Predictable Interest Rate Movements and Their Implications for Emerging Markets

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Motivation

- US FRB broadly *expected* to raise rates 6+ times in 2022, by 25-50bps each.
- Implications for emerging market borrowers? Perceived as *bad news*.

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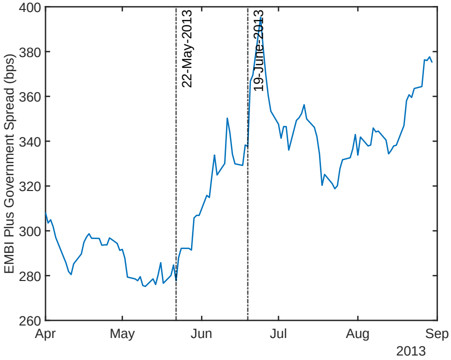
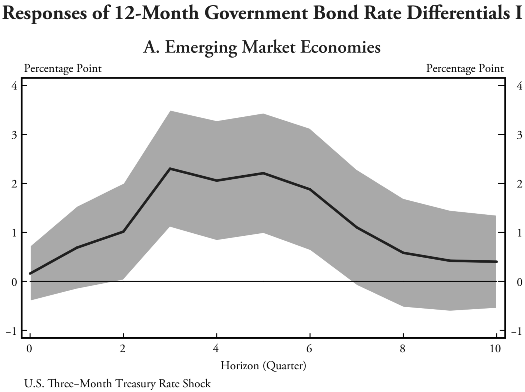
- Our contribution: Sovereign default model with…
  - News about persistent dynamics of lenders' opportunity cost
  - Domestic financial frictions
- News of higher risk-free rates: recessionary, increase spreads
- Bonus: endogenously no "consumption boom before default" puzzle

Motivating Evidence



2013 “taper tantrum” and EMBI spread



Source: Kalemli-Özcan (2019)

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

The Simplest Sovereign Default Model

Risk-free rate movements in a tractable model:

$$V(b) = \max_{b'} \left\{ u\left[\bar{y} - b + q(b')b'\right] + \beta \mathbf{E}_\nu \max\left[V(b'), V^d - \nu\right] \right\} \tag{1}$$

with only iid default value shocks, ν with PDF ϕ and CDF Φ

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Default policy takes a threshold form:

$$\nu^{*}(b) \equiv V^{d} - V\left(b\right)$$

$$q(b') = \frac{1 - \Phi\left[\nu^{*}(b')\right]}{1 + r^{\text{rf}}}$$

The Simplest Sovereign Default Model, Continued

All together, a 1-equation default model…

$$V(b) = \max_{b'} u\left[\bar{y} - b + \frac{1 - \Phi\left[V^d - V(b')\right]}{1 + r^{\text{rf}}} b'\right] + \beta\left[\int_{-\infty}^{V^d - V(b')} \left(V^d - v\right) d\Phi(v) + \int_{V^d - V(b')}^{\infty} V(b') d\Phi(v)\right]$$

The Simplest Sovereign Default Model, Continued

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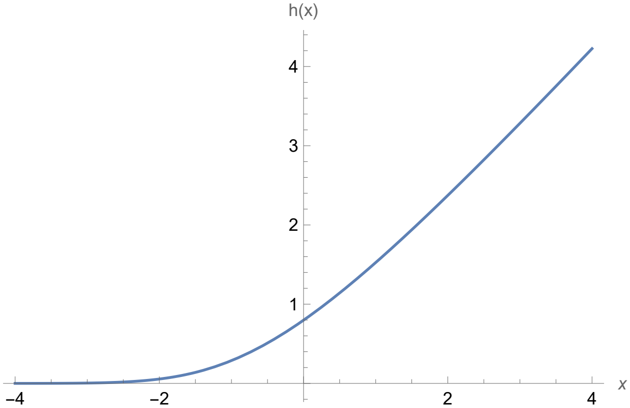
FOC:

$$[1 - \underbrace{h\left(V^d - V(b')\right)}_{\text{Optimum default risk}} b'] \underbrace{\frac{u'(c)}{u'(c')}}_{\text{Smooth c}} = \beta\left(1 + r^{\mathrm{rf}}\right)$$

