

# International Credit Supply Shocks

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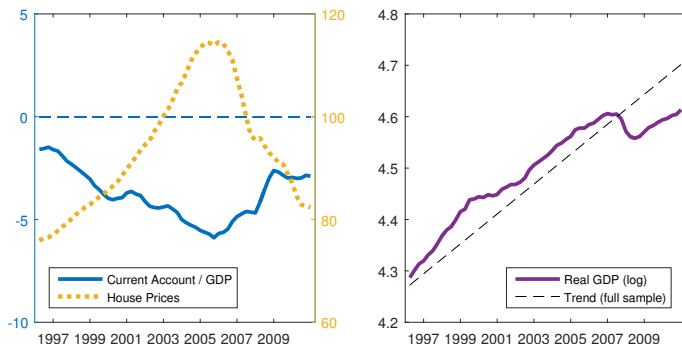
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# Motivation

- ▶ Capital inflows often associated with expansions and asset price booms...
  - “Global saving glut” and U.S. house price bubble (Bernanke, 2010)
  - But also in several other boom-bust episodes (Obstfeld and Rogoff, 2010)

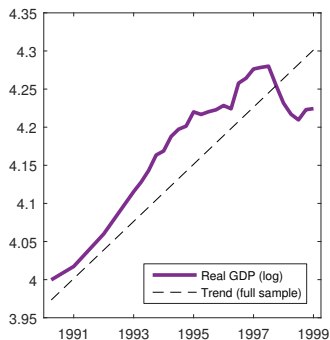
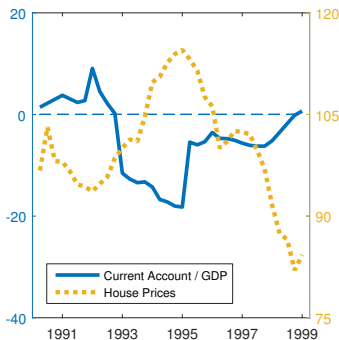
## United States



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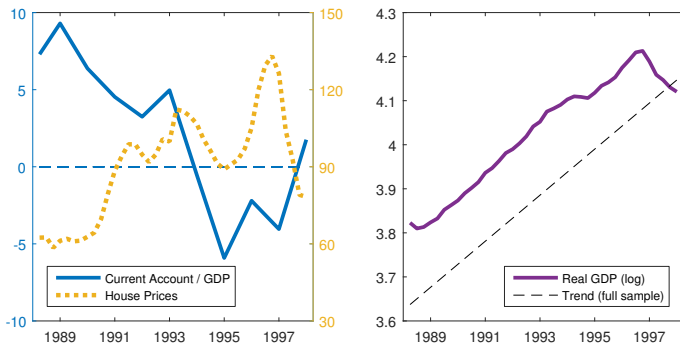
## Colombia



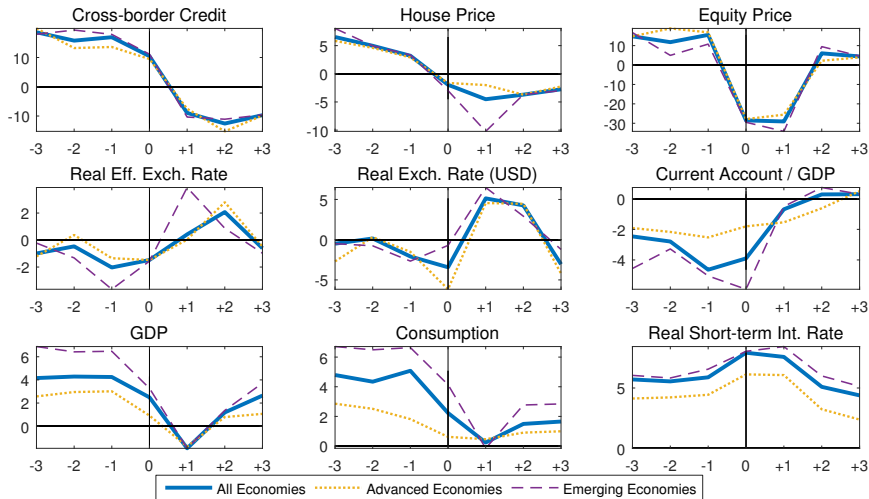
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## Hong Kong



