Technology, Employment and the Business Cycle: Do Technology Shocks Explain Aggregate Fluctuations?
J. Gali’ (1999)

presented by Salvatore Lo Bello

Advanced Econometrics - UC3M

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A Challenge to RBC Theory

- RBC theory: technology shocks cause aggregate fluctuations.
  - Success of RBC theory: match of unconditional second moments.
  - Failure of RBC theory: cannot match conditional second moments.
    - Employment-Productivity Puzzle: positive correlation in the model, negative in the data.
    - Solutions? Augmenting the model with non-technology shocks (Christiano and Eichenbaum, 1992; Bencivenga, 1992).

- This paper: alternative explanation of the puzzle reverting the dynamic effects of technology shocks.
The Contribution of This Paper

- To offer a **new mechanism** linking labor productivity and employment (the sign can be negative).
- To identify and estimate the components of variations due to technology and non-technology shocks (SVAR).
- Findings (very difficult to reconcile with RBC theory):
  - conditional correlation between hours worked and productivity:
    - **negative** for technology shocks;
    - positive for non-technology shocks.
  - hours persistently decline with a positive technology shock.
A Monetary Model with Sticky Prices

- **Households’ problem:**

  \[
  \max_{\{ (c_{it})_{i=0}^{1}, M_t, N_t, U_t \}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t \{ \log C_t + \lambda_m \log \frac{M_t}{P_t} - H(N_t, U_t) \}
  \]  
  \[ (1) \]

  \[
  \text{s.t. } \int_{0}^{1} P_{it} C_{it} \, di + M_t = W_t N_t + V_t U_t + M_{t-1} + \gamma_t + \Pi_t
  \]  
  \[ (2) \]

- \( C_t = \left( \int_{0}^{1} (C_{it})^{\epsilon - \frac{1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon - 1}} \quad \epsilon > 1 \) (elasticity of substitution)

- \( P_t = \left( \int_{0}^{1} (P_{it})^{1 - \epsilon} \right)^{\frac{1}{1 - \epsilon}} \)

- \( H(N_t, U_t) = \frac{\lambda_n}{1 + \sigma_n} N_t^{1 + \sigma_n} + \frac{\lambda_u}{1 - \sigma_u} U_t^{1 + \sigma_u} \)
Firms’ problem:

\[
\max_{P_{it}, U_{it}, N_{it}} \{P_{it} Y_{it} - W_t U_{it} - V_t U_{it}\}
\]  \hspace{1cm} (3)

\[
Y_{it} = Z_t L_{it}^\alpha
\]  \hspace{1cm} (4)

\[
L_{it} = N_{it}^\theta U_{it}^{1-\theta}
\]  \hspace{1cm} (5)

\[
Z_t = Z_{t-1} \exp(\eta_t) \quad \eta_t \sim N(0, s_z^2)
\]  \hspace{1cm} (6)

Monetary policy:

\[
M_t^s = M_t^{s-1} \exp(\xi_t + \gamma \eta_t) \quad \xi_t \sim N(0, s_m^2) \quad \eta_t \perp \xi_t
\]  \hspace{1cm} (7)
Equilibrium Results

- **Reduced-form equilibrium relationship:**
  \[ Y_t = AZ_t N_t^\phi \] (8)

- \( \phi = \alpha \theta + \frac{\alpha(1-\theta)(1+\sigma_n)}{(1+\sigma_u)} \)

- \[ \text{cov}(\Delta n_t, \Delta x_t \mid z) = -\frac{(1-\gamma)}{\phi^2} \left[ (2 - \phi) + 2\gamma(\phi - 1) \right] s_z^2 \] (9)

- **Under** \( \gamma \in [0,1) \) and \( \phi \in (1,2) \), \( \text{cov}(\Delta n_t, \Delta x_t \mid z) < 0. \)

- \[ \text{cov}(\Delta n_t, \Delta x_t \mid m) = \frac{2(\phi - 1)}{\phi^2} s_m^2 \] (10)

- **Under** \( \phi > 1 \), \( \text{cov}(\Delta n_t, \Delta x_t \mid m) > 0. \)
The Empirical Model

▶ **A1**: H1, strictly concave, aggregate production function ($Z$ exogenous with a unit root):

$$Y_t = F(K_t, Z_t L_t)$$

▶ **A2**: $\frac{K_t}{Z_t L_t}$ follows a stationary stochastic process.

$$r_t = \frac{F_K(\frac{K_t}{Z_t L_t}, 1)}{\text{markup}} - \text{depreciation}$$

▶ **A3**: H1 labor input function; $\frac{U_t}{N_t}$ follows a stationary stochastic process:

$$L_t = g(N_t, U_t)$$

▶ $X_t = \frac{Y_t}{L_t} \frac{L_t}{N_t} \iff x_t = z_t + \zeta_t$ (logs: notice that $\zeta_t$ is stationary).
Specification of the Empirical Model

\[
\begin{bmatrix}
\Delta x_t \\
\Delta n_t
\end{bmatrix} = \begin{bmatrix}
C^{11}(L) & C^{12}(L) \\
C^{21}(L) & C^{22}(L)
\end{bmatrix}\begin{bmatrix}
\epsilon^z_t \\
\epsilon^m_t
\end{bmatrix}
\] (11)

