

The Consequences of Financial Center Conditions for Emerging Market Sovereigns

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

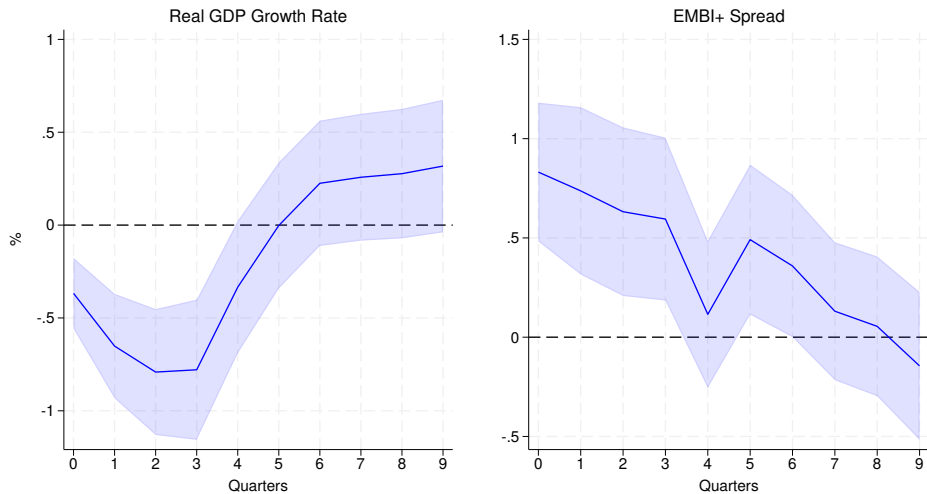
Financial Center Conditions

- Consequences of *tight financial conditions* in the US for EM sovereigns?
 - In the data: recessionary, increased yield spreads
 - Focus on the sovereign borrowing and default risk *channel*
- Less known about *predictable* changes in future conditions
 - E.g. the start of a US monetary tightening cycle

Financial Center Conditions

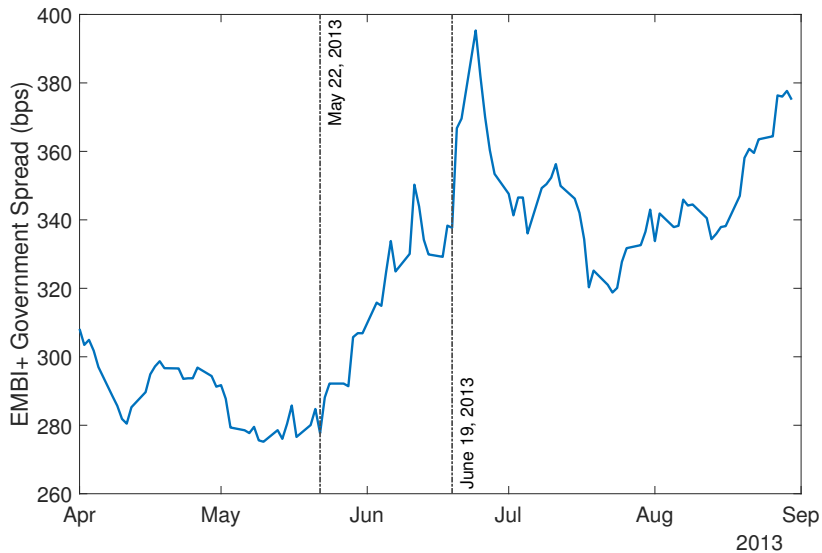
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 - In the data: recessionary, increased yield spreads
 - Focus on the sovereign borrowing and default risk *channel*
- Less known about *predictable* changes in future conditions
 - E.g. the start of a US monetary tightening cycle
- What we do...
 - 1 Isolate incentives for borrowing and default in a tractable model
 - Ambiguity in the response of spreads
 - 2 Statistical model of US yield curve and inflation with predictable dynamics
 - 3 Sovereign default model to confront the evidence
 - Domestic financial frictions