# Event Study: Advanced vs. Emerging Economies



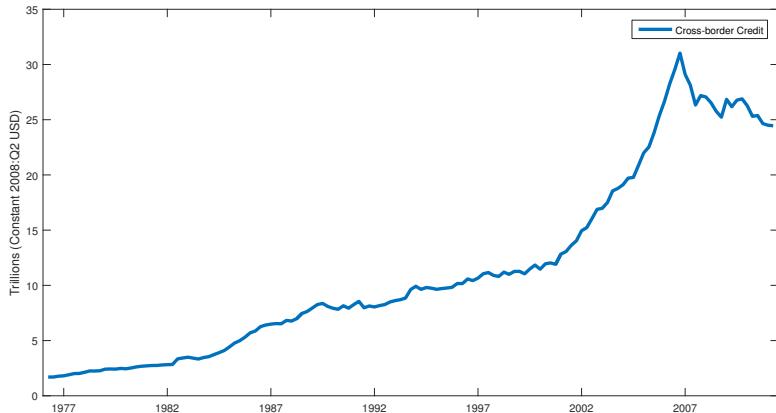
# Data

- ▶ Unbalanced panel of quarterly time series for 57 countries from 1970 to 2012
  - GDP ( $Y$ ), Consumption ( $C$ ), Short-term Real Rates (ex post) ( $RIR$ )
  - Equity Prices ( $EQ$ ), House Prices ( $HP$ ), Exchange Rates ( $RER$ )
  - Cross-border Credit ( $KF$ ), Current Account / GDP ( $CA/Y$ ) Data Sources
- ▶ All variables are in real terms (deflated with CPI) except  $CA/GDP$
- ▶ Cross-border Credit Data (BIS): foreign banks' claims to country  $i$  (banks + non-banks, all currencies)

$$KF_{it} = \sum_{j=1}^N KF_{ji}$$

# International Cross-Border Credit

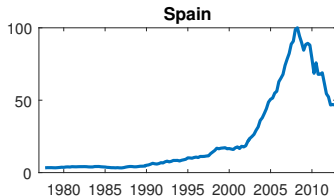
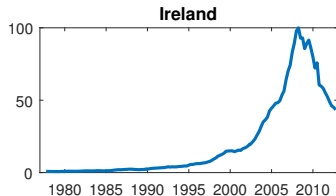
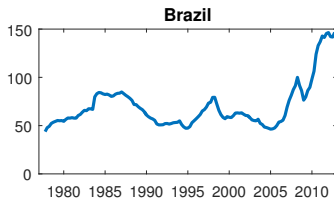
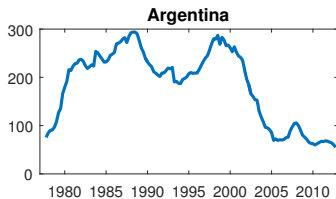
- ▶ Increasing role of banks in international financial transactions
  - Highly correlated with index of financial globalization (Kose et al., 2010)



NOTE. BIS Locational Banking Statistics.

# International Cross-Border Credit

► Four examples



NOTE. BIS Locational Banking Statistics.



# Boom-Bust Cycles in Cross-Border Credit

- ▶ Boom-bust identification procedure
  - Follow procedure in Mendoza and Terrones (2008)
  - Boom (Bust) = At least 3 consecutive years of  $\Delta \ln KF_{it} > 0$  ( $< 0$ )
- ▶ Episodes in our data set
  - 134 boom, 81 bust, and 50 boom-bust episodes
- ▶ Event study
  - Combine other series in the data set
  - Observe economy's behavior around boom-bust cycles' peak

# Summary Statistics of Boom-Bust Episodes

	Boom		Bust		Boom-bust	
	AE	EM	AE	EM	AE	EM
Number	2.00	2.00	1.00	2.00	1.00	1.00
Duration	8.58	6.33	3.00	4.50	13.00	11.50
Max	0.28	0.33	-0.03	-0.04	0.28	0.32
Min	0.03	0.06	-0.15	-0.19	-0.16	-0.24
Amplitude	1.21	1.25	-0.32	-0.52	1.06	0.56

# Event Study: Takeaways

- ▶ Increase of cross-country credit leads to boom of receiving economy
  - Quantities (GDP and consumption) increase
  - Asset prices (house prices and equity prices) soar
  - Real exchange rate appreciates
  - Current account deteriorates
- ▶ Dynamics possibly even more pronounced in reverse and in EMs
  - Consistent with sudden stop literature (Mendoza, 2010)
- ▶ **Next** Develop a model to understand nature of push shocks and their transmission

# Questions & What We Do

## ▶ Questions

- What are the specific mechanisms through which capital inflows lead to macroeconomic booms in the receiving economies?
- And what are the country characteristics that are associated with country differences in vulnerability?

