The Transmission Mechanisms of International Business Cycles: Output Spillovers through Trade and Financial Linkages

Falk Bräuning    Viacheslav Sheremirov
Federal Reserve Bank of Boston

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The views expressed herein are those of the authors and do not indicate concurrence by the Federal Reserve Bank of Boston, the principals of the Board of Governors, or the Federal Reserve System.
We study the international transmission of U.S. monetary shocks and their effects on output abroad.

Motivation:
– The U.S. economy is large and open.
– The dollar is a global, dominant currency.
– Methods to identify U.S. monetary shocks are available in the literature.

Main findings:
– U.S. monetary shocks have sizeable output effects abroad, comparable to domestic effects.
– The output responses are relatively large in countries more open to international trade.
– Indirect transmission through the international trade network accounts for 40% to 50%.
– The role of financial linkages is overall nuanced.
Estimation

Local projections with instruments (LPIV):

\[
y_{i,t+h} = \alpha_{i}^{h} + \beta^{h} r_{t} + \sum_{k=1}^{4} \gamma_{k}^{h} y_{i,t-k} + \sum_{k=1}^{4} \delta_{k}^{h} r_{t-k} + \sum_{k=1}^{4} \zeta_{k}^{h} s_{t-k} + \theta_{i}^{h} x_{t} + \varepsilon_{i,t+h}^{h}
\]

\( y_{i,t} \) is the logarithm of real GDP per capita in country \( i \), quarter \( t \).

\( r_{t} \) is the U.S. monetary policy shadow interest rate, instrumented with \( s_{t} \).

\( s_{t} \) is a vector of monetary shocks.

\( x_{t} \equiv (t \ t^{2})' \) is a deterministic trend.

\( \beta^{h} \) measures the output response abroad, pooled across countries, after \( h \) quarters.
Data

Macro panel:
- 44 countries: 1995–2017, quarterly
- real GDP per capita
  (IMF, OECD, Penn World Tables)
- interest rates (various sources)
- aggregate exports, imports (World Bank)
- international investment positions (IMF)

Bilateral linkages:
- gross and value-added trade flows
  (U.N. Comtrade)
- banking claims
  (BIS; 18 countries starting 2005)

U.S. interest rates:
- monetary shocks, identified using high-frequency methods
  (Gürkaynak, Sack & Swanson 2005; Gertler & Karadi 2015)
- monetary policy shadow rates
  (Wu and Xia 2016)
- Treasury yields
Responses to a 1 percentage point U.S. monetary tightening

Foreign output per capita

Foreign interest rates

Shaded areas indicate 90% and 68% confidence intervals. Standard errors are two-way clustered at time and countries.
The high (low) trade group is defined based on the total-trade share in GDP being above (below) the median. The trade shares are fixed at their 1995 values.
### Transmission mechanism

#### USD / local currency unit

<table>
<thead>
<tr>
<th>Log points</th>
<th>Response period, quarters</th>
</tr>
</thead>
<tbody>
<tr>
<td>-9</td>
<td>0</td>
</tr>
<tr>
<td>-6</td>
<td>4</td>
</tr>
<tr>
<td>-3</td>
<td>8</td>
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<tr>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>6</td>
<td>20</td>
</tr>
</tbody>
</table>

- **High trade shares**
- **Low trade shares**

#### Real exports + imports per capita

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>-6</td>
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<td>0</td>
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<tr>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
</tr>
</tbody>
</table>

- **High trade shares**
- **Low trade shares**
Responses by international investment positions (IIP)

Low IIP countries

High IIP countries

Response, log points

Response period, quarters

High trade shares

Low trade shares

High IIP countries

Response, log points

Response period, quarters
Trade openness versus financial openness

Output response, log points

Trade openness (orthogonalized), standard deviations from the mean

Output response, log points

Financial openness (orthogonalized), standard deviations from the mean
Estimating network spillovers

Specification:

\[ y_t = \beta r_t + \rho W y_t + \text{Controls} + \text{Error} \]

Total effects:

\[
\frac{\partial y_t}{\partial r_t} = (I - \rho W)^{-1} \times \beta \\
\equiv J
\]

