International Credit Supply Shocks

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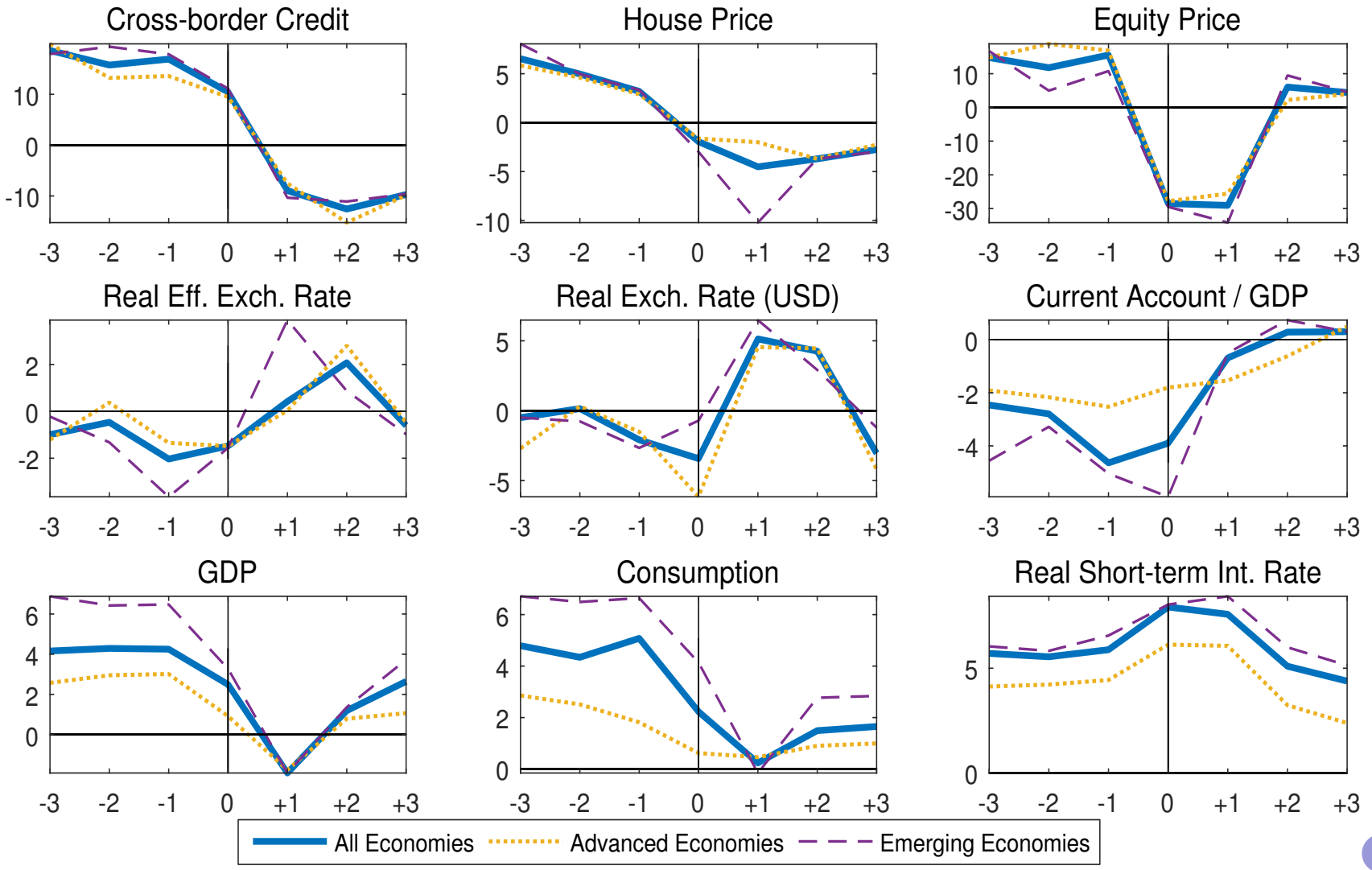
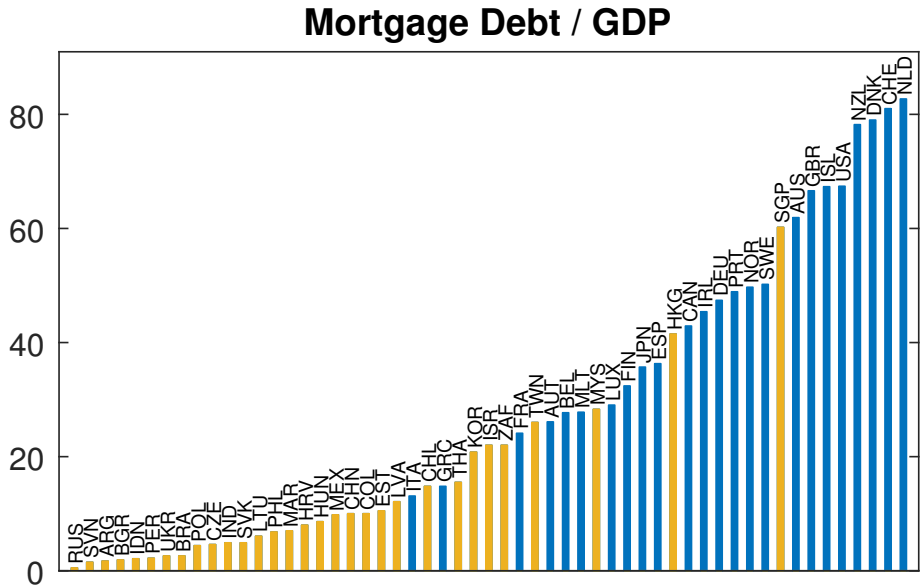
*The views expressed in this paper do not necessarily reflect the position of the Bank of England.

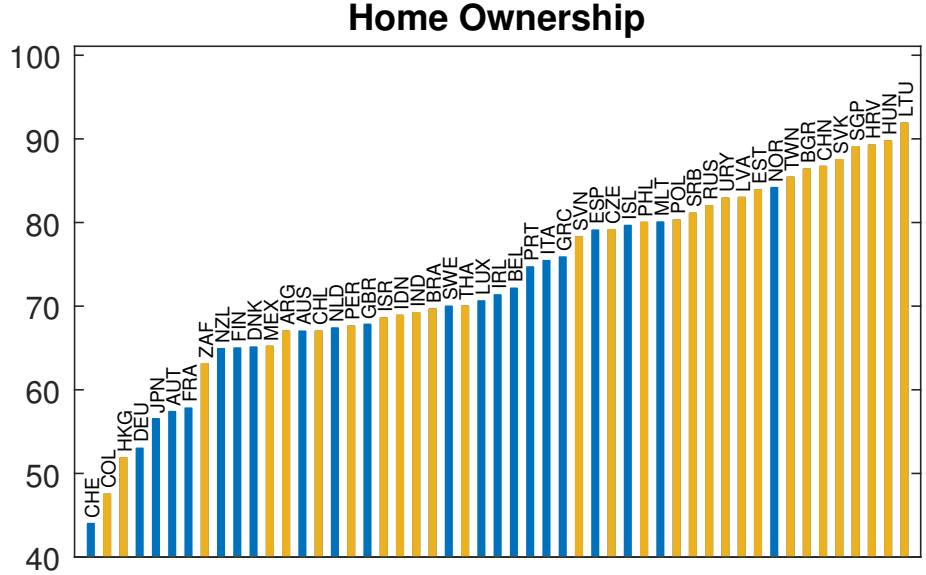
Capital inflows associated with expansions and asset price booms, but not all countries affected equally

