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.*

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- Capital inflows typically associated with expansions and asset price booms

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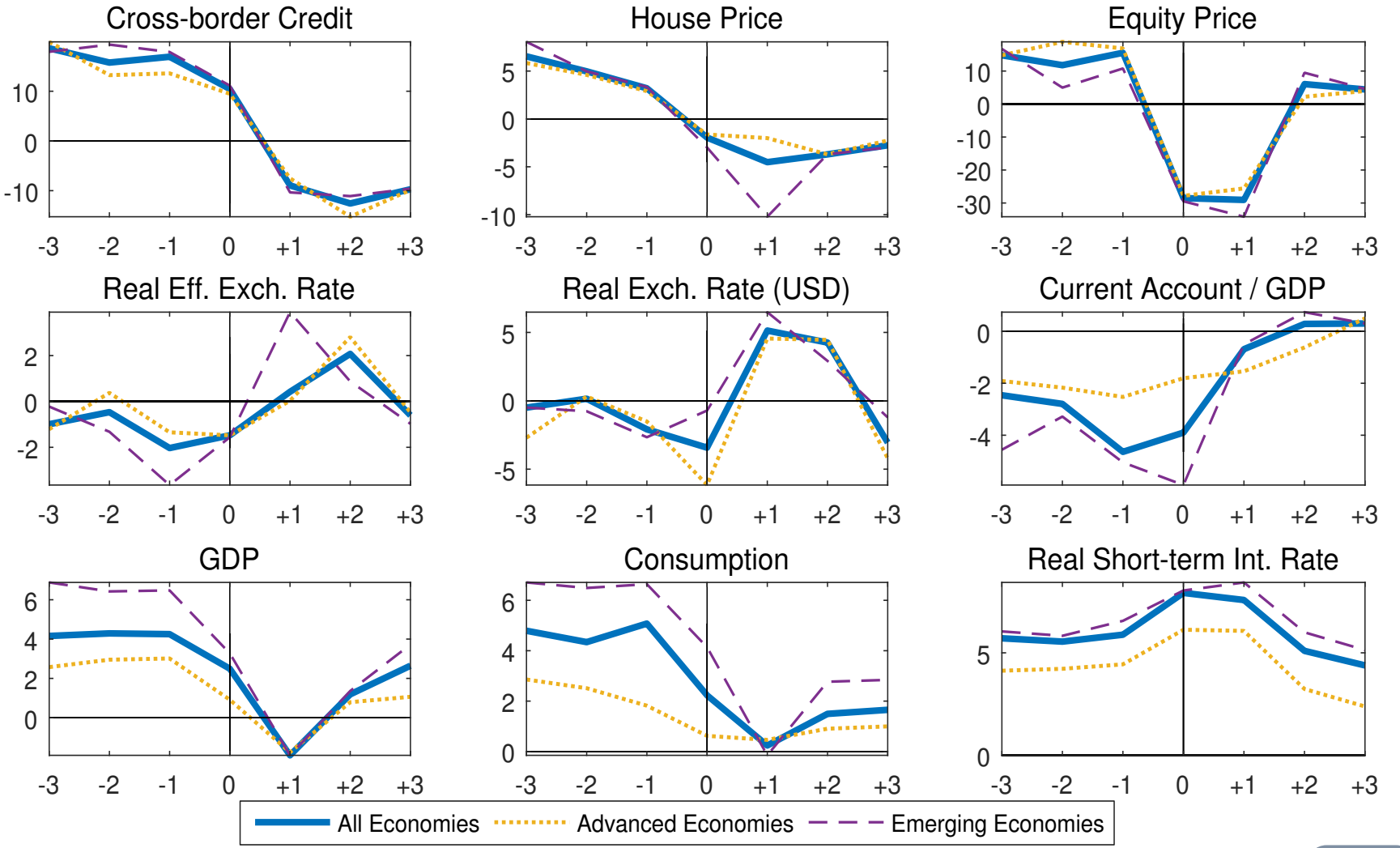

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  - A push factor driven by changes in leverage of global banks
- Policy debate: Manage capital flows to mitigate boom-bust episodes
  - Exchange rate regimes
  - Capital controls
  - Macro-prudential policy

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  - Heterogeneity: Role of foreign currency liabilities and mortgage markets

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  - Heterogeneity: Role of foreign currency liabilities and mortgage markets
- Expansionary capital inflows due to international credit supply shock
  - Both in theory and empirics

Selected Related Literature

- Global financial cycle
  - Cetorelli and Goldberg (2011, 2012), Rey (2013, 2016), Bruno and Shin (2015), Dedola, Rivolta, and Stracca (2015), Gabaix and Maggiori (2015), Forbes, Reinhart, and Wieladek (2016), Aoki, Benigno, and Kiyotaki (2016)

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- Capital flows, house prices, and exchange rates
  - Aizenman and Jinjarak (2009), Gete (2009), Bernanke (2010), Justiniano, Primiceri and Tambalotti (2014), Cesa-Bianchi, Cespedes, and Rebucci (2015), Ferrero (2015), Favilukis, Ludvigson and Van Nieuwerburgh (2017)

Model

Overview of the Model

- Build on Justiniano, Primiceri and Tambalotti (2014)
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- 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 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

$$\begin{aligned} c_1 + q h_1 - b - s_1 f &= p_{H1} y + q h_0 \\ c_2 &= p_{H2} y - R^b b - s_2 R f \end{aligned}$$

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 in Home currency	b/s_1	Deposits	d
Loans in Foreign currency	f		
		Equity	e

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- 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', $\phi'' > 0$)

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- 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

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  - $u'(c) = \bar{c} > 0$ 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**

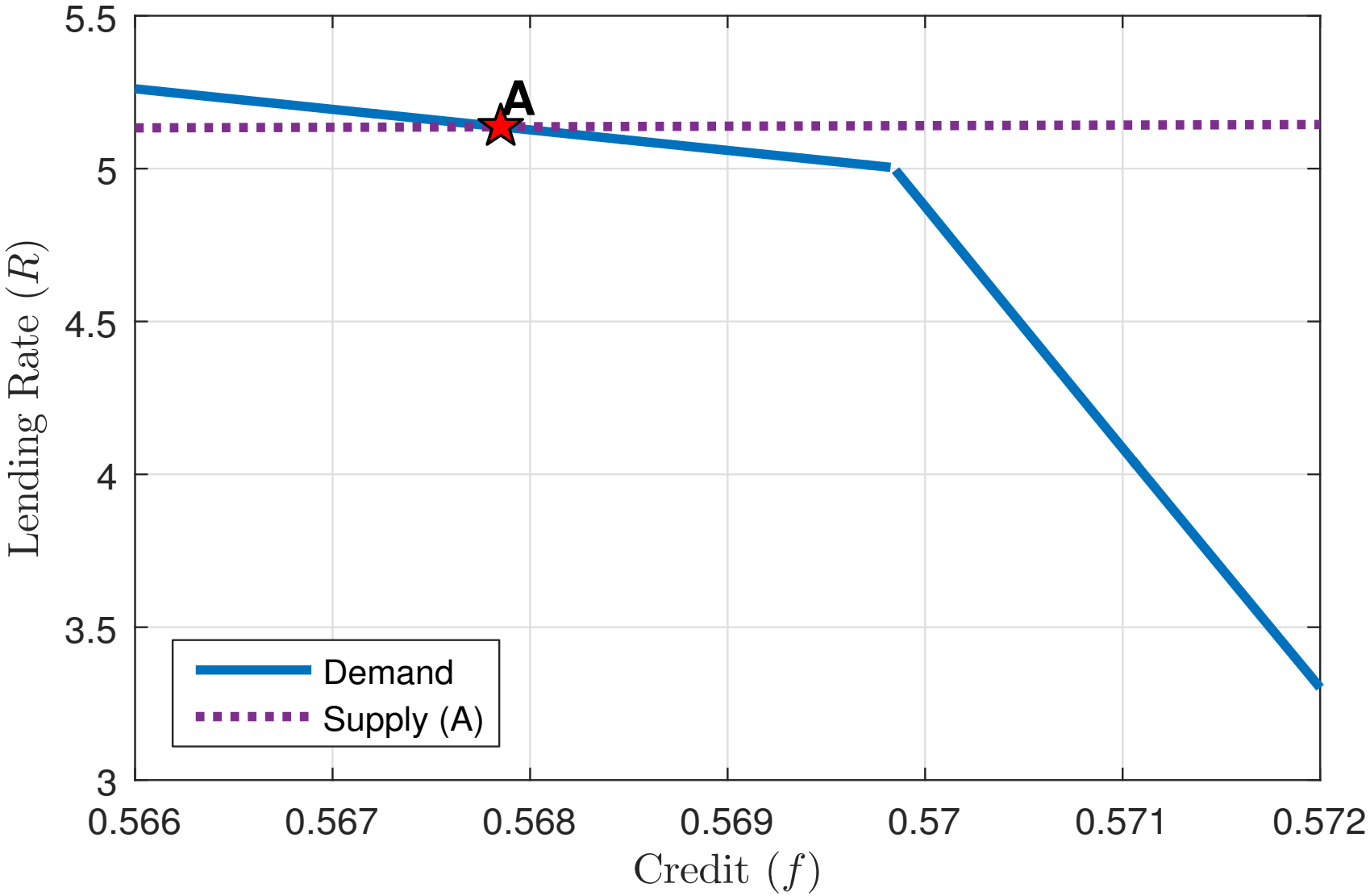
$$s_1 = \left[\frac{\lambda y}{\lambda y^* + (1-\lambda)(1+\eta)f}\right]^{1-\lambda} \qquad s_2 = \left[\frac{\lambda y}{\lambda y^* - (1-\lambda)R(1+\eta)f}\right]^{1-\lambda}$$