Impact of US Short-term Real Rates on EMs

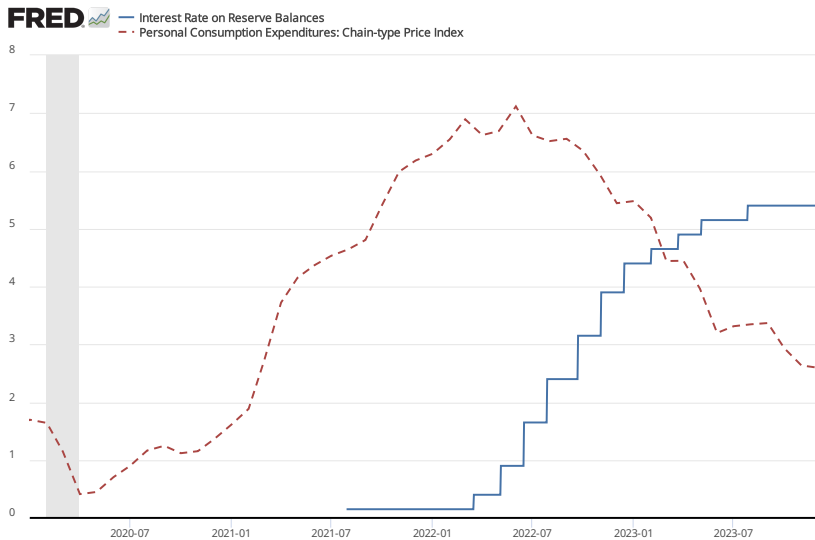


Panel IV local projection of annualized quarterly GDP growth and EMBI+ Spread using 'naive' 3mo real Tbill yield, instrumented with Bauer Swanson (2013) identified monetary policy shocks, controlling for 4 lags of shock and outcome variables.

2013 “Taper Tantrum” Episode



2022– Tightening Cycle



Sources: Board of Governors; BEA

fred.stlouisfed.org

- 1 Intuition on borrowing and spreads in the simplest default model
- 2 A statistical model of 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

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

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

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

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

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

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

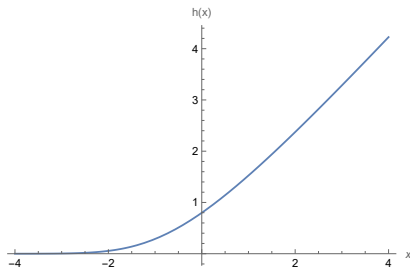
Borrowing Behavior

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

(Optimal Borrowing)

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

(Hazard)



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

- 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' :

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

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

Future Interest Rates

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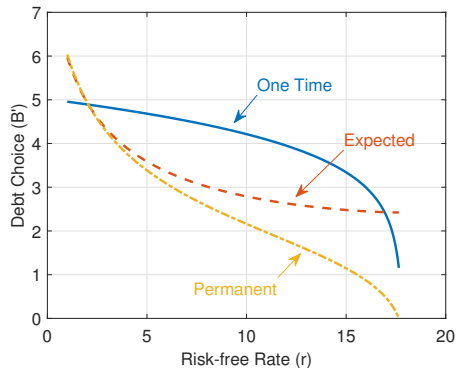
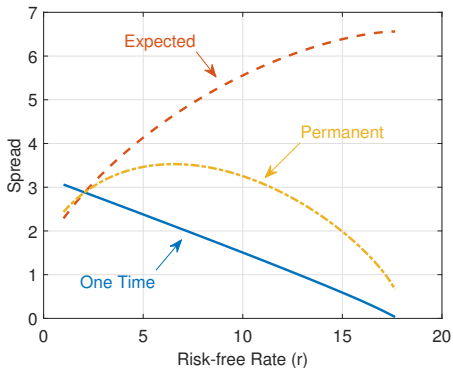
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$$v^*(b'|r') \equiv V^d - V(b'|r', r') \quad (\text{Default Threshold})$$

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

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

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 Predictable Dynamics

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

$$q_t^{\$,n} = \mathbf{E}_t \left\{ \frac{\textcolor{red}{m}_{t+1}}{\textcolor{blue}{\Pi}_{t+1}} q_{t+1}^{\$,n-1} \right\}, \quad q_t^{\$,0} = 1 \quad (\text{ZC Bond Prices})$$

$$-\log \textcolor{red}{m}_{t+1} = x_t + \frac{\lambda_m^2}{2} + \lambda_m \varepsilon_{t+1} \quad (\text{Real SDF})$$