where the *hazard function* is the ratio of PDF to complement of CDF…

$$h(v) \equiv \phi(v) / [1 - \Phi(v)]$$

Hazard Function



Hazard function for the Standard Normal distribution

The Linear Utility Case

Disable consumption smoothing motive with $u(c) = c \ldots$

$$1 - h\left(V^d - V(b')\right) b' = \beta\left(1 + r^{\mathrm{rf}}\right)$$

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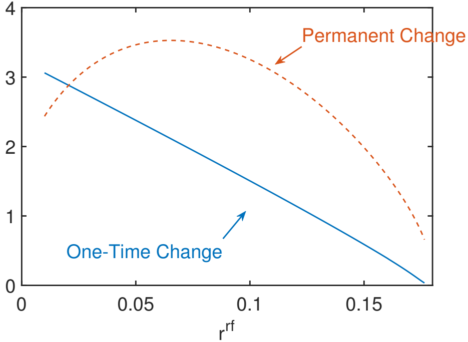
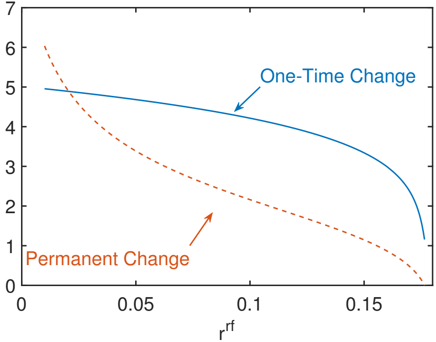
Restrict attention to $h(v) > 0$ and $h'(v) \geq 0$. Then, can show…

1. If $\beta(1 + r^{\text{rf}}) < 1$ the country borrows, $b' > 0$
2. An unexpected, 1-period increase in r^{rf} *lowers* b' and the spread
3. An unexpected, permanent increase in r^{rf} is *ambiguous* for spreads (wip)

Comparative Statics of Tractable Model



Default Probability ($\Phi(v^*(b'))$)

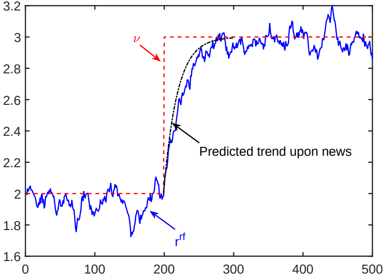


Borrowing Choice (b')

$$1 - h\left[K\left(r^{\text{rf}}_{\text{future}}\right) + b'\right] b' = \beta\left(1 + r^{\text{rf}}_{\text{current}}\right)$$

Time Series Model of Predictable Risk-free Rate Movements

Predictable Risk-free Rate Dynamics



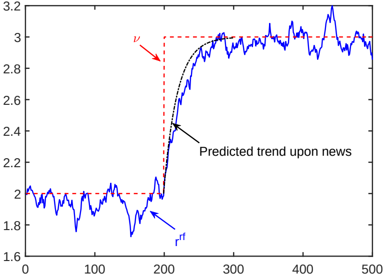
Sample episode

Allow for slow-moving, predictable dynamics in the risk-free rate using regime-switching AR(1) with regime-specific intercept

$$r^{\text{rf}}_{t+1} = (1-\rho_r)\nu_t + \rho_r r^{\text{rf}}_t + \sigma_{r,\varepsilon}\varepsilon_{t+1}$$
$$\nu_{t+1} \sim F(\nu_{t+1} | \nu_t)$$

ν_t: known at t, shifts mean from $t+1$.

Predictable Risk-free Rate Dynamics



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Long-term risk-free bond price:

$$q^{\text{rf}}_t = \frac{1}{1+r^{\text{rf}}_t}\left[\kappa + (1-\delta)\,\mathbf{E}_t q^{\text{rf}}_{t+1}\right]$$