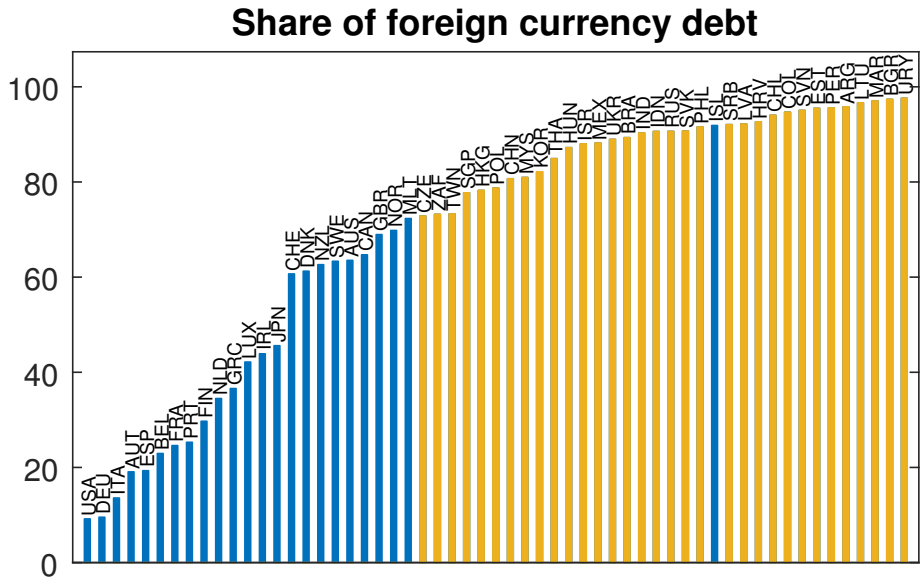


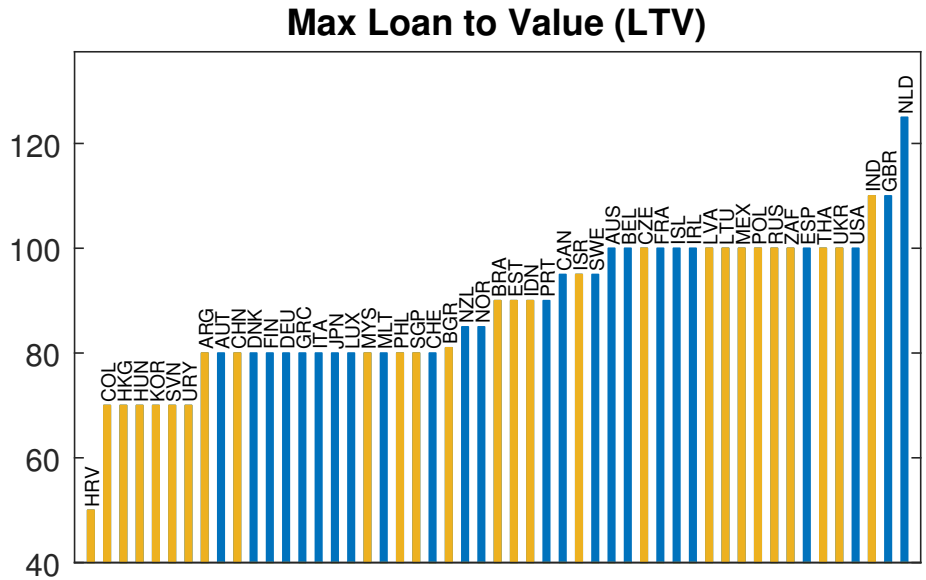
Overall

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









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:
  - Cetorelli and Goldberg (2011, 2012); Rey (2013, 2016); Bruno and Shin (2015); Dedola, Rivolta, and Stracca (2015); Forbes, Reinhart, and Wieladek (2016); Aoki, Benigno, and Kiyotaki (2016); Boz and Mendoza (2014).
- 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 of 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

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

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 in Home currency	b/s_1	Deposits	d
Loans in Foreign 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 ϕ', $\phi'' > 0$)

- 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 $\eta \equiv b/(s_1 f) \Rightarrow 1 + \eta =$ Inverse share of foreign currency liabilities
  - Take η 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**

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

- **Real Exchange Rate**

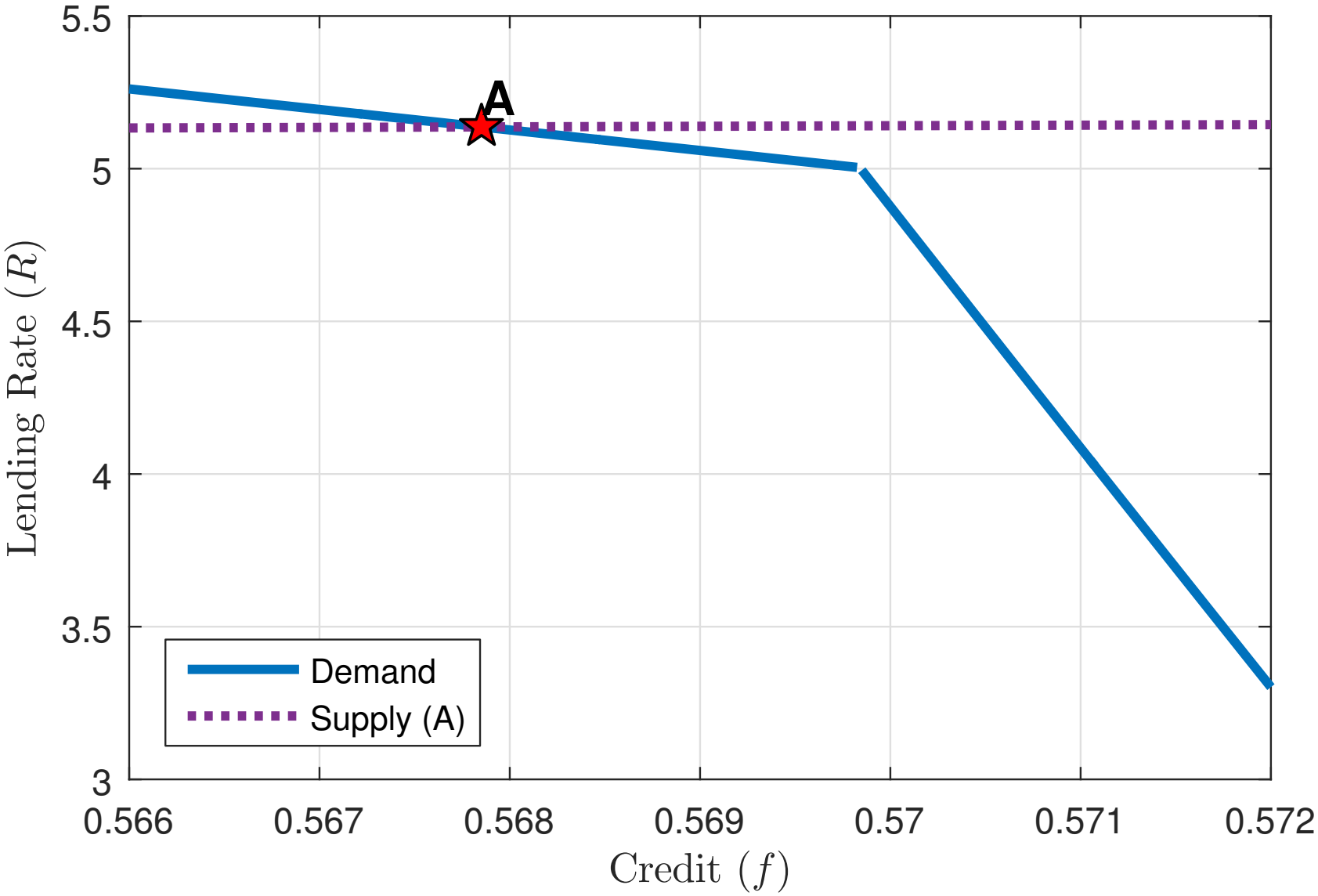
$$s_1 = \left[\frac{\lambda y}{\lambda y^* + (1-\lambda)(1+\eta)f}\right]^{1-\lambda} \qquad s_2 = \left[\frac{\lambda y}{\lambda y^* - (1-\lambda)R(1+\eta)f}\right]^{1-\lambda}$$

Parameters

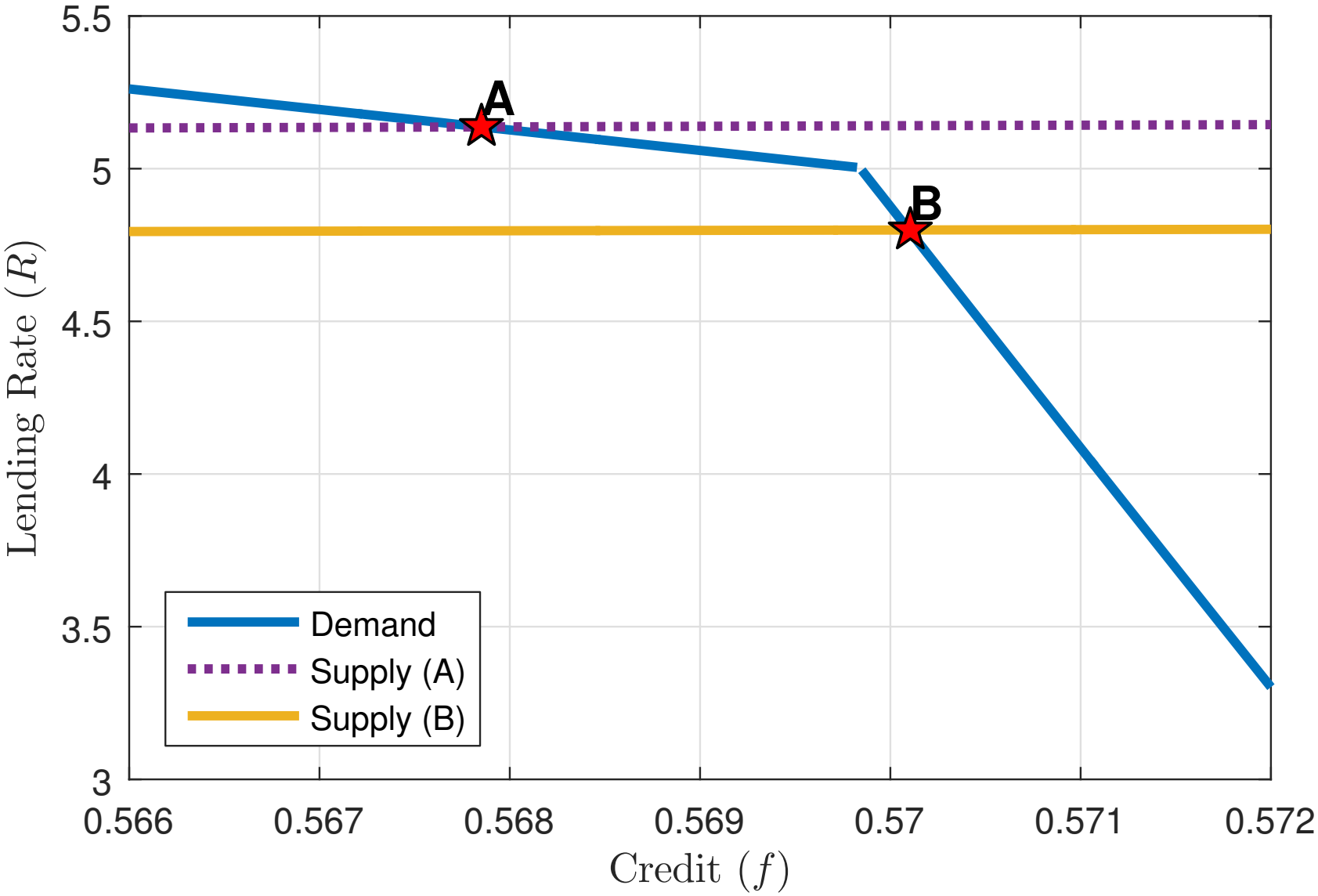
Parameter	Description	Value
β	Country H discount factor	0.9
β^*	Country F discount factor	0.99
κ	Normalized marginal utility of housing	0.85
λ	Degree of openness	0.79
θ	LTV ratio	0.92
η	Share of foreign debt	0.43
χ	Capital requirement	0.1
$y = y^*$	Endowments	1