## ▶ Traditionally, push-pull factor analysis of capital flows and their impact

## ▶ This paper

- Focus on one particular type of “push” shock, an **international credit supply shock**
- Consider house prices (i.e., a key domestic currency asset price) and their interaction with exchange rates
- Explore the interaction between asset price inflation, mortgage market characteristics, and the currency denomination of foreign financing

# Approach

- ▶ Event study
  - Document stylized facts around boom-bust episodes in capital flows
- ▶ Theoretical model
  - Build an open economy model with housing as collateral for foreign borrowing and leverage constrained global banks
  - International credit supply shock is triggered by an increase in global banks' leverage
- ▶ Panel VAR
  - Identify a 'push' shock in line with theoretical model and estimate its impact on a large number of countries
- ▶ Cross-country Analysis
  - Investigate the factors associated with the heterogeneous response across countries to identified push shock

# Preview of Results

## ▶ Event study

- During international credit booms asset prices appreciate, current account deteriorates, domestic economy expands
- Boom dynamics similar to bust (latter more pronounced)

## ▶ Theoretical model

- Increase in financial intermediaries' leverage leads to a boom in cross-border lending, consumption, and asset prices
- Amplification via valuation effects due to house prices and exchange rates

# Preview of Results (cont'd)

## ▶ Panel VAR

- Transmission of identified push shock is consistent with unconditional evidence and theoretical model
- Shock explains a non-trivial share of the variance of domestic variables

## ▶ Cross-country Analysis

- Impact of push shock is stronger in economies with
  - ▶ Large share of liabilities denominated in foreign currency
  - ▶ High maximum loan-to-value (LTV) ratios
- Cross-country dimension of transmission is also consistent with theoretical model

# Selected Related Literature

- ▶ Global financial cycle
  - Cetorelli and Goldberg (2011, 2012), Rey (2013, 2016), Bruno and Shin (2015), Miranda-Agrippino and Rey (2016), Dedola, Rivolta, and Stracca (2015), Gabaix and Maggiori (2015), Forbes, Reinhart, and Wieladek (2016), Aoki, Benigno, and Kiyotaki (2016)
- ▶ Sensitivity of macro variables to asset prices and credit shocks
  - Jappelli and Pagano (1989), Almeida, Campello, and Liu (2006), Boz and Mendoza (2014), Calza, Monacelli, and Stracca (2014), Berger, Guerrieri, Lorenzoni, and Vavra (2016), Mian, Sufi, and Verner (2016)
- ▶ Capital flows, house prices, and exchange rates
  - Aizenman and Jinjark (2009), Gete (2009), Bernanke (2010), Justiniano, Primiceri and Tambalotti (2014), Cesa-Bianchi, Cespedes, and Rebucci (2015), Ferrero (2015), Favilukis, Ludvigson and Van Nieuwerburgh (2017)



# Outline

1. Data and stylized facts
2. **Model of international financial intermediation with credit frictions**
3. Macroeconomic impact of international credit supply shocks
4. Inspecting heterogeneity of transmission mechanism

# Interpreting the Evidence

- ▶ Build on Justiniano, Primiceri and Tambalotti (2014)
  - Endowment economy with no uncertainty (two-period, two-country, two-good)
- ▶ Impatient Home households ( $i \in [0, n]$ )
  - Want to buy housing, subject to collateral constraint
- ▶ Patient Foreign households ( $i \in (n, 1]$ )
  - Save via deposits and equity in financial intermediaries
- ▶ Global financial intermediaries
  - Channel funds internationally from lenders to borrowers
  - Fraction of lending denominated in local currency
  - Subject to leverage constraint (capital requirement)

# Households (Home)

- ▶ 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

$$\begin{aligned}c_1 + qh_1 - b - s_1f &= p_{H1}y + qh_0 \\c_2 &= p_{H2}y - R^b b - s_2Rf\end{aligned}$$

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)

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

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

subject to

$$\begin{aligned}c_1^* + d + e + \psi(e) &= p_{F1}^* y^* \\c_2^* &= p_{F2}^* y^* + R^d d + R^e e + \Pi\end{aligned}$$

with  $\psi', \psi'' > 0$ , and

$$c^* = \frac{c_H^{*\alpha^*} c_F^{*1-\alpha^*}}{\alpha^{*\alpha^*} (1 - \alpha^*)^{1-\alpha^*}}$$

# Global Financial Intermediaries

- ▶ Balance sheet

Assets		Liabilities	
Loans in H currency	$b/s_1$	Deposits	$d$
Loans in F currency	$f$	Equity	$e$

