International Credit Supply Shocks

A. Cesa-Bianchi[1]   A. Ferrero[2]   A. Rebucci[3]

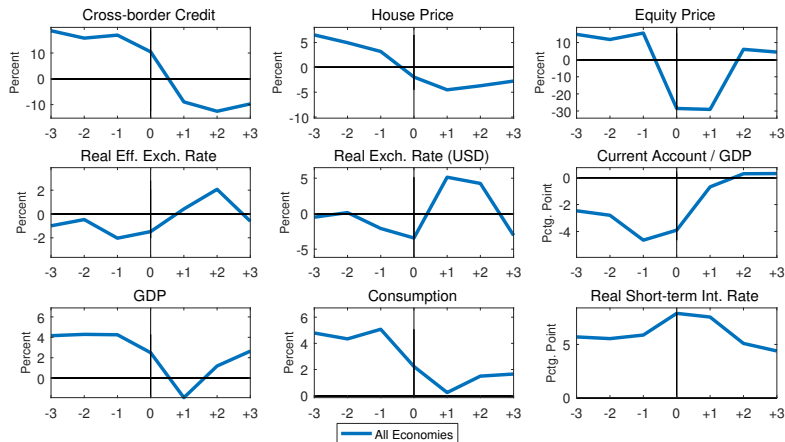[1]Bank of England and Center for Macroeconomics
[2]Oxford University
[3]Johns Hopkins Carey Business School and NBER

18th Jacques Polak Annual Research Conference
IMF - November 2-3, 2017

*The views expressed in this paper do not necessarily reflect the position of the Bank of England.

# Fact 1: Capital inflows are typically associated with expansions and asset price surges

NOTE. Each panel plots the median across all boom-bust episodes, using a 6-year window that goes from three year before the peak to three years after the peak. In each panel, time o marks the peak of the boom-bust cycle in cross-border bank claim growth (i.e., the last period of a boom in which cross-border bank claims displays a positive growth rate), which is also depicted with a vertical line. All variables are expressed in percentage changes, with the exception of the short-term interest rate and the current account over GDP which are expressed in percentage points.

Fact 2: Some countries seem more sensitive than others to the volatility of capital inflows
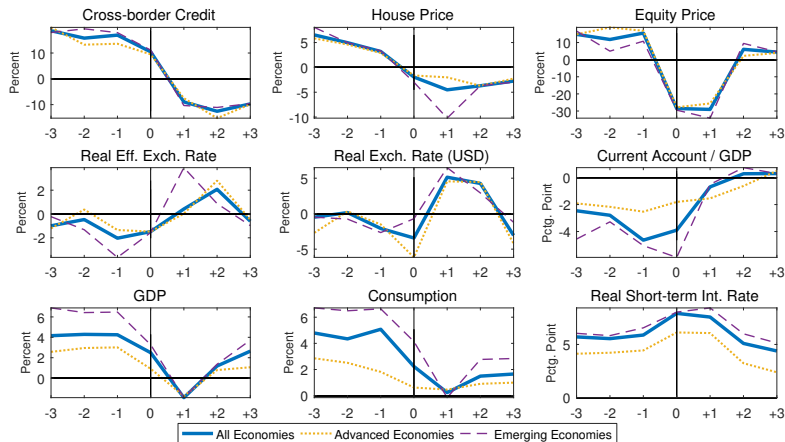
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Fact 3: Countries differ in important dimensions, and the EMs vs. AEs divide may not be whole story

Mortgage Debt / GDP

Home Ownership

Share of foreign currency debt

Max Loan to Value (LTV)
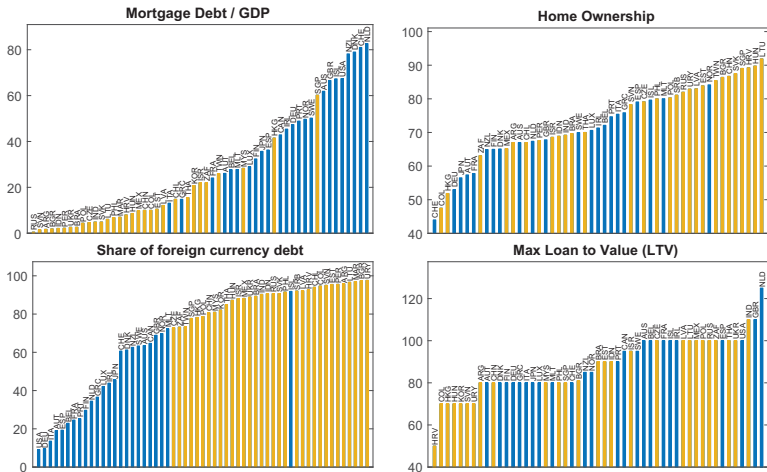
NOTE. Each bar corresponds to a country. The lighter (yellow) bars are classified as emerging markets and the darker (blue) bars as advanced economies. See the data appendix for variable definitions and data sources.

This paper

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

- ▶ This paper focuses on one particular push shock $\Rightarrow$ A change in the leverage constraint of global banks that shifts the **international credit supply**

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- Questions

  (1) What are the mechanisms through which capital inflows lead to macroeconomic booms?

  (2) What are the characteristics that account for the differences in sensitivity across countries?