- LR restriction: \( C^{12}(1) = 0 \). Only technology shocks have permanent effects on productivity.

\[
\rho(\Delta x_t, \Delta n_t \mid i) = \frac{\sum_{j=0}^{\infty} C^1_j C^2_j}{\sqrt{\text{var}(\Delta x_t \mid i)} \sqrt{\text{var}(\Delta n_t \mid i)}}
\] (12)
### Table 1—Correlation Estimates: Bivariate Model

<table>
<thead>
<tr>
<th></th>
<th>Unconditional</th>
<th>Conditional</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Technology</td>
</tr>
<tr>
<td><strong>Panel A: First-differenced labor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours</td>
<td>$-0.26^{**}$</td>
<td>$-0.82^{**}$</td>
</tr>
<tr>
<td></td>
<td>$(0.08)$</td>
<td>$(0.12)$</td>
</tr>
<tr>
<td>Employment</td>
<td>$-0.02$</td>
<td>$-0.84^{**}$</td>
</tr>
<tr>
<td></td>
<td>$(0.07)$</td>
<td>$(0.26)$</td>
</tr>
<tr>
<td><strong>Panel B: Detrended labor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours</td>
<td>$-0.26^{**}$</td>
<td>$-0.81^{**}$</td>
</tr>
<tr>
<td></td>
<td>$(0.08)$</td>
<td>$(0.11)$</td>
</tr>
<tr>
<td>Employment</td>
<td>$-0.02$</td>
<td>$-0.35$</td>
</tr>
<tr>
<td></td>
<td>$(0.07)$</td>
<td>$(0.49)$</td>
</tr>
</tbody>
</table>

**Notes:** Table 1 reports estimates of unconditional and conditional correlations between the growth rates of productivity and labor input (hours or employment) in the United States, using quarterly data for the period 1948:1–1994:4. Standard errors are shown in parentheses. Significance is indicated by one asterisk (10-percent level) or two asterisks (5-percent level). Conditional correlation estimates are computed using the procedure outlined in the text, and on the basis of an estimated bivariate VAR for productivity growth and labor-input growth (Panel A) or productivity growth and detrended labor input (Panel B). Data sources and definitions can be found in the text.
Estimated Impulse Responses (US)

**Figure 2.** Estimated Impulse Responses from a Bivariate Model: U.S. Data, First-Differenced Hours (Point Estimates and ±2 Standard Error Confidence Intervals)
## TABLE 3 — CORRELATION ESTIMATES: INTERNATIONAL EVIDENCE

<table>
<thead>
<tr>
<th></th>
<th>Unconditional</th>
<th>Conditional</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Technology</td>
</tr>
<tr>
<td>Canada</td>
<td>-0.12*</td>
<td>-0.59*</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td>(0.32)</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>-0.11</td>
<td>-0.91**</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(0.16)</td>
</tr>
<tr>
<td>Germany</td>
<td>0.08</td>
<td>-0.55**</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td>(0.28)</td>
</tr>
<tr>
<td>France</td>
<td>0.00</td>
<td>-0.81**</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
<td>(0.27)</td>
</tr>
<tr>
<td>Italy</td>
<td>-0.47**</td>
<td>-0.93**</td>
</tr>
<tr>
<td></td>
<td>(0.12)</td>
<td>(0.13)</td>
</tr>
<tr>
<td>Japan</td>
<td>-0.07</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td>(0.47)</td>
</tr>
<tr>
<td>Average</td>
<td>-0.11</td>
<td>-0.56</td>
</tr>
<tr>
<td>Average (excluding Japan)</td>
<td>-0.12</td>
<td>-0.75</td>
</tr>
</tbody>
</table>

*Notes:* Table 3 reports estimates of unconditional and conditional correlations between the growth rates of productivity and employment for Canada (62:1—94:4), the United Kingdom (62:1—94:3), Germany (70:1—94:4), France (70:1—94:4), Italy (70:1—94:3), and Japan (62:1—94:4). Standard errors are shown in parentheses. Significance is indicated by one asterisk (10-percent level) or two asterisks (5-percent level). The conditional correlation estimates are computed using the procedure outlined in the text on the basis of an estimated bivariate VAR for productivity and employment growth (detrended employment for France). Data sources and exact definitions can be found in the text.
Estimated Impulse Responses (G7)

Figure 5. Estimated Impulse Responses of Employment (Solid Line) and Productivity (Dashed Line) for Other Industrialized Economies
Estimated Impulse Responses (G7)
Technology and Non-Technology Components of GDP and hours (US)

Figure 6. Estimated Technology and Non-Technology Components of U.S. GDP and Hours
Conclusions

- This paper challenges RBC theory, unable to replicate conditional second moments of key macroeconomic variables.
- It interprets the near-zero unconditional correlation between employment and productivity.
- Empirically, technology shocks seem to have a negative impact on employment.
- Non-technology shocks seem to have played a much bigger role in the aggregate fluctuations of the postwar US economy.