International Credit Supply Shocks

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*The views expressed in this paper do not necessarily reflect the position of the Bank of England.
Capital inflows associated with expansions and asset price booms, but not all countries affected equally.

Motivation 2
Countries differ in important dimensions, and the EMs vs. AEs divide may not be whole story

Mortgage Debt / GDP

Home Ownership

Share of foreign currency debt

Max Loan to Value (LTV)
This paper

- Focuses on one particular shock: international credit supply
  - A push shock that is expansionary, both in our model and in the data

- Theory: sets up a open economy model with housing and collateralized borrowing in foreign or domestic currency and international financial intermediation
  - International credit supply shock brought about by changes in leverage constraint of global banks
  - Possible amplification role for both house prices and exchange rates

- Empirics: quarterly panel VAR model for more than 50 countries
  - Shock identified with changes in leverage of US broker-dealers
  - Study trasmission and relative importance of this shock for the typical economy
  - Investigate differences in country countries’ responses relative to characteristics we can pin in both the model and the data
Main Results

▶ Model:
  • International credit supply shock is expansionary
  • Real exchange rate appreciate
  • If constraint binds, house prices increase (and yields decline) and amplify initial shock
  • Transmission stronger the higher the LTV ratio and the share of FX liabilities

▶ PVAR:
  • Shock is expansionary like in the model, and has sizable impact on the typical economy
  • Shock explains a significant fraction of macroeconomic and asset price variance
  • Heterogeneity associated with share of foreign currency liabilities and characteristics of the housing market

▶ Important implication: LTV ratios and FX shares, which are related to macro-prudential policy, are linked to final outcomes
Related Literature

- Global financial cycle and drivers of leverage:

- House prices and capital flows into the United States
  - Aizenman and Jinjarak (2009); Gete (2009); Bernanke (2010); Justiniano, Primiceri and Tambalotti (2014); Favilukis, Ludvigson and Van Nieuwerburgh (2017); Ferrero (2015).

- Sensitivity of consumption to asset price and credit shocks
  - Jappelli and Pagano (1989); Almeida, Campello, and Liu (2006); Calza, Monacelli, and Stracca (2014); Berger, Guerrieri, Lorenzoni, and Vavra (2016); Mian, Sufi, and Verner (2016).
Outline

- Model
- Empirics
- Conclusions
Model
Overview of the Model

- Two-period, two-country, two-good endowment economy with no uncertainty

- Impatient Home households \((i \in [0, n])\)
  - Borrow (in domestic or foreign currency) to finance housing and non-housing consumption, subject to collateral constraint

- Patient Foreign households \((i \in (n, 1])\)
  - Save via deposits and equity in financial intermediaries

- Global financial intermediaries
  - Channel funds from lenders to borrowers
  - Fixed fraction of lending denominated in local currency
  - Subject to leverage constraint (capital requirement)
Households

- Home country (starts with zero initial credit)

\[
\max_{\{c_1, c_2, h_1, f\}} u(c_1) + \beta u(c_2) + v(h_1)
\]

with \( \beta \in (0, 1) \) and \( h_0 \) given, subject to

\[
c_1 + qh_1 = p_{H1}y + qh_0 + b + s_1f
\]
\[
c_2 = p_{H2}y - R^b b - s_2Rf
\]

where

\[
c_t \equiv \frac{c_{Ht}^{\alpha} c_{Ft}^{1-\alpha}}{\alpha^\alpha (1 - \alpha)^{1-\alpha}}
\]

- Collateral constraint

\[
b + s_1f \leq \theta qh_1
\]
Households

- Foreign country \( (1 > \beta^* > \beta) \)

\[
\max_{\{c_1^*, c_2^*, d, e\}} u(c_1^*) + \beta^* u(c_2^*)
\]

subject to

\[
c_1^* + d + e + \psi(e) = p_{F1}^* y^*
\]

\[
c_2^* = p_{F2}^* y^* + R^d d + R^e e + \Pi
\]

with \( \psi' \), \( \psi'' > 0 \), and

\[
c^* = \frac{c_H^* c_F^* 1 - \alpha^*}{\alpha^* \alpha^* (1 - \alpha^*)^{1 - \alpha^*}}
\]
Global Financial Intermediaries

- **Balance sheet**

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
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<tr>
<td>Loans in Home currency ( \frac{b}{s_1} )</td>
<td>Deposits</td>
</tr>
<tr>
<td>Loans in Foreign currency ( f )</td>
<td>Equity</td>
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</table>

- **Profits**

\[ \Pi = Rf + \frac{R^b b}{s_2} - R^d d - R^e e - \phi \left( \frac{b}{s_1} \right) \]

where \( \phi(\cdot) \) is cost of swapping loans in Foreign currency (with \( \phi', \phi'' > 0 \))

