

# The Consequences of Financial Center Conditions for Emerging Market Sovereigns

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<sup>1</sup>The views expressed herein are those of the authors and should not be attributed to the IMF, its Executive Board, or its management.

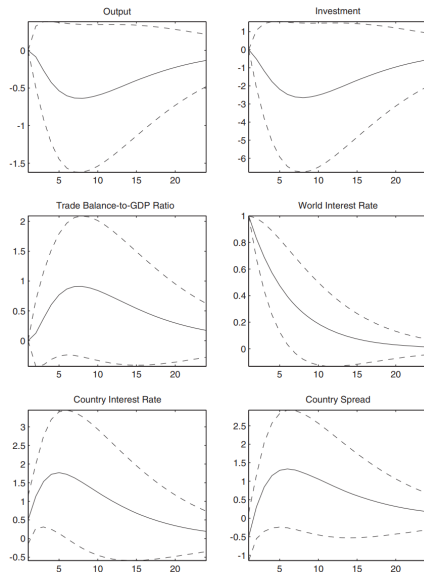
# Financial Center Conditions

- Consequences of *tight financial conditions* in the US for EM sovereigns?
  - Recessionary, increased default risk
  - Consistent with widespread expressions of concern in EMs
- Less is known about *news* of future conditions
  - The start of a US monetary tightening cycle, policy announcements, etc.

# Financial Center Conditions

- Consequences of *tight financial conditions* in the US for EM sovereigns?
  - Recessionary, increased default risk
  - Consistent with widespread expressions of concern in EMs
- Less is known about *news* of future conditions
  - The start of a US monetary tightening cycle, policy announcements, etc.
- What we do...
  - 1 Identify incentives for borrowing and default in a tractable model
    - Ambiguity in the response of spreads
  - 2 Model of US yield curve/SDF with news shocks
  - 3 Sovereign default model consistent with the evidence
    - Domestic financial frictions
    - A story of three interest rates: financial center, sovereign's, and domestic

# Panel VAR, Uribe Yue 2006



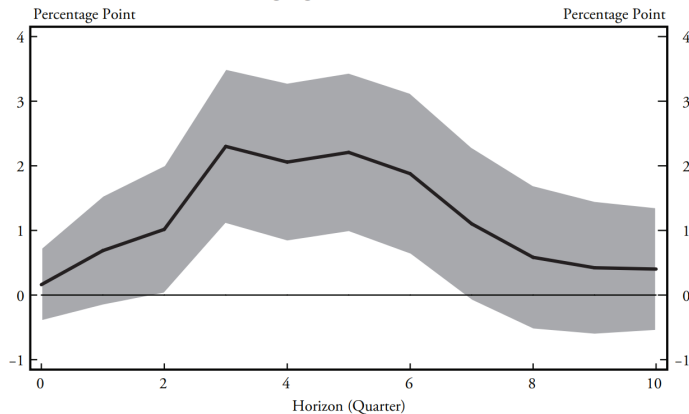
Impulse responses to a 1% increase in the financial center rate (Uribe Yue, 2006)

- *Depressed output and investment*
- Current Account reversal
- Higher yields *and spreads*

Work-in-progress:  
extend sample, panel Local Projection, IV

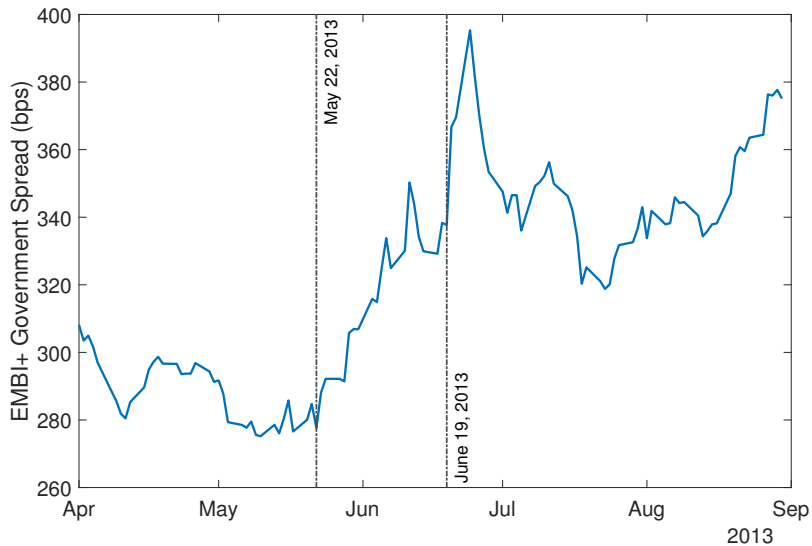
## Responses of 12-Month Government Bond Rate Differentials I