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

Equilibrium: Graphical Analysis



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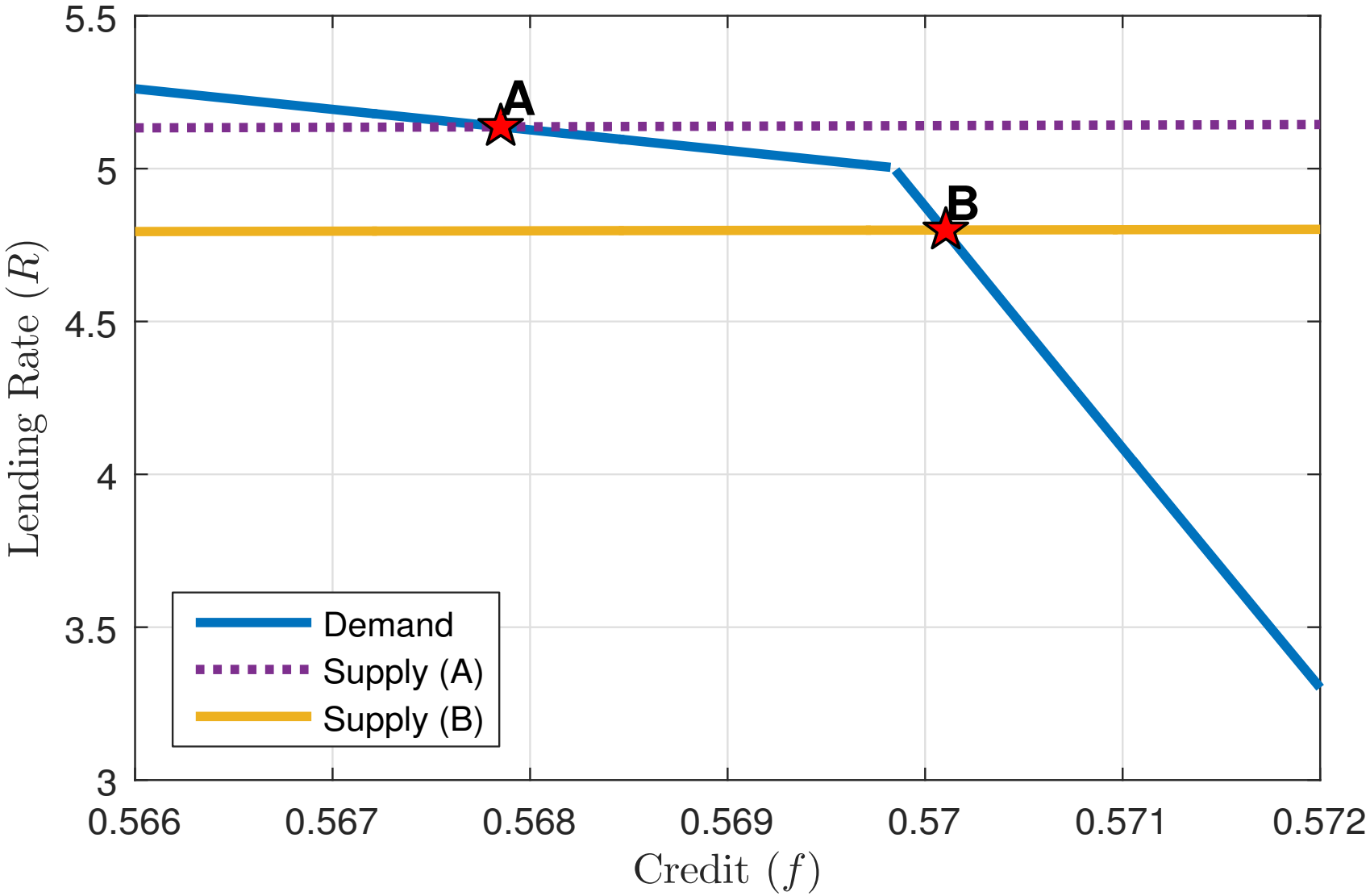

Credit Supply Shock ($\chi \downarrow$)

- International credit supply shock
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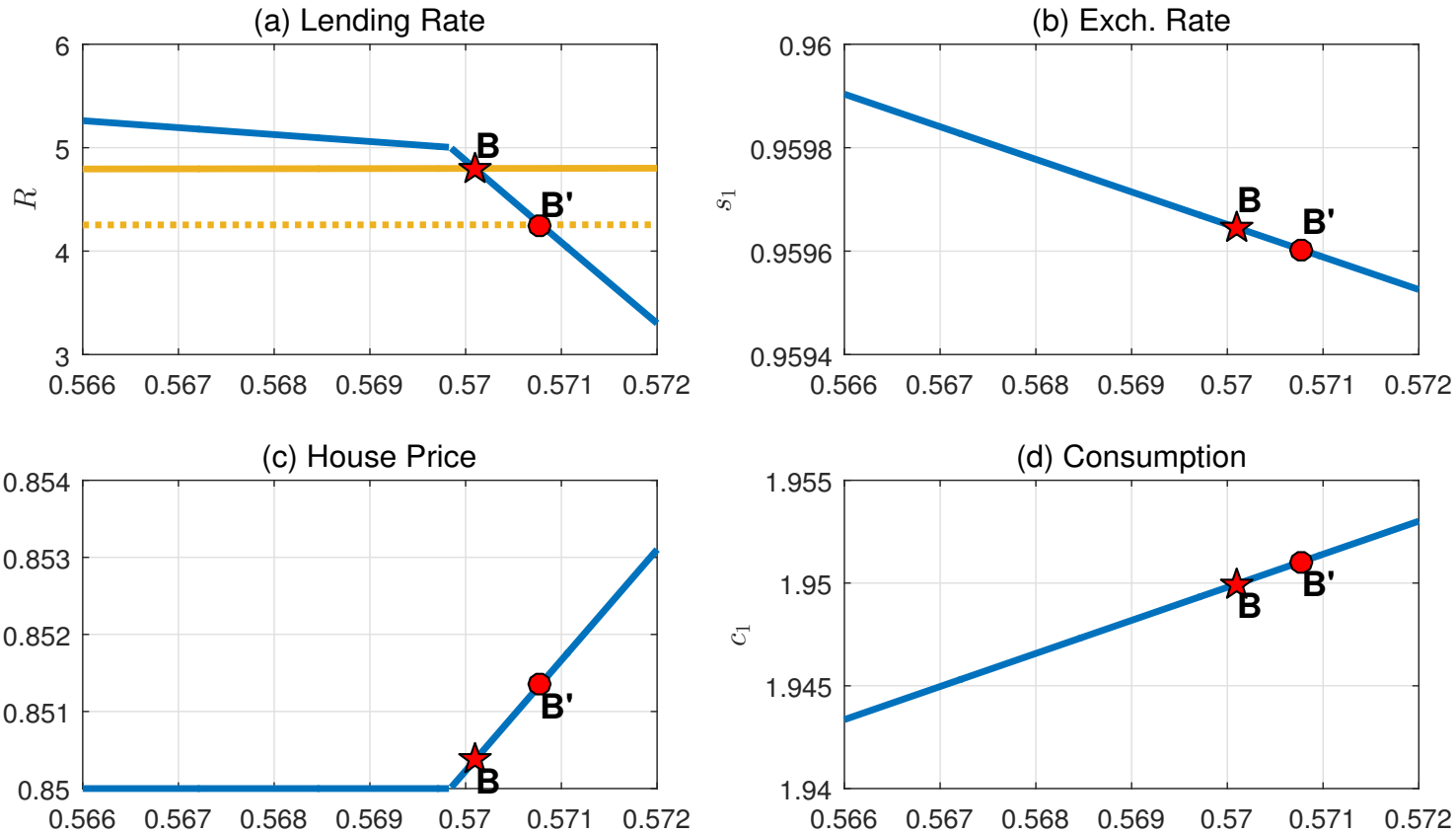

Credit Supply Shock: Summary

- 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 ($s_1 \downarrow$)
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- 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

Data

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- Sample: 57 countries between 1977 and 2012 Data Sources

International Credit Claims

- Foreign banks' claims to country i from BIS data

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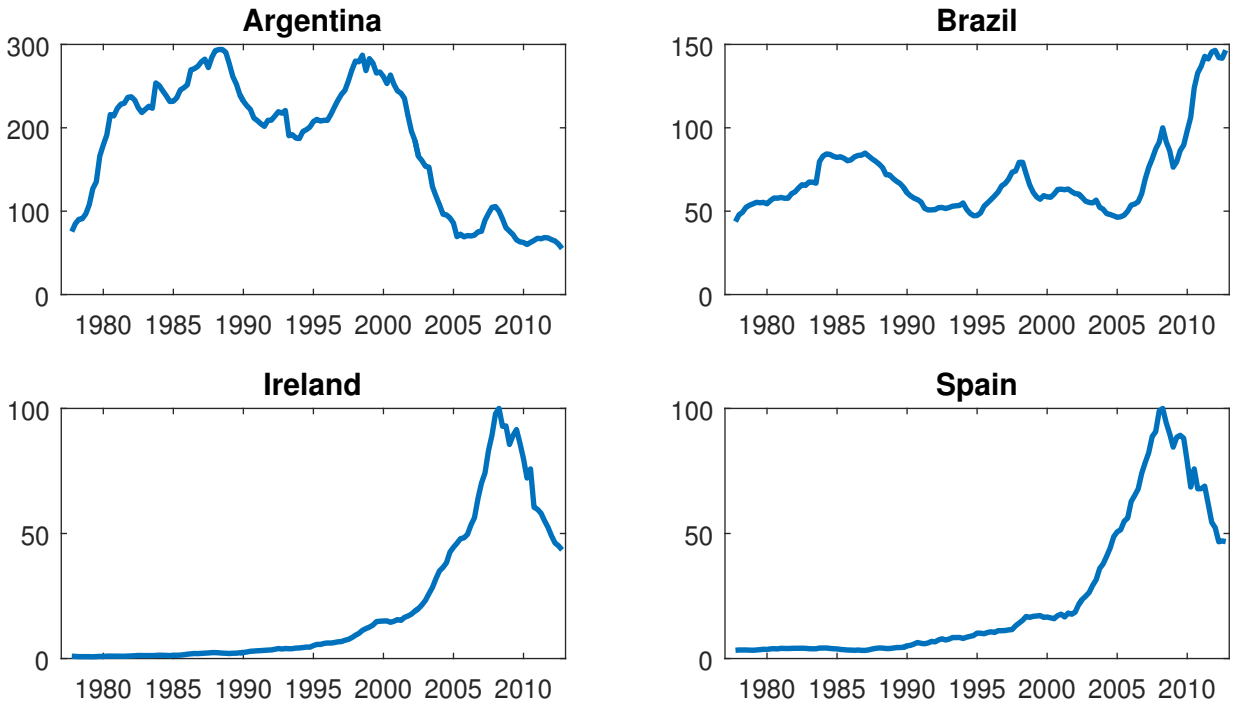