- **Leverage constraint** (capital requirement)

\[ e \geq \chi \left( \frac{b}{s_1} + f \right) \]
Equilibrium: Analytical Characterization

- Assume $\alpha = 1 - (1 - \lambda)n$ and $\alpha^* = n\lambda$
  - $\lambda \in (0, 1)$ measures degree of openness
  - Take limit for $n \to 0 \Rightarrow$ Home becomes small open economy

- Abstract from intermediaries portfolio problem
  - Define $\eta \equiv b/(s_1f) \Rightarrow 1 + \eta =$ Inverse share of foreign currency liabilities
  - Take $\eta$ as parameter

- All households are risk-neutral and housing (land) is in fixed supply
  - $u'(c) = \bar{c} > 0$ and $h_0 = h_1 = 1$

- Then, we can solve analytically for
  - Terms of trade from goods market equilibrium ($\Rightarrow$ Real exchange rate)
  - Credit demand and credit supply
Summary of Equilibrium Conditions

▶ Credit Supply

\[
R = \frac{1 + \chi \psi' [\chi (1 + \eta)f]}{\beta^*} + \frac{\eta \phi' (\eta f)}{1 + \eta}
\]

▶ Credit Demand

\[
R = \begin{cases} 
\frac{1}{\beta} \frac{s_1}{s_2} & \text{if } s_1 (1 + \eta)f < \theta q \\
\frac{1}{\beta} \frac{s_1}{s_2} \left[ \frac{\kappa}{s_1(1 + \eta)f} - \frac{1 - \theta}{\theta} \right] & \text{if } s_1 (1 + \eta)f = \theta q
\end{cases}
\]

▶ Real Exchange Rate

\[
s_1 = \left[ \frac{\lambda y}{\lambda y^* + (1 - \lambda)(1 + \eta)f} \right]^{1-\lambda} \quad s_2 = \left[ \frac{\lambda y}{\lambda y^* - (1 - \lambda)R(1 + \eta)f} \right]^{1-\lambda}
\]
Parameters

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<th>Parameter</th>
<th>Description</th>
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<td>Country F discount factor</td>
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<td>$\kappa$</td>
<td>Normalized marginal utility of housing</td>
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<td>$\lambda$</td>
<td>Degree of openness</td>
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<td>LTV ratio</td>
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<td>Share of foreign debt</td>
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<td>$\chi$</td>
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<td>$y = y^*$</td>
<td>Endowments</td>
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- Pick adjustment cost parameters to target
  - Interest rate on credit
  - Equity premium
Credit Market Equilibrium

![Credit Market Equilibrium Diagram](image)

The diagram illustrates the credit market equilibrium, where the demand and supply curves intersect at point A. The graph shows the relationship between the lending rate (R) and the credit (f). The demand curve is represented by a solid blue line, and the supply curve is shown with a dotted purple line. The equilibrium is marked by the point where the two curves meet, indicating the balance between credit supply and demand at a specific rate and credit level.
We assume economy is constrained at point B.
International credit supply shock in the model (χ ↓):

(a) Lending Rate
(b) Exch. Rate
(c) House Price
(d) Consumption

Model 18
International credit supply shock in the Model:

- In response to reduction of equity requirement on global banks ($\chi \downarrow$)
  - Home country experiences credit inflow and lending rate declines ($f \uparrow$, $R \downarrow$)
  - Real exchange rate appreciates ($s_1 \downarrow$)
  - House prices increase (if borrowing constraint is binding) ($q \uparrow$)
  - Consumptions expands ($c_1 \uparrow$)

- Role of asset prices
  - **Collateral valuation effect:** With binding borrowing constraint, higher house prices (and appreciated real exchange rate) amplify boom
  - **Endowment valuation effect:** Home agents’ endowment worth more because of real exchange rate appreciation
  - **Debt valuation effect:** Home agents’ borrowing in foreign currency worth less because of real exchange rate appreciation
Empirics
PVAR Model

Objective: Study transmission, relative importance and differential incidence of international credit supply

VAR for country $i$ is

$$X_{it} = a_i + b_it + c_it^2 + F_{1i}X_{i,t-1} + u_{it},$$

where

$$X_{it} = \begin{bmatrix} LEV_t & KF_{it} & C_{it} & HP_{it} & RER_{it} & CA_{it}/Y_{it} \end{bmatrix}$$

All variables are in real terms and in levels

Variables and Data

- Macro variables: private consumption and current account to GDP
- Asset prices: rouse prices and real exchange rate vis-a-vis the US dollar
  - Sample: 57 countries with quarterly house price series between 1977 and 2012 (Source Cesa-Bianchi, Cespedes, and Rebucci, 2015)