### A. Emerging Market Economies

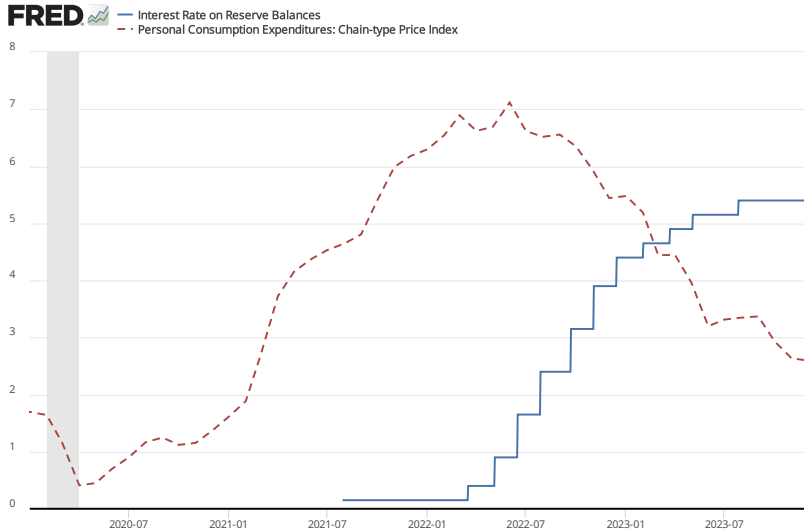


U.S. Three-Month Treasury Rate Shock

# 2013 “Taper Tantrum” Episode



# 2022 Tightening Cycle



Sources: Board of Governors; BEA

fred.stlouisfed.org

- 1 Intuition in the simplest default model
- 2 A pricing kernel with news, disciplined by the US yield curve
- 3 A quantitative sovereign default model with domestic financial frictions



# Simple Analytics of Risk-free Rate Movements in a Tractable Default Model

# A Tractable Default Model

$$V(b|r, r') = \max_{b'} \left\{ \bar{y} - b + q(b'|r, r')b' + \beta \mathbf{E}_v \max \left\{ V(b'|r', r'), V^d - v \right\} \right\}$$

$$q(b'|r, r') = \frac{1}{1+r} \Pr \left[ V(b'|r', r') \geq V^d - v \right]$$

- Linear utility
- One period debt
- Constant endowment  $\bar{y}$
- Default value shock  $v$ , with pdf  $\phi$  and cdf  $\Phi$
- Risk-free rate  $r$  this period,  $r'$  in all future periods

$$\nu^*(b'|r') \equiv V^d - V(b'|r', r') \quad (\text{Default Threshold})$$

$$V(b|r, r') = \bar{y} - b + \max_{b'} \left\{ q(b'|r, r')b' + \beta \left[ \int_{-\infty}^{\nu^*(\cdot)} (V^d - \nu) d\Phi + \int_{\nu^*(\cdot)}^{\infty} V(b'|r', r') d\Phi \right] \right\}$$

