NBER Conference on Risks in Agricultural Supply Chains

Exchange Rate Volatility and Global Food Supply Chains

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Motivation

• Most countries moved to a floating or soft-pegged currency system since the collapse of the Bretton Woods system in the early 1970s (Clark et al., 2004 IMF)

• Higher volatility of foreign exchange associated with uncertainty regarding the terms of trade (McKenzie, 1999 JES)

• Implications for international trade poorly understood and literature is largely inconclusive (Auboin and Ruta, 2013 WTR)

• Theoretical literature ambiguous regarding the sign of the relationship:
  • Exchange rate uncertainty causes increase in revenue uncertainty which can hamper international trade (Ethier, 1973 AER; Demers, 1991 RES)
  • Arbitrage between spot and forward markets (Johnson, 1969 JSLR) and market power (Franke, 1991 JIMF) can lead to more international trade

1. Introduction

Exchange Rate Volatility and Global Food Supply Chains
• Substantial **uncertainty regarding the impact of exchange rate volatility** echoed in the empirical literature (Auboin and Ruta, 2013 WTR)

• Earlier studies provide evidence for an **adverse effect** of exchange rate volatility on manufacturing (Thursby and Thursby, 1987 RES; Koray and Lastrapes, 1989 RES; Rose, 2000 EP) and food trade (Pick, 1990 AJAE; Cho et al., 2002 AJAE; Kandilov, 2008 AJAE)

• Tenreyro (2007 JDE) challenged this view arguing that the negative and significant effect estimates are the result of **endogeneity and heteroskedasticity biases** → no significant relationship between short-run volatility and international trade

• Broda et al. (2011 NBER) argue that insignificant volatility estimates are due to **aggregation bias**
• Analyze the **impact of exchange rate volatility on international food trade** at the product level (781 products) using detailed retrospective trade and exchange rate data for 159 countries over the period from 2001 to 2017

• Use sectoral gravity-type regression specification to measure the impact of **short-run** and **long-run exchange rate volatility**

• Investigate differences according to supply chain position and industry/product characteristics

• Find **some evidence** for association between exchange rate volatility and food trade according to **supply chain position** and **strong evidence** for differences according to **industry/product characteristics**
Identification strategy

• Exploit variation in global food trade between countries at the product level and over time with the following product-specific gravity model:

\[ X_{ij,t}^s = \exp(e_{i,t}^s + m_{j,t}^s + t_{ij}^s - \theta \log \tau_{ij,t}^s) \eta_{ij,t} \] (1)

• \( X_{ij,t}^s \) is bilateral export flows of product \( s \) from country \( i \) to country \( j \) in year \( t \)
  
  – Time-variant multilateral resistance terms for exporters are denoted by \( e_{i,t}^s \) and for importers by \( m_{j,t}^s \), while country-pair fixed effects are denoted by \( t_{ij}^s \)
  
  – Trade cost function denoted by \( \tau_{ij,t}^s \) (symmetric and of the iceberg form) includes measures of exchange rate volatility and common gravity-type control variables
  
  – Used Poisson PML with multiple high-dimensional fixed effects (Silva and Tenreyro, 2007 RES; Correia et al., 2020 SJ) and clustering at product-country-pair level (Cameron and Trivedi, 2015 JHR)
How to measure exchange rate volatility?

- **Nominal exchange rate volatility** ($\delta_{ij,t}$) defined by the standard deviation ($\sigma$) of the first difference of the logarithmized bilateral exchange rate ($e_{ij,k}$) as follows:

  \[
  \delta_{ij,t} = \sigma \left[ \ln(e_{ij,k}) - \ln(e_{ij,k-1}) \right]
  \]  

- Used **daily exchange rate data** for 18,632 currency pairs and 21 years from Refinitiv Financial Solutions (2019)

- Calculated **daily** and **end-month exchange rate** measures

- Measured **short-run volatility** $\alpha^S_\delta$ based on preceding year (Tenreyro, 2007 JDE) and **long-run volatility** $\alpha^L_\delta$ based on the five preceding years (Rose, 2000 EP)
Does the temporal resolution of the exchange rate data matters?