- International credit: total claims (all instruments, to financial and non-financial sectors) of BIS reporting banks on country \( i \)

\[
K_{F_{it}} = \sum_{j=1(j\neq i)}^{N} K_{F_{ij,t}}
\]

- \( L E V_{t} \) is leverage of US broker-dealers from the flows of funds
  - Shock to \( L E V_{t} \) $\equiv$ International credit supply shock

Data Sources
Important role of banks in international financial intermediation in the run up to the global financial crisis

### Determinants of Leverage

\[ LEV_t = \alpha + \beta x_t + \varepsilon_t \]

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<th>( u_t^{UI} )</th>
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Identification of push shock that shifts international supply of credit in the data

1. We use shocks to \( LEV_t \)

2. Changes in \( LEV_t \) shift global supply of cross-border bank credit
   - Bruno and Shin (2014)
   - Consistent with shock to \( \chi \) in our theoretical model

3. Arguably exogenous to conditions in individual country \( i \)
   - Not driven by country-specific “pull” factors
   - Drop US from our sample

4. Is endogenous to global conditions and we can control for that \( i \)

5. Implementation with country by country Choleski decomposition and \( LEV_t \) order first (robust to using \( LEV_t \) as instrument)
Transmission consistent with model and the stylized facts of boom bust in capital flows

- Leverage
- Cross-border Credit
- Consumption
- House Price
- Real Exch. Rate
- Current Account

Empirics 26
The shock explains fraction of variance larger than a US monetary policy shock

Empirics 27
Robustness to controlling for global factors in $LEV$

- Small open economy assumption rules out local factors can drive $LEV_t$
  - No single country can affect leverage of global banks

- But $LEV_t$ could be affected by globally synchronized factors

- Synchronized shocks should affect world GDP
  - Augment vector of endogenous variables with world GDP

$$X_{it} = \begin{bmatrix} Y_t \quad LEV_t \quad KF_{it} \quad C_{it} \quad HP_{it} \quad RER_{it} \quad CA_{it}/Y_{it} \end{bmatrix}$$

- Shock to leverage of US broker-dealers still identified with Choleski
IRFs to Leverage Shock (Robustness)

- Leverage
- Cross-border Credit
- Consumption
- House Price
- Real Exch. Rate
- Current Account

Empirics 29
Variance Decomposition (Robustness)

Leverage

Cross-border Credit

Consumption

House Price

Real Exch. Rate

Current Account

Quarters

Percent

Empirics 30
Understanding Cross-Country Heterogeneity

▶ Conjecture: Country responses depend on
- Share foreign currency liabilities \(1/(1 + \eta)\)
- Maximum LTV limit \(\theta\)

▶ Derive sensitivity of response of endogenous variable to \(\eta\) and \(\theta\)

\[
\frac{\partial^2 x}{\partial \chi \partial \eta} \quad \text{and} \quad \frac{\partial^2 x}{\partial \chi \partial \theta}
\]

for \(x = \{c_1, q, s_1\}\)

▶ Compare theoretical predictions with data
- Scatter plot of peak IRFs of \(C_i, HP_i,\) and \(RER_i\) to \(e_i^{LEV}\) vs. \(\theta_i\) and \(\eta_i\) in the data
LTV Ratios

Prediction 1: A larger LTV ratio (higher $\theta$) implies a higher sensitivity of $C_i$, $HP_i$, and $RER_i$ to shocks to $\chi$

- If constraint binds, higher $\theta$ leads to higher house price response, and hence larger collateral effect and amplification
- Higher $\theta$ leads to higher credit and demand and hence larger real exchange rate response
Prediction 2: A larger share of foreign currency debt (lower $\eta$) may imply a higher sensitivity of $C_i$, $HP_i$, and $RER_i$ to shocks to $\chi$

- Lower $\eta$ implies larger collateral valuation and debt valuation effects
- If collateral effect dominates valuation effect, higher $\eta$ leads to higher credit and demand, and hence larger real exchange rate response, potentially amplifying the initial credit impulse
Conclusions

- International credit supply shock ⇒ Boom in receiving economy in the model and in the data

- Theory: Source and transmission of international credit supply shocks ⇒ Variations of capital requirements that shift credit supply outward
  - Credit expands, lending rates and housing yields decline, exchange rate appreciates and consumption increases
  - House prices and exchange rates can amplify initial impulse via collateral constraint
  - The more so the higher the max LTV and share of FX liabilities

- Empirics: Identified shock to US broker-dealers’ leverage
  - Increases cross-border credit and a domestic boom
  - Shock explains a significant share of variance
  - LTV ratios and FX shares associated with peak responses of consumption, house prices and exchange rates
  - Macro-prudential policy could target them
Appendix
Data Sources: Countries

- **24 Advanced Economies**: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, UK, and US

- **33 Emerging Economies**: Argentina, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Czech Republic, Estonia, Hong Kong, Hungary, India, Indonesia, Israel, Korea, Latvia, Lithuania, Malaysia, Mexico, Morocco, Peru, Philippines, Poland, Russia, Serbia, Singapore, Slovakia, Slovenia, South Africa, Taiwan, Thailand, Ukraine, and Uruguay

- Sample: 1970:Q1–2012:Q4 (subject to data availability)
Data Sources: Quantities

- **Cross-border banking flows.** Foreign claims (all instruments, in all currencies, locational by residence) of all BIS reporting banks vis-à-vis all sectors deflated by US consumer price inflation. Source: BIS.