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

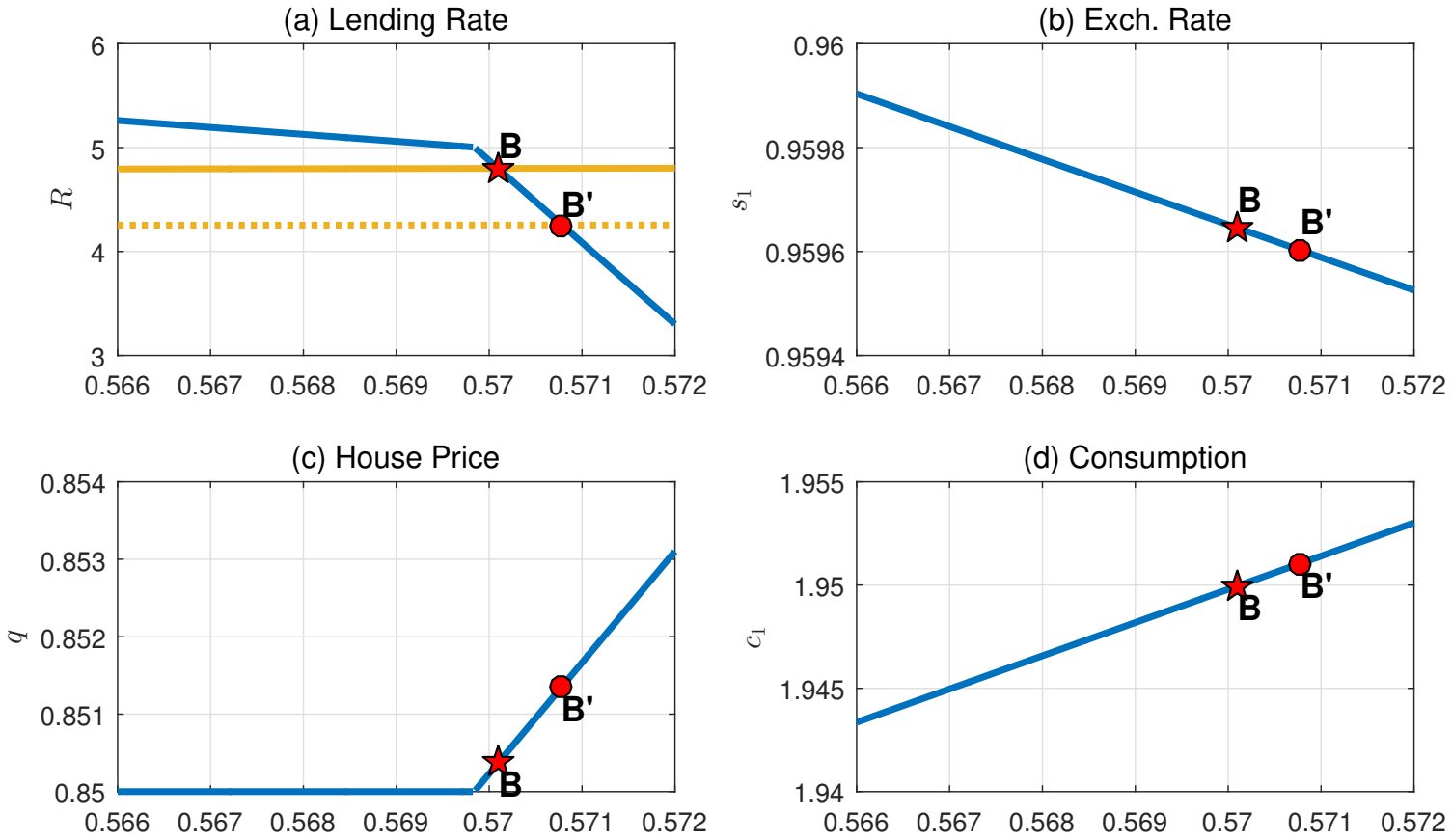
Credit Market Equilibrium



We assume economy is constrained at point B



International credit supply shock in the model ($\chi \downarrow$):



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

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

where

$$X_{it} = \left[\begin{array}{ccccccc} LEV_t & KF_{it} & C_{it} & HP_{it} & RER_{it} & CA_{it}/Y_{it} \end{array} \right]$$

- All variables are in real terms and in levels
- MG estimation following Pesaran and Smith (1995) and Pesaran (2006).

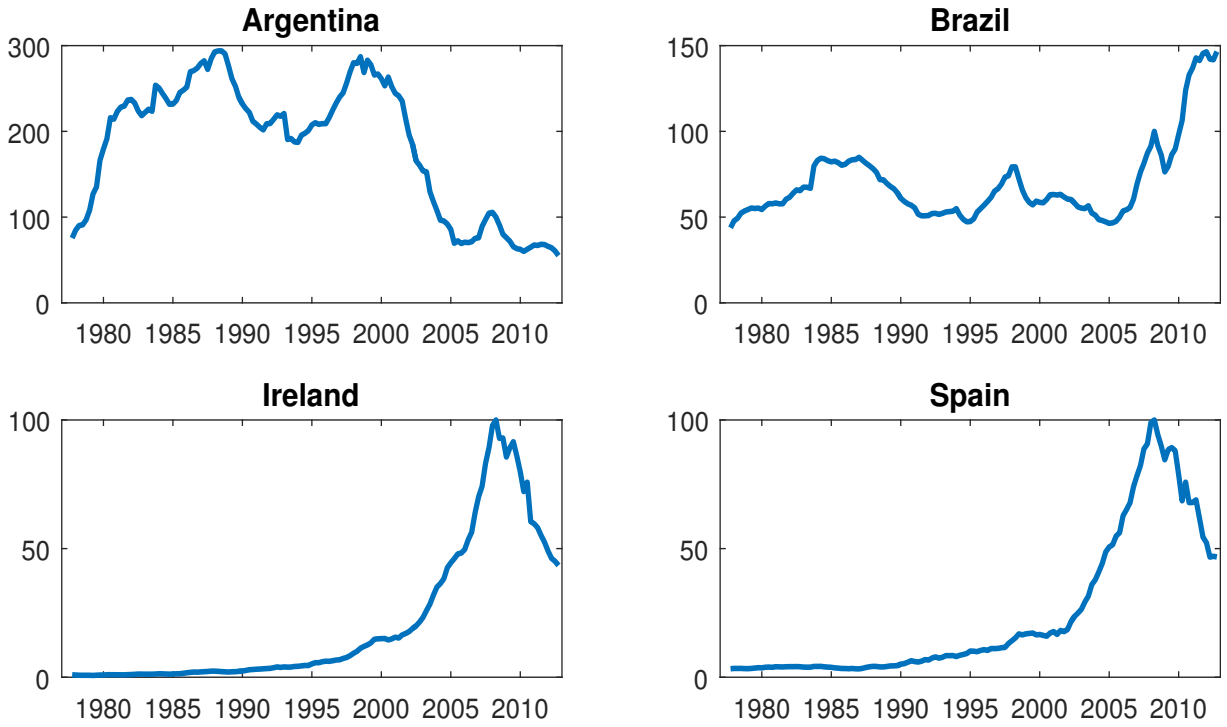
Variables and Data

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

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

- LEV_t is leverage of US broker-dealers from the flows of funds
  - Shock to $LEV_t \equiv$ International credit supply shock

Four examples of international credit series



- Important role of banks in international financial intermediation in the run up to the global financial crisis
  - Well correlated with measures of global liquidity–Bruno and Shin, (2015) and Cesa-Bianchi, Cespedes, and Rebucci (2015).