- ▶ 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  $n \rightarrow 0 \Rightarrow$  Home becomes small open economy
- ▶ Abstract from intermediaries portfolio problem
  - Define  $\eta \equiv b/(s_1 f) \Rightarrow 1 + \eta =$  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

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

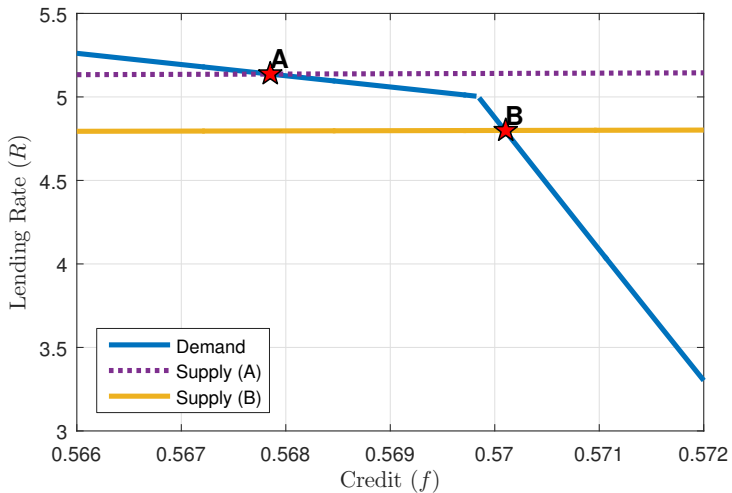
# Parameters

Parameter	Description	Value
$\beta$	Country H discount factor	0.9
$\beta^*$	Country F discount factor	0.99
$\kappa$	Normalized marginal utility of housing	0.85
$\lambda$	Degree of openness	0.79
$\theta$	LTV ratio	0.92
$\eta$	Share of foreign debt	0.43
$\chi$	Capital requirement	0.1
$y = y^*$	Endowments	1

- ▶ Pick adjustment cost parameters to target
  - Interest rate on credit
  - Equity premium



# Equilibrium: Graphical Analysis

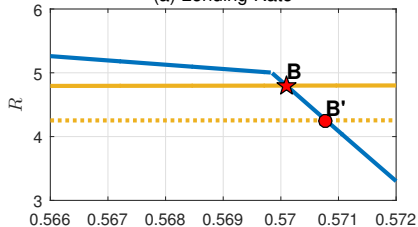


# Credit Supply Shock ( $\chi \downarrow$ )

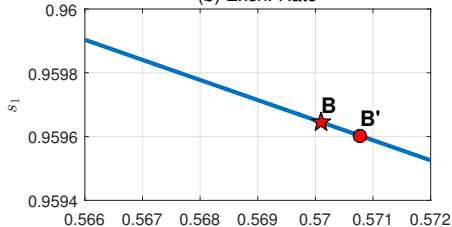
- ▶ International credit supply shock
  - Reduction of equity requirement for global banks ( $\chi \downarrow$ )
- ▶ A push shock from Home country's perspective
- ▶ Do not take a stand on (several) possible drivers
  - Financial innovation/deregulation
  - Monetary policy
  - Risk appetite
  - ...

# Credit Supply Shock ( $\chi \downarrow$ )

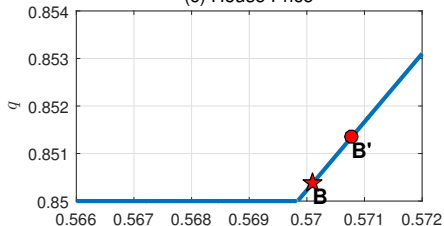
(a) Lending Rate



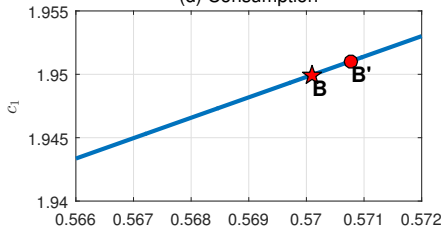
(b) Exch. Rate



(c) House Price



(d) Consumption



# Credit Supply Shock: Summary

- ▶ In response to reduction of equity requirement on global banks ( $\chi \downarrow$ )
  - Home country experiences credit inflow ( $f \uparrow$ )
  - Lending rate falls and consumption increases ( $R \downarrow, c_1 \uparrow$ )
  - Real exchange rate appreciates ( $s_1 \downarrow$ )
  - House prices increase (in region where borrowing constraint is binding) ( $q \uparrow$ )
  
