close to it) to measure the overall level of technology
  - Catch-up for non frontier countries
  - Variation of human capital (education, life expectancy...)

- In $Z$, we want to capture the dynamics of real-interest rates
  - Volatility of past inflation
  - Uncertainty of economic policy
  - Age structure
Estimations

- We start by estimating the two equations separately
- Problem of endogeneity if errors are serially correlated
- Hence we use GMM
  - Instrument real-interest rates by the past realization of nominal interest rates
  - Instrument TFP using past values of ICT coefficient and electricity consumption per capita
  - Consistent estimation results
- Hence we develop simultaneous equations
  - Consistent results
Simultaneous estimations

- Estimation of the full system to account for feedback effects
- We consider that the system of equation displays contemporaneous cross-equation error correlation → seemingly unrelated regression system (Zellner, 1962).
- We estimate this system using an iterative GLS method
- Magnitude: a 1 pp increases in \( r \) raises \( g \) by 0.065 pp.
  → 5 pp decreases in \( r \) since 1985 implies -0.3 pp of TFP growth.
Simultaneous estimation: results

<table>
<thead>
<tr>
<th>Estimator</th>
<th>SURE (1)</th>
<th>SURE (2)</th>
<th>SURE (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( g_{i,t-1} )</td>
<td>0.228***</td>
<td>0.223***</td>
<td>0.226***</td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.028)</td>
<td>(0.028)</td>
</tr>
<tr>
<td>( r_{i,t-1} )</td>
<td>0.035*</td>
<td><strong>0.051</strong></td>
<td><strong>0.050</strong></td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.021)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>Catch-up</td>
<td>-5.657***</td>
<td>-5.025***</td>
<td>-4.961***</td>
</tr>
<tr>
<td></td>
<td>(0.476)</td>
<td>(0.453)</td>
<td>(0.447)</td>
</tr>
<tr>
<td>Variation in Relat. Price</td>
<td>-0.188***</td>
<td>-0.087*</td>
<td>-0.187*</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td>(0.046)</td>
<td>(0.103)</td>
</tr>
<tr>
<td>Variation in educ</td>
<td><strong>8.147</strong></td>
<td><strong>7.430</strong></td>
<td><strong>7.252</strong></td>
</tr>
<tr>
<td></td>
<td>(1.296)</td>
<td>(1.299)</td>
<td>(1.287)</td>
</tr>
<tr>
<td>Variation in Life Exp.</td>
<td>0.184</td>
<td>0.181</td>
<td>0.196</td>
</tr>
<tr>
<td></td>
<td>(0.181)</td>
<td>(0.183)</td>
<td>(0.183)</td>
</tr>
</tbody>
</table>

**Panel A:** dependent variable: \( g_{i,t} \)

<table>
<thead>
<tr>
<th>Panel B: dependent variable: ( r_{i,t} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( r_{i,t-1} )</td>
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<tr>
<td></td>
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<tr>
<td>( g_{i,t} )</td>
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<tr>
<td>Age Dep Ratio</td>
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<td>Inflation Volat.</td>
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<tr>
<td>Policy Instability</td>
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</tr>
</tbody>
</table>

\( R^2 \) 0.255 0.245 0.245
Observations 1105 1105 1105
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Simulation

- We take the coefficients from the simultaneous estimations (col 2)
- We simulate a technological shock that translates through relative price of investment
  - Same length and magnitude as the ICT shock
- This shock will directly affect the TFP of the economies that are close to the frontier. Other economies then catch-up
- The shock also indirectly affects real-interest rates
Figure: Variations in relative IT price with respect to GDP price and projections. Source: BEA and authors’ calculation
Results

Figure: Simulation results in the Euro Area and in the US for a shock in the US. Response of the growth rate of TFP $g$ (as difference with baseline without shock) in pp.
Results

Figure: Simulation results in the Euro Area and in the US for a shock in the US. Response of the real interest rate $r$ (as difference with baseline without shock) in pp.
Discussion

- Without any positive technology or education shocks, the equation system converges towards a low TFP growth/low real interest rate equilibrium.
- A low cleansing intensity leads to the survival of low productivity firms thanks to low real interest rates.
  - Real interest rates are maintained low by the population ageing.
- A positive impact through an increase in average years of education of the working age population can be foreseen only for a limited number of countries.
- Only a technological shock would allow to escape the secular stagnation trap.
- The shock we simulate is smaller than other shocks during the 20th century. It could stem from a second IT wave.
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Conclusion

