The Effects of Anticipated and Surprise Technology Changes on International Relative Prices and Trade

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All views are those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of Dallas, or the Federal Reserve System.
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- Surprise changes (contemporaneous shocks)
- Anticipated changes (news shocks)
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- International relative prices
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An example of news and contemporaneous shocks:

\[
a_{t+1} = \rho_a a_t + x_{t-p} + \varepsilon_{a,t+1},
\]

\[
x_{t+1} = \rho_x x_t + \varepsilon_{x,t+1}
\]

- Contemporaneous shock \( \varepsilon_{a,t+1} \) changes TFP immediately.
- News shock \( \varepsilon_{x,t+1} \) affects TFP only in the future.
Motivation

- Revived interest on news shocks in driving business cycles
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- Our paper compares the international transmission of news and surprise TFP shocks.
  - International relative prices: the real exchange rate and TOT
  - International trade
Motivation

- Studies on international transmission of US technology shocks focus on surprise shocks.
  - BKK (1992, 1994)
  - Corsetti, Dedola, and Leduc (2006 and forthcoming)
  - Enders and Mullers (2009)
  - Enders, Mullers, and Scholl (2011)
  - Juvenal (2011)
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- Distinguishing news and contemporaneous TFP shocks reconciles puzzling findings in previous studies.
We find

- The US real exchange rate exhibits different dynamics following these two shocks: J-curve vs Hump-shaped.
- The news shock is more important in driving exchange rate movements.
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It is important to distinguish these two shocks when discussing the international spill-over of technology changes.

Standard international business cycle models fail to replicate these empirical findings.
Three steps to achieve these goals

- **Step one: benchmark identification method**
  - Identify shocks from SVAR using Barsky and Sims (2011).
  - Investigate effects of these shocks.

- **Step two: evaluation of a structural model**
  - Estimate a standard international RBC model using the impulse response function matching estimation.
  - Evaluate the performance of estimated model.

- **Step three: robustness check**
  - Identify shocks from SVAR using the sign restrictions method.
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Identification Strategy (Barsky and Sims, 2011)

- Identification assumption: Variation in TFP is fully explained by two shocks

  One shock affects TFP immediately (surprise or contemporaneous shock).

  The other shock only changes TFP in the future (called news shock).

Identification restrictions:
- Contemporaneous shocks: reduced form innovations in TFP from VARs.
- News shocks: orthogonal to the contemporaneous shock and contributes to the variation in future TFP as much as possible.
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- G7 data (1973Q1-2010Q4)
- Benchmark VAR
  - US: Utilization-adjusted TFP (Fernald, 2009)

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- Benchmark VAR
  - US: Utilization-adjusted TFP (Fernald, 2009)
  - US-ROW data
    - Real consumption
    - Real investment
    - Real GDP
    - Hours worked
    - The real exchange rate
- Most data are from OECD, IMF, BEA, and BLS.
IRFs to a positive news TFP shock

IRFs to a Positive News TFP Shock

US TFP

Relative Consumption

Relative Investment

Relative GDP

Relative Hours

Real Exchange Rate
IRFs to a positive contemporaneous TFP shock

IRFs to a Positive Contemporaneous TFP Shock

- **US TFP**
- **Relative Consumption**
- **Relative Investment**
- **Relative GDP**
- **Relative Hours**
- **Real Exchange Rate**
Effects of shocks on trade

- Seven-variable VAR
- Replace the real exchange rate in the benchmark VAR with the TOT
- Add one of the
  - Real export
  - Real import
  - Trade balance (nominal trade balance divided by nominal GDP)
IRFs to a positive news TFP shock

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Terms of Trade

Trade Balance

Real Exports

Real Imports
IRFs to a positive contemporaneous TFP shock

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Importance of news shocks in driving the exchange rate
(Table 1)

- News TFP shocks are more important than contemporaneous shocks for exchange rate movements.
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- Two TFP shocks together account for
  - 40% of the FEV of the exchange rate for horizons more than 8 quarters.
  - 10% for horizons less than 4 quarters.
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- Two TFP shocks together account for
  - 40% of the FEV of the exchange rate for horizons more than 8 quarters.
  - 10% for horizons less than 4 quarters.
  - Other shocks drive short-run exchange rate movement: demand, monetary, risk premium, etc.
Section 2: Evaluation of a Theoretical Model

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  - Match the model and theoretical IRFs.
- Evaluate the model’s performance.
A standard international RBC model (e.g., Chari, Kehoe, and McGrattan 2002, Kollmann 2002)

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- Final goods are used for domestic consumption and capital formation.
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- Two symmetric countries with representative households
- Capital and labor are used to produce intermediate goods.
- Home and foreign intermediate goods are used to produce final goods.
- Final goods are used for domestic consumption and capital formation.
- The model shares many features widely used in the literature.
  - Variable capital utilization rate
  - Capital adjustment costs
  - Calvo type sticky prices in PCP or LCP
TFP Process

- Two-factor model for $a_t = \log(A_t)$ (Ferrero, Gertler, and Svensson 2010)
  - $a_t = a_t^u - a_t^s$
TFP Process

- Two-factor model for $a_t = \log(A_t)$ (Ferrero, Gertler, and Svensson 2010)
  - $a_t = a_t^u - a_t^s$
  - $a_t^u = \xi^u a_{t-1}^u + \varepsilon_t^c + \varepsilon_{t-p}^n$
  - $a_t^s = \xi^s a_{t-1}^s + \varepsilon_{t-p}^n$
  - where $\xi^u > \xi^s$