Preliminary Estimates

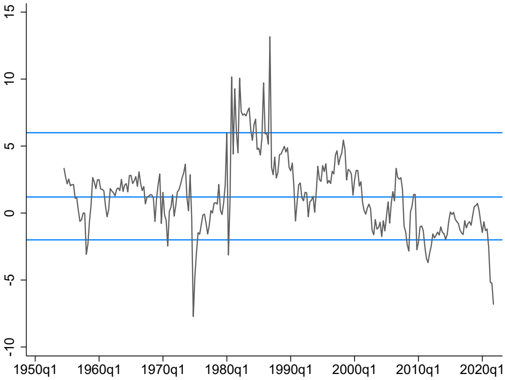
Using ex-ante real Fed Funds rate, MA $\mathbf{E}\pi$…

$$
\begin{aligned}
r^{\text{rf}}_{t+1} &= (1-\rho_r)\nu_t + \rho_r r^{\text{rf}}_t + \sigma_{r,\varepsilon}\varepsilon_{t+1} \\
\nu_{t+1} &\sim F(\nu_{t+1} | \nu_t)
\end{aligned}
$$

$$\nu \in [-2\%, \quad 1.2\%, \quad 6\%]$$

$$F\left(\nu' \middle| \nu\right) = \begin{bmatrix} 0.57 & 0.35 & 0.08 \\ 0.03 & 0.96 & 0.01 \\ 0.80 & 0.00 & 0.20 \end{bmatrix}$$

$$\rho_r = 0.94 \qquad \sigma_{r,\varepsilon} = 0.25\%$$



Quantitative Model

Model Outline

- Domestic Economy
  - Households: labor supply
  - Producers: labor demand, working capital demand
  - Domestic Financial Intermediaries: working capital supply
- Fiscal Authority (Sovereign)
  - Operates in international bond markets
  - Transfers net proceeds lump sum to household
  - Default: temporary exclusion, haircut/recovery, productivity loss
- International Financial Intermediaries
  - Stochastic & predictable opportunity cost of funds, r^{rf}

Domestic Economy: Households

Static labor supply problem

$$\max_{\ell_t} u\left(c_t, \ell_t\right) \text{ s.t. } c_t = w_t \ell_t + \Pi_t + \Pi_t^f + T_t$$

given

- wage rate w_t
- profits of producers Π_t
- profits of domestic financial intermediaries π_t^f
- lump sum tax or transfer from fiscal authority T_t

Discount with β.

Domestic Economy: Producers

Hire labor subject to a working capital constraint

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

given aggregate productivity level A_t, and where a share θ of the wage bill must be paid before production takes place. *Intra-period* loan rate i_t.

Compare to Mendoza Yue (2012) and Fuerst (1992).

Productivity penalty in default $A_t^d = h(A_t) \leq A_t$.

Domestic Economy: Financial Intermediaries

Extend intra-period working capital loans

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

and in equilibrium firms demand $a_t = \theta w_t \ell_t$.

Operate on behalf of their owners, the households, and use the *domestic interest rate*

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

to price the loans. In equilibrium $\mathbf{E}_t u_{c,t+1}$ reflects default risk.

The GHH Domestic Economy, Summary

In good credit standing...

$$\left[c_t - \psi \frac{\ell_t^{1+\mu}}{1+\mu}\right]^{-\sigma} = \beta(1+i_t)\overbrace{\mathbf{E}_t u_c\left(c_{t+1}, \ell_{t+1}\right)}^{H_t(b_{t+1})}$$

where

$$c_t = A_t \ell_t^{\alpha} + T_t(b_{t+1})$$

and

$$\ell_t = \left[\frac{\alpha}{\psi} \cdot \frac{A_t}{1+\theta i_t}\right]^{1/(1-\alpha+\mu)}.$$

In default, same, except $T_t^d = 0$ and productivity loss $A_t^d = h(A_t) \leq A_t$.

Fiscal Authority

Conditional on not defaulting, chooses b_{t+1} and thus determines

$$T_t = -\kappa b_t + q_t \left[b_{t+1} - (1 - \delta) \, b_t \right]$$

Understands how b_{t+1} choice impacts

- the bond price q_t
- this period's domestic economy $c_t, \ell_t, i_t, w_t, \ldots$
- next period's domestic economy, for $\mathbf{E}_t u_{c,t+1}$ purposes.

In default: $T_t^d = 0$ and productivity penalty $A_t^d = h(A_t) \leq A_t$.

Centralized borrowing, centralized default. Market segmentation.