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

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

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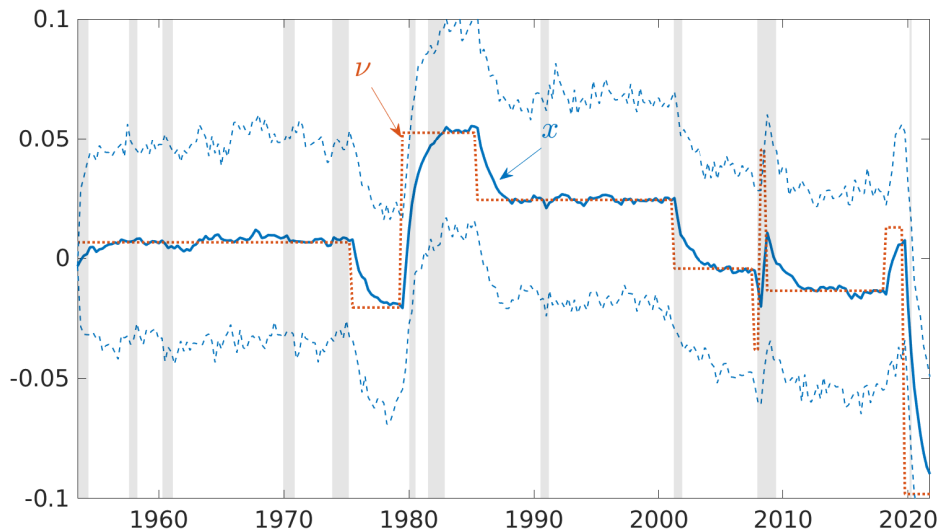
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$$-\log \textcolor{blue}{\Pi}_{t+1} = \mu_\pi + \iota_v v_t + \iota_x x_t + A_4(L) \eta_{t+1} \quad (\text{Inflation})$$

x_t and ν_t Estimates



A Quantitative Sovereign Default Model

- 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 x_t and ν_t
- Equilibrium default (Markov Perfect Equilibrium)

The Household and the Domestic Interest Rate

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

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

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

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

Producers and the Working Capital Constraint

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

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

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

In default, $A_t \rightarrow h(A_t) \leq A_t$

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

$$a_t = \theta w_t \ell_t$$

(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)

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

Transfers to household

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

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

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

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

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

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

Domestic versus Sovereign Yields

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

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

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

- 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 δ
- Use B' to **alter domestic allocation**

- Utility function. Greenwood, Hercowitz, and Huffman (1988)

$$u(c, \ell) = \frac{\left(c - \psi \frac{\ell^{1+\mu}}{1+\mu}\right)^{1-\sigma} - 1}{1 - \sigma}$$

- Default productivity penalty, as in Chatterjee and Eyigungor (2012)

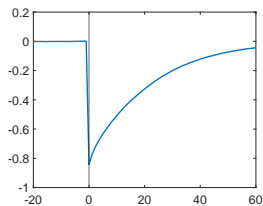
$$h(A_t) = A_t - \max \{0, \lambda_0 A_t + \lambda_1 A_t^2\}$$

Work-in-Progress: Calibration

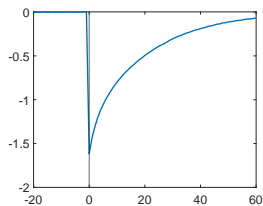
	Value	Comment
σ	2.0	CRRA
β	0.98	Discounting
ψ	0.7	Normalization, mean ℓ
μ	1.0/0.7	Inverse of Frisch elasticity (GHH)
α	0.67	Returns to scale
θ	1.5	Working capital constraint
\bar{G}	0.15	Public spending
δ	0.05	5 year debt Macaulay duration
κ	$\delta + \mu_v$	Normalization
λ_0	-0.24	Penalty, linear
λ_1	+0.27	Penalty, quadratic
χ	1/8	Market return probability
ρ_x	0.74	Autocorrelation of pricing kernel factor
σ_x	0.0036	Volatility of factor
μ_v	$-8.3e^{-4}$	Average factor level
σ_v	0.011	Volatility of factor trend shocks
p	0.9672	Probability of renewal
λ_m	-0.236	Market price of risk
ρ_A	0.9	Autocorrelation of productivity
σ_A	0.005	Volatility of productivity shock
η_D	$1e^{-6}$	Default taste shock
η_B	$1e^{-5}$	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

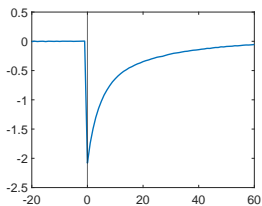
IRF: Productivity A_t



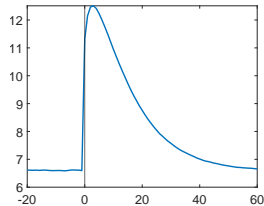
Productivity (A)