$$q(b'|r, r') = \frac{1 - \Phi[\nu^*(b'|r')]}{1 + r}$$

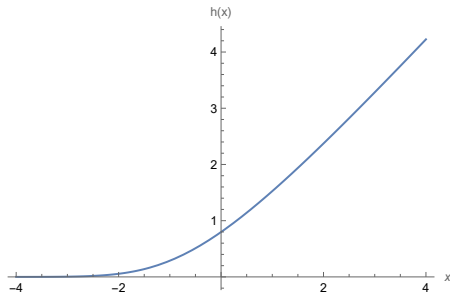
# Borrowing Behavior

$$h(v^*(b'|r')) b' = \underbrace{1 - \beta(1+r)}_{>0}$$

(Optimal Borrowing)

$$h(v) \equiv \frac{\phi(v)}{[1 - \Phi(v)]}$$

(Hazard Ratio)



# A One Time Increase in $r$

Start at  $r = r' = \bar{r}$  and consider a one time increase in today's  $r$ :

$$h(v^*(b'|r')) b' = \underbrace{1 - \beta(1 + r)}_{\downarrow} \quad (\text{Optimal Borrowing})$$

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- LHS  $\downarrow$ , must have RHS  $\downarrow$ , and therefore  $b' \downarrow$
- $r'$  unchanged, so  $v^*(b'|r') \downarrow$
- *Lower* default probability and spread

# Future Interest Rates

Start at  $r = r' = \bar{r}$  and consider an increase in all future rates  $r'$ :

$$h\left(\nu^*(b'|r')\right)b' = \underbrace{1 - \beta(1 + r)}_{\text{no change}} \quad (\text{Optimal Borrowing})$$

$$\nu^*(b'|r') \equiv V^d - V(b'|r', r') \quad (\text{Default Threshold})$$

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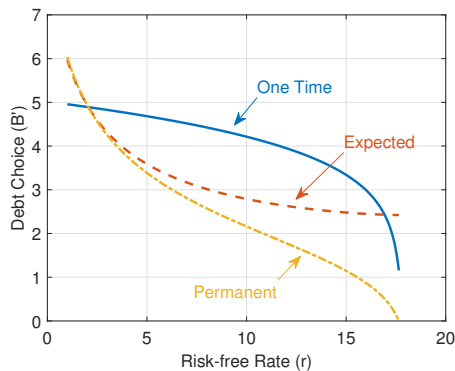
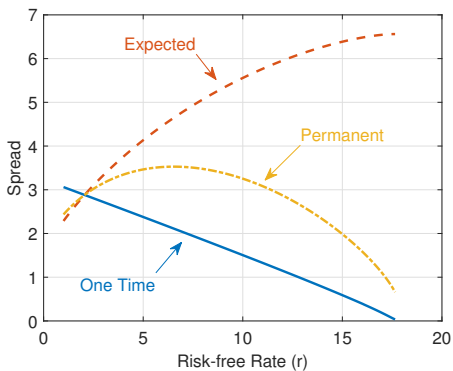
$$v^*(b'|r') \equiv V^d - V(b'|r', r') \quad (\text{Default Threshold})$$

$$\frac{\partial}{\partial r'} V(b'|r', r') \stackrel{?}{<} 0 \quad (\text{Value of Market Access})$$

$$r' \uparrow \Rightarrow V(b'|r', r') \downarrow \Rightarrow v^*(b'|r') \uparrow \Rightarrow b' \downarrow$$



# Spread and Borrowing Response to Risk-free Rate Shocks



- One Time:  $r > \bar{r}, r' = \bar{r} = 2\%$
- Expected:  $r = \bar{r}, r' > \bar{r}$
- Permanent:  $r = r' > \bar{r}$

## A Pricing Kernel with News

# A One-Factor SDF with News

$$q_t^{\$,n} = \mathbf{E}_t \left\{ \frac{m_{t+1}}{\Pi_{t+1}} q_{t+1}^{\$,n-1} \right\}, \quad q_t^{\$,0} = 1 \quad (\text{ZC Bond Prices})$$