International Credit Claims

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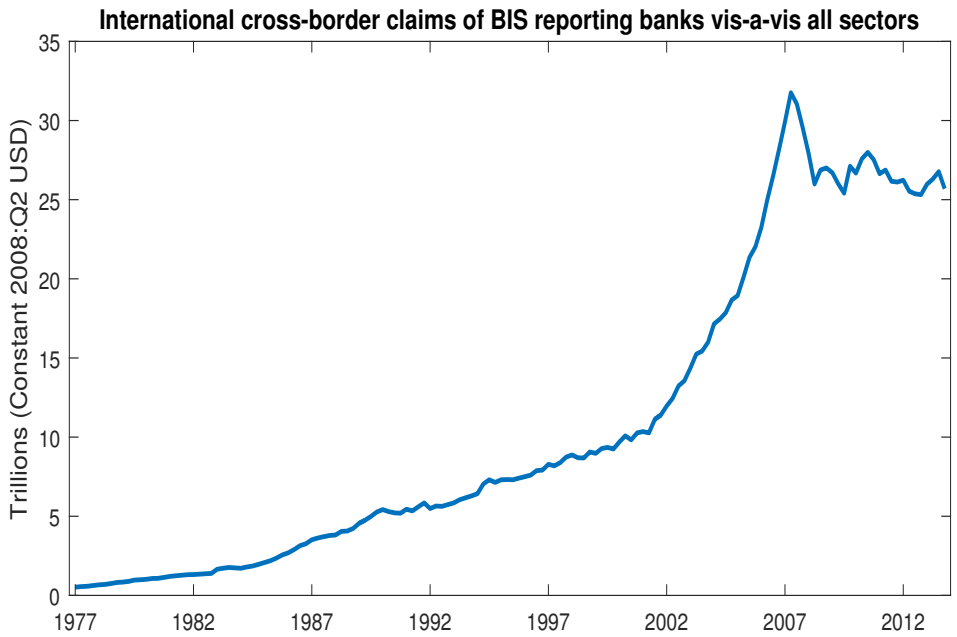
$$KF_{it} = \sum_{j=1(j\neq i)}^{N} KF_{ij,t}$$

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



Split

International Credit Supply Shock

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- 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

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

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- $LEV_t \equiv$ Leverage of US broker-dealers (source: Flow of Funds)
  - Shock to LEV_t = International credit supply shock

Identification and Estimation

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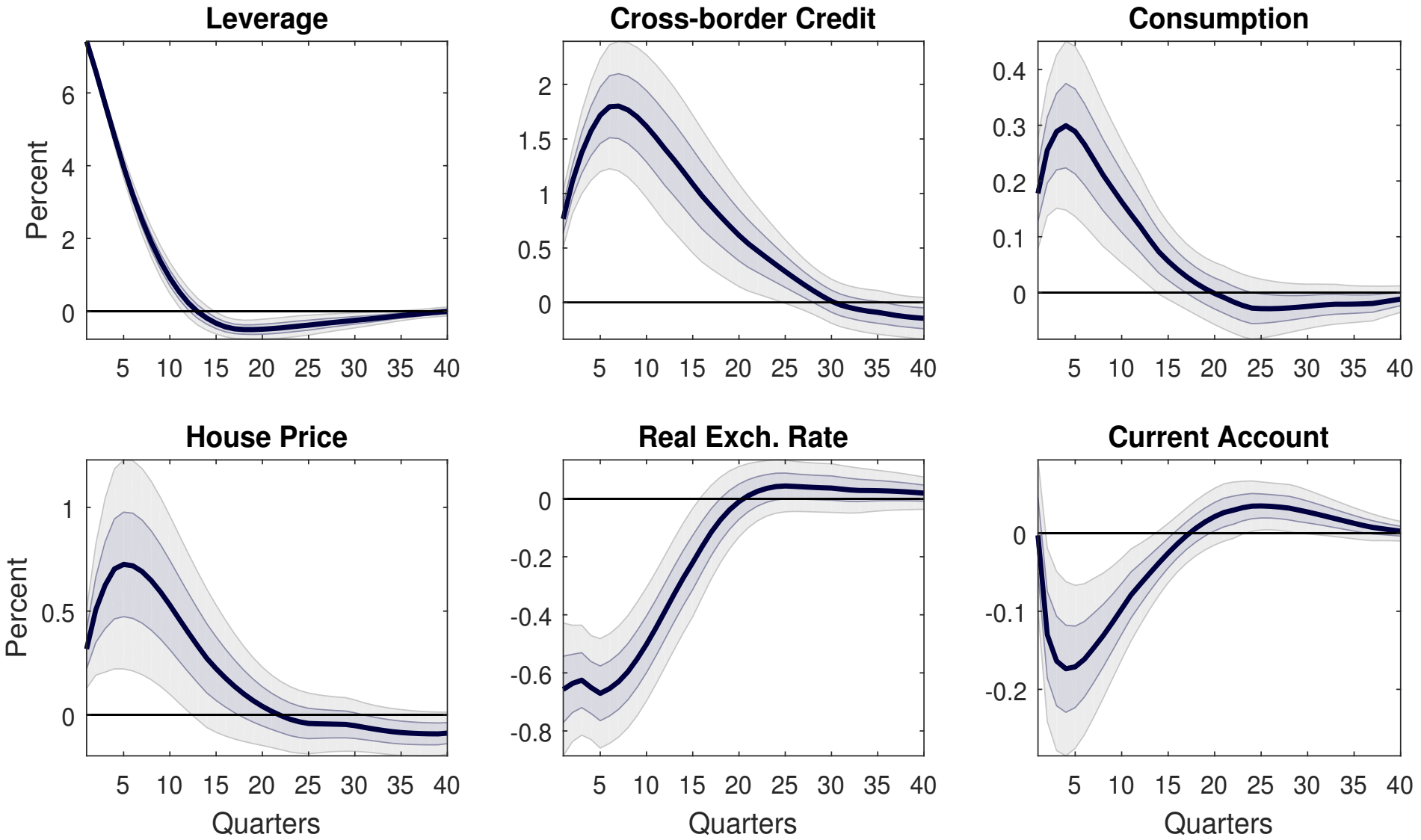
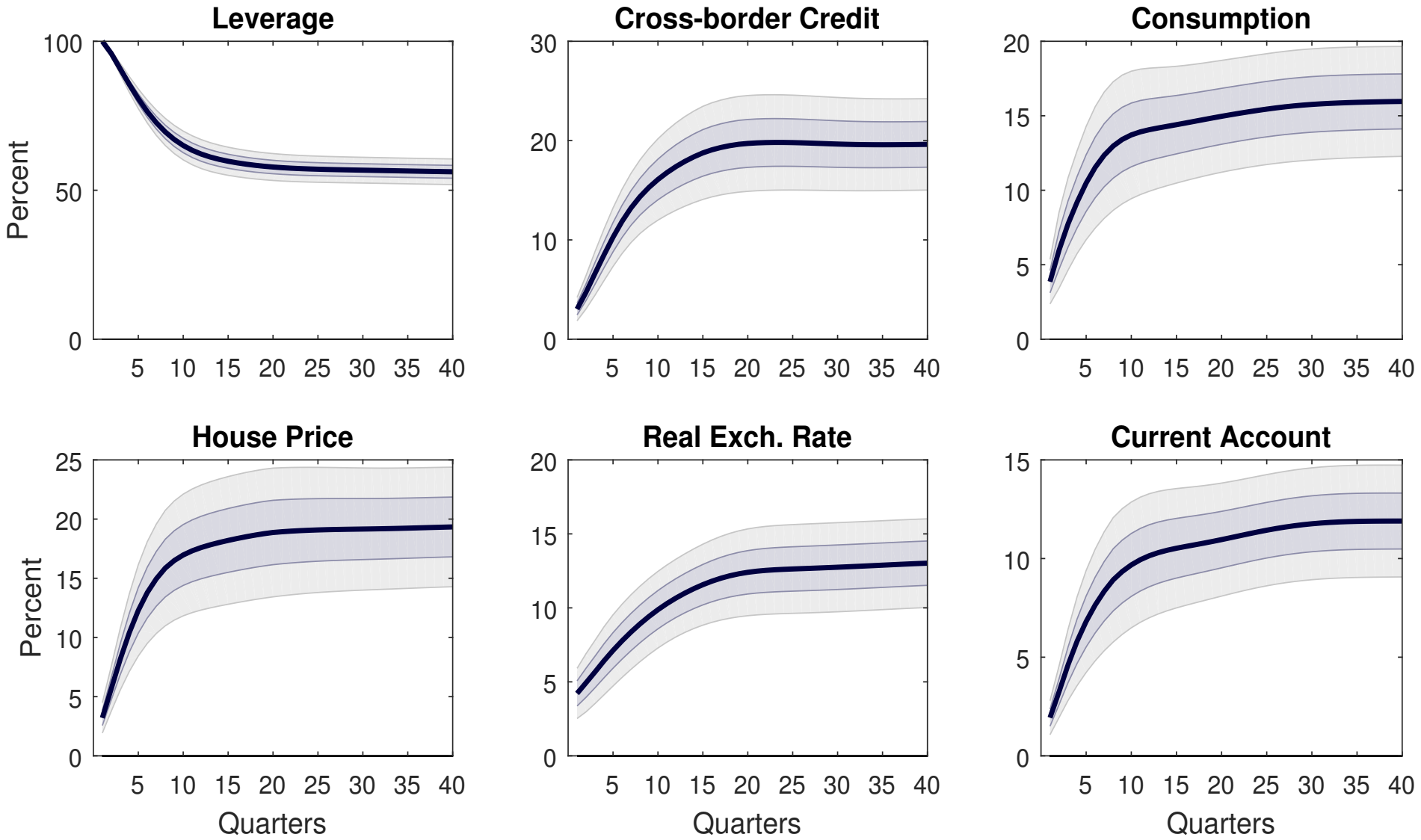
- Choleski identification
  - Mean group estimator (Pesaran and Smith, 1995)

