# Predictable Interest Rate Movements and Their Implications for Emerging Markets


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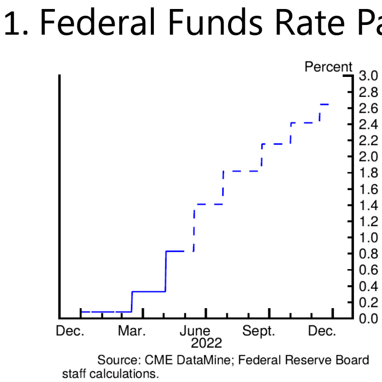
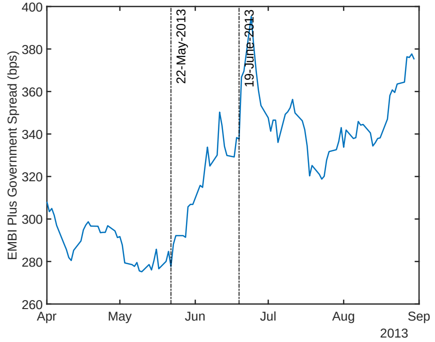
# Preannounced or Expected Interest Rate Movements




2022 “tightening cycle”

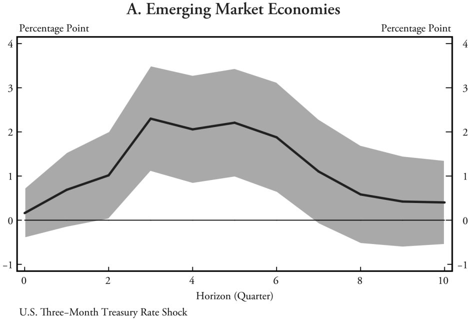



EMBI spread around “taper tantrum”

Frequent cases of “early warning” in financial center. Implications for emerging markets? For the workhorse quantitative sovereign default model?

# *Bad News* for Emerging Markets

Responses of 12-Month Government Bond Rate Differentials I




Kalemli-Özcan (Jackson Hole '19)

*"If you are a country that's borrowed heavily in dollar terms, then you are particularly vulnerable to the current period of rising interest rates."* – Gita Gopinath (CNN, Jun 17)

Widely perceived by policymakers as

- worsening financial conditions
- recessionary

Our objectives

- Evaluate canonical sov default model
- Develop minimal extensions

# Outline

1. Simple Analytics of Tractable Model
   - Borrowing FOC in a 1-equation model
   - Impact of (un)expected financial center rate hikes
2. A Pricing Kernel with News
   - Extending Vasicek (1977) with news
   - Financial center yield curve and long-term bonds
3. Quantitative Model
   - Expected and realized movements in interest rates
   - Domestic financing frictions
   - Financial center rate hikes: recessionary, crisis risk

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

# A Standard, 1-period Debt Model

Risk-neutral competitive lenders, as standard, e.g. Arellano (2008):

$$q_t = \frac{1}{1 + r_t^{\mathrm{rf}}} \left(1 - \mathbf{E}_t d_{t+1}\right)$$

$$\Rightarrow$$

$$\underbrace{r_t - r_t^{\mathrm{rf}}}_{\text{Spread}} \approx \mathbf{E}_t d_{t+1}$$

For spread to *increase* with $r_t^{\mathrm{rf}}$, we need to country to *borrow into* a tighter schedule, and cond default risk $\mathbf{E}_t d_{t+1}$ to *increase*.

Possible with long-term debt and volatility shocks, Johri et al. (2022), or domestic frictions, Wolf and Zessner-Spitzenberg (2022).

Going forward:

- Disentangle the mechanism in a stripped-down model
- Role of shock *persistence*
- Domestic financial frictions and recessionary impact

# A Tractable Default Model

Borrowing with an option to default, like Aguiar et al. (2019):

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

with only iid default value shocks, $\nu$ with PDF $\phi$ and CDF $\Phi$

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with only iid default value shocks, $\nu$ with PDF $\phi$ and CDF $\Phi$

Default policy takes a threshold form:

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

# A Tractable Default Model, Continued

All together, a 1-equation default model…

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

# A Tractable Default Model, Continued

All together, a 1-equation default model…

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

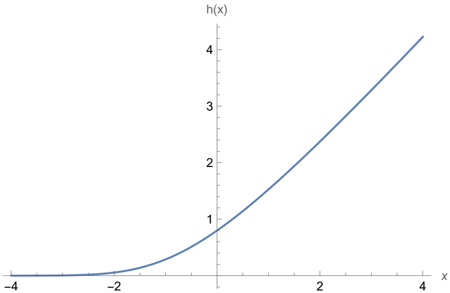
FOC:

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

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

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

# Hazard Function




$$h(x) = \frac{\phi(x)}{1 - \Phi(x)}$$

Hazard function for the Standard Normal distribution

# The Linear Utility Case

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

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

# The Linear Utility Case

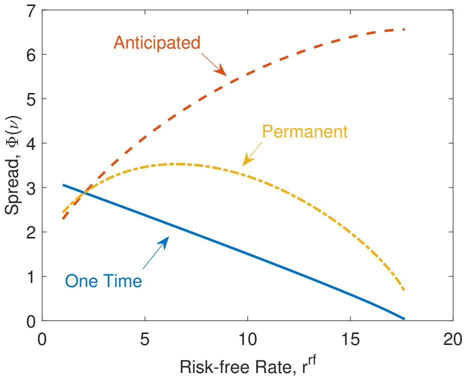
Disable consumption smoothing motive with $u(c) = c\ldots$