# A One-Factor SDF with News

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$$-\log m_{t+1} = x_t + 0.5\lambda_m^2 + \lambda_m \varepsilon_{t+1} \quad (\text{Real SDF})$$

$$x_{t+1} = (1 - \rho)v_t + \rho_x x_t + \sigma_x \varepsilon_{t+1} \quad (\text{Factor})$$

$$v_{t+1} = \begin{cases} v_t, & \text{w.p. } p \\ \text{iid } N(\mu_v, \sigma_v^2), & \text{otherwise} \end{cases} \quad (\text{News})$$

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$$-\log \Pi_{t+1} = \mu_\pi + \iota_v v_t + \iota_x x_t + A_4(L)\eta_{t+1} \quad (\text{Inflation})$$

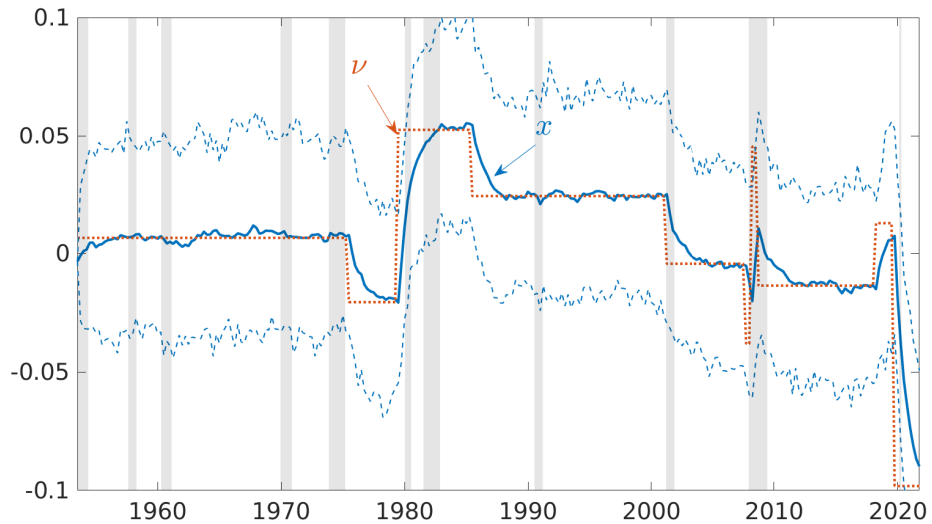
# SDF Parameter Estimates

	Estimate	95% CI
First Stage		
$\rho_x$	0.7395	[0.6123, 0.8183]
$\sigma_x$	0.0036	[0.0000, 0.0048]
$\sigma_\eta$	0.0045	[0.0000, 0.0524]
$J$	9	
$p$	0.9672	
$\mu_v$	$-8.2e^{-4}$	
$\sigma_v$	0.0109	
Second Stage		
$\iota_x$	-0.7425	
$A_1$	-0.4676	
$A_2$	-0.1445	
$A_3$	0.0369	
$A_4$	-0.0578	
$\lambda_m$	-0.2359	

Two stage procedure...

- 1 Use 3mo yield and inflation to estimate and filter  $x_t$  and  $v_t$  (including breaks/jumps)
- 2 Use higher maturities to estimate  $\Pi_{t+1}$  equation and market price of risk  $\lambda_m$

# $x_t$ and $\nu_t$ Estimates



# A Quantitative Sovereign Default Model



# Model Outline

- Domestic private sector
  - Households
  - Financial Intermediaries
  - Producers
- The sovereign
  - Operates in international financial markets
  - Long-term defaultable bond
  - Transfers (or taxes) lump sum proceeds to household
- International lenders
  - Price and hold the sovereign's bond
  - One factor SDF with news
- Equilibrium default (Markov Perfect equilibrium)