IRFs to Leverage Shock



Variance Decomposition



Robustness

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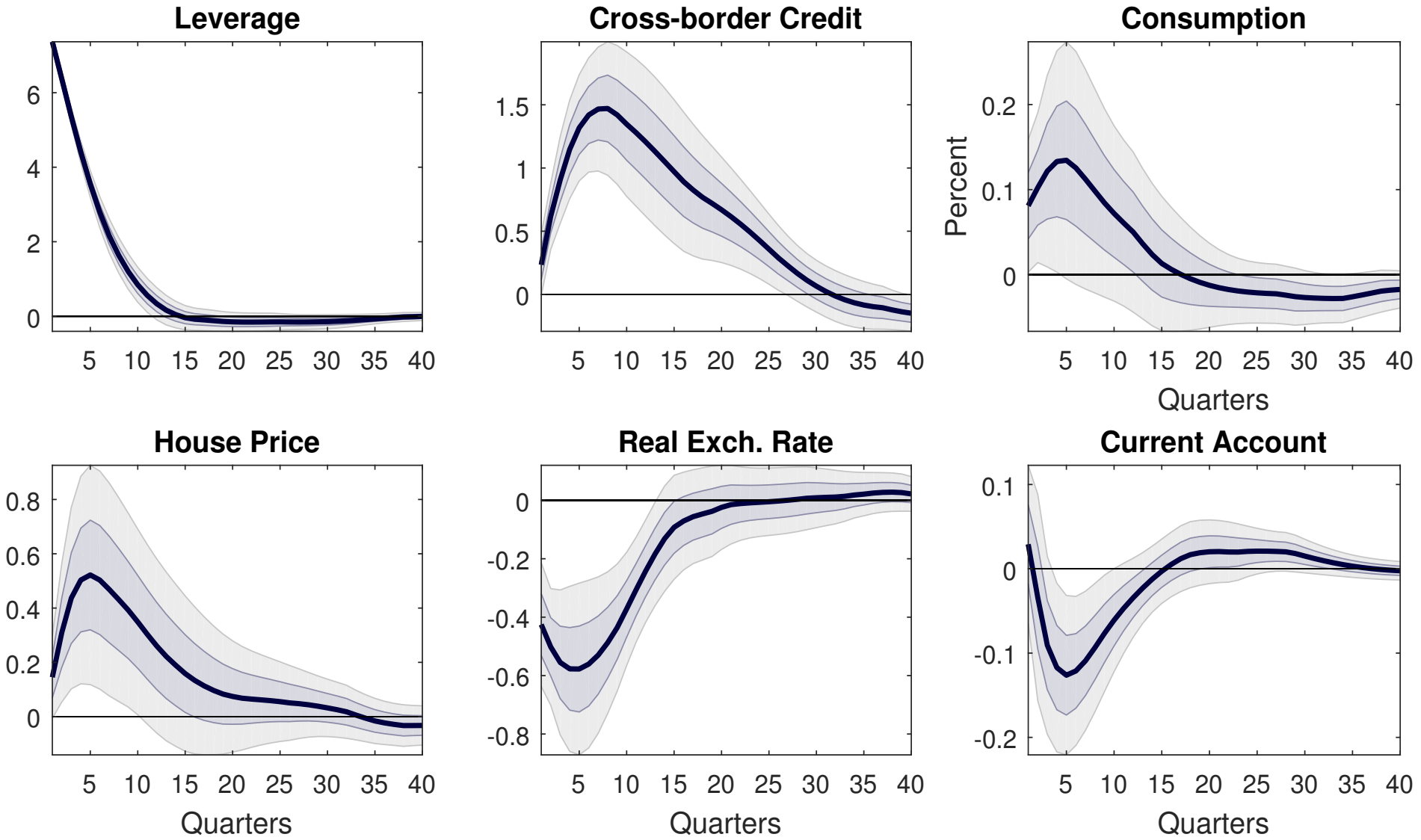
  - No single country can affect leverage of global banks
- But LEV_t could be affected by globally synchronized factors
- Synchronized shocks should affect world GDP
  - Augment vector of endogenous variables with world GDP

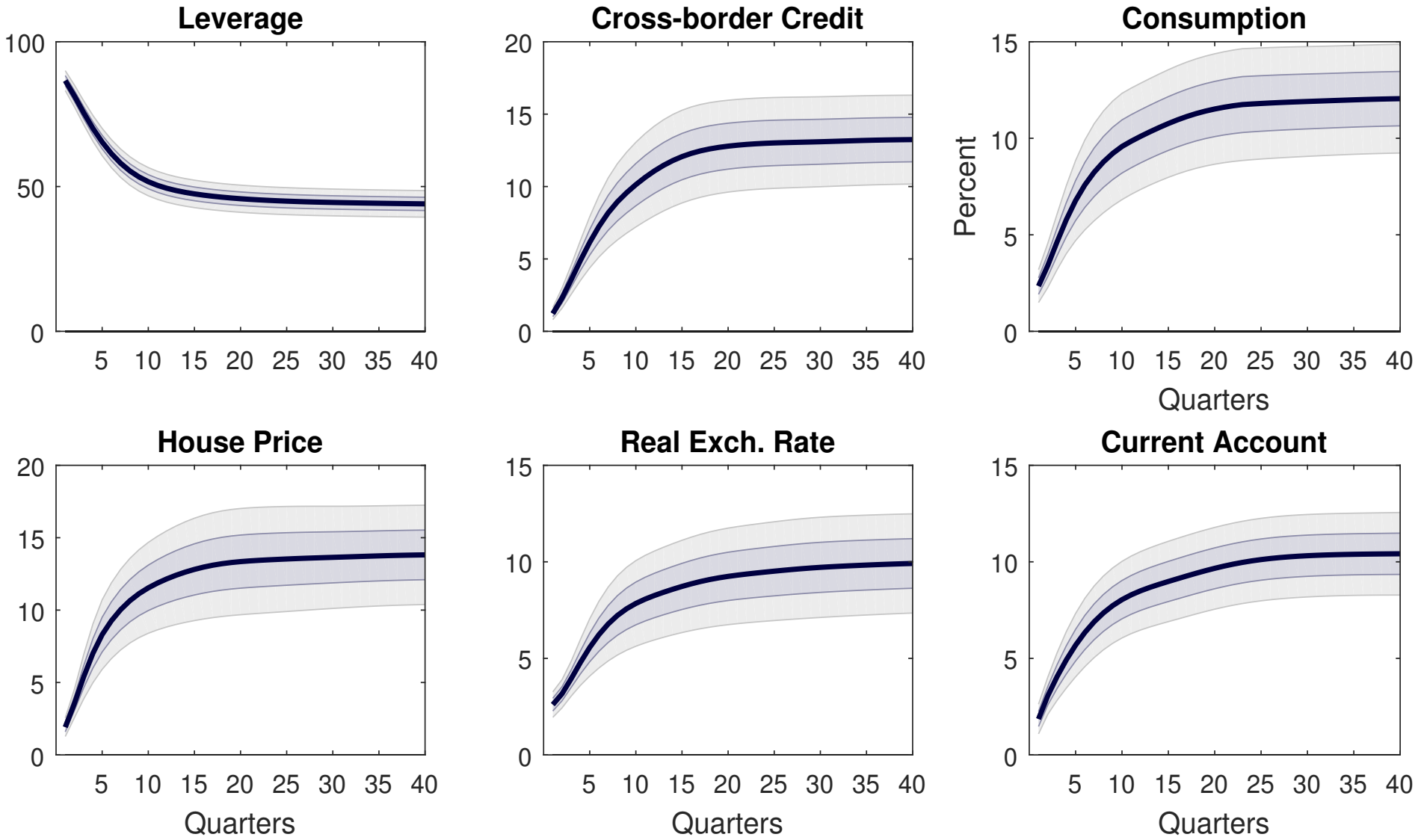
$$X_{it} = \left[\begin{array}{ccccccc} Y_t^w & LEV_t & KF_{it} & C_{it} & HP_{it} & RER_{it} & CA_{it}/Y_{it} \end{array} \right]$$

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

IRFs to Leverage Shock (Robustness)



Variance Decomposition (Robustness)



Understanding Cross-Country Heterogeneity

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

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for $x = \{c_1, q, s_1\}$

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- 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

Share of Foreign Currency Debt

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

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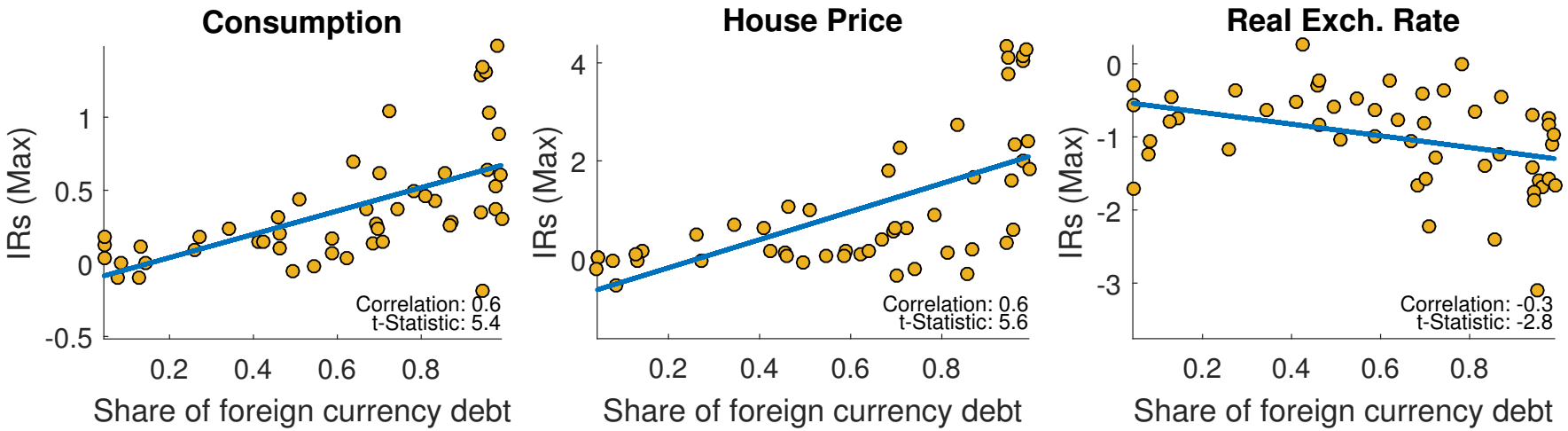

NOTE: Share of foreign currency liabilities computed using BIS banking data.