Determinants of Leverage

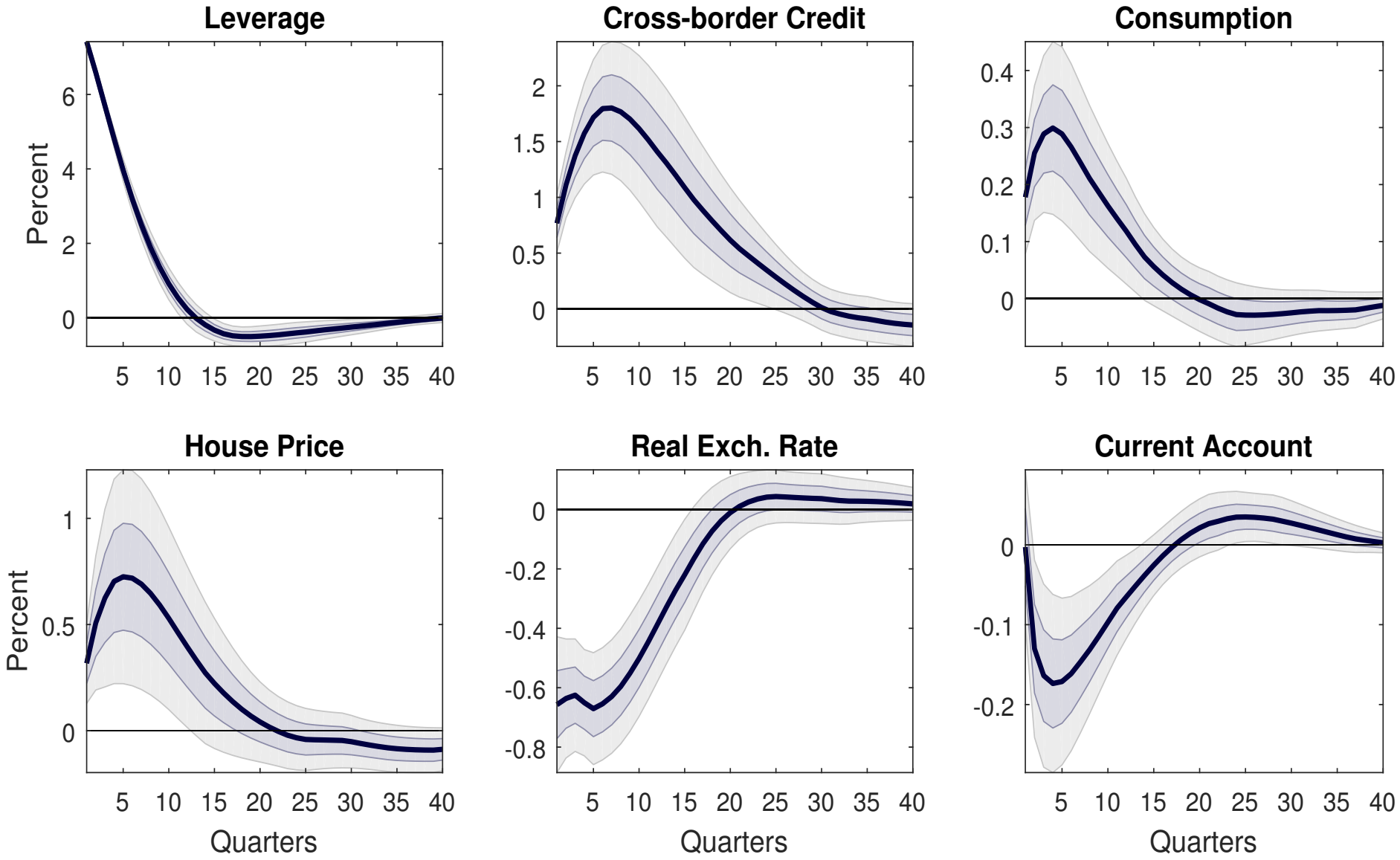
$$LEV_t = \alpha + \beta x_t + \varepsilon_t$$

x_t								
ΔFFR_t	-2.617^{**}						-2.819^{**}	-2.876^{**}
	$[-2.164]$						$[-2.407]$	$[-2.464]$
u_t^m		-0.0126						
		$[-0.172]$						
VIX_t			-0.00275^{***}				-0.00289^{***}	-0.00264^{***}
			$[-2.744]$				$[-2.940]$	$[-2.649]$
$R_t^L - R_t$				-1.0078^{*}				-0.844
				$[-1.711]$				$[-1.377]$
Y_t^{US}					1.304			
					[0.953]			
Y_t^w						6.101		
						[1.390]		
α	-0.00178	-0.000286	-0.0579^{*}	-0.0156	-0.00827	0.0192	0.0589^{***}	0.0658^{***}
	$[-0.221]$	$[-0.0341]$	[2.568]	[1.280]	$[-0.693]$	$[-1.197]$	[2.669]	[2.919]
Obs.	111	111	111	111	111	111	111	111
Adj. R^2	0.041	0.000	0.065	0.026	0.008	0.017	0.096	0.103

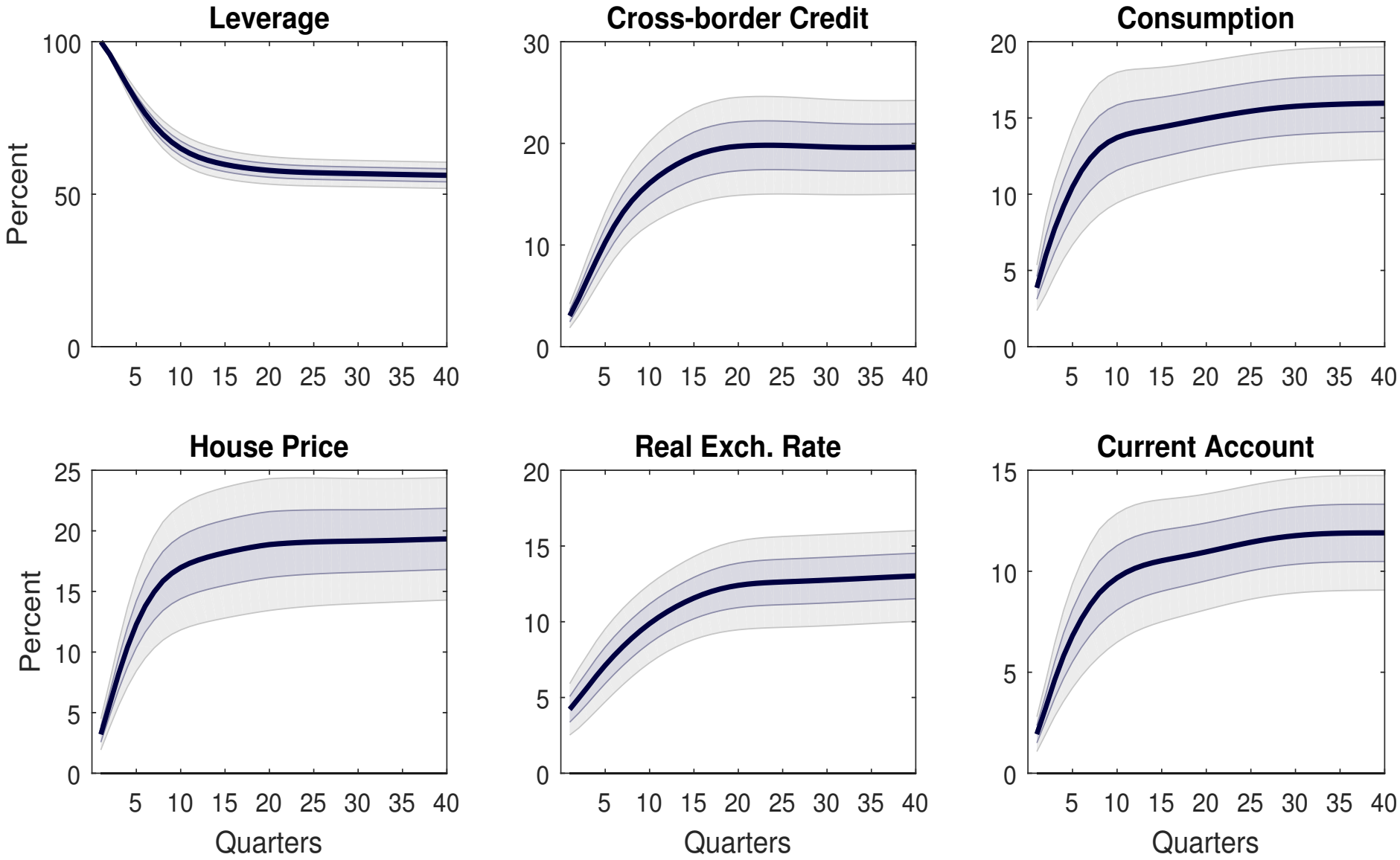
Identification of push shock that shifts international supply of credit in the data

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 χ 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)

Tasmission consistent with model and the stylized facts of boom bust in capital flows