▶ We have emphasized a positive circular relationship between \( r \) and \( g \)
▶ A downward pressure on \( r \) negatively impacts TFP growth (cleansing) which negatively affects \( r \) and so on...
▶ In our model, only a technological shock, that would shift \( g \) exogenously can allow OECD countries to escape secular stagnation trap
  ▶ Such shock can come from the diffusion of new technologies (AI, self-driving cars...)
  ▶ Such shock would affect first frontier economies, and then others by the convergence dynamics
▶ We illustrate this thanks to a realistic (but conservative) simulation
BACK-UP SLIDES
Figure: Coevolution of real interest rates and growth rate of TFP in the USA since 1955
Motivation

- How can we explain this comovement between \( r \) and \( g \)?
- Positive effect from \( g \) to \( r \) is clear:
  - In the long-run, the ratio of capital to output ratio is roughly constant, thus \( \downarrow \) (expected) growth \( \iff \downarrow \) demand for investment
  - Literature survey from Marx et al. (2017)
- Positive effect from \( r \) to \( g \) is less known.
  - Relaxation of credit allows low productive firms to survive
  - Negative impact on business dynamism and thus on growth
  - If \( r \) is low enough, this effect dominates the positive investment effect of reducing credit constraints
  - To show this \( \iff \) Schumpeterian model (ABCLM)
- Cleansing effect dominates
Quick glance at the model

  \[ g = (z_e + z_i)\ln(\gamma), \]

- \( z_e \) and \( z_i \) depend upon \( \gamma \), the number of scientists \( \psi \), the size of the population \( L \), the Poisson innovation rate of innovation \( \frac{1}{\eta} \), a scale parameter \( \zeta \) and the discount rate \( \rho \)

\[
\begin{align*}
  z_e &= \frac{\gamma - 1}{\gamma} \frac{L}{\psi} - \frac{1}{\eta} \left( \frac{\psi}{\eta \zeta} \right)^{\frac{1}{\eta - 1}} - \frac{\rho}{\gamma} \\
  z_i &= \left( \frac{\psi}{\eta \zeta} \right)^{\frac{1}{\eta - 1}}.
\end{align*}
\] (2) (3)
Quick glance at the model

- We introduce credit constraints in a stylized way: firms cannot invest more than $\mu$ times their current market value.
  - Condition not binding for entrants
- This yields:
  
  \[ z_e = \frac{\gamma - 1}{\gamma} \frac{L}{\psi} - \mu - \frac{\rho}{\gamma} \quad (4) \]

  \[ z_i = \left( \frac{\mu \psi}{\zeta} \right)^{\frac{1}{\eta}} \quad (5) \]

- $\mu$ captures the inverse of the tightness of credit constraints in the economy (evolve with $-r$)
Quick glance at the model

- If $\mu$ is large enough $\uparrow$ credit constraints $\implies \uparrow$ growth by increasing the contribution of entrants ($z_e$) relatively more than it reduces the contribution of incumbents to growth ($z_i$)

\[
\frac{dg}{d\mu} = -\ln(\gamma_e) + \psi \left( \frac{\mu \psi}{\zeta} \right)^{\frac{1}{\eta} - 1} \ln(\gamma_i) < 0, \quad \text{if } \mu > \left( \frac{\psi}{\zeta} \right)^{\frac{1}{\eta} - 1} \left( \frac{\ln(\gamma_i)}{\ln(\gamma_e) \eta} \right)^{\frac{\eta}{\eta - 1}}.
\]

- This relationship shows how decreasing real interest rates can negatively impact growth through a reallocation effect if the level of credit constraints is already low enough.

- On the contrary, if $\mu$ is close to 0, a fall in real interest rates reduces the cost of capital and spurs corporate investment.
## Separate estimations: TFP equation