This paper: What we do & What we find

- ► What we do
  - *Theory*: Open economy model with international financial intermediation
  - *Empirics*: Heterogeneous panel VAR model for more than 50 countries

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► Three main takeaways

1. Leverage shock is expansionary both in the model and in the data

2. In the average economy, the shock has sizable impact and explains a significant fraction of macroeconomic and asset price variance

3. In the cross-section, a stronger transmission is *associated* with higher max LTV ratios and shares of FX liabilities

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▶ **Important implication** LTV ratios and shares of FX liabilities, which can be influenced by policy, are linked to final outcomes

Selected related literature

▶ Global financial cycle
Rey (2013, 2016); Passari and Rey (2015); Bruno and Shin (2015a,b); Miranda-Agrippino and Rey (2015); Dedola, Rivolta, and Stracca (2015); Forbes, Reinhart, and Wieladek (2016); Cerutti, Claessens, Rose (2017); Aoki, Benigno, and Kiyotaki (2016); Boz and Mendoza (2014); Cetorelli and Goldberg (2011, 2012)

▶ House prices and capital flows in 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)

The Model

Overview of the model

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

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- Impatient Home household ($i \in [0, n]$)
  - Borrows in domestic currency (b) and foreign currency (f) to consume and purchase housing services (h_1)
  - Subject to collateral constraint: $b + s_1 f \leq \theta \, q h_1$

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  - Subject to capital requirement: $e \geq \chi \, (b/s_1 + f)$

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  └─ Capital ratio

Equilibrium: Graphical analysis

▶ Equilibrium can be represented in the '*quantity of credit – interest rate*' space

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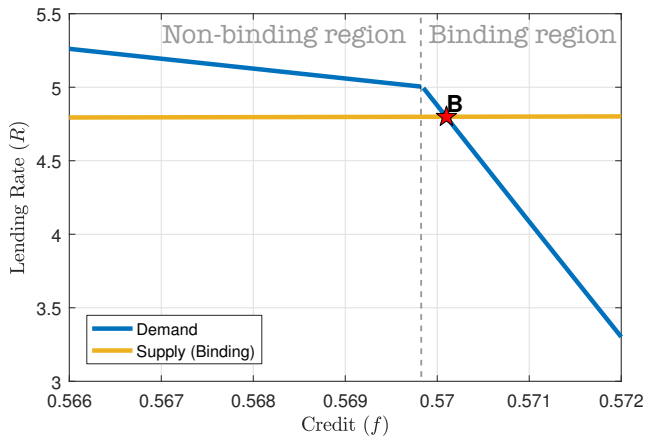
International credit supply shock

- **Experiment** Reduction of equity requirement for global banks ($\chi \downarrow$)
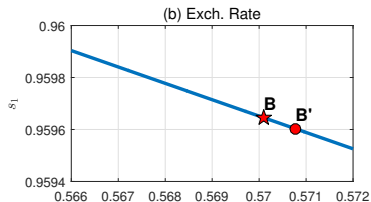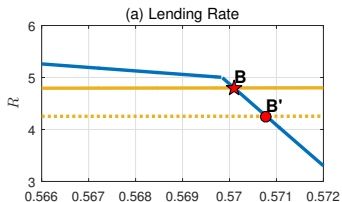 - A push shock from Home country's perspective

International credit supply shock

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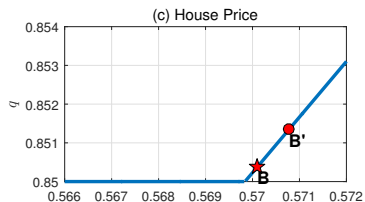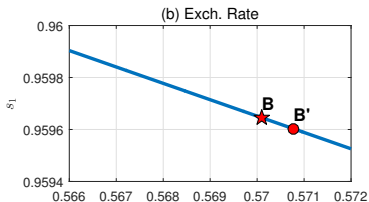
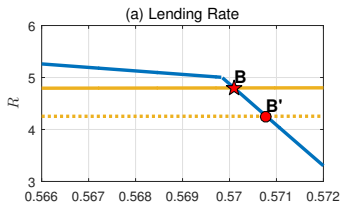- Credit flows into Home country, lending rate falls
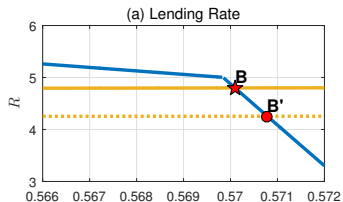
(a) Lending Rate

International credit supply shock

- **Experiment** Reduction of equity requirement for global banks ($\chi \downarrow$)
 - Real exchange rate appreciates

(a) Lending Rate

(b) Exch. Rate

International credit supply shock

▶ **Experiment** Reduction of equity requirement for global banks ($\chi \downarrow$)

- House prices increase (if binding borrowing constraint)

(a) Lending Rate

(b) Exch. Rate

(c) House Price

International credit supply shock

▶ **Experiment** Reduction of equity requirement for global banks ($\chi \downarrow$)

- Consumption increases

(a) Lending Rate

(b) Exch. Rate

(c) House Price

(d) Consumption
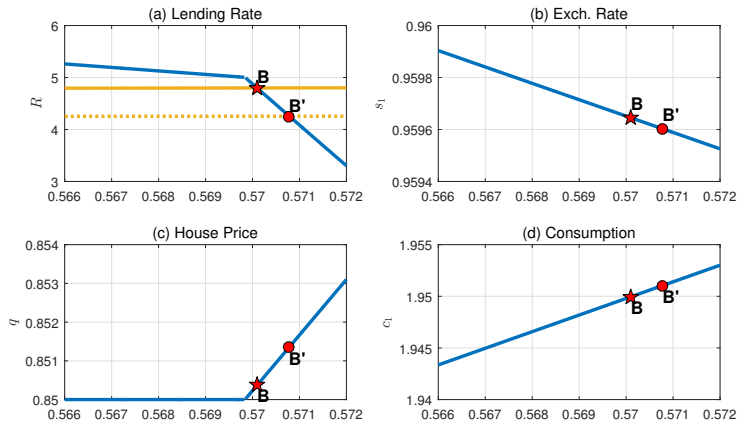
Empirics

A Heterogeneous Panel VAR model

- **Objective** Identify an international credit supply shock in the data
  - (1) Transmission and relative importance for the average economy
  - (2) Differential impact across countries