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



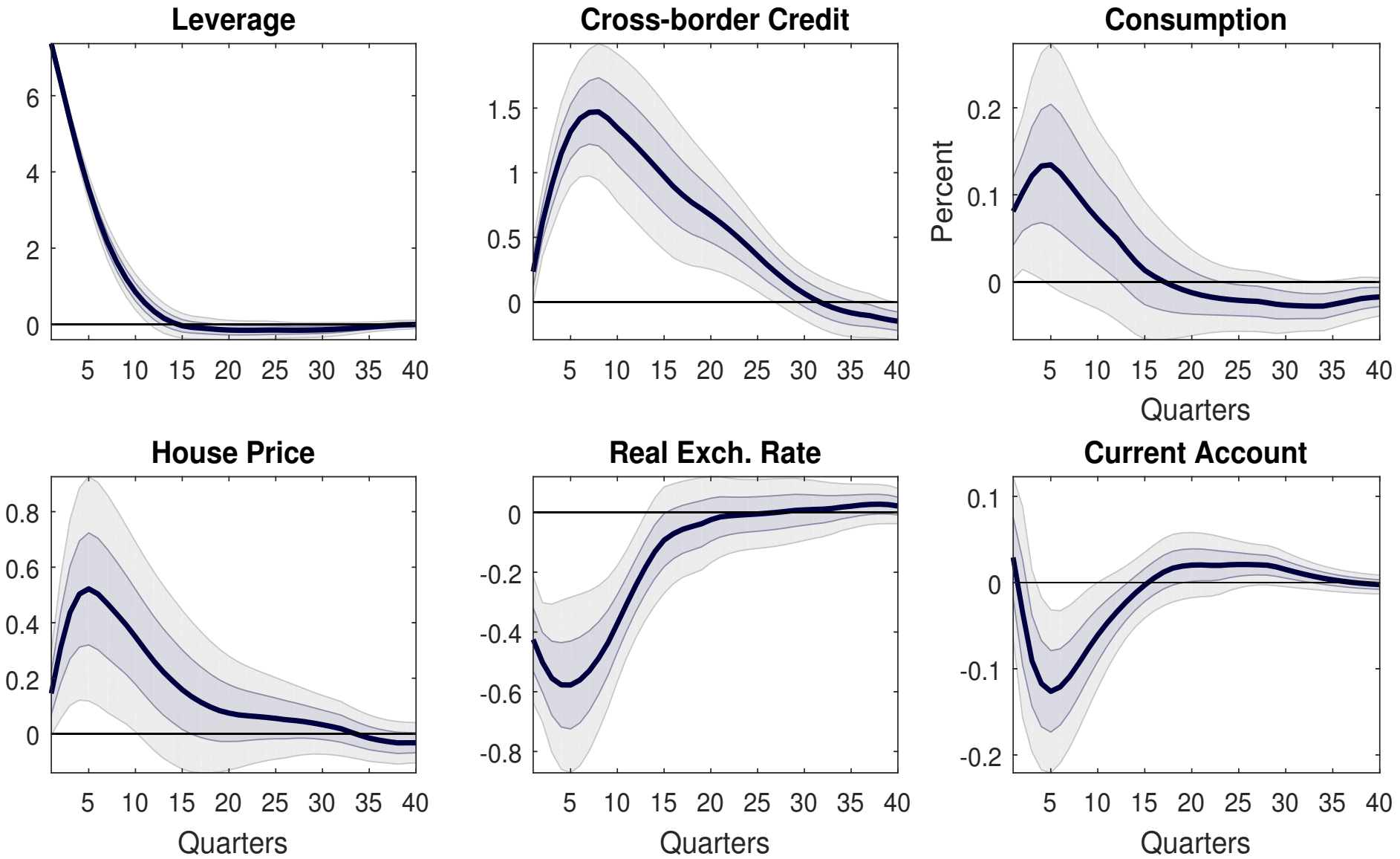
Robustness to controlling for global factors in LEV

- 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

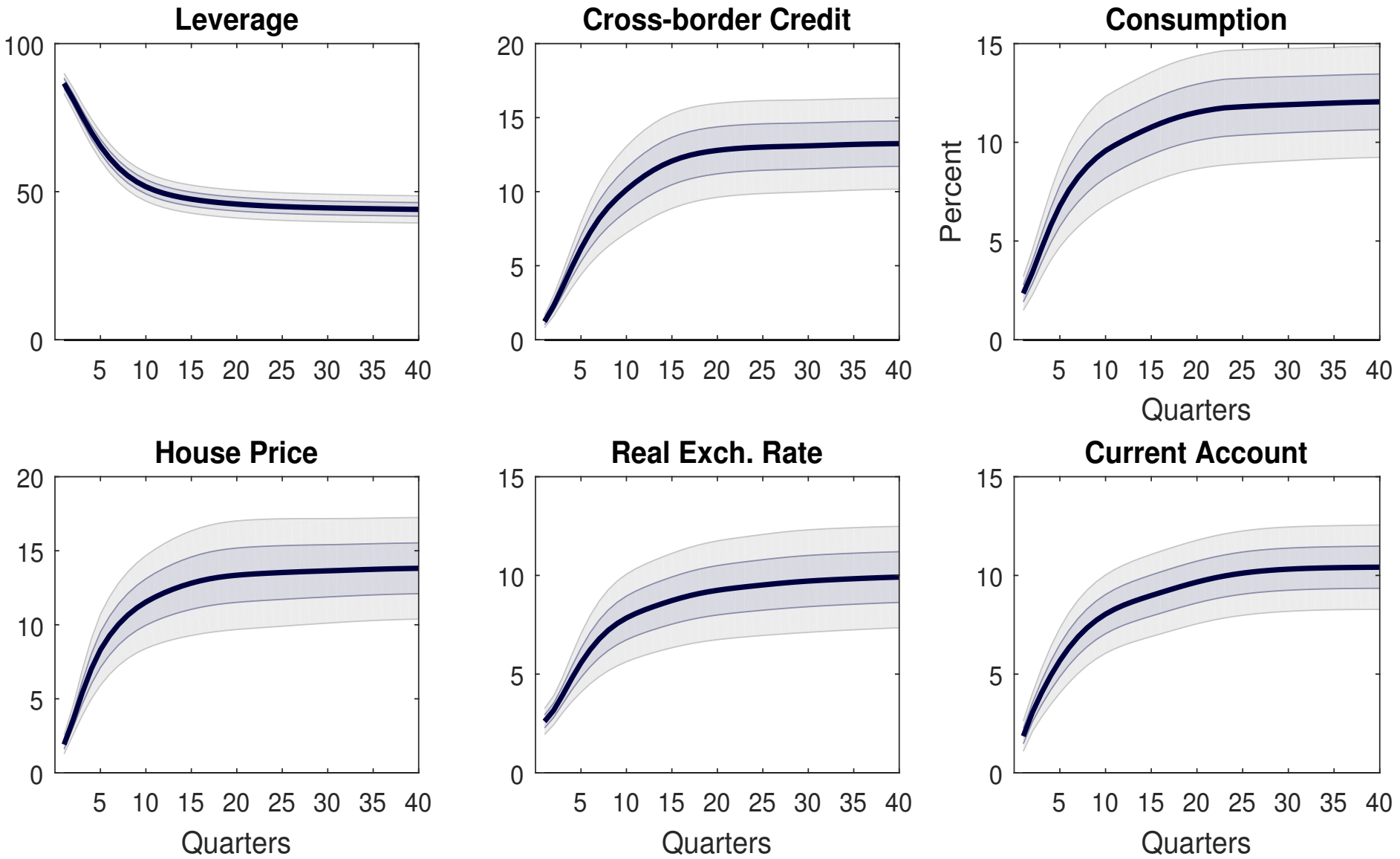
$$X_{it} = \left[\begin{array}{ccccccc} Y_t^w & LEV_t & KF_{it} & C_{it} & HP_{it} & RER_{it} & CA_{it}/Y_{it} \end{array} \right]$$

  - Shock to leverage of US broker-dealers still identified with Choleski

IRFs to Leverage Shock (Robustness)



Variance Decomposition (Robustness)



Understanding Cross-Country Heterogeneity

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

- Derive sensitivity of response of endogenous variable to η and θ

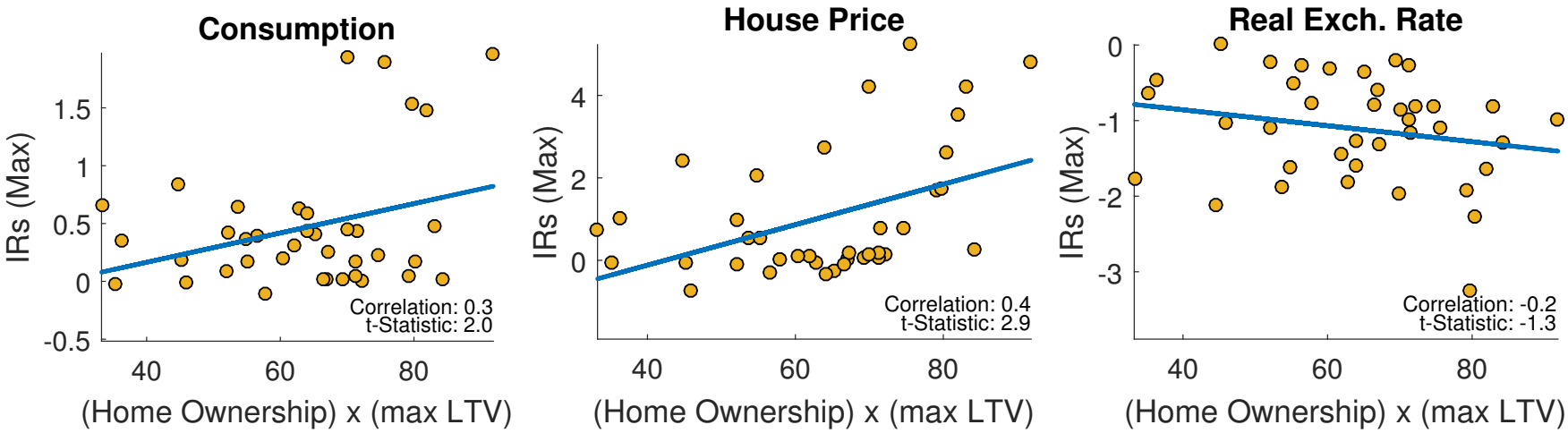
$$\frac{\partial^2 x}{\partial \chi \partial \eta} \qquad \text{and} \qquad \frac{\partial^2 x}{\partial \chi \partial \theta}$$