- ▶ 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

# Outline

1. Data and stylized facts
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# International Credit Supply Shock

- ▶ **Objective** Identify push shock that shifts international supply of credit
- ▶ Panel VAR approach: VAR for country  $i$  is

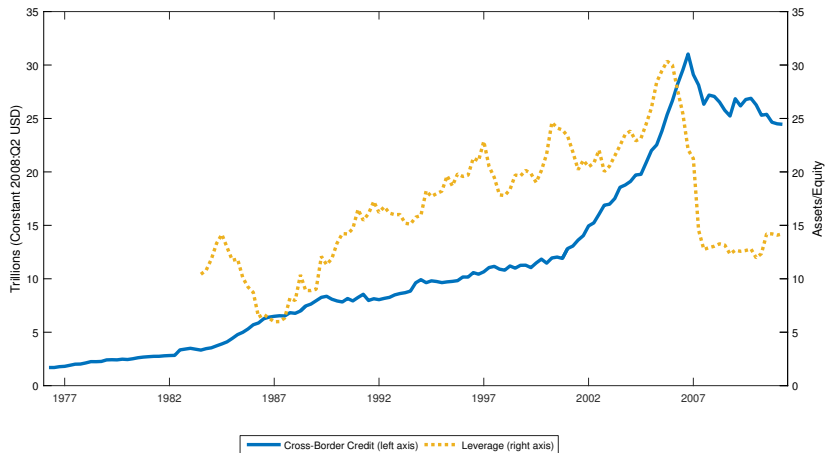
$$X_{it} = a_i + b_i t + c_i t^2 + F_{1i} X_{i,t-1} + u_{it},$$

where

$$X_{it} = [ \text{LEV}_t \quad KF_{it} \quad C_{it} \quad HP_{it} \quad RER_{it} \quad CA_{it}/Y_{it} ]$$

- ▶  $\text{LEV}_t \equiv$  Leverage of US broker-dealers (source: Flow of Funds)
  - Shock to  $\text{LEV}_t =$  International credit supply shock

# US Broker-Dealers Leverage



NOTE. Source: US Flow of Funds.

# Identification

- ▶ Why US broker-dealers leverage as proxy for international credit supply shocks?

## 1. Changes in $LEV_t$ shift the global supply of cross-border bank credit

- Consistent with shock to  $\chi$  in theoretical model
- Bruno and Shin (2014)

## 2. Exogenous to individual country $i$

- Not driven by country-specific “pull” factors
- Drop US from sample

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

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

Alternative Identification

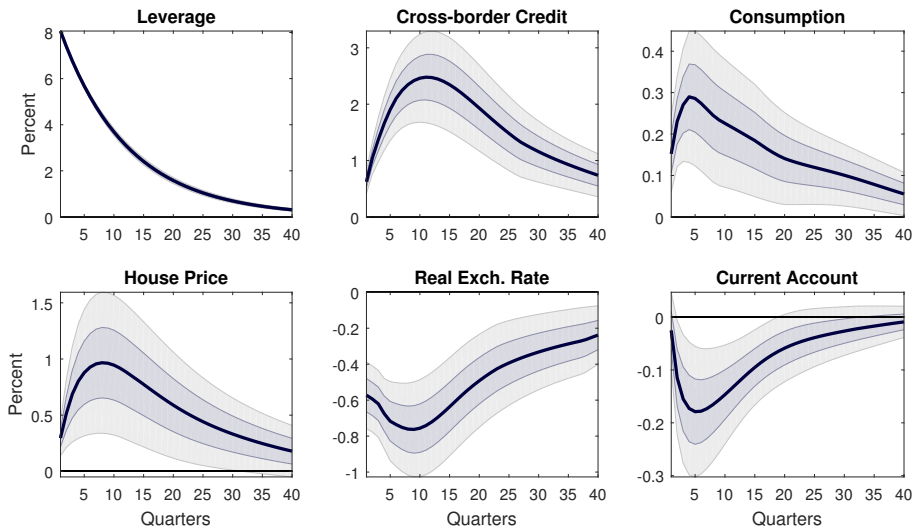


# Estimation

- ▶ Relative to event study
  - Sample is shorter (1985q1-2012q4) for stability concerns
  - Sample is smaller (48 countries)
    - ▶ Drop four countries because of unstable dynamics
    - ▶ Drop four countries because of small number of observations ( $<40$ )
- ▶ Mean group estimator (Pesaran and Smith, 1995)
  - Dynamic panel with heterogeneous slope coefficients
  - Estimate country by country with OLS
  - Take average IRFs across countries
- ▶ Identification implement identification via Choleski decomposition of covariance matrix