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

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- LEV_t: Leverage of US Broker-Dealer sector (Flow of Funds)
  - Empirical proxy for global banks' leverage
  - Common to all countries

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- KF_{it}: Cross-border claims of BIS reporting banks on country i
  - All instruments, to financial and non-financial sectors

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- All variables are in real terms (except LEV_t and CA_{it}/Y_{it}) and in log-levels (except CA_{it}/Y_{it})

- Mean group estimator [Pesaran and Smith (1995); Pesaran (2006)] over 1985:Q1-2012:Q4 sample period

Identification of international credit supply 'push' shock in the data

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▶ Robustness
  - Control for globally synchronized pull shocks
  - Drop 'not so small' open economies

Transmission consistent with model and stylized facts on boom-bust episodes in cross-border credit
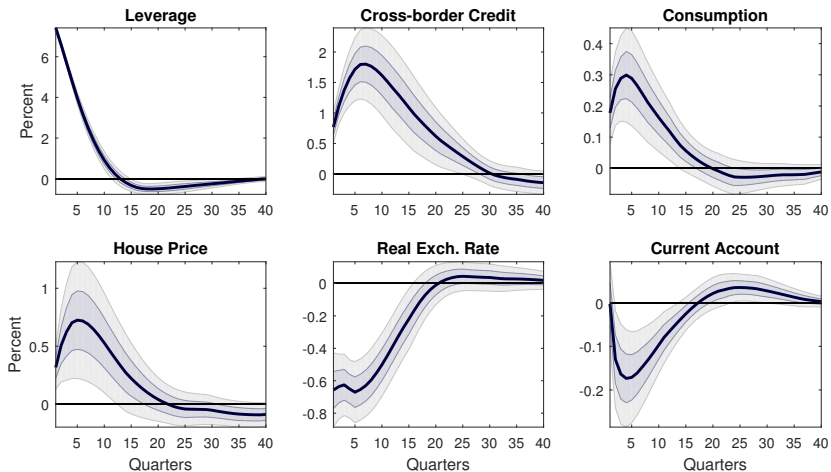
The shock explains a substantial fraction of the forecast error variance of domestic variables
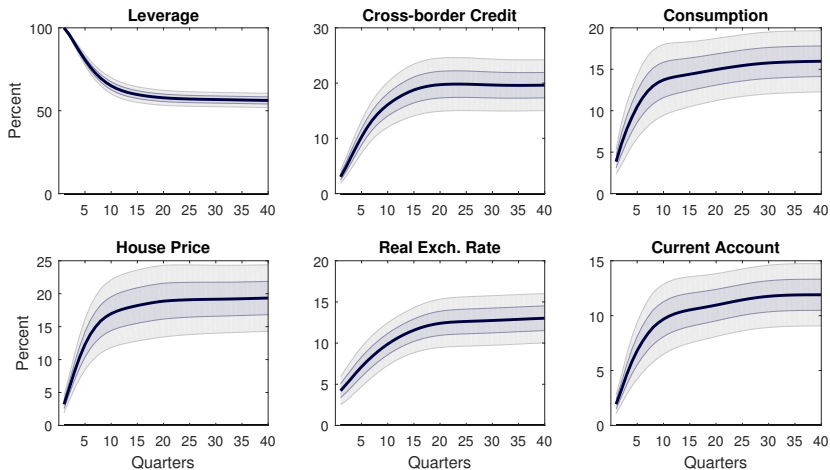
# Understanding cross-country heterogeneity

- ▶ Error bands for IRFs and FEVDs are relatively wide $\Rightarrow$ Significant differences across countries

- ▶ Does heterogeneity follow specific patterns?

Understanding cross-country heterogeneity

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► Does heterogeneity follow specific patterns?

► **Conjecture** Transmission affected by country characteristics. Focus on two characteristics that have a clear counterpart in the model
  - Maximum LTV limit (θ_i)
  - Share foreign currency liabilities (ψ_i)

► Compare theoretical predictions with data

Loan-to-Value ratios

- **Prediction 1** *A larger LTV ratio (higher θ) implies a higher sensitivity of C_i, HP_i, and RER_i to shocks to χ*

    - If constraint binds, higher θ leads to higher house price response, and hence larger collateral effect and amplification

    - Higher θ leads to higher credit and demand, and hence larger real exchange rate response

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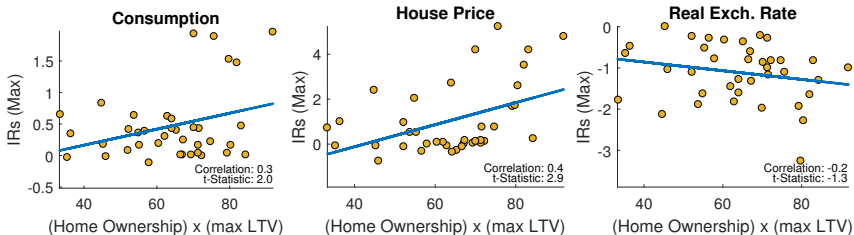
NOTE: LTV is maximum LTV weighted by homeownership rate.