  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. θ_i and η_i in the data

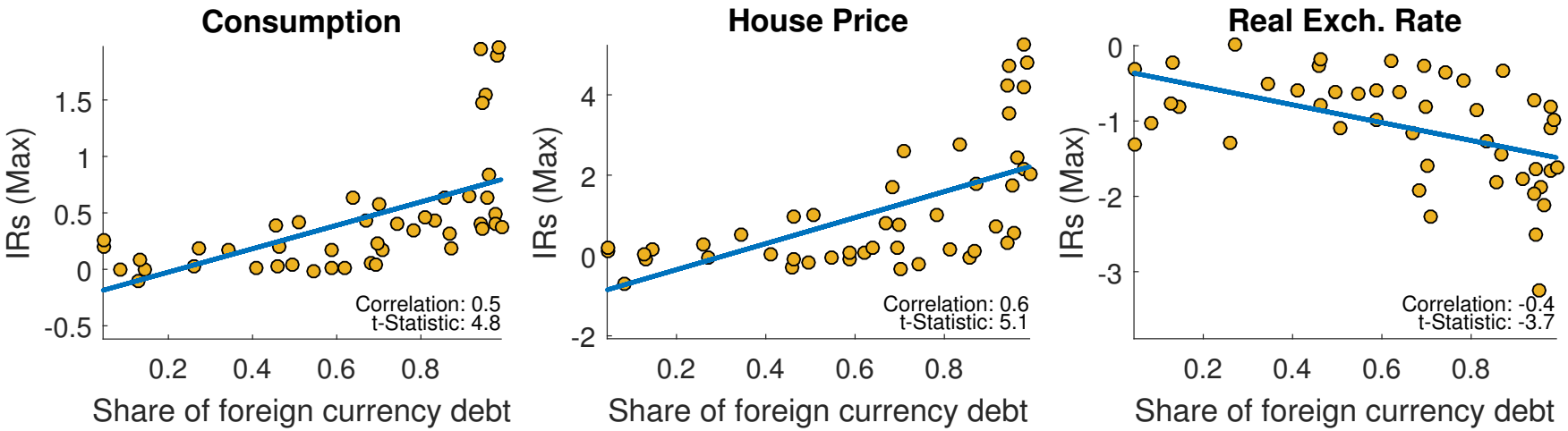
LTV Ratios

- 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



FX Shares

- Prediction 2: *A larger share of foreign currency debt (lower η) may imply a higher sensitivity of C_i, HP_i, and RER_i to shocks to χ*
  - Lower η implies larger collateral valuation and debt valuation effects
  - If collateral effect dominates valuation effect, higher η leads to higher credit and demand, and hence larger real exchange rate response, potentially amplifying the initial credit impulse



Conclusions

- International credit supply shock $\Rightarrow$ Boom in receiving economy in the model and in the data
- Theory: Source and trasmission of international credit supply shocks $\Rightarrow$ 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)

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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.

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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.

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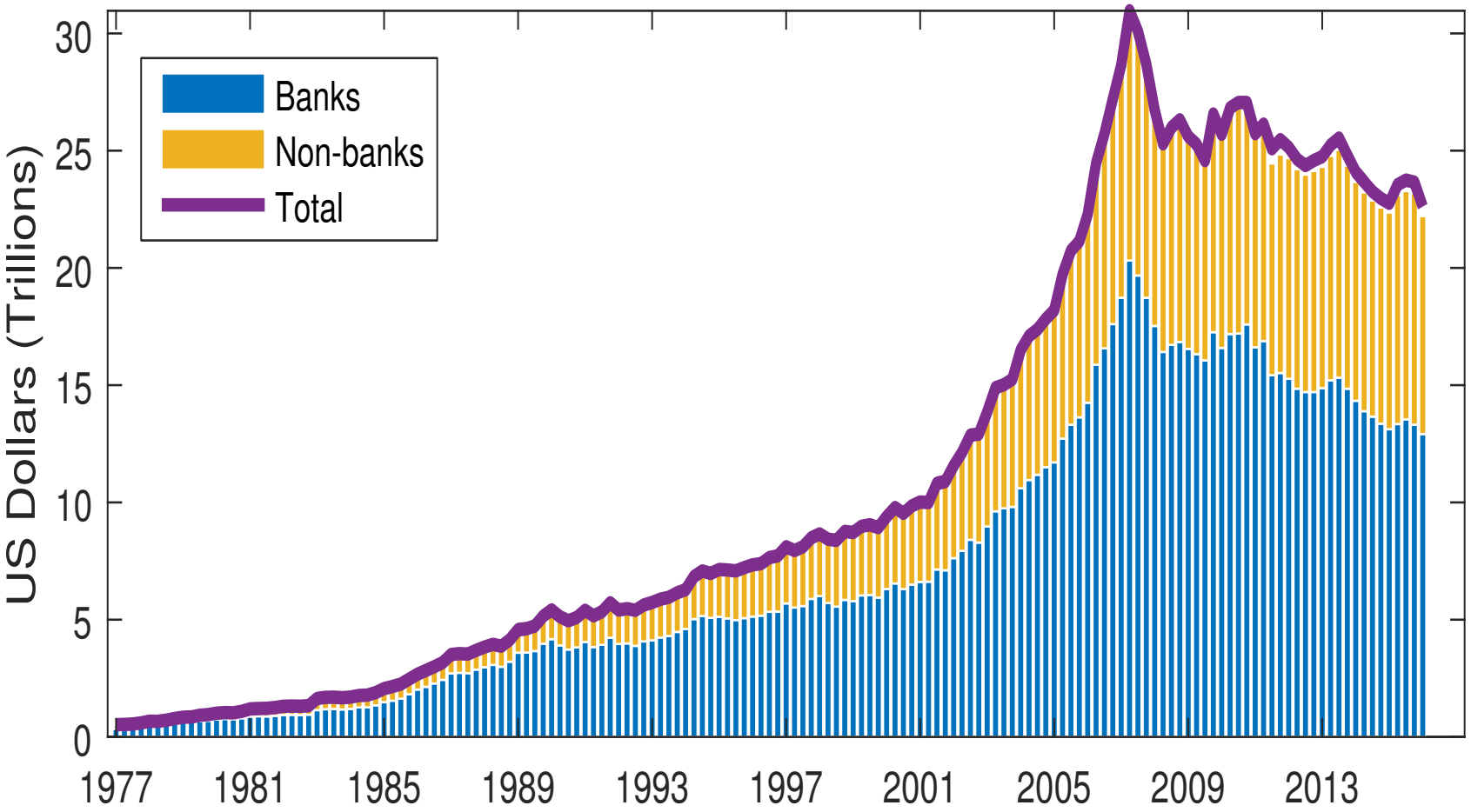
Cross-Border Credit: Banks vs. Non-Banks



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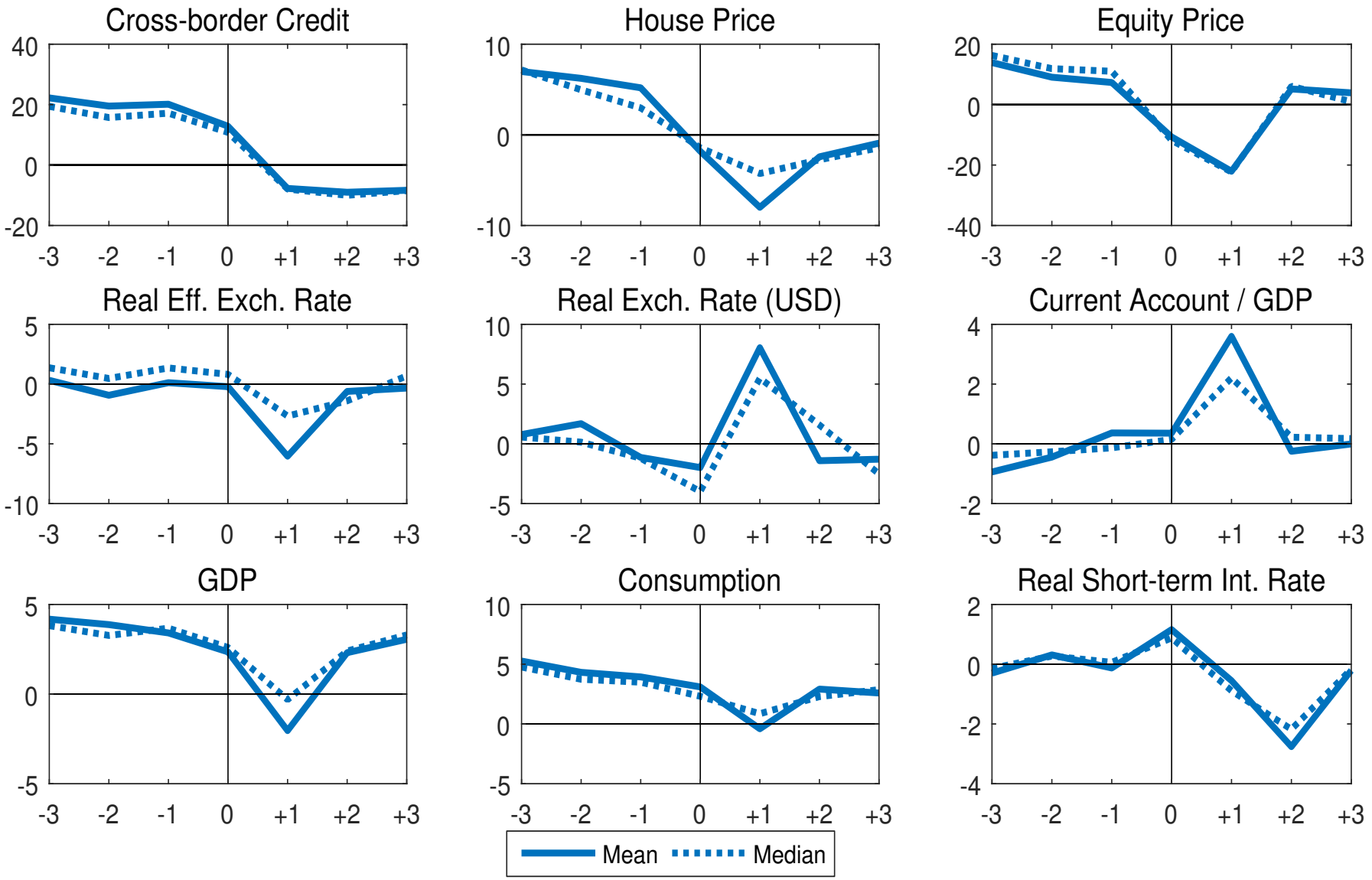
Boom-Bust Cycles in Cross-Border Credit