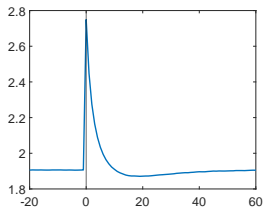
GDP



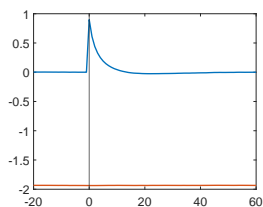
Consumption (c)



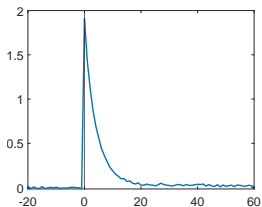
Share in Default



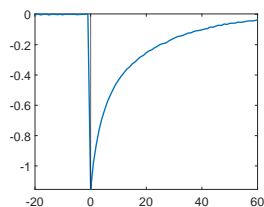
Spread



Yields

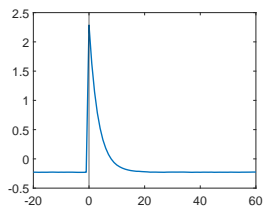


Domestic Rate (i)

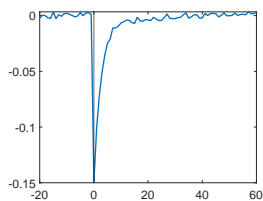


Labor (ℓ)

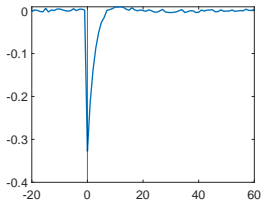
IRF: SDF Factor x_t



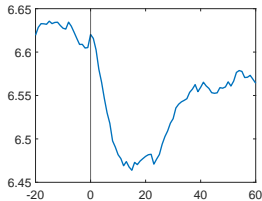
Factor (x)



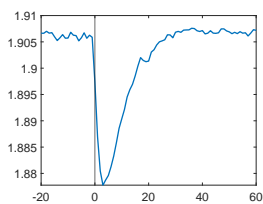
GDP



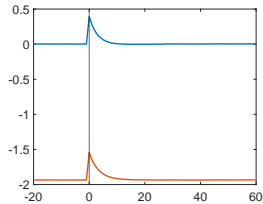
Consumption (c)



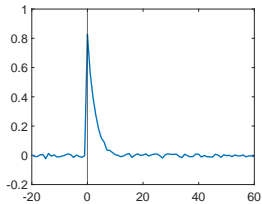
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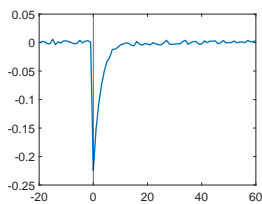
Spread



Yields

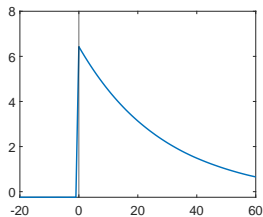


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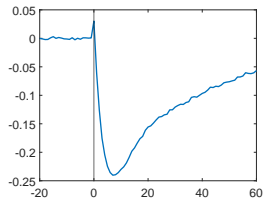


Labor (ℓ)

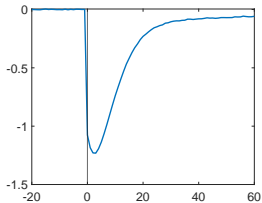
IRF: SDF Trend ν_t



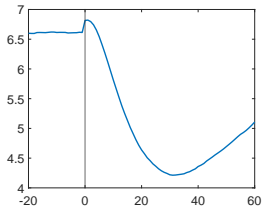
Trend (ν)



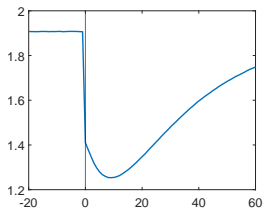
GDP



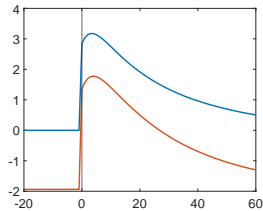
Consumption (c)



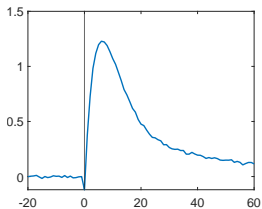
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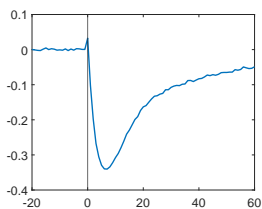
Spread