Share of foreign currency debt

- **Prediction 2** *A larger share of foreign currency debt (higher ψ) may imply a higher sensitivity of C_i, HP_i, and RER_i to shocks to χ*

  - Higher ψ implies larger collateral and endowment valuation effects ($\uparrow$), and larger debt valuation effect ($\downarrow$)

  - Depending on which effect dominates, higher ψ can lead to both higher/lower amplification

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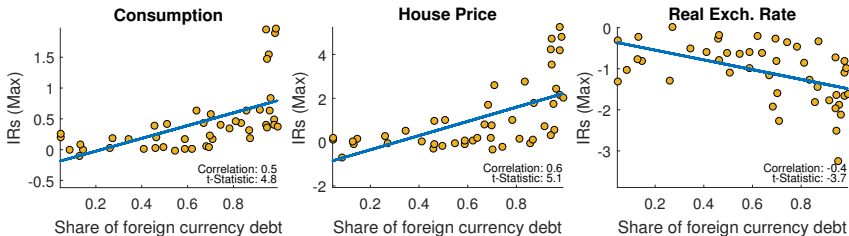
NOTE: Share of foreign currency liabilities computed using BIS banking data.

Robustness checks

- ▶ Control for synchronized pull shocks Go
  - • Augment vector of endogenous variables with world GDP

- ▶ Drop 'not so small' economies that can affect global credit supply Go
  - • Japan, Switzerland, UK, and Germany

- ▶ Exclude lagged country variables from the leverage equation Go

- ▶ Scatter plots vs. VARs on sub-groups Go

- ▶ VAR vs. Local Projections Go

Conclusions

- Theory
  - Expansionary push shock triggered by changes in leverage of global banks

- Empirics
  - Identified shock to US broker-dealers' leverage explains a significant share of domestic variance
  - Transmission consistent with model (both time series and cross-section)

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- Policy implications
  - Max LTV ratios and shares of FX liabilities associated with sensitivity to shock
  - Macro-pru can try to influence them and hence affect final outcome

- Next on agenda: Quantitative model and policy analysis

Appendix:
Event Study

Event study: Methodology

- ► Event study follows 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

Event Study: Summary Statistics

Mean Across Episodes

	Boom			Bust			Boom-bust		
	ALL	AE	EM	ALL	AE	EM	ALL	AE	EM
Number	2.4	2.5	2.3	1.4	1.1	1.6	0.9	0.8	0.9
Duration	7.3	8.8	6.1	4.4	3.7	4.8	12.7	13.4	12.4
Max	32.6	28.5	35.9	-4.2	-4.6	-4.1	36.3	29.5	40.5
Min	5.0	3.7	5.9	-20.4	-17.5	-21.9	-21.8	-19.2	-23.5
Amplitude	131.6	130.1	132.8	-53.2	-36.9	-61.3	103.5	115.7	96.0

Median Across Episodes

	Boom			Bust			Boom-bust		
	ALL	AE	EM	ALL	AE	EM	ALL	AE	EM
Number	2.0	2.0	2.0	1.0	1.0	2.0	1.0	1.0	1.0
Duration	6.0	8.0	5.0	4.0	3.0	4.0	12.0	13.0	12.0
Max	28.5	26.0	31.0	-3.0	-3.0	-3.0	29.0	27.0	31.0
Min	3.0	2.0	4.0	-18.0	-15.0	-19.0	-19.0	-18.0	-20.0
Amplitude	105.5	121.0	84.0	-42.0	-30.0	-51.5	80.5	106.0	39.0

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.

Appendix:
Data

Data

- Global variable
  - Global banks' leverage: US Broker-Dealers' leverage (LEV_t)

- Country-specific variables
  - International credit: cross-border claims of BIS reporting banks (KF_{it})
  - Macro variables: private consumption (C_{it}) and current account to GDP (CA_{it}/Y_{it})
  - Asset prices: house prices (HP_{it}) and real exchange rate vis-a-vis the US dollar (RER_{it})
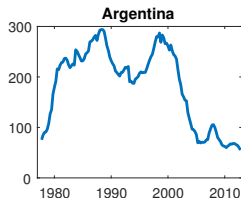
- Sample: 57 countries between 1977 and 2012 (unbalanced)

Data sources

International credit claims

▶ Cross-border total claims (all instruments, to financial and non-financial sectors) of BIS reporting banks on country i

$$KF_{it} = \sum_{j=1(j \neq i)}^{N} KF_{ij,t}$$

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

▶ Three examples
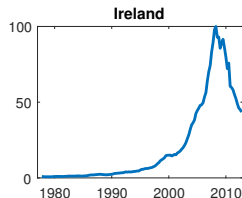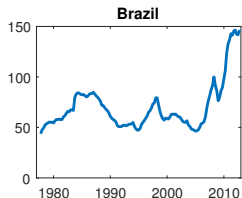
Leverage of US Broker-Dealers

- ▶ Leverage is defined as *Assets/Equity* of the US broker dealer sector from the Federal Reserve's Flow of Funds

- ▶ Empirical proxy for global banks' leverage
  - • [Bruno and Shin (2015); Rey (2013)]
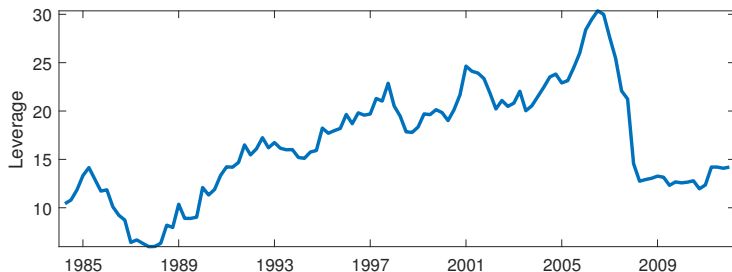
Data sources: Countries

- **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)

Back

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.