- 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



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Event Study: Summary Statistics

Mean Across Episodes

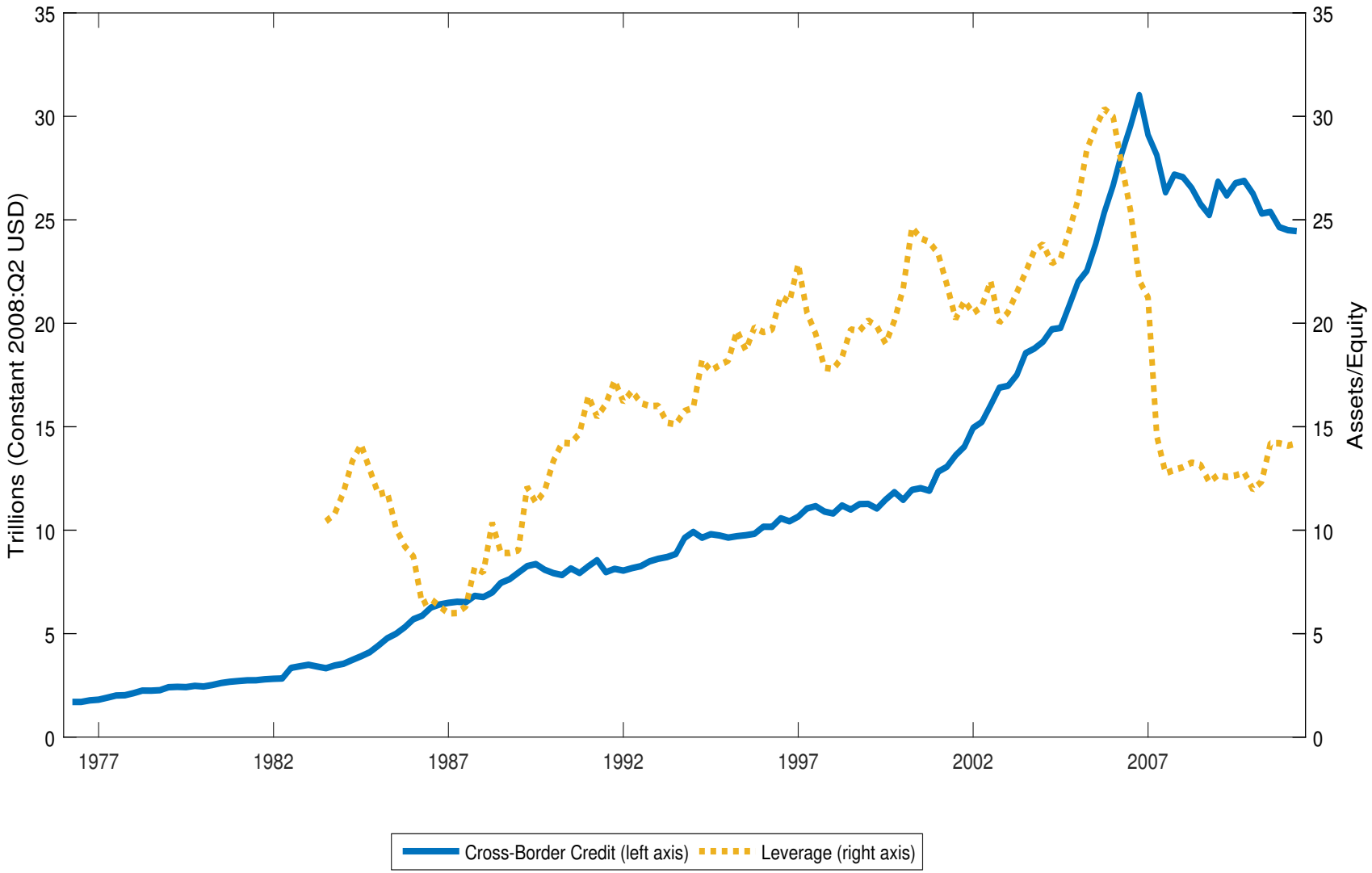
	Boom			Bust			Boom-bust		
	ALL	AE	EM	ALL	AE	EM	ALL	AE	EM
Number	2.4	2.5	2.3	1.4	1.1	1.6	0.9	0.8	0.9
Duration	7.3	8.8	6.1	4.4	3.7	4.8	12.7	13.4	12.4
Max	32.6	28.5	35.9	-4.2	-4.6	-4.1	36.3	29.5	40.5
Min	5.0	3.7	5.9	-20.4	-17.5	-21.9	-21.8	-19.2	-23.5
Amplitude	131.6	130.1	132.8	-53.2	-36.9	-61.3	103.5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

US Broker-Dealers Leverage



Source: US Flow of Funds

Alternative Identification

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

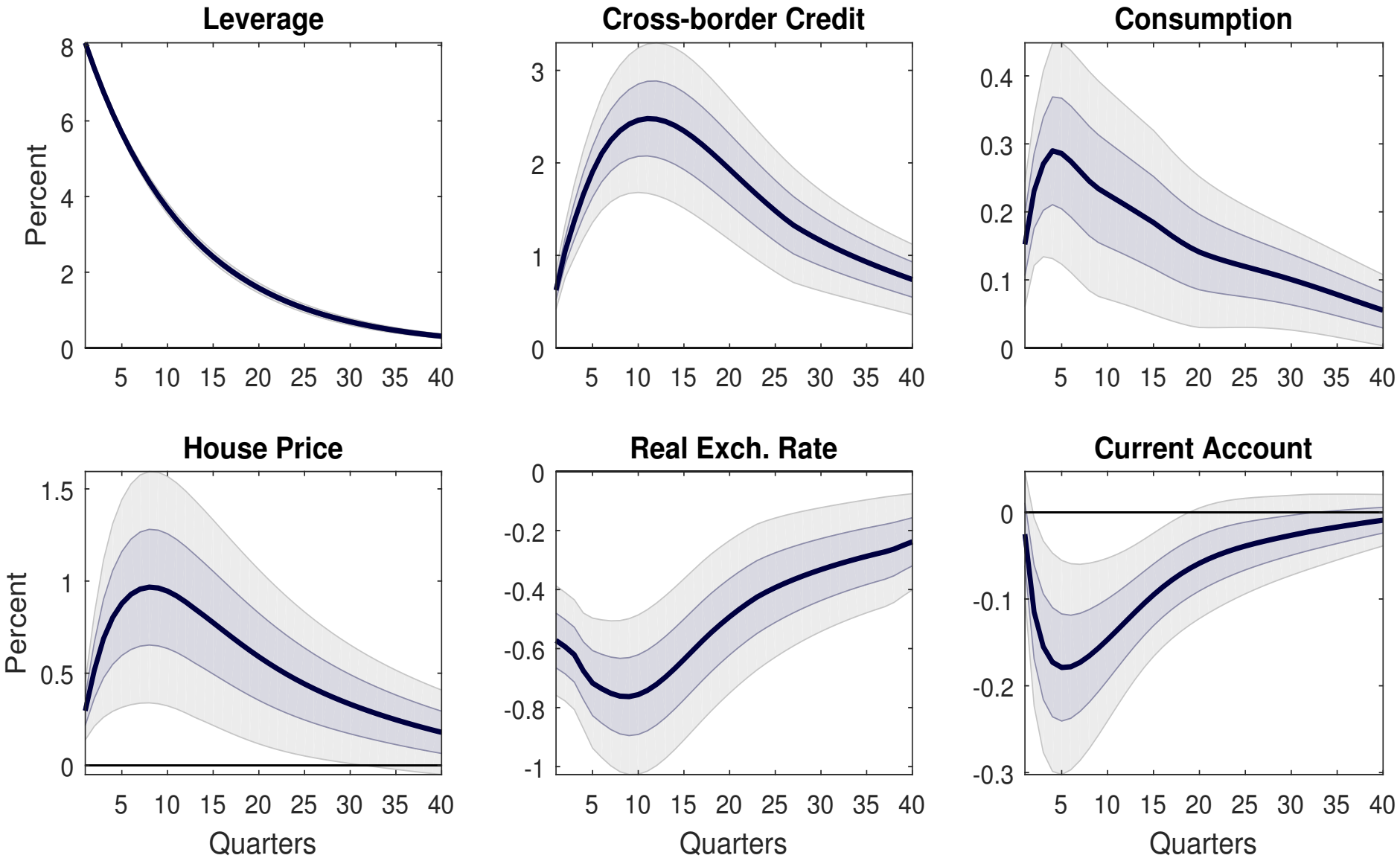
$$\begin{bmatrix} LEV_t \\ x_{i,t} \end{bmatrix} = \begin{bmatrix} F_{11,i} & 0 \\ F_{21,i} & F_{22,i} \end{bmatrix} \begin{bmatrix} LEV_{t-1} \\ x_{i,t-1} \end{bmatrix} + \begin{bmatrix} B_{11,i} & 0 \\ B_{21,i} & B_{22,i} \end{bmatrix} \begin{bmatrix} e_t^{LEV} \\ e_{i,t}^{x} \end{bmatrix}$$