LTV Ratios

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

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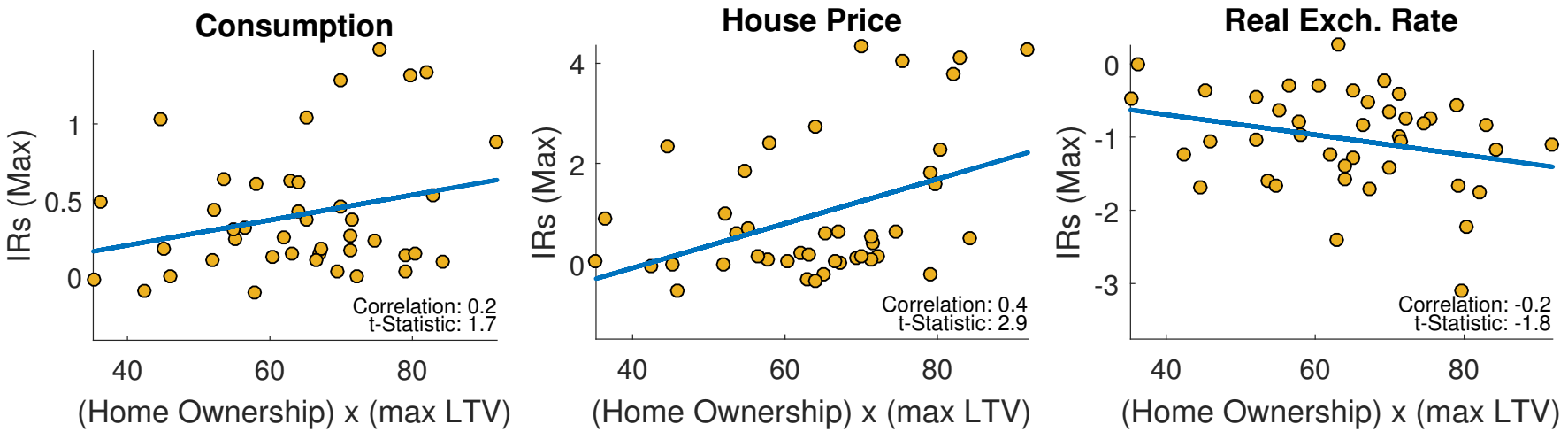


NOTE: LTV is maximum LTV weighted by homeownership rate.

Conclusions

- Positive international credit supply shock $\Rightarrow$ Boom in receiving economy
- Theory: Source of credit supply shocks $\Rightarrow$ Variations of capital requirements
  - Amplification: House prices and exchange rate via collateral constraint
- Empirics: Identified shock to US broker-dealers' leverage
  - Increases cross-border credit
  - Leads to domestic boom
  - Share of foreign currency liabilities and LTVs account for heterogeneity
- Next on agenda: Quantitative model and policy implications

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)

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.

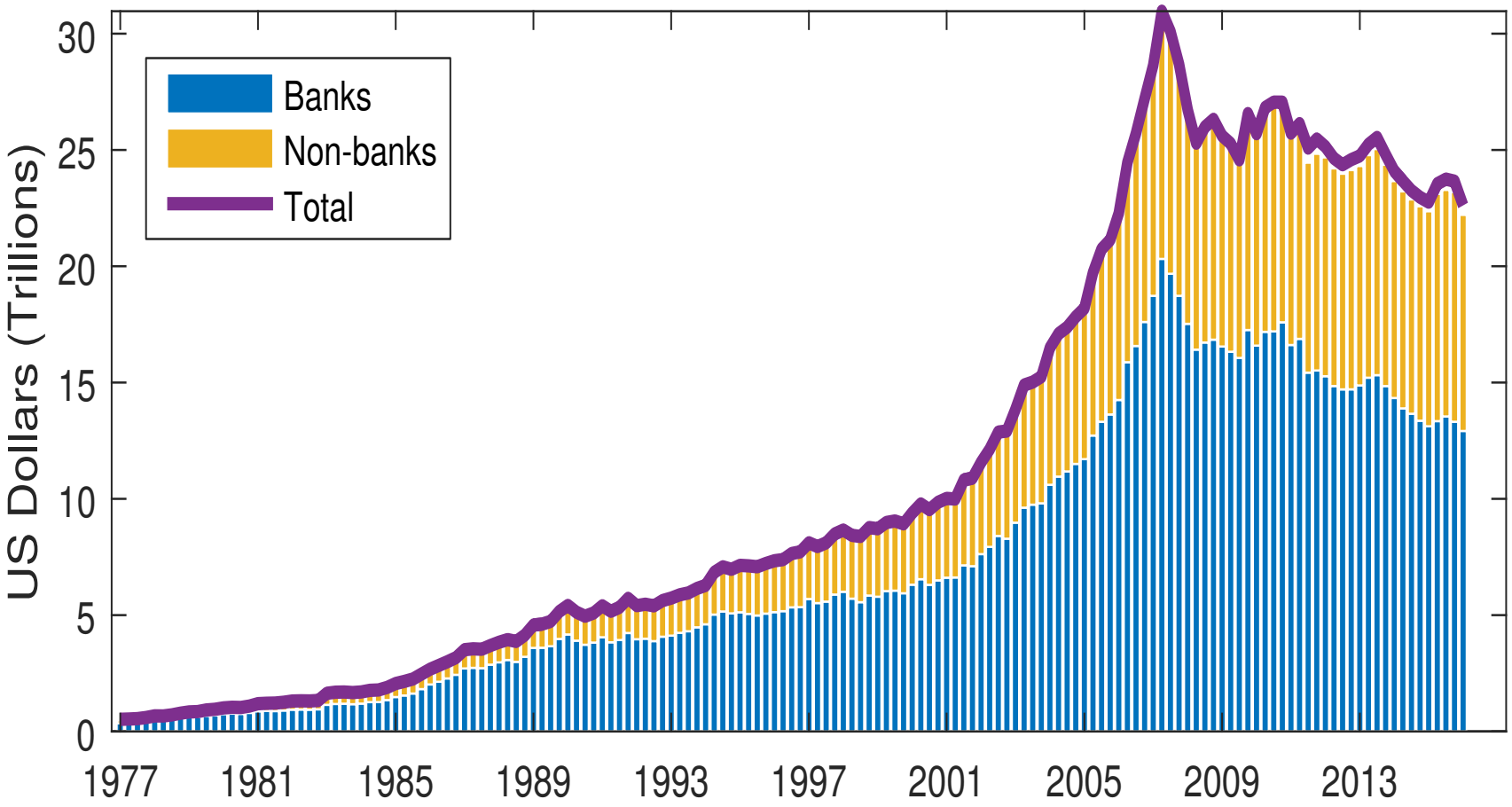
Back

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.

Back

Cross-Border Credit: Banks vs. Non-Banks



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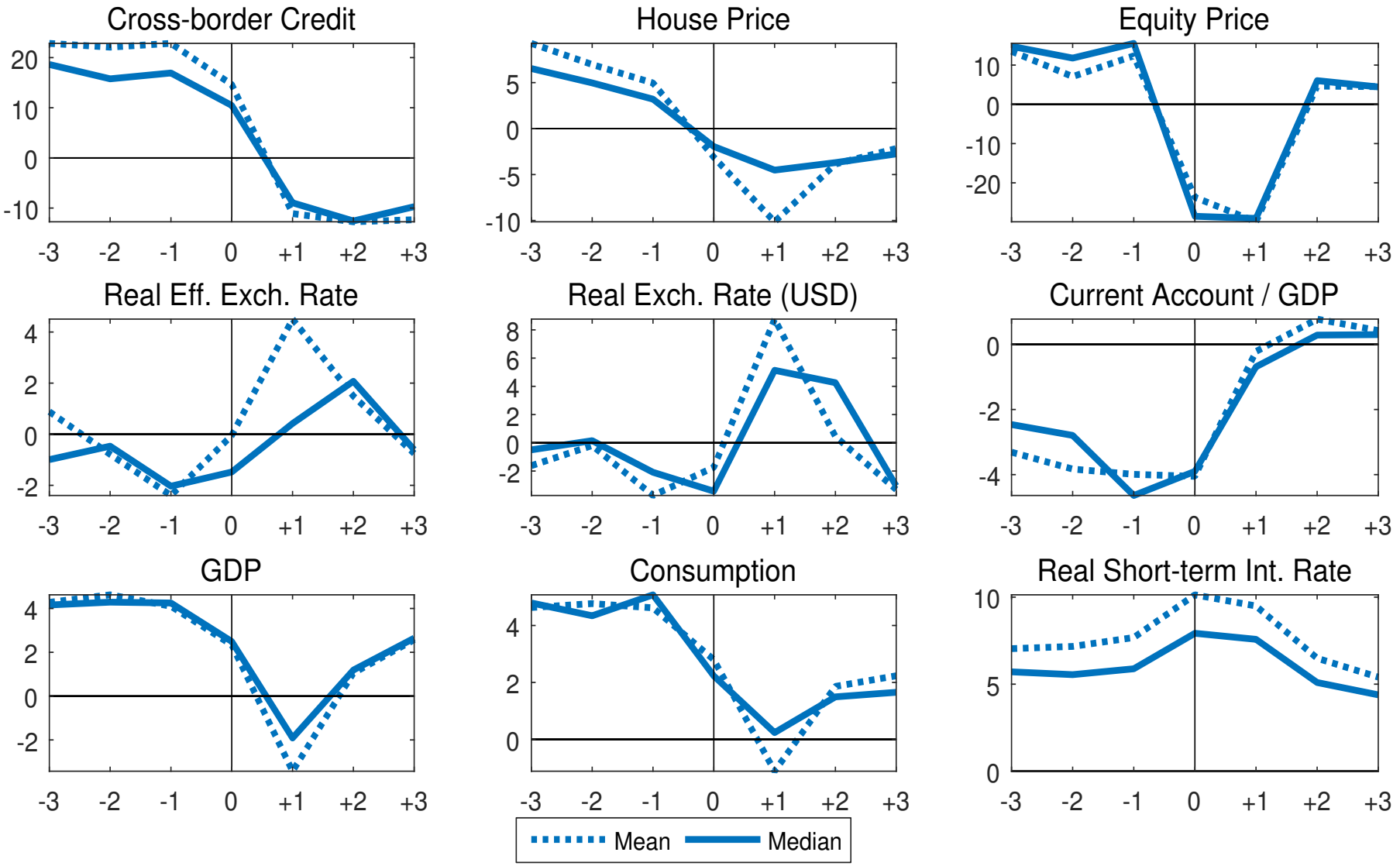
Boom-Bust Cycles in Cross-Border Credit