Back

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
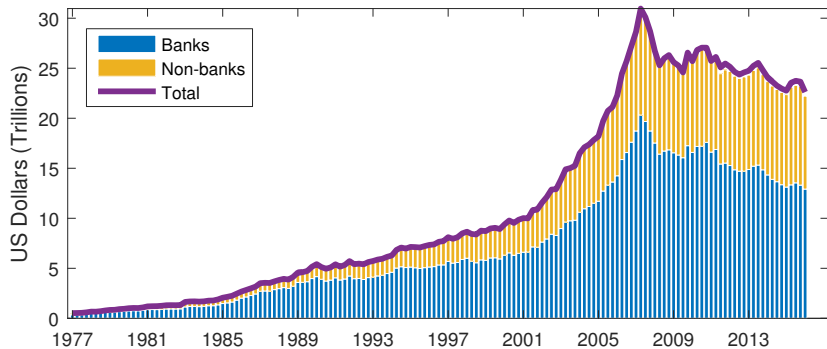
Appendix:
Model

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

$$
\begin{aligned}
c_1 + qh_1 - b - s_1 f &= p_{H1} y + qh_0 \\
c_2 &= p_{H2} y - R^b b - s_2 R f
\end{aligned}
$$

where

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

- Collateral constraint

$$b + s_1 f \leq \theta q h_1$$

Households

- 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 ψ', $\psi'' > 0$, and

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

Global financial intermediaries

► Balance sheet

Assets		**Liabilities**	
Loans (H currency):	b/s_1	Deposits (F currency):	d
Loans (F currency):	f		
		Equity (F currency):	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 ϕ', $\phi'' > 0$)

► Leverage constraint (capital requirement)

$$e \geq \chi\left(\frac{b}{s_1} + f\right)$$

Equilibrium: Analytical characterization

- ▶ Take limit for $n \to 0 \Rightarrow$ Home becomes small open economy

- ▶ Abstract from intermediaries portfolio problem
  - Fix the ratio between domestic and foreign currency liabilities (η)

- ▶ All households are risk-neutral and housing (land) is in fixed supply

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

- ▶ Represent the equilibrium in the $\{f, R\}$ space

Parameters

Parameter	Description	Value
β	Country H discount factor	0.9
β^*	Country F discount factor	0.99
κ	Normalized marginal utility of housing	0.85
λ	Degree of openness	0.79
θ	LTV ratio	0.92
η	Share of foreign debt	0.43
χ	Capital requirement	0.1
$y = y^*$	Endowments	1

- Adjustment cost parameters pin down equity and loans risk premia

- In turn, the level of risk premia will determine whether the equilibrium lies in the unconstrained/constrained region

Appendix:
Identification

Estimated international credit supply shock

▶ Orthogonalized leverage innovations for each of the country-specific models (light solid lines) can differ slightly across countries
  - Lagged feedback from the rest of the system to leverage equation
  - Models are estimated over different sample periods (depending on data availability)
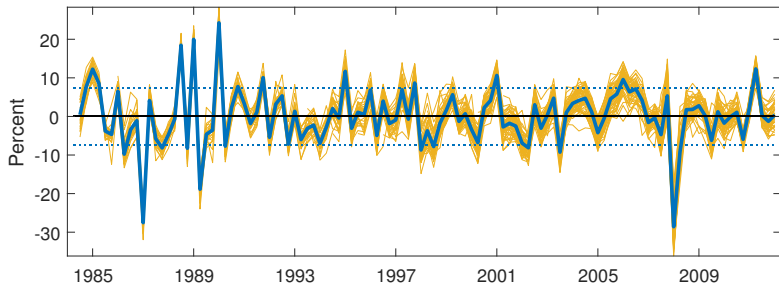
NOTE. The light solid lines are the orthogonalized leverage innovations for each of the country-specific models. The dark solid line is the cross-country average of the country-specific leverage innovations. The dotted lines are the average of the one-standard deviation bands, equal to 7.5 percent per quarter.

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Brokers-Dealers' leverage innovations and their underlying determinants

▶ Leverage is exogenous in our model, but in the data various factors can affect the leverage of US Broker-Dealers

x_t	(1)	(2)	(3)	(4)	(5)
ΔFFR_t	-2.477** [-2.364]				-2.613** [-2.536]
ϵ^{MP}		-0.0497 [-0.650]			
$R_t^L - R_t$			-0.900 [-1.642]		
VIX_t				-0.00182** [-2.057]	-0.00195** [-2.252]
Obs.	111	91	111	111	111
Adj. R^2	0.049	0.005	0.024	0.037	0.091

NOTE. The Table reports a regression of the leverage innovations (average across countries) on their possible determinants: $\epsilon_t^{LEV} = \beta x_t$. ΔFFR_t is the first difference of the real (ex-post) federal fund rate; ϵ^{MP} is Romer and Romer (2004) monetary policy shock; $R_t^L - R_t$ is the slope of the US yield curve; VIX_t is the VIX index. The regressions also include a constant and world GDP (not reported).