Yields

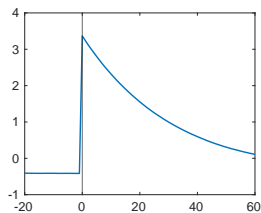


Domestic Rate (i)

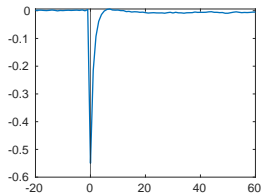


Labor (ℓ)

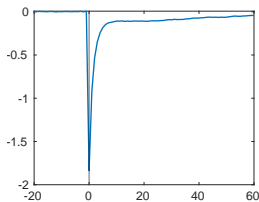
IRF: SDF Trend ν_t , Short-Term Debt (4q)



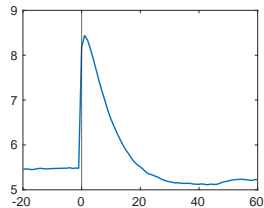
Trend (ν)



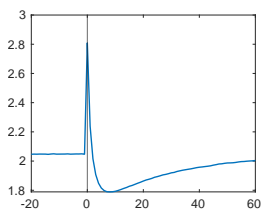
GDP



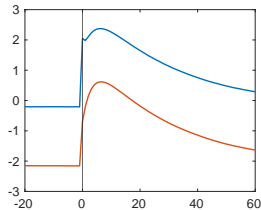
Consumption (c)



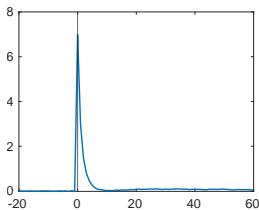
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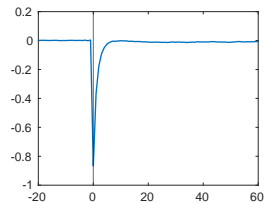
Spread



Yields



Domestic Rate (i)

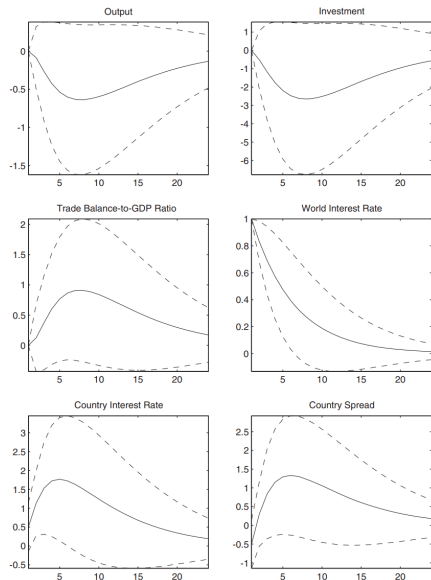


Labor (ℓ)

- Theory highlights spreads ambiguity: shock persistence and predictability
- Preliminary evidence on 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 fall, except if maturity is low (too willing to drop B' ?)

Appendix

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*

◀ Back

SDF Parameter Estimates

	Estimate	95% CI
First Stage		
ρ_x	0.7395	[0.6123, 0.8183]
σ_x	0.0036	[0.0000, 0.0048]
σ_η	0.0045	[0.0000, 0.0524]
J	9	
p	0.9672	
μ_v	$-8.2e^{-4}$	
σ_v	0.0109	
Second Stage		
ι_x	-0.7425	
A_1	-0.4676	
A_2	-0.1445	
A_3	0.0369	
A_4	-0.0578	
λ_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 Π_{t+1} equation and market price of risk λ_m

Consolidate sovereign, household, and domestic firms...

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

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

Equilibrium

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

- Productivity penalty

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

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

Recursive Formulation

- State variables: $s = \langle A, x, v \rangle$ and B
- Private domestic outcomes for arbitrary $\langle s, B, B' \rangle$
 - $c(s, B, B'), \ell(s, B, B'), i(s, B, B'), \dots$
- Sovereign policies $d(s, B)$ and $B'(s, B)$
Taking as given private outcomes and future policies
- Forward-looking functions (Markov):
 - Bond price schedule $q(s, B')$
 - Expected marginal utility $H(s, B'), H^d(s)$

$$H(s, B') = \mathbb{E}_{s'|s} \left\{ (1 - d(s', B')) u_c(s', B', B'') + d(s', B') u_c^d(s') \right\}$$

$$u_c(s, B, B') = \beta [1 + i(s, B, B')] H(s, B')$$

- 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