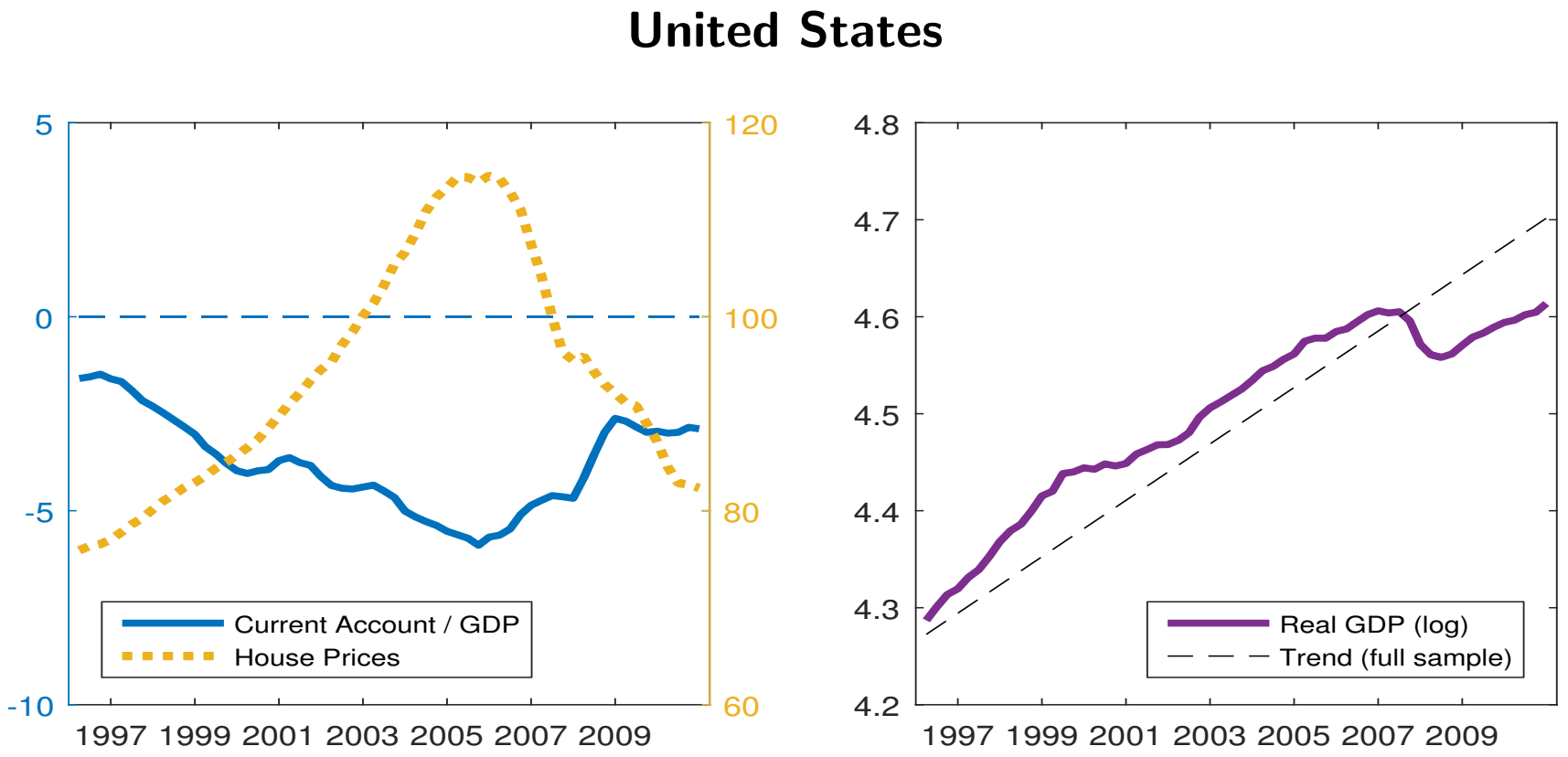
- Event study (Mendoza and Terrones, 2008):
- Boom (Bust) = At least 3 consecutive years of $\Delta \ln KF_{it} > 0$ (< 0)
- 134 boom, 81 bust, and 50 boom-bust episodes
- Observe economy's behavior around boom-bust cycles' peak