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Appendix:
Identification Robustness

Identification robustness: controlling for globally synchronized 'pull' shocks

- ▶ 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

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

- ▶ Shock to leverage of US broker-dealers still identified with Cholesky

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IRFs to leverage shock (Identification robustness)
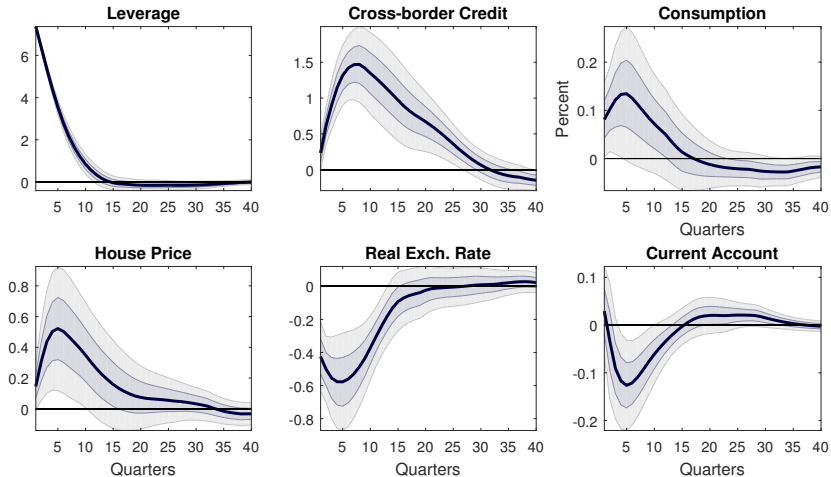
Variance decomposition (Identification robustness)
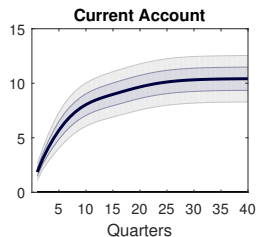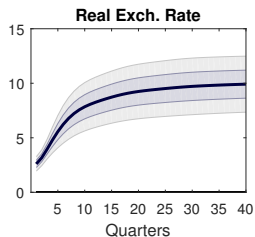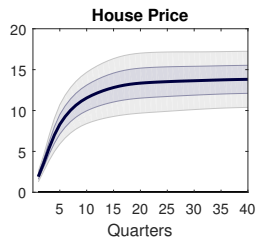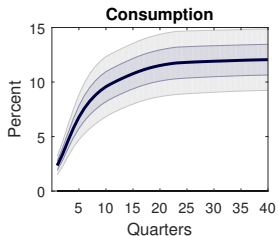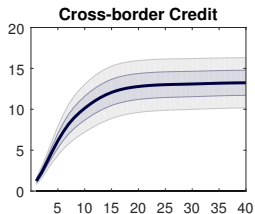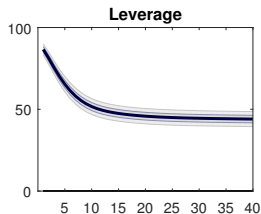
Identification robustness: World equity prices

▶ World GDP might not have enough forward looking component to capture globally synchronized pull shocks

▶ Estimate a VAR with world equity prices (world MSCI index) instead of GDP

▶ Results are robust qualitatively, but a bit weaker quantitatively
  • World equity prices incorporate information, like risk premia, also captured by the leverage variable

Identification robustness: World equity prices

▶ Impulse responses
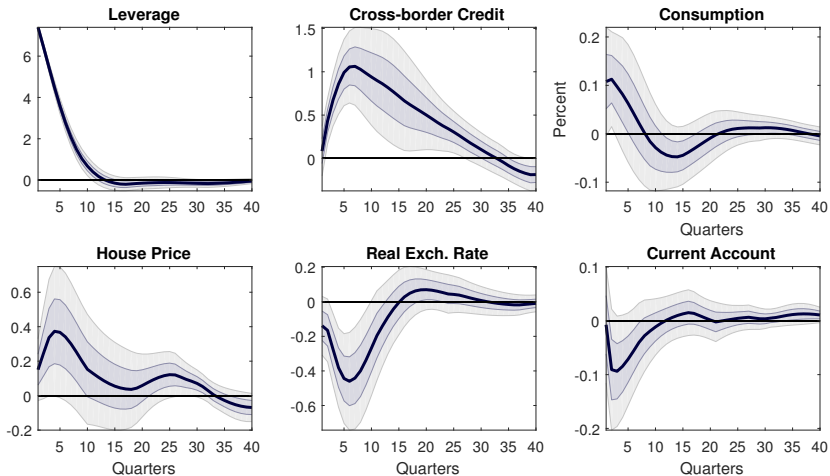
Identification robustness: World equity prices

▸ Forecast error variance decompositions
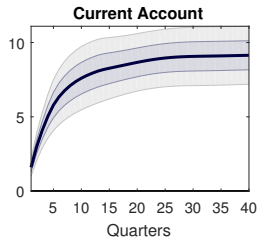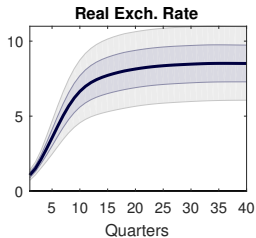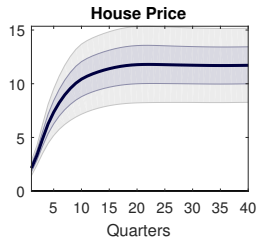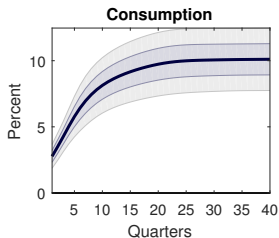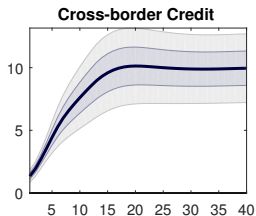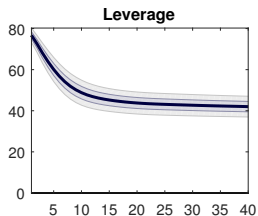
Appendix:
VAR Robustness