![Exchange rate (USD/CAD) from Dec 2009 to Dec 2010]

2. Methods
### Summary of regression results

<table>
<thead>
<tr>
<th></th>
<th>Agriculture and food</th>
<th>All other products</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\alpha^S_\delta$</td>
<td>$\alpha^L_\delta$</td>
</tr>
<tr>
<td>Positive estimates</td>
<td>51.54</td>
<td>51.50</td>
</tr>
<tr>
<td></td>
<td>52.27</td>
<td>53.89</td>
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<tr>
<td>Negative estimates</td>
<td>48.46</td>
<td>48.50</td>
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<tr>
<td></td>
<td>47.73</td>
<td>46.11</td>
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</tbody>
</table>

**Panel A: Sign of parameter estimates**

**Panel B: Significance of parameter estimates**

<table>
<thead>
<tr>
<th></th>
<th>$\alpha^S_\delta$</th>
<th>$\alpha^L_\delta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant at 1% level</td>
<td>15.90</td>
<td>12.83</td>
</tr>
<tr>
<td></td>
<td>13.33</td>
<td>14.34</td>
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<tr>
<td>Significant at 5% level</td>
<td>24.87</td>
<td>24.12</td>
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<tr>
<td></td>
<td>29.60</td>
<td>26.86</td>
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<tr>
<td>Significant at 10% level</td>
<td>34.36</td>
<td>33.25</td>
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<tr>
<td></td>
<td>37.87</td>
<td>35.52</td>
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</tbody>
</table>

**Panel C: Magnitude of parameter estimates**

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<table>
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</thead>
<tbody>
<tr>
<td>Mean estimate</td>
<td>0.008</td>
<td>0.115</td>
<td>0.002</td>
<td>−0.068</td>
</tr>
<tr>
<td>Median estimate</td>
<td>−0.050</td>
<td>−0.105</td>
<td>−0.033</td>
<td>−0.167</td>
</tr>
<tr>
<td>25% percentile estimate</td>
<td>−0.800</td>
<td>−1.554</td>
<td>−0.659</td>
<td>−1.343</td>
</tr>
<tr>
<td>75% percentile estimate</td>
<td>0.767</td>
<td>1.631</td>
<td>0.623</td>
<td>1.147</td>
</tr>
</tbody>
</table>

*Note: Panels A and B based on all parameter estimates and Panel C on statistically significant estimates.*
Trade effects of exchange rate volatility

(a) Short-run volatility
(b) Long-run volatility

*Note: Product-level trade effects are calculated by the formula $\beta^* = \frac{sd_x}{sd_y} \times \hat{\beta}$ based on statistically significant estimates.
Global value chain integration implies that exchange rate movements among upstream suppliers and downstream buyers can affect a country’s trade flows through **backward and forward linkages** (Amiti et al., 2014 AER).

Upstream (backward) global value chain integration can lower the sensitivity of export flows to exchange rate movements because it causes trade and marginal costs to move in parallel (Gopinath et al., 2020 AER).

- Upstreamness measured according to Antrás et al. (2012 AER) as distance between production stage and final demand
- Downstreamness defined as average position in the value chain at which an industry’s output is used (Antrás and Chor, 2013 ECTA)

Used crosswalk between NAICS and HS-6 level to classify trade products according to the supply chain position.
Upstreamness and trade effects of exchange rate volatility

(a) Short-run volatility

(b) Long-run volatility

*Note: Cubic spline interpolation indicated with dashed lines.*
Downstreamness and trade effects of exchange rate volatility

(a) Short-run volatility

(b) Long-run volatility
Product heterogeneity

(a) Average trade effects
(b) Export-weighted trade effects

*Note: Trade products categorized according to Rauch (1999 JIE) and Regmi et al. (2015 ERS).
Exchange rate volatility and product characteristics

- Exchange rate volatility positively associated with **product price** (Campa and Goldberg, 2005 RES)
  - Use average export price to compare trade effects

- Exported products differ in **technological sophistication** (Hidalgo et al., 2007 Science)
  - Sophisticated products less prone to trade shocks (Weldemicael, 2013 WE)
  - Quantify the productivity level by weighted average of the per capita GDPs of countries exporting a given product (Hausmann et al., 2007 JEG)

- **Product complexity** correlates with income inequality which in turn is strongly associated with **exchange rate volatility** (Galí & Monacelli, 2005 RES)
  - Measure the relative knowledge intensity of a product (Hartmann et al., 2017 WD)
Price effect

(a) Short-run volatility

(b) Long-run volatility
Product sophistication

(a) Short-run volatility

(b) Long-run volatility
5. Product heterogeneity

5.1 Exchange Rate Volatility and Global Food Supply Chains

Product complexity

(a) Short-run volatility

(b) Long-run volatility
Model specification

(a) Short-run volatility

(b) Long-run volatility
Comparison of trade effects for daily and end-month volatility measures

(a) Agricultural and food products
(b) All other products
Economic development and trade effects

(a) Short-run volatility

(b) Long-run volatility
• Theoretical literature ambivalent regarding the sign and magnitude of the exchange rate volatility effect, while most empirical studies indicate a negative association.

• Study contributes by investigating the relationship at the product-level based on detailed retrospective trade and exchange rate data.

• **Limited evidence for a significant (and systematic) relationship** between exchange rate volatility and international food trade.

• Positive trade effects of exchange rate volatility for upstream but **no evidence for downstream products**.

• Endogeneity and aggregation bias drive earlier negative (and statistically significant) findings.