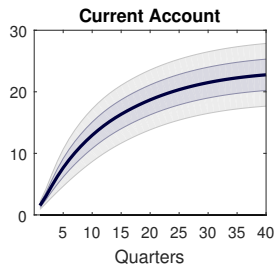
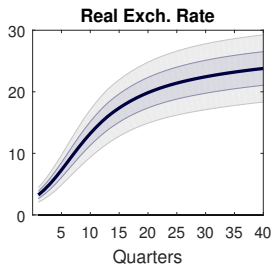
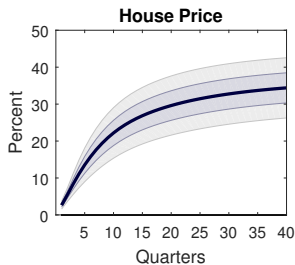
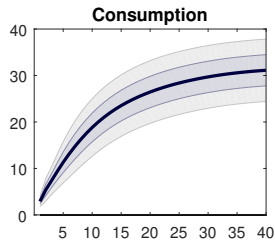
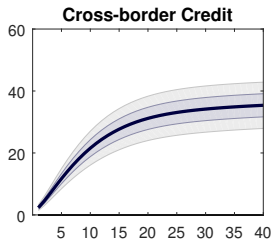
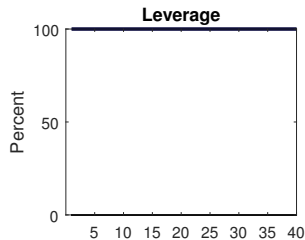
# IRFs to Leverage Shock

- ▶ Conditional evidence consistent with event study



# Variance Decomposition

- ▶ Shock explains significant share of variance of domestic variables



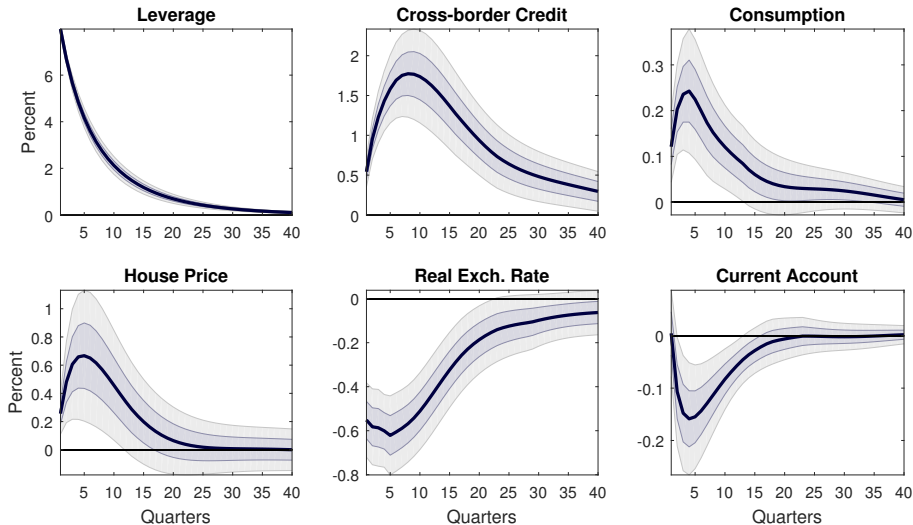
# Robustness

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

$$\begin{aligned}LEV_t &= F_{11}LEV_{t-1} + \beta GDP_t^w + u_t^{LEV} \\ x_{i,t} &= F_{21,i}LEV_{t-1} + F_{22,i}x_{i,t-1} + u_{i,t}^x\end{aligned}$$

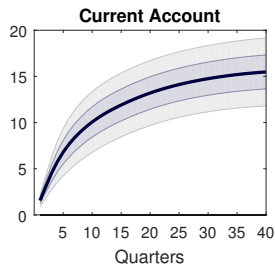
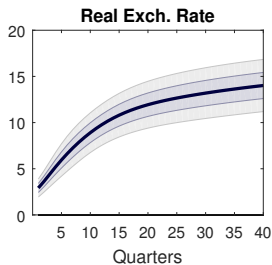
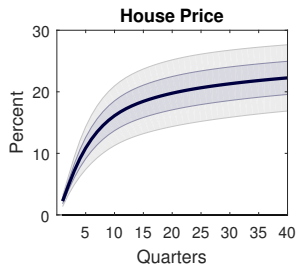
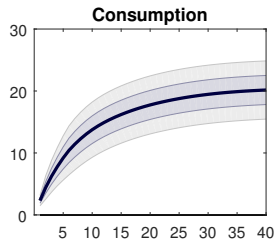
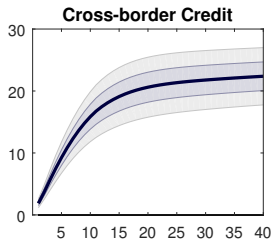
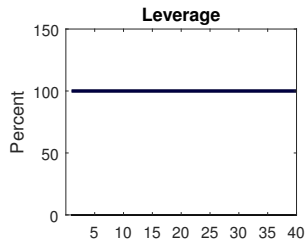
# IRFs to Leverage Shock (Robustness)