VAR robustness: Drop large countries (IRF)
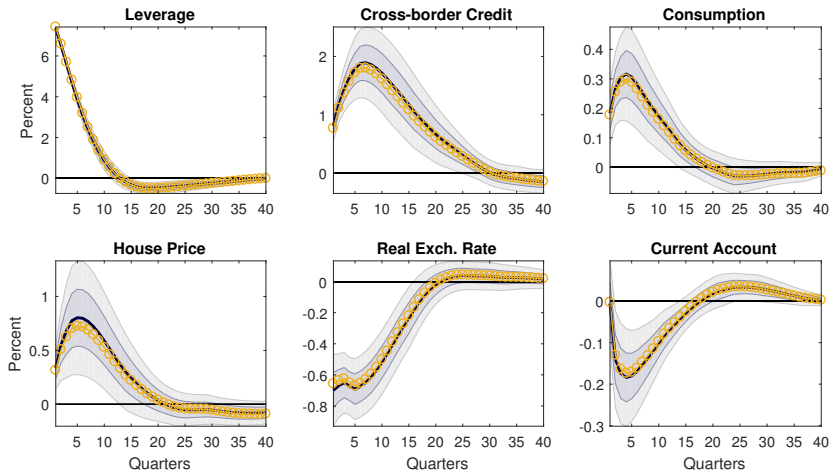
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VAR robustness: No feedback from SOE

- ▶ Block exogenous VAR: no feedback from endogenous variables in country i to Broker-Dealers' leverage

- ▶ VAR for country i (abstracting from constant and time trend) is

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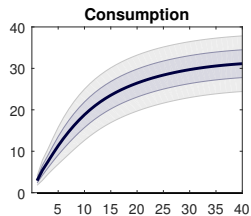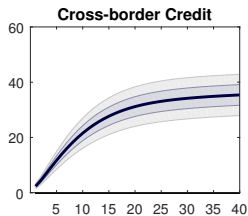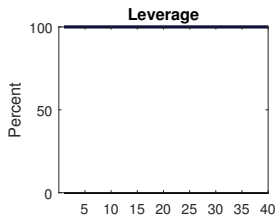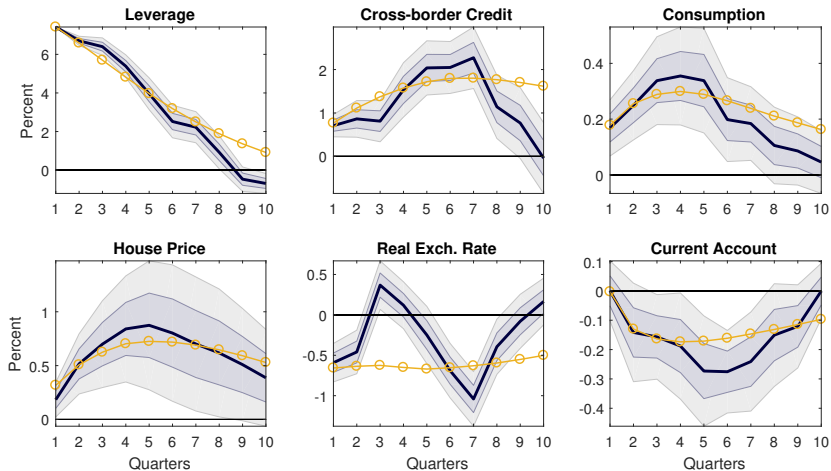$$