- **GDP.** Real index. Source: OECD, IMF IFS, Bloomberg.

- **Consumption.** Real private final consumption index. Source: OECD, IMF, IFS, Bloomberg.

- **Current account to GDP ratio.** Current account balance divided by nominal GDP. Source: OECD, IMF IFS, Bloomberg.
Data Sources: Prices

- **House prices.** Nominal house prices deflated by consumer price inflation. Source: Cesa-Bianchi et al (2015, JMCB)

- **Short-term interest rates.** Short-term nominal market rates. A real ex-post interest rate is obtained by subtracting consumer price inflation. Source: OECD, IMF, IFS, Bloomberg.

- **Consumer prices.** Consumer price index. Source: OECD, IMF IFS, Bloomberg.

- **Equity prices.** Equity price index deflated by consumer price inflation. Source: OECD, IMF IFS, Bloomberg.

- **Exchange rate vis-à-vis US dollar.** US dollars per unit of domestic currency. A real exchange rate is obtained with US and domestic consumer price inflation. Source: Datastream.

- **Real effective exchange rate.** Index (such that a decline of the index is a depreciation). Source: IMF IFS, BIS, Bloomberg.
Cross-Border Credit: Banks vs. Non-Banks

US Dollars (Trillions)

- Banks
- Non-banks
- Total

Boom-Bust Cycles in Cross-Border Credit

- Event study (Mendoza and Terrones, 2008):
  - Boom (Bust) = At least 3 consecutive years of $\Delta \ln KF_{it} > 0$ ($< 0$)
  - 134 boom, 81 bust, and 50 boom-bust episodes
  - Observe economy’s behavior around boom-bust cycles’ peak
Boom-Bust Cycles in Cross-Border Credit

- Cross-border Credit
- House Price
- Equity Price
- Real Eff. Exch. Rate
- Real Exch. Rate (USD)
- Current Account / GDP
- GDP
- Consumption
- Real Short-term Int. Rate

Mean
Median
### Event Study: Summary Statistics

#### Mean Across Episodes

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#### Median Across Episodes

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</tbody>
</table>

**Note:** *Number* is number of episodes; *Duration* is length of episodes in years; *Max* and *Min* are maximum and minimum growth rate of cross-border credit during episode, respectively; *Amplitude* is cumulative sum of growth rate of cross-border credit over episode.
Source: US Flow of Funds
Alternative Identification

- Block exogenous VAR (abstracting from constant and time trend)

\[
\begin{bmatrix}
    LEV_t \\
    x_{i,t}
\end{bmatrix}
= 
\begin{bmatrix}
    F_{11,i} & 0 \\
    F_{21,i} & F_{22,i}
\end{bmatrix}
\begin{bmatrix}
    LEV_{t-1} \\
    x_{i,t-1}
\end{bmatrix}
+ 
\begin{bmatrix}
    B_{11,i} & 0 \\
    B_{21,i} & B_{22,i}
\end{bmatrix}
\begin{bmatrix}
    e_t^{LEV} \\
    e_{i,t}^x
\end{bmatrix}
\]

- Can still achieve identification with Choleski decomposition

- Robustness
  - “Clean” leverage of variation due to world GDP

\[
LEV_t = F_{11}LEV_{t-1} + \beta GDP_t^w + u_t^{LEV}
\]

\[
x_{i,t} = F_{21,i}LEV_{t-1} + F_{22,i}x_{i,t-1} + u_{i,t}^x
\]
Alternative Identification: IRFs to Leverage Shock

- **Leverage**
- **Cross-border Credit**
- **Consumption**
- **House Price**
- **Real Exch. Rate**
- **Current Account**
Alternative Identification: Variance Decomposition

Leverage

Cross-border Credit

Consumption

House Price

Real Exch. Rate

Current Account

Appendix
Alternative Identification: Robustness

**Leverage**

**Cross-border Credit**

**Consumption**

**House Price**

**Real Exch. Rate**

**Current Account**
Alternative Identification: Robustness FEVD

Leverage

Cross-border Credit

Consumption

House Price

Real Exch. Rate

Current Account

Appendix