International Financial Intermediaries

Bond prices in good credit standing

$$q_t = \frac{1}{1+r_t^{\mathrm{rf}}} \mathbf{E}_t \left\{ (1-d_{t+1}) \left[\kappa + (1-\delta) q_{t+1} \right] + d_{t+1} q_{t+1}^d \right\}$$

and secondary market value in default

$$q_t^d = \frac{1}{1+r_t^{\mathrm{rf}}} \mathbf{E}_t \left\{ (1-\lambda)\, q_{t+1}^d + \lambda \phi \left[d_{t+1} q_{t+1}^d + (1-d_{t+1}) \left(\kappa + (1-\delta) q_{t+1} \right) \right] \right\}$$

The risk-free rate in the financial center $r_{t+1}^{\mathrm{rf}} = (1-\rho_r)\nu_t + \rho_r r_t^{\mathrm{rf}} + \sigma_{r,\varepsilon} \varepsilon_{t+1}$

Yield-to-maturity spreads $\kappa / q_t - \kappa / q_t^{\mathrm{rf}}$, but also in default, with q_t^d

Work in Progress

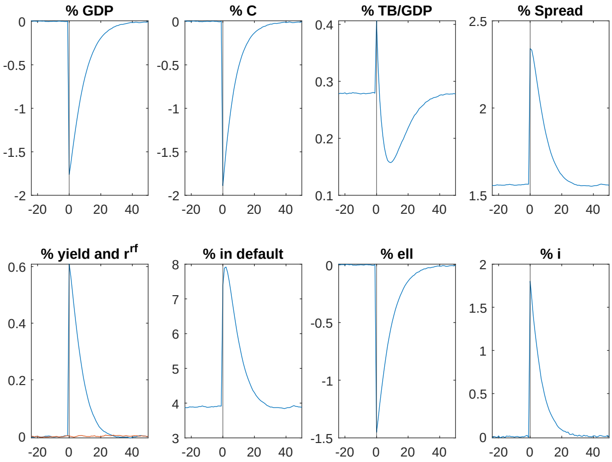
Skipped today…

- Recursive formulation with states $\langle s = \langle A, r^{\mathrm{rf}}, \nu \rangle, b \rangle$, sov choice b'
- Markov Perfect Equilibrium definition
- Calibration
- Methods for construction of stochastic IRFs (Koop et al., 1996)

Coming up…

- IRFs for A_t, r_t^{rf}, and ν_t shocks
- Policies, as functions of b_{t+1}, counterfactual capital flows
- Policies, as functions of b_t, indebtedness and default risk on eq'm path

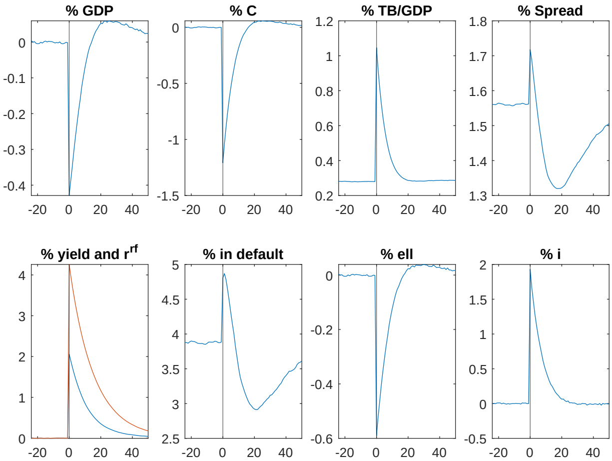
IRF: Productivity Shock $A \downarrow$



Standard behavior

- Low output and consumption
- Depressed labor input
- Tight domestic financial conditions
- CA reversal
- High spread

IRF: Risk-free Rate Shock $r^{\text{rf}} \uparrow$

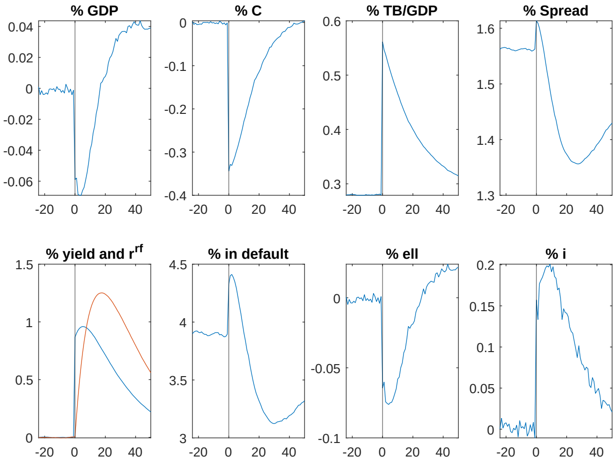


Recession, high spreads

- Low output and consumption
- Depressed labor input
- Tight domestic financial conditions
- CA reversal
- High spread

Fairly transitory.