- ▶ Identification: Cholesky decomposition as in the baseline

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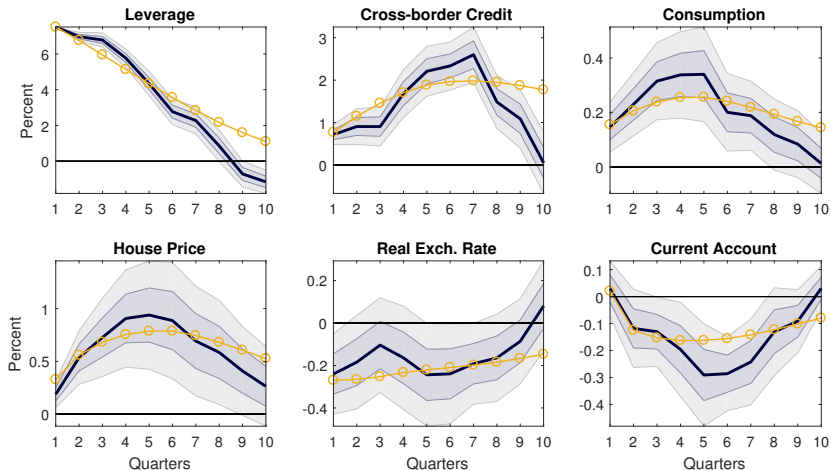# VAR robustness: No feedback from SOE (IRF)
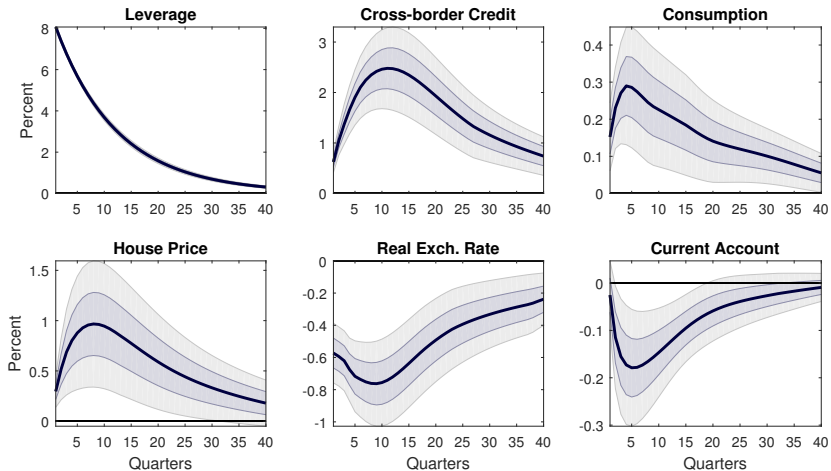
VAR robustness: No feedback from SOE (FEVD)
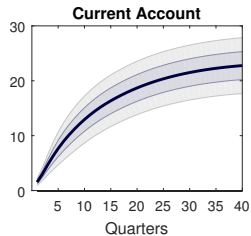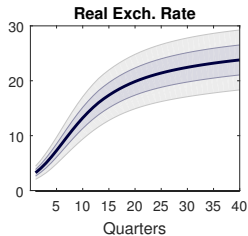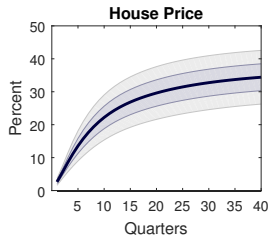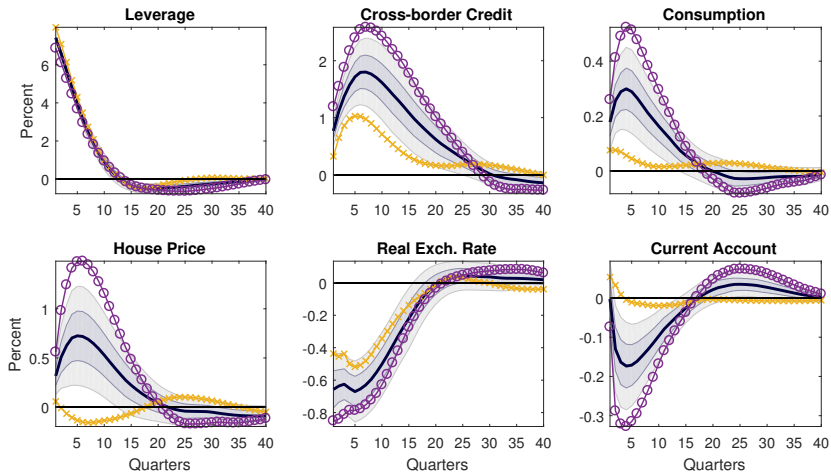
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VAR robustness: Local Projections

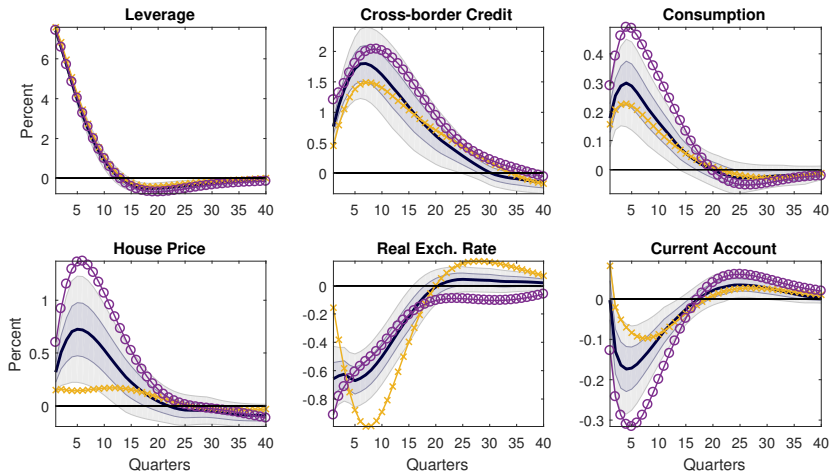# VAR robustness: Local Projections (with REER)

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VAR estimated on 'bins': High and low share of foreign currency liabilities

Back

VAR estimated on 'bins': High and low maximum Loan-to-Value

Leverage

Cross-border Credit

Consumption

House Price

Real Exch. Rate

Current Account

Quarters

Back

**Appendix:
Cross-Section**

Other characteristics

- Focus on share of foreign currency liabilities ($1/(1+\eta)$) and the maximum LTV limit (θ) as they have a clear counterpart in the model

- But other characteristics might be relevant
  - Exchange rate flexibility
  - Controls on capital inflows
  - Mortgage credit over GDP

	Consumption	House Price	Exch. Rate
Max Loan to Value	0.32	0.44	-0.21
Foreign currency liability	0.53	0.54	-0.39
Exch. Rate flexibility	-0.40	-0.41	0.16
Capital controls (inflows)	0.23	0.32	-0.28
Mortgage debt / GDP	-0.31	-0.42	0.25

NOTE. Correlation between the peak impulse response of selected variables (columns) and country characteristics (rows). See the appendix on data definition and sources.

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