# The Household and the Domestic Interest Rate

$$\max_{\{\ell_t, b_{t+1}^h\}} \mathbf{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t, \ell_t) \text{ s.t. } c_t = w_t \ell_t + \Pi_t + \Pi_t^f + T_t - b_t^h + \frac{1}{1+i_t} b_{t+1}^h$$

$$u_\ell(c_t, \ell_t) + u_c(c_t, \ell_t) w_t = 0 \quad (\text{FOC } \ell_t)$$

$$u_c(c_t, \ell_t) = \beta(1+i_t) \mathbf{E}_t u_c(c_{t+1}, \ell_{t+1}) \quad (\text{FOC } b_{t+1}^h)$$

$$b_t^h = b_{t+1}^h = 0 \quad (\text{Zero Net Supply})$$

# Producers and the Working Capital Constraint

$$\Pi_t = \max_{\ell_t} \{A_t \ell_t^\alpha - [(1 - \theta) w_t \ell_t + \theta (1 + i_t) w_t \ell_t]\}$$

$$\ell_t = \left( \frac{\alpha}{1 + \theta i_t} \cdot \frac{A_t}{w_t} \right)^{1/(1-\alpha)} \quad (\text{FOC } \ell_t)$$

$$\log A_{t+1} = \rho_A \log A_t + \sigma_A \varepsilon_{t+1} \quad (\text{Productivity})$$

$$\Pi_t^f = -a_t + (1 + i_t) a_t = i_t a_t$$

$$a_t = \theta w_t \ell_t$$

(Market Clearing)

$$i_t = \frac{u_c(c_t, \ell_t)}{\beta \mathbf{E}_t u_c(c_{t+1}, \ell_{t+1})} - 1$$

(Domestic Rate)

$$T_t = q_t [B_{t+1} - (1 - \delta) B_t] - \kappa B_t - \bar{G}$$

Transfer to household

- proceeds from sale of new issuance  $B_{t+1} - (1 - \delta)B_t$  at market price  $q_t$ ,
- minus debt service payment  $\kappa B_t$ ,
- minus government spending

In default,  $T_t = -\bar{G}$

$$q_t = \mathbf{E}_t \{ m_{t+1} (1 - d_{t+1}) [\kappa + (1 - \delta) q_{t+1}] \} \quad (\text{Sovereign Bond Price Schedule})$$

$$q_t^{\text{rf}} = \mathbf{E}_t \left\{ m_{t+1} \left[ \kappa + (1 - \delta) q_{t+1}^{\text{rf}} \right] \right\} \quad (\text{Risk-free Bond})$$

- $m_t$  driven by  $x_t$  factor and news  $v_t$  (real SDF)
- Same duration for sovereigns' and risk-free bonds
- Yield-to-maturity spread

$$sp_t = \kappa \left( \frac{1}{q_t} - \frac{1}{q_t^{\text{rf}}} \right)$$

Consolidate sovereign, household, and domestic firms...

$$w_t \ell_t + \Pi_t = A_t \ell_t^\alpha = c_t + \bar{G} + tb_t \quad (\text{GDP})$$

$$tb_t = \kappa B_t - q_t [B_{t+1} - (1 - \delta) B_t] \quad (\text{BoP})$$

Equilibrium  $\ell_t(A_t, i_t, B_t, B_{t+1})$

- Productivity penalty

$$A_t \rightarrow h(A_t) \leq A_t$$

- Market exclusion of random length (stops w.p.  $\chi$ )
- Return to market without outstanding debt (full repudiation)



# Domestic versus Sovereign Yields

Why is the domestic rate  $i_t$  not the yield on the sovereign's bond?

$$u_c(c_t, \ell_t) = \beta(1 + i_t) \mathbf{E}_t u_c(c_{t+1}, \ell_{t+1}) \quad (\text{Household FOC})$$

$$u_c(c_t, \ell_t) = \beta \frac{\kappa}{q_t + \frac{\partial q_t}{\partial B_{t+1}} B_{t+1}} \mathbf{E}_t (1 - d_{t+1}) u_c(c_{t+1}, \ell_{t+1}) \quad (\text{Sovereign FOC})$$

- Sovereign as monopolist in own bonds: internalize **slope of demand**
- Marginal cost of borrowing **only in repayment** (default option)
- Difference in maturity: one period vs long-term with  $\delta$