<table>
<thead>
<tr>
<th>Dependent variable: $g_{i,t}$</th>
<th>Estimator</th>
<th>OLS (1)</th>
<th>GMM (2)</th>
<th>OLS (3)</th>
<th>GMM (4)</th>
<th>OLS (5)</th>
<th>GMM (6)</th>
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<tr>
<td>$g_{i,t-1}$</td>
<td></td>
<td>0.214***</td>
<td>0.204***</td>
<td>0.210***</td>
<td>0.202***</td>
<td>0.214***</td>
<td>0.206***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.036)</td>
<td>(0.036)</td>
<td>(0.035)</td>
<td>(0.036)</td>
<td>(0.036)</td>
<td>(0.037)</td>
</tr>
<tr>
<td>$r_{i,t-1}$</td>
<td></td>
<td>0.042*</td>
<td>0.123**</td>
<td>0.056**</td>
<td>0.118*</td>
<td>0.054**</td>
<td>0.113*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.023)</td>
<td>(0.061)</td>
<td>(0.024)</td>
<td>(0.062)</td>
<td>(0.025)</td>
<td>(0.066)</td>
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<td>Catch-up</td>
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<td>-6.026***</td>
<td>-5.945***</td>
<td>-5.428***</td>
<td>-5.446***</td>
<td>-5.366***</td>
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<td></td>
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<td>(0.595)</td>
<td>(0.601)</td>
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<td>Variation in Relat. Price</td>
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<td></td>
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<td>(0.049)</td>
<td>(0.056)</td>
<td>(0.036)</td>
<td>(0.044)</td>
<td>(0.092)</td>
<td>(0.118)</td>
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<td>7.953***</td>
<td>8.013***</td>
<td>7.335***</td>
<td>7.432***</td>
<td>7.163***</td>
<td>7.292***</td>
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<tr>
<td></td>
<td></td>
<td>(1.339)</td>
<td>(1.364)</td>
<td>(1.296)</td>
<td>(1.300)</td>
<td>(1.270)</td>
<td>(1.276)</td>
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<td>0.321</td>
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<td>0.328</td>
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<td></td>
<td></td>
<td>(0.289)</td>
<td>(0.291)</td>
<td>(0.292)</td>
<td>(0.292)</td>
<td>(0.291)</td>
<td>(0.291)</td>
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<tr>
<td>$R^2$</td>
<td></td>
<td>0.273</td>
<td>0.263</td>
<td>0.264</td>
<td>0.258</td>
<td>0.264</td>
<td>0.259</td>
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<td>1122</td>
<td>1122</td>
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<td>50.191</td>
<td>45.114</td>
<td>39.999</td>
<td>39.999</td>
<td>39.999</td>
<td>39.999</td>
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</tbody>
</table>

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Magnitude

- The median real interest rate in our sample declined from 5.2% in 1985 to 0.5% at the end of the period.
- Over the same period, median TFP growth declined from 2.5% to 0.5%
- 0.7 percentage point of the decline in TFP growth or 35% of the slowdown could be attributed to the decrease in interest rates.
- Education has the expected magnitude (7-10% increases in TFP when the average education duration in the working age population increases by 1 year).
- Catch-up coefficient involves a convergence speed of around 5% per year.
Separate estimations: interest rate equation

<table>
<thead>
<tr>
<th>Dependent variable: $r_{i,t}$</th>
<th>Estimator</th>
<th>OLS</th>
<th>GMM (2)</th>
<th>GMM (3)</th>
<th>GMM (4)</th>
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<td>$r_{i,t-1}$</td>
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<tr>
<td></td>
<td></td>
<td>0.705***</td>
<td>0.692***</td>
<td>0.691***</td>
<td>0.690***</td>
<td>0.697***</td>
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<tr>
<td></td>
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<td>(0.040)</td>
<td>(0.040)</td>
<td>(0.039)</td>
<td>(0.041)</td>
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<tr>
<td>$g_{i,t}$</td>
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<td>0.103***</td>
<td>0.112</td>
<td>0.121*</td>
<td>0.218***</td>
<td>0.208***</td>
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<tr>
<td></td>
<td></td>
<td>(0.032)</td>
<td>(0.088)</td>
<td>(0.073)</td>
<td>(0.070)</td>
<td>(0.068)</td>
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<tr>
<td>Age Dep Ratio</td>
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<td></td>
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<td>-0.048***</td>
<td>-0.048***</td>
<td>-0.050***</td>
<td>-0.064***</td>
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<td>(0.014)</td>
<td>(0.017)</td>
<td>(0.014)</td>
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<td>Inflation Volat.</td>
<td></td>
<td>0.125*</td>
<td>0.106</td>
<td>0.105</td>
<td>0.109</td>
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<td>(0.074)</td>
<td>(0.076)</td>
<td>(0.076)</td>
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<td>Policy Instability</td>
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<td>0.089</td>
<td>0.095</td>
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<td></td>
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<td>(0.065)</td>
<td>(0.067)</td>
<td>(0.067)</td>
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<tr>
<td>R²</td>
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<td>0.531</td>
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<td>0.000</td>
<td>0.000</td>
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<tr>
<td>KP Wald F-stat.</td>
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<td>46.588</td>
<td>47.917</td>
<td>125.583</td>
<td>63.217</td>
<td></td>
</tr>
<tr>
<td>Hansen-J p-val.</td>
<td></td>
<td>0.842</td>
<td>0.478</td>
<td></td>
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</tr>
</tbody>
</table>

"***", "+", and "-" denote significance levels at the 1%, 5%, and 10% levels, respectively.
Magnitude

- Given a 0.7 autoregressive coefficient and a 0.1 TFP coefficient, the long run impact of a 1 pp increase in TFP on the level of interest rates is about 0.3 pp.

- A higher age dependency ratio, which could lead to an increased supply of savings, weighs on interest rates: a 1pp increase in the age dependency decreases TFP by about 0.07pp in the long run.
  - demography exerts a continuous downward pressure on long-term real interest rates as this ratio is expected to increase in the next decades