IRF: Risk-free Rate *News* Shock $\nu \uparrow$



Recession, high spreads

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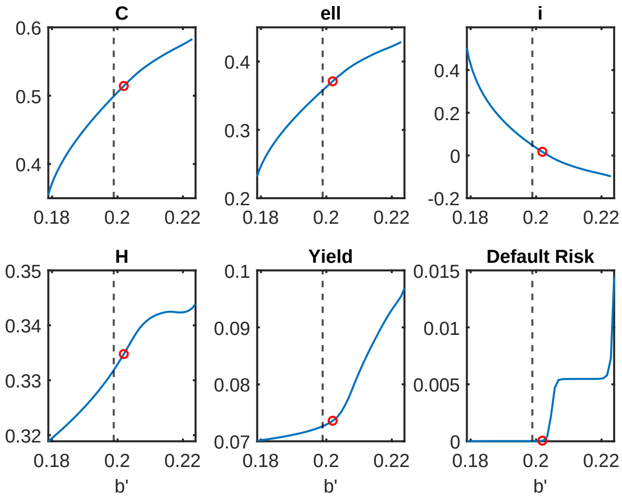
Persistent. Predictable.

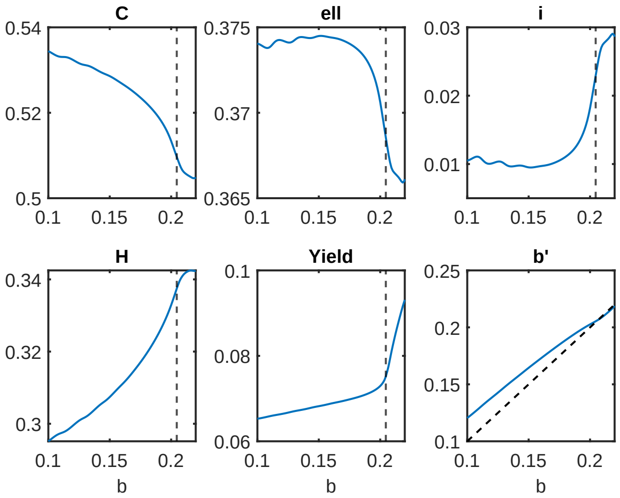
Policy Functions, the Role of b_{t+1}



Expansionary capital inflows.
Counterfactual $b_{t+1} \uparrow$

- Higher output and consumption
- Higher labor supply
- Looser domestic financial frictions
- Higher expected MU next period
- Higher default risk

Policy Functions, the Role of b_t



On the equilibrium path, higher debt implies

- Low output and consumption
- Depressed labor input
- Tight domestic financial conditions
- Lower capital inflows
- High yields

No "Consumption Boom Before Default" aka "Full Dilution"

In standard models, with recovery, instead of defaulting today

- Choose $b_{t+1} \to \infty$ (highest on grid)
- Lenders transfer to you now $q_t b_{t+1} \to$ NPV of eventual recovery (level)
- Default next period with probability 1

Some proposed fixes: underwriting standards ($q_t \geq \underline{q}$), portfolio adjustment costs

Not needed in our model. *Domestic labor market distortions discipline borrowing.*

Tentative Conclusions

A near-standard sovereign default model with production exhibits

- low output & high spread in response to (expected) risk-free rate movements
- standard productivity shock dynamics
- expansionary capital inflows
- domestic financial frictions mirror international conditions in eq'm

Missing so far

- Quantitative analysis
- Role of ν persistence
- Limitations of the standard model ($r^{\text{rf}} \uparrow \Rightarrow$ spread $\downarrow$)