# Work-in-Progress: Calibration

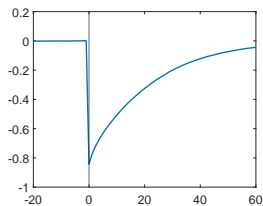
	Value	Comment
$\sigma$	2.0	CRRA
$\beta$	0.99	Discounting
$\psi$	1.0	Normalization, mean $\ell$
$\mu$	1.0	Inverse of Frisch elasticity (GHH)
$\alpha$	0.67	Returns to scale
$\theta$	1.5	Working capital constraint
$\bar{G}$	0.0	Public spending
$\delta$	0.05	5 year debt Macaulay duration
$\kappa$	$\delta + \mu_v$	Normalization
$\lambda_0$	-0.24	Penalty, linear
$\lambda_1$	+0.27	Penalty, quadratic
$\chi$	1/8	Market return probability
$\rho_x$	0.74	Autocorrelation of pricing kernel factor
$\sigma_x$	0.0036	Volatility of factor
$\mu_v$	$-8.3e^{-4}$	Average factor level
$\sigma_v$	0.011	Volatility of factor trend shocks
$p$	0.9672	Probability of renewal
$\lambda_m$	-0.236	Market price of risk
$\rho_A$	0.95	Autocorrelation of productivity
$\sigma_A$	0.005	Volatility of productivity shock
$\eta_D$	$1e^{-6}$	Default taste shock
$\eta_B$	$5e^{-5}$	Borrowing taste shock

	Model
Mean	
Spread	1.96
Debt to GDP	12.3
Standard Deviations	
Spread	1.37
GDP	3.91
Consumption	4.87
Domestic Rate	3.51
Correlations	
Spread and GDP	-24.1
Trade Balance/GDP and GDP	-67.4

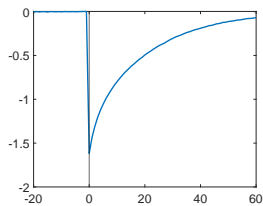
- Default model  $\Rightarrow$  no steady state, but ergodic distribution
- *Where* to shock for IRFs?
- Idea, based on Koop, Pesaran, and Potter (1996), ...
  - Simulate long and wide panel of model economies (independent)
  - Eventually, cross section  $\Rightarrow$  ergodic distribution
  - Then, shock all panel units by the same amount
  - Trace out average responses

Equivalent to shocking everywhere and weighting by ergodic distribution

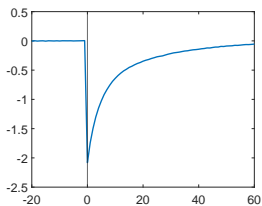
# IRF: Productivity $A_t$



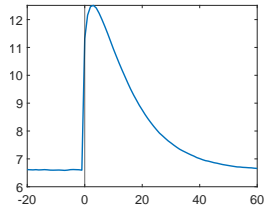
Productivity ( $A$ )



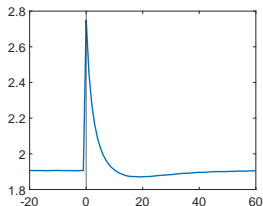
GDP



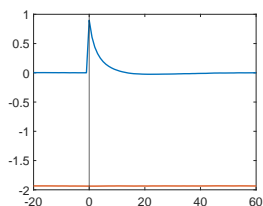
Consumption ( $c$ )



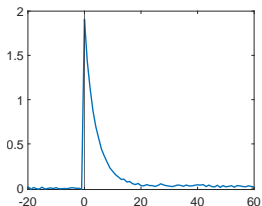
Share in Default



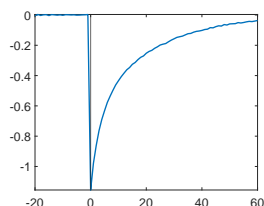
Spread



Yields

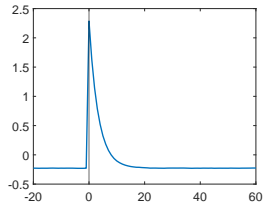


Domestic Rate ( $i$ )