- Can still achieve identification with Choleski decomposition

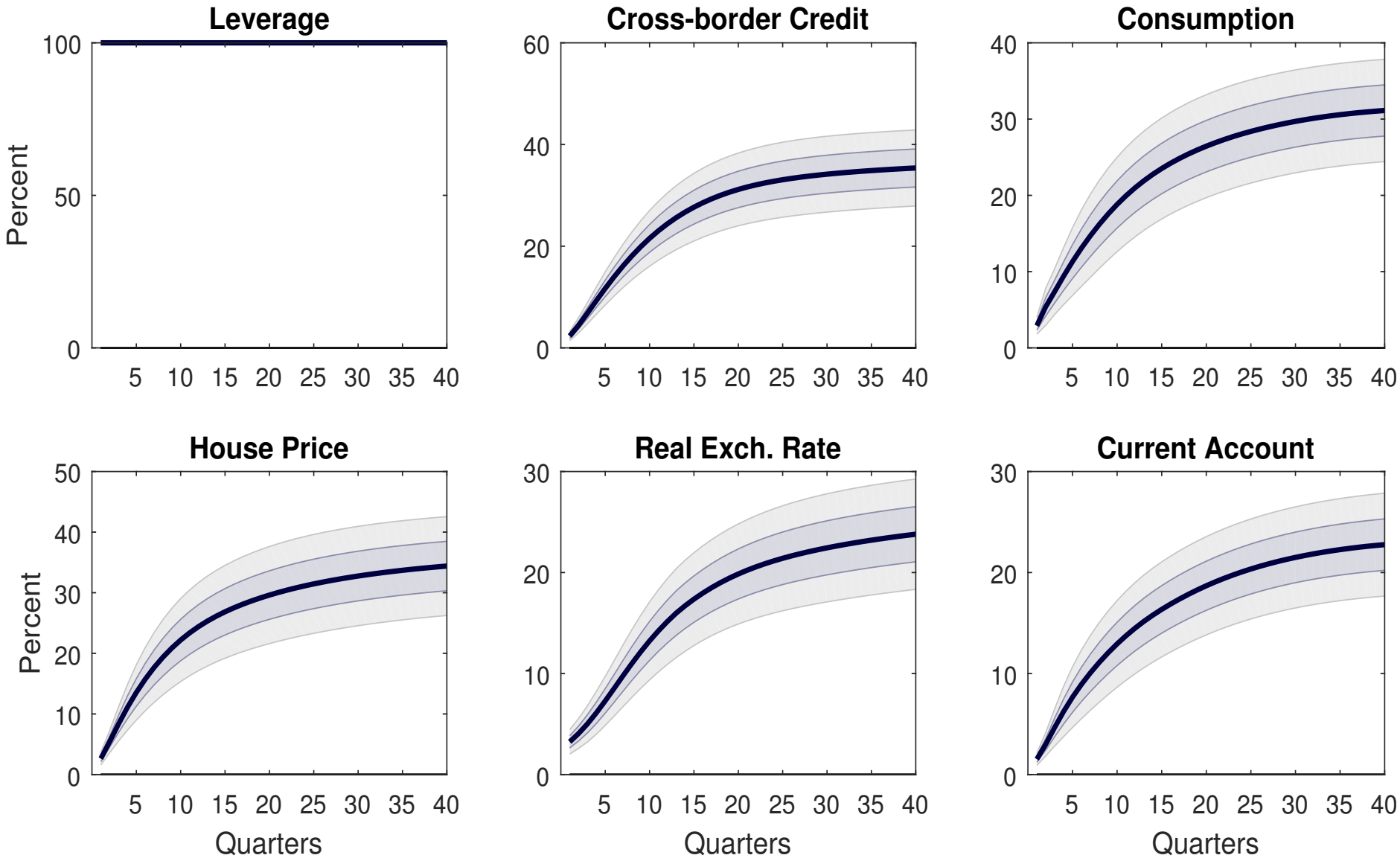
- Robustness
  - "Clean" leverage of variation due to world GDP

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

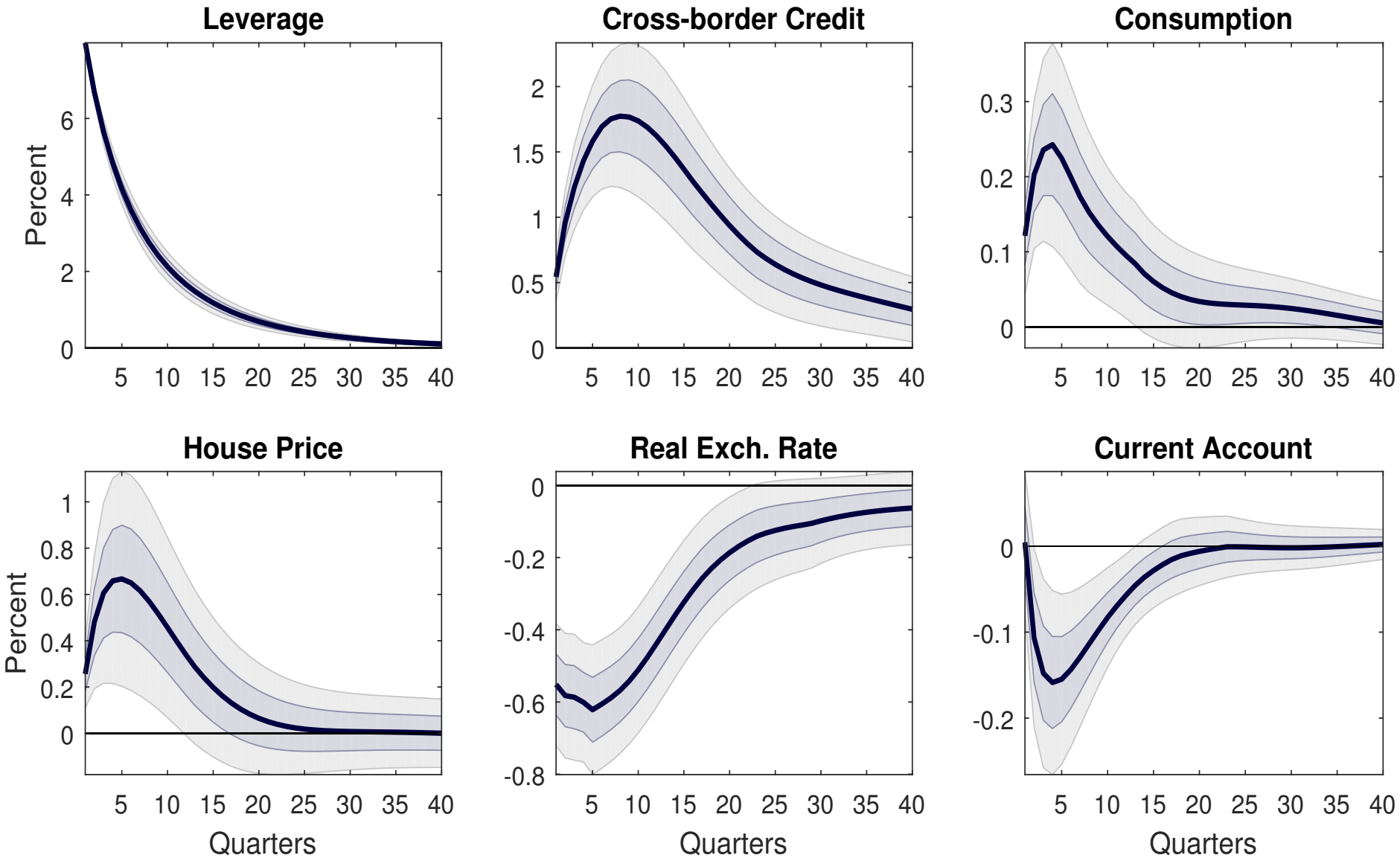
Alternative Identification: IRFs to Leverage Shock



Alternative Identification: Variance Decomposition



Alternative Identification: Robustness



Alternative Identification: Robustness FEVD