- ▶ Smaller impact and less persistent response but qualitatively unchanged



# Variance Decomposition (Robustness)

- ▶ Somewhat smaller but still significant



# Summary of Empirical Findings

- ▶ Identified international credit supply shock
  - Shock to leverage of US broker-dealers
- ▶ Response of receiving economy consistent with unconditional evidence
  - Domestic activity booms, asset prices soar, current account deteriorates
- ▶ Robust to controlling for global factors
- ▶ Shock explains significant fraction of variance of domestic variables
- ▶ **Next** Study drivers of cross-country IRFs heterogeneity

# Outline

1. Data and stylized facts
2. Model of international financial intermediation with credit frictions
3. Macroeconomic impact of international credit supply shocks
4. **Inspecting heterogeneity of transmission mechanism**



# Understanding Cross-Country Heterogeneity

- ▶ **Conjecture** Country-specific responses depend on
  - Share foreign currency liabilities  $1/(1 + \eta)^{-1}$
  - Maximum LTV limit  $\theta$
- ▶ Derive sensitivity of response of endogenous variable to  $\eta$  and  $\theta$

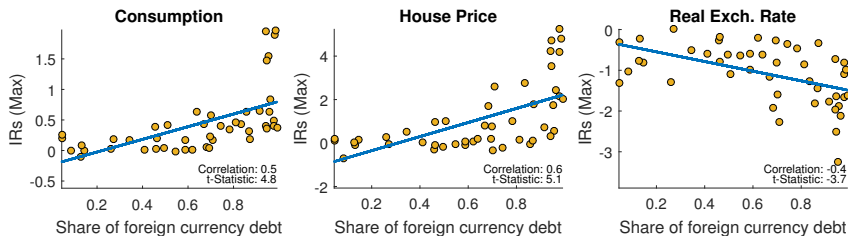
$$\frac{\partial^2 x}{\partial \chi \partial \eta} \quad \text{and} \quad \frac{\partial^2 x}{\partial \chi \partial \theta}$$

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  $e_t^{LEV}$  vs.  $\theta_i$  and  $\eta_i$

# Share of Foreign Currency Debt

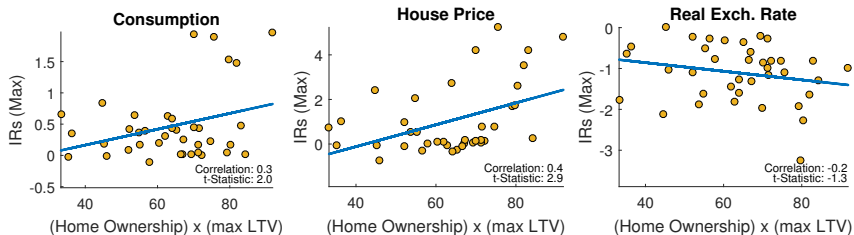
- **Prediction 1** A larger share of foreign currency debt (lower  $\eta$ ) implies a higher sensitivity of  $C_i$ ,  $HP_i$ , and  $RER_i$  to shocks to  $\chi$
- Lower  $\eta$  implies larger collateral valuation
  - Real exchange rate responds more to variations in level of credit



NOTE: Share of foreign currency liabilities computed using BIS banking data.

# LTV Ratios

- **Prediction 2** A larger LTV ratio (higher  $\theta$ ) implies a higher sensitivity of  $C_i$ ,  $HP_i$ , and  $RER_i$  to shocks to  $\chi$
- Higher  $\theta$  leads to higher credit demand
  - Larger real exchange rate response and amplification effect



NOTE: LTV is maximum LTV weighted by homeownership rate.