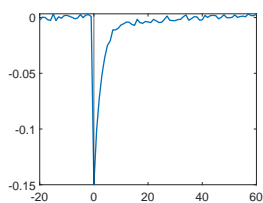


Labor ( $\ell$ )

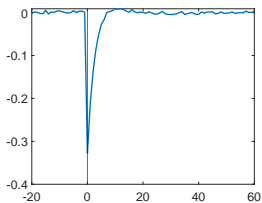
# IRF: SDF Factor $x_t$



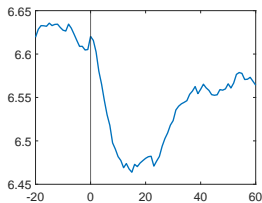
Factor ( $x$ )



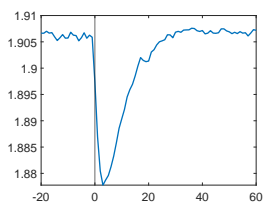
GDP



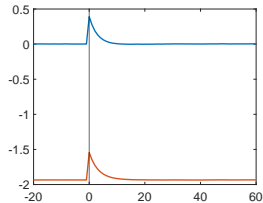
Consumption ( $c$ )



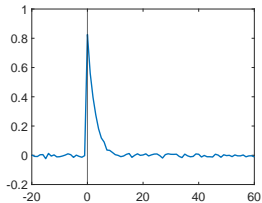
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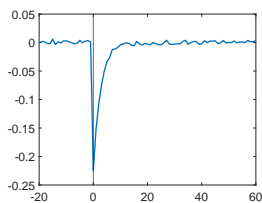
Spread



Yields

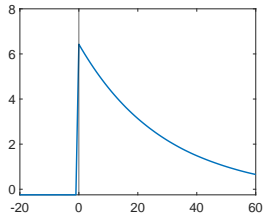


Domestic Rate ( $i$ )

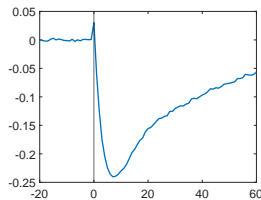


Labor ( $\ell$ )

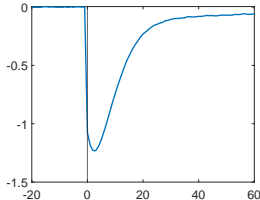
# IRF: SDF News $\nu_t$



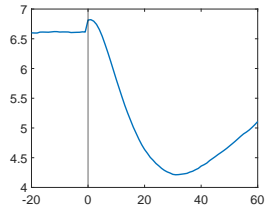
News ( $\nu$ )



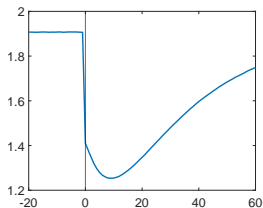
GDP



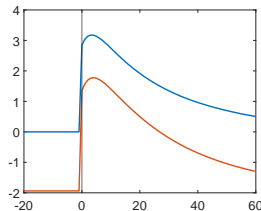
Consumption ( $c$ )



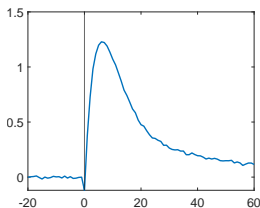
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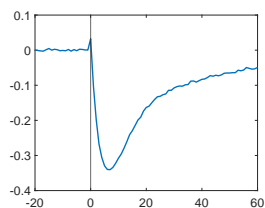
Spread



Yields



Domestic Rate ( $i$ )



Labor ( $\ell$ )

- Simple theory highlights ambiguity for spreads: shock persistence and news
- Preliminary evidence on news and anticipated movements for US yield curve
- Quantitative model
  - Financial frictions key for output response
  - Domestic interest rate volatility is a costly side-effect of sovereign borrowing
  - A “puzzle:” spreads consistently fall (too willing to drop  $B'$ ?)