Boom-Bust Cycles in Cross-Border Credit

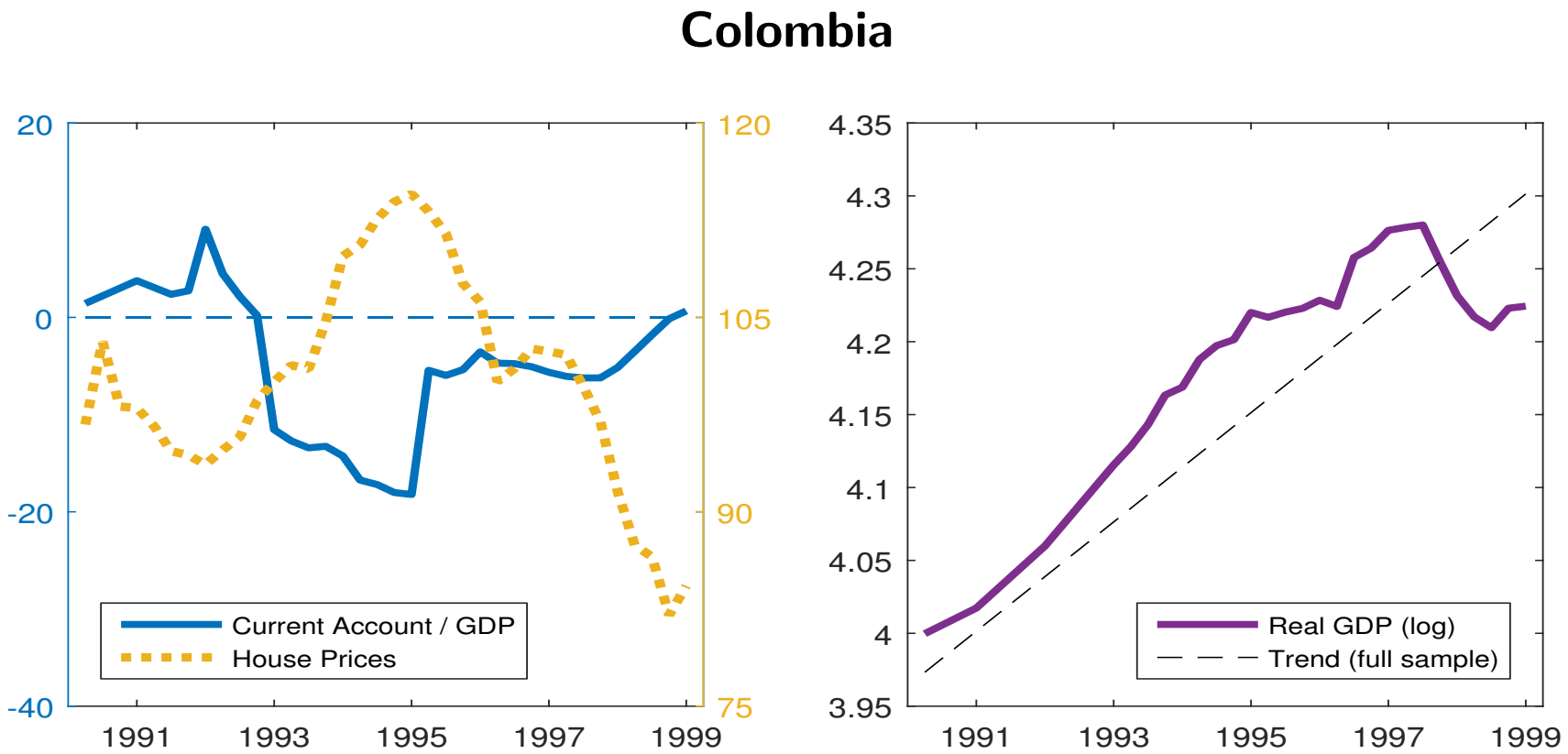


Back

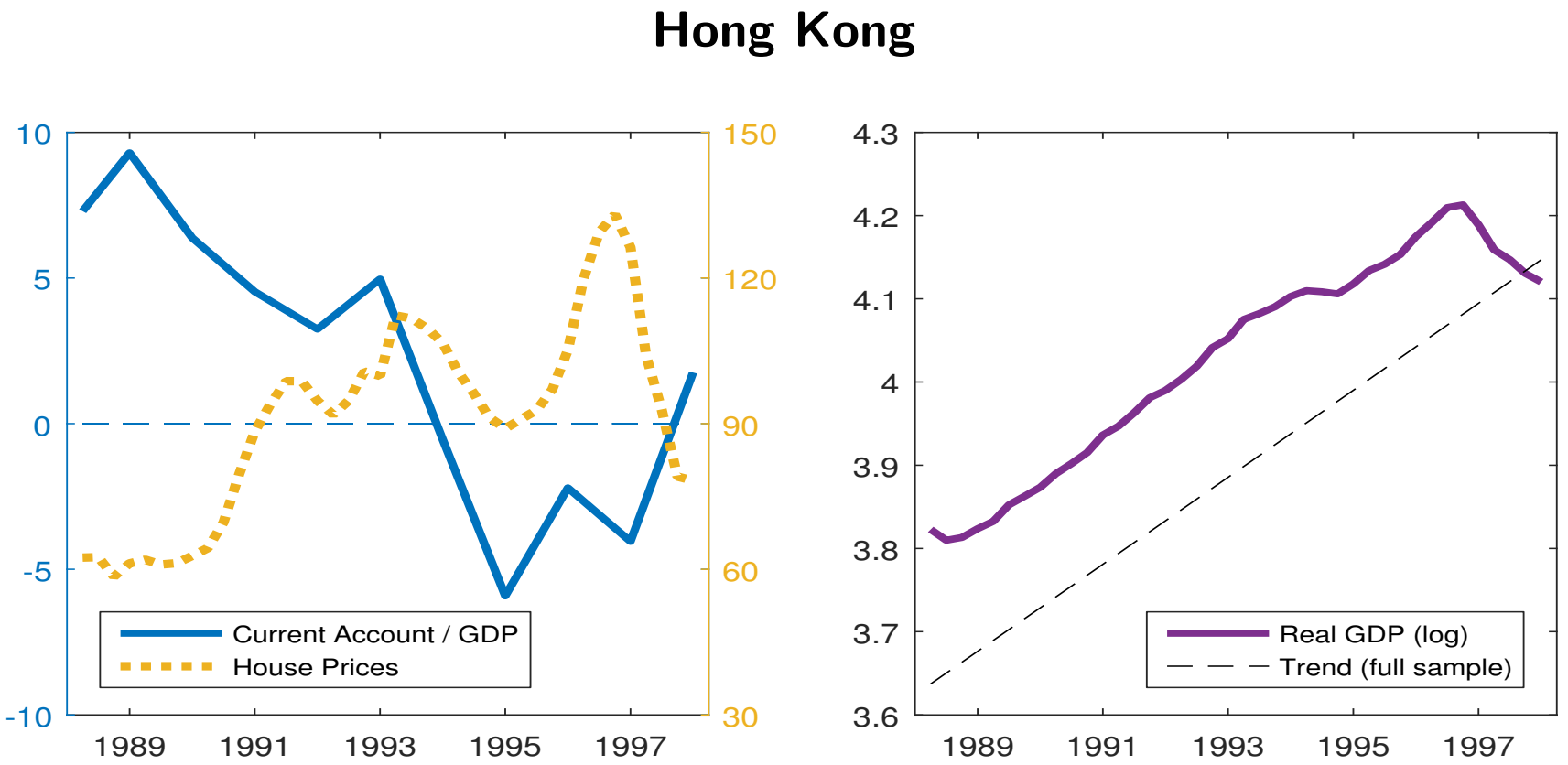
Examples of Booms



Examples of Booms



Examples of Booms



Event Study: Summary Statistics

Mean Across Episodes

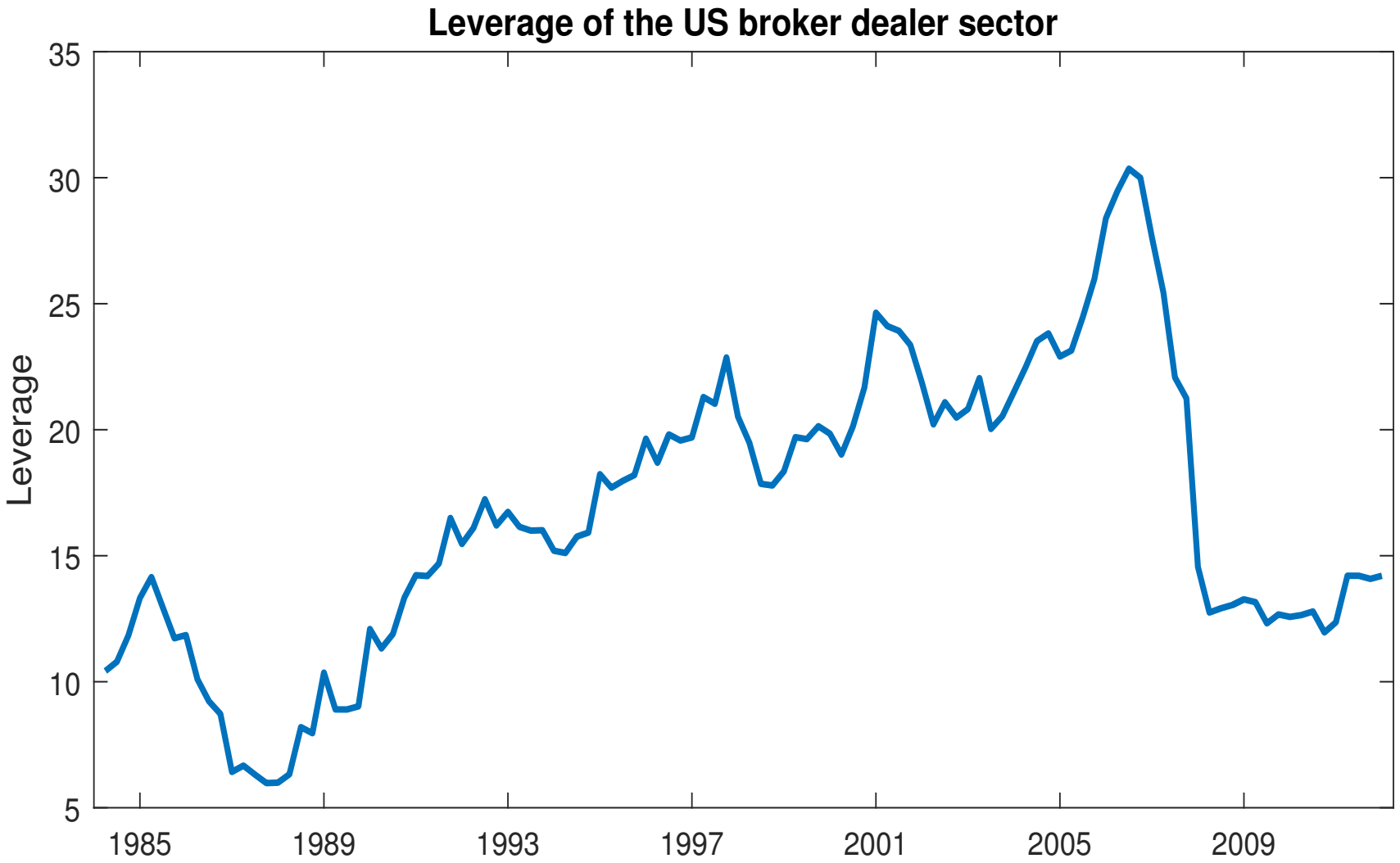
	Boom			Bust			Boom-bust		
	ALL	AE	EM	ALL	AE	EM	ALL	AE	EM
Number	2.4	2.5	2.3	1.4	1.1	1.6	0.9	0.8	0.9
Duration	7.3	8.8	6.1	4.4	3.7	4.8	12.7	13.4	12.4
Max	32.6	28.5	35.9	-4.2	-4.6	-4.1	36.3	29.5	40.5
Min	5.0	3.7	5.9	-20.4	-17.5	-21.9	-21.8	-19.2	-23.5
Amplitude	131.6	130.1	132.8	-53.2	-36.9	-61.3	103.5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

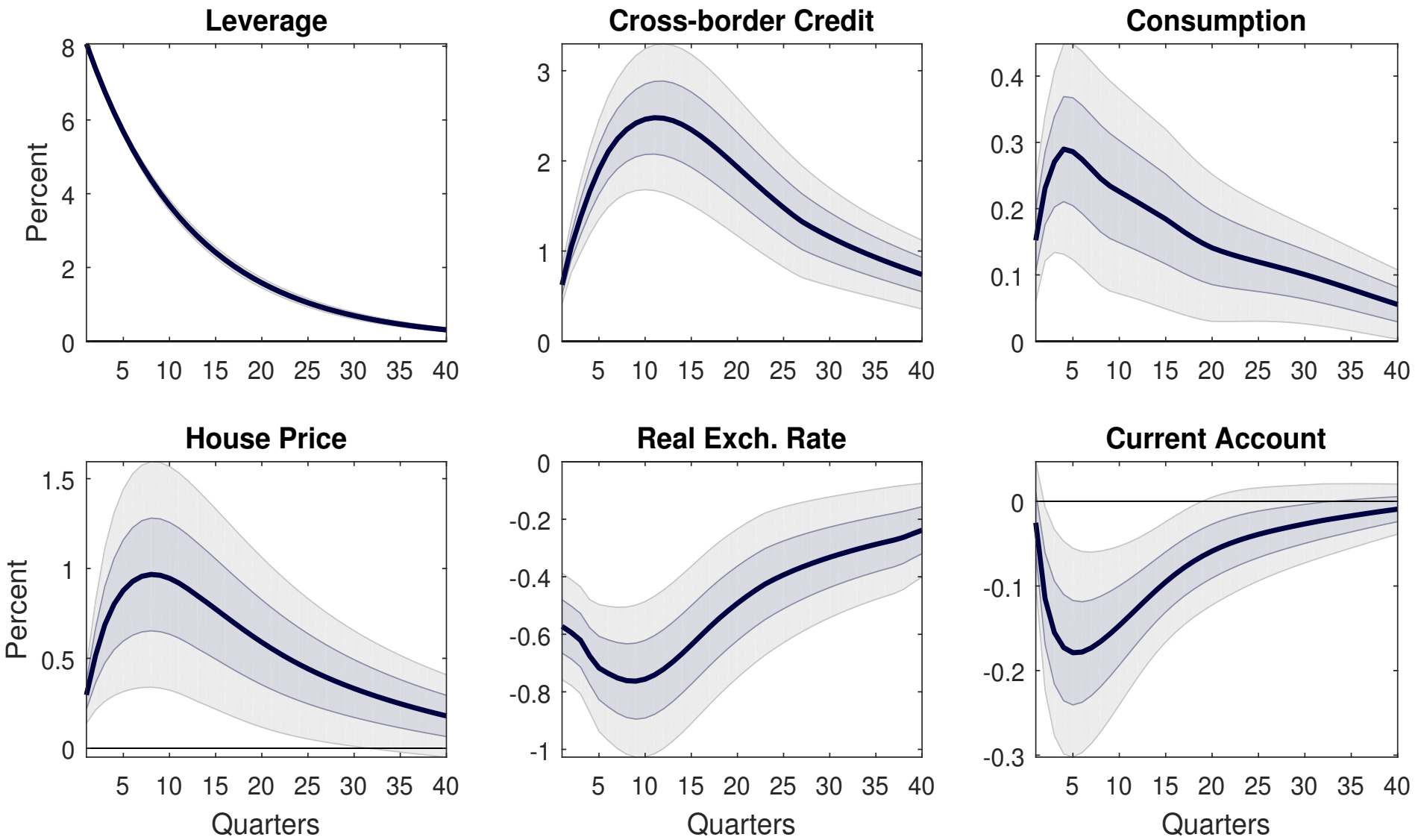
$$\begin{bmatrix} LEV_t \\ x_{i,t} \end{bmatrix} = \begin{bmatrix} F_{11,i} & 0 \\ F_{21,i} & F_{22,i} \end{bmatrix} \begin{bmatrix} LEV_{t-1} \\ x_{i,t-1} \end{bmatrix} + \begin{bmatrix} B_{11,i} & 0 \\ B_{21,i} & B_{22,i} \end{bmatrix} \begin{bmatrix} e_t^{LEV} \\ e_{i,t}^{x} \end{bmatrix}$$