- $\varepsilon_{t-p}^n$ is a news shock
Estimation Strategy

- Calibrate a group of standard parameters
Estimation Strategy

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- Estimate the rest of parameters by solving
  \[ \min_{\zeta} \left( \hat{M} - M(\zeta) \right)' W \left( \hat{M} - M(\zeta) \right) \]
  - \( \hat{M} \) contains VAR IRFs in the data
  - \( M(\zeta) \) are theoretical IRF in the model
### Estimation Results

**Table: Estimated Parameter Values**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Matching IRFs to Both TFP Shocks</th>
<th>Matching IRFs to News TFP Shocks</th>
<th>Matching IRFs to Cont. TFP Shocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi$</td>
<td>Investment adjustment costs</td>
<td>4.00</td>
<td>2.73</td>
<td>4.00</td>
</tr>
<tr>
<td>$\delta_2 / \delta_1$</td>
<td>Sensitivity of capital utilization to rental rate of capital</td>
<td>0.20</td>
<td>0.84</td>
<td>0.01</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Trade price elasticity</td>
<td>1.51</td>
<td>0.30</td>
<td>1.53</td>
</tr>
<tr>
<td>$\alpha_I$</td>
<td>Calvo parameter</td>
<td>0.80</td>
<td>0.79</td>
<td>0.80</td>
</tr>
<tr>
<td>$\psi_I$</td>
<td>Degree of price indexation</td>
<td>0.11</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>$\Theta_i$</td>
<td>Interest smoothing coefficient</td>
<td>0.71</td>
<td>0.73</td>
<td>0.60</td>
</tr>
<tr>
<td>$\Theta_{\pi}$</td>
<td>Inflation targeting coefficient</td>
<td>1.57</td>
<td>1.97</td>
<td>1.63</td>
</tr>
<tr>
<td>$\Theta_y$</td>
<td>Output gap coefficient</td>
<td>0.00</td>
<td>0.33</td>
<td>0.00</td>
</tr>
<tr>
<td>$\xi^u$</td>
<td>Persistence of contemporaneous TFP shocks</td>
<td>0.91</td>
<td></td>
<td>0.87</td>
</tr>
<tr>
<td>$\sigma_{\varepsilon^c}$</td>
<td>Standard deviation of contemporaneous TFP shocks</td>
<td>0.51</td>
<td></td>
<td>0.58</td>
</tr>
<tr>
<td>$\xi^s$</td>
<td>Degree of diffusion of news TFP shocks</td>
<td>0.70</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>$\sigma_{\varepsilon^n}$</td>
<td>Standard deviation of news TFP shocks</td>
<td>0.99</td>
<td>0.93</td>
<td></td>
</tr>
</tbody>
</table>
Evaluation of the Model

IRFs to a Positive News TFP Shock

- US TFP
- Relative Consumption
- Relative Investment
- Relative GDP
- Relative Hours
- Real Exchange Rate
Evaluation of the Model

IRFs to a Positive Contemporaneous TFP Shock
Summary of Section 2

- Standard international RBC models fail to replicate the dynamics of the real exchange rate following news and contemporaneous TFP shocks.
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- Standard international RBC models fail to replicate the dynamics of the real exchange rate following news and contemporaneous TFP shocks.
- This is true even if we allow the model has different parameter values under different shocks.
Section 3: Robustness Check

- An alternative identification method: Sign restrictions method
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- Two purposes for this exercise
  - Check robustness of our results from Barsky and Sims’ method.
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  - Relate our findings with other studies using the sign restrictions.
### Sign Restrictions to Identify Shocks

#### A. Sign Restrictions

<table>
<thead>
<tr>
<th>US TFP</th>
<th>Relative Consumption</th>
<th>Relative Investment</th>
<th>Relative GDP</th>
<th>Relative Inflation</th>
<th>Relative Interest Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>News</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TFP Shocks</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>[0, 0]</td>
<td>[0, 7]</td>
<td>[8, 15]</td>
<td>[4, 11]</td>
<td>[0, 3]</td>
</tr>
<tr>
<td><strong>Contemporaneous</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TFP Shocks</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>[0, 27]</td>
<td>[1, 8]</td>
<td>[0, 7]</td>
<td>[0, 7]</td>
<td>[0, 2]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>[0, 5]</td>
</tr>
</tbody>
</table>

#### B. Alternative Sign Restrictions for Identifying News TFP Shock

<table>
<thead>
<tr>
<th>US TFP</th>
<th>Relative Consumption</th>
<th>Relative Investment</th>
<th>Relative GDP</th>
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<tbody>
<tr>
<td><strong>Identification I</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TFP Shocks</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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</tr>
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<td>[8, 15]</td>
<td>[4, 11]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Identification II</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>+</td>
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<td></td>
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<tr>
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<td>0</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
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<td>[0, 0]</td>
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Results of the Sign Restrictions Method

IRFs to a News TFP Shock Identified by Sign Restrictions

- US TFP
- Relative Consumption
- Relative Investment
- Relative GDP
- Relative Hours
- Real Exchange Rate
- Relative Inflation
- Relative Nominal Interest Rate

Zero on impact
Results of the Sign Restrictions Method

IRFs to a Contemporaneous TFP Shock Identified by Sign Restrictions
Discussions

- Enders, Muller, and Scholl (2011) used similar sign restrictions to identify contemporaneous TFP shocks.
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  - IRF of the real exchange rate is hump-shaped.

- Different from other studies using long-run restrictions method (Enders and Muller, 2009).

- Juvenal (2011) also impose restrictions to identify contemporaneous TFP shocks.
  - TFP shocks are not important (less than 10%) for exchange rate movement.

- But Juvenal (2011) only identifies part of TFP shocks.
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- It is important to distinguish news and contemporaneous TFP shocks
  - Two shocks imply distinct international transmission of technology changes.
  - Standard international RBC models fail to replicate such transmission channels.
  - Incomplete or even misleading results if two shocks are not separated.