# Conclusions

1. Data and stylized facts
  - Unconditional evidence of boom-bust cycles associated with cross-border credit expansions and contractions
2. Macroeconomic impact of international credit supply shocks
  - Identified shock to US broker-dealers' leverage in panel VAR transmits internationally to generate domestic booms
3. Model of international financial intermediation with credit frictions
  - Consistent with evidence, highlights amplification role of key asset prices: house prices and real exchange rate
4. Inspecting heterogeneity of transmission mechanism
  - Role of exchange rate regime and interaction with amplification mechanism

# Data Sources: Countries

- ▶ We consider 57 countries in our empirical analysis
  - **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

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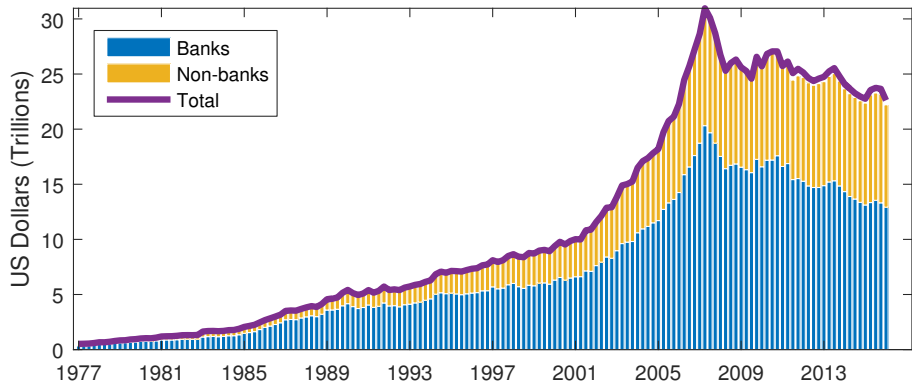
# Data Sources: Quantities

- ▶ We collect data over the 1990:Q1–2012:Q4 (subject to data availability) for the following variables:
  - **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.
  - **House prices.** Nominal house prices deflated by consumer price inflation. Source: Cesa-Bianchi et al (2015, JMCB)

# Data Sources: Prices

- ▶ We collect data over the 1990:Q1–2012:Q4 (subject to data availability) for the following variables:
  - **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



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# Alternative Identification

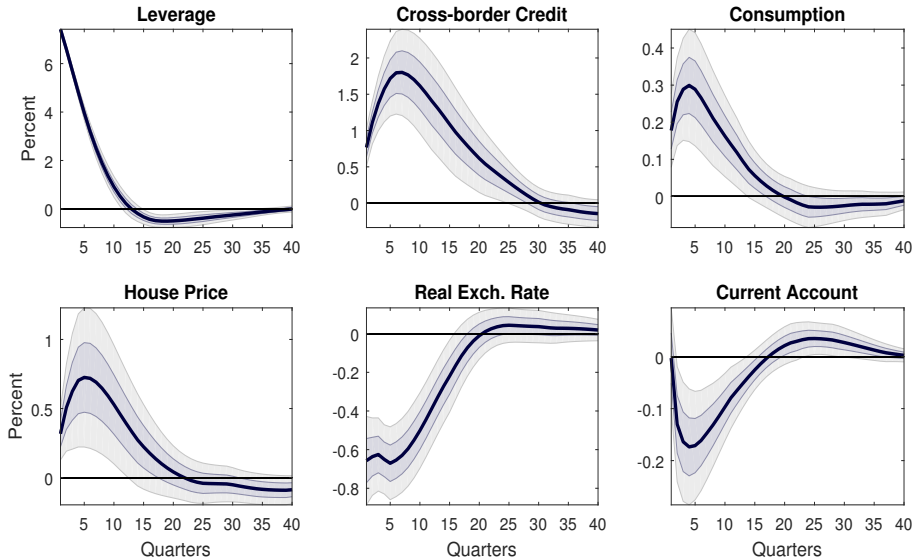
- ▶ Baseline identification allows for no lagged feedback effect from country  $i$  to US broker-dealers' leverage
- ▶ Alternative: Assume no contemporaneous effect only

$$\begin{bmatrix} LEV_t \\ x_{it} \end{bmatrix} = \begin{bmatrix} F_{11,i} & F_{12,i} \\ F_{21,i} & F_{22,i} \end{bmatrix} \begin{bmatrix} LEV_{t-1} \\ x_{i,t-1} \end{bmatrix} + \begin{bmatrix} B_{11,i} & 0 \\ B_{21,i} & B_{22,i} \end{bmatrix} \begin{bmatrix} e_t^{LEV} \\ e_{it}^x \end{bmatrix}$$

- ▶ Can still achieve identification with Choleski decomposition of  $\Sigma_u = u'_{it}u_{it}$

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# Alternative Identification: IRFs to Leverage Shock



# Alternative Identification: Variance Decomposition