- Can still achieve identification with Choleski decomposition

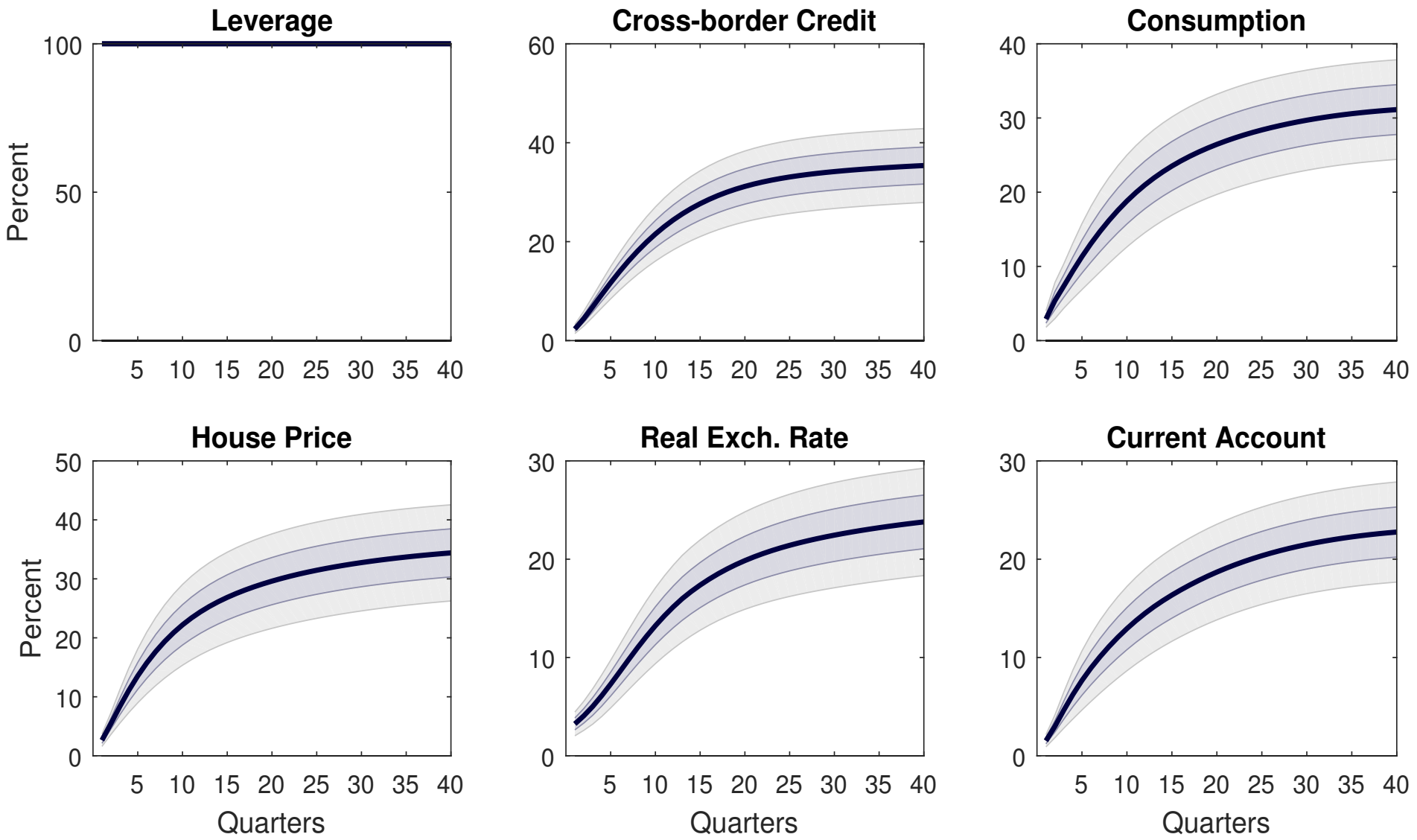
- Robustness
  - "Clean" leverage of variation due to world GDP

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

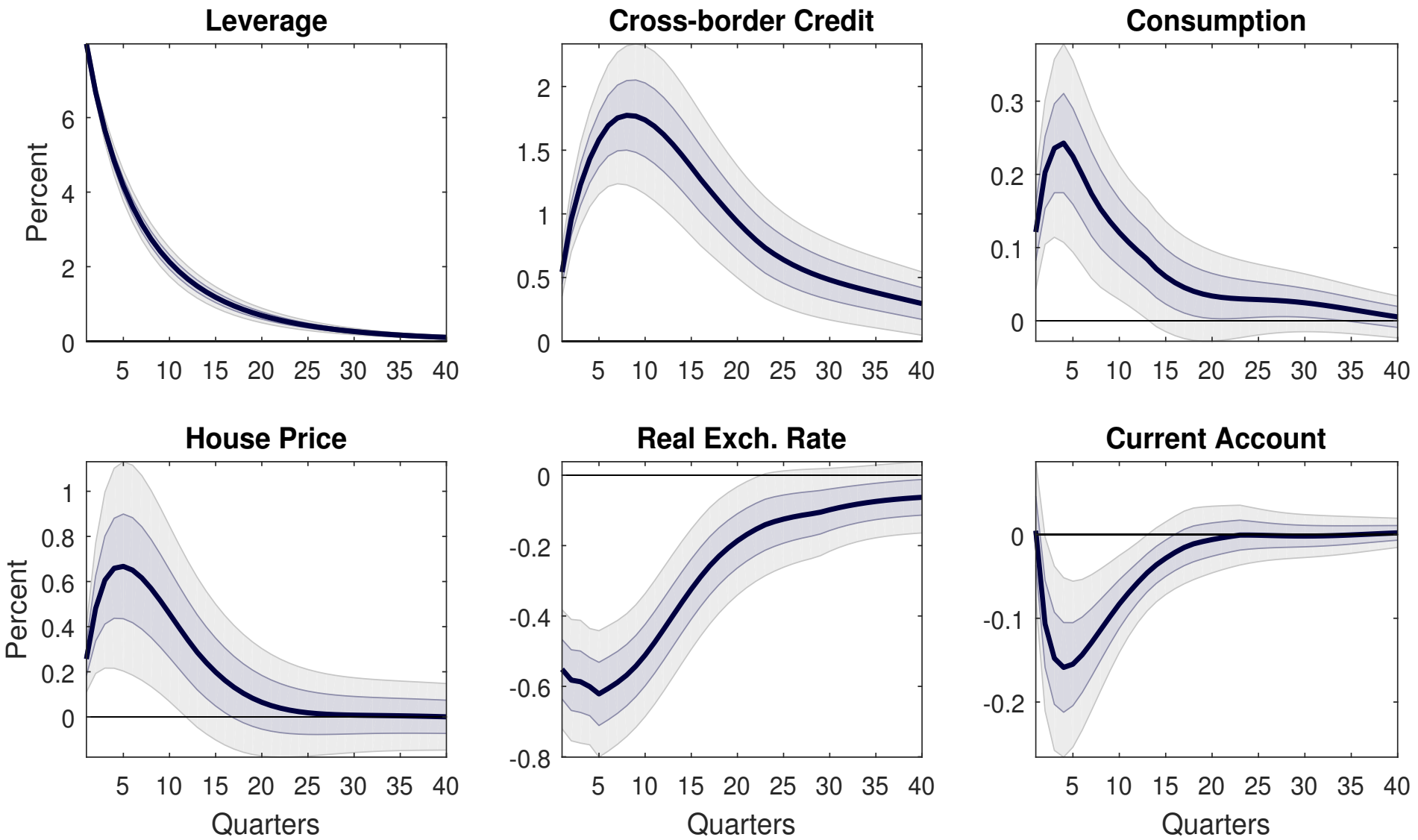
Alternative Identification: IRFs to Leverage Shock



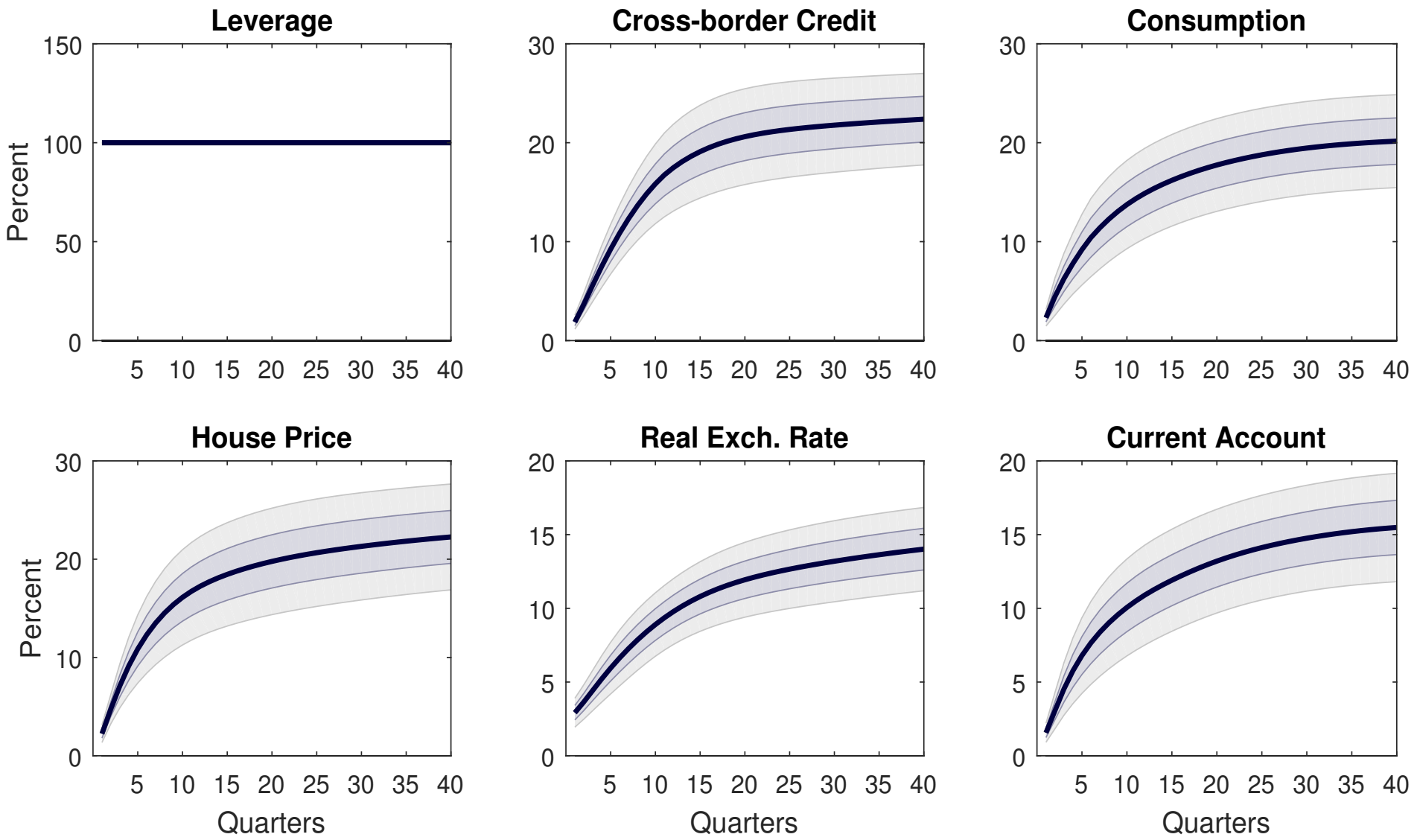
Alternative Identification: Variance Decomposition



Alternative Identification: Robustness



Alternative Identification: Robustness FEVD



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