Decomposition:

\[
\frac{\partial y_t}{\partial r_t}^{\text{direct}} = \text{diag}(J) \times \beta \\
\frac{\partial y_t}{\partial r_t}^{\text{indirect}} = (J - \text{diag}(J)) \times \beta
\]
Example (country 1 perspective)

\[
\frac{\partial y_{1,t}}{\partial r_t} = \beta_2 \times (\rho w_{1,2} + \rho^2 w_{1,3}w_{3,2}) \times |J| + \beta_3 \times (\rho w_{1,3} + \rho^2 w_{1,2}w_{2,3}) \times |J|
\]

\[+ \beta_1 \times (1 - \rho^2 w_{2,3}w_{3,2}) \times |J|\]

Indirect effect through \(y_2\)

Indirect effect through \(y_3\)

Direct effect
The size and the shading of the nodes correspond to the degree of network centrality, measured by the average share of a country in the total trade for every other country (column average). Weights are based on total trade as a share in GDP in 1995. Thicker and darker arrows represent larger weights. Only weights larger than 5% are shown.
The international spatial correlation of output growth is strong.

The scatterplots comprise 50 bins.
All variables in the right panel are orthogonal to country, time fixed effects and four lags of GDP growth.
The spatial correlation at the peak response horizon is 0.506 (standard error = 0.058).
Comparison of trade and financial linkages

Financial network

Trade network (constant sample)

The linkages are for the constant sample of 18 countries.
Financial linkages appear to be weaker than trade linkages, and the indirect effects are small.

<table>
<thead>
<tr>
<th></th>
<th>11 quarters</th>
<th>12 quarters</th>
<th>13 quarters</th>
<th>14 quarters</th>
<th>15 quarters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>Spatial lag, $\rho$</td>
<td>0.230</td>
<td>0.193</td>
<td>0.196</td>
<td>0.153</td>
<td>0.076</td>
</tr>
<tr>
<td></td>
<td>(0.190)</td>
<td>(0.176)</td>
<td>(0.179)</td>
<td>(0.195)</td>
<td>(0.197)</td>
</tr>
<tr>
<td>Indirect effect</td>
<td>$-0.25$</td>
<td>$-0.23$</td>
<td>$-0.23$</td>
<td>0.03</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>(0.28)</td>
<td>(0.27)</td>
<td>(0.29)</td>
<td>(0.15)</td>
<td>(0.29)</td>
</tr>
<tr>
<td>% of total</td>
<td>23.6</td>
<td>19.7</td>
<td>19.9</td>
<td>13.3</td>
<td>7.3</td>
</tr>
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</table>

(a) Financial linkages

<table>
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<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>Spatial lag, $\rho$</td>
<td>0.371*</td>
<td>0.344</td>
<td>0.335**</td>
<td>0.336**</td>
<td>0.206*</td>
</tr>
<tr>
<td></td>
<td>(0.205)</td>
<td>(0.228)</td>
<td>(0.170)</td>
<td>(0.143)</td>
<td>(0.119)</td>
</tr>
<tr>
<td>Indirect effect</td>
<td>$-0.57$</td>
<td>$-0.60$</td>
<td>$-0.38$</td>
<td>0.23</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>(0.43)</td>
<td>(0.48)</td>
<td>(0.34)</td>
<td>(0.30)</td>
<td>(0.25)</td>
</tr>
<tr>
<td>% of total</td>
<td>39.8</td>
<td>35.9</td>
<td>34.7</td>
<td>31.4</td>
<td>20.3</td>
</tr>
</tbody>
</table>

(b) Trade linkages (constant sample)

The data are quarterly and cover 18 countries from 2005 through 2017.
Final remarks

Summary:
– U.S. monetary shocks have sizeable effects on output abroad.
– These effects are larger in countries relatively more open to trade.
– Bilateral trade linkages serve as an important propagation channel.
– The network amplification is quantitatively strong.

Implications:
– International spillovers and trade linkages may have a role in the optimal policy design.
– Open economy models that do not account for network effects are likely incomplete.