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

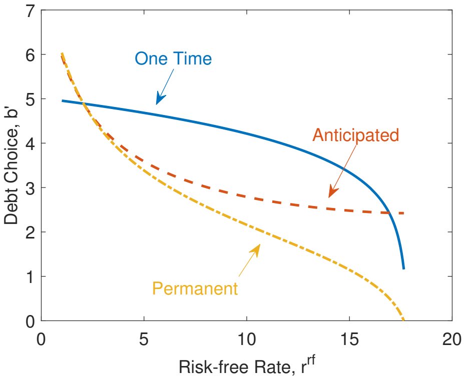
Restrict attention to $h(v) > 0$ and $h'(v) \geq 0$ and consider...

1. Fully transitory, *one-time* increase in $r^{\mathrm{rf}}$ (keep $V(\cdot)$ function fixed)
2. Anticipated, *permanent* increase in $r^{\mathrm{rf}}$ (from next period, shift in $V(\cdot)$ function)
3. Immediate, *permanent* increase in $r^{\mathrm{rf}}$ (shift in $V(\cdot)$ function)

# Comparative Statics of Tractable Model



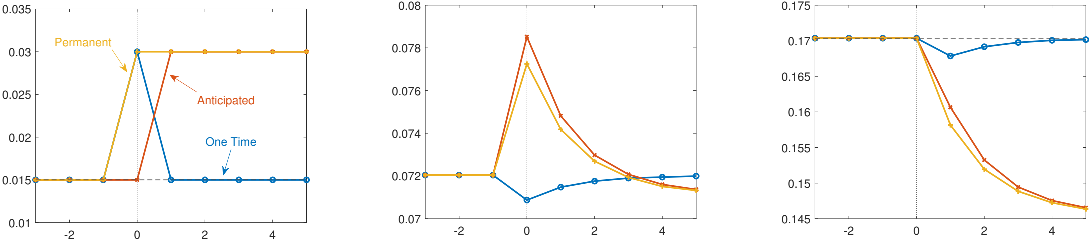

Equilibrium Spread




Borrowing Choice

$$1 - h\left[K\left(r^{\prime,\mathrm{rf}}\right) + b'\right]b' = \beta\left(1 + r^{\mathrm{rf}}\right)$$

# The Consumption-Smoothing Case




Risk-free Rate | Equilibrium Spread | Borrowing Choice

$b'$ falls on impact in all cases. Spread ambiguous. Role of shock persistence.

# A Simple Pricing Kernel with News

# Pricing Sovereign Debt with News in the Financial Center

Extension of Vasicek (1977):

$$\begin{aligned} -\log m_{t+1} &= x_t + 0.5 \cdot \lambda^2 + \lambda \varepsilon_{t+1} \\ x_{t+1} &= (1-\rho)\nu_t + \rho x_t + \sigma \varepsilon_{t+1} \\ \nu_{t+1} &= \begin{cases} \nu_t, & \text{w.p. } p \\ \hat{\nu}_{t+1} \sim G(\nu_t), & \text{otherwise} \end{cases} \end{aligned}$$

Financial center real yield curve:

$$q_t^n = \mathbf{E}_t \left\{ m_{t+1} \cdot q_{t+1}^{n-1} \right\}$$

Long-term bond:

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

*Known* at time $t$:

- Current short rate $x_t$
- Conditional mean next period, $\nu_t$

Seldom-changing conditional mean:

- $\nu$ jumps with probability $1-p$
- Regime expected to last $1/p$ periods
- $\nu_{t+1} | \nu_t$

Nominal Pricing Kernel Intermediaries

# 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 $m$ SDF

# 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 $\Pi_t$
- profits of domestic financial intermediaries $\pi_t^f$
- lump sum tax or transfer from fiscal authority $T_t$

Discounts with $\beta$, for welfare purposes.

# 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 $\theta$ of the wage bill must be paid before production takes place. *Intra-period* loan rate $i_t$.

Compare to Neumeyer Perri (2005), 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 endogenous 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.

Bond prices in good credit standing

$$q_t = \mathbf{E}_t \left\{ m_{t+1} \left[ (1 - d_{t+1}) \left( \kappa + (1-\delta) q_{t+1} \right) + d_{t+1} q^d_{t+1} \right] \right\}$$

and secondary market value in default $q^d_t$ reflects eventual recovery

- constant recovery rate $\phi$
- but not in excess of $\xi$ share of GDP.

Pricing Kernel

# Recursive Formulation

- State variables...
  - Exogenous: TFP ($A$), SDF factor ($x$), SDF news ($\nu$), collected in $s \equiv \langle A, x, \nu \rangle$
  - Endogenous: debt ($b$)

- Equilibrium consists of...
  - Value functions: $V(s,b), V^d(s,b)$
  - Policies with market access: $b'(s,b), d(s,b), c(s,b), \ell(s,b), \dots$
  - Policies in default: $c^d(s,b), \ell^d(s,b), \dots$
  - Forward-looking functions:
    - Bond price schedules: $q(s,b'), q^d(s,b)$
    - Expected marginal utility: $H(s,b'), H^d(s,b)$

- Computation with taste shocks, like Dvorkin et al. (2021), ...
  - On borrowing decision ($b'$) for convergence,
  - On default decision ($d$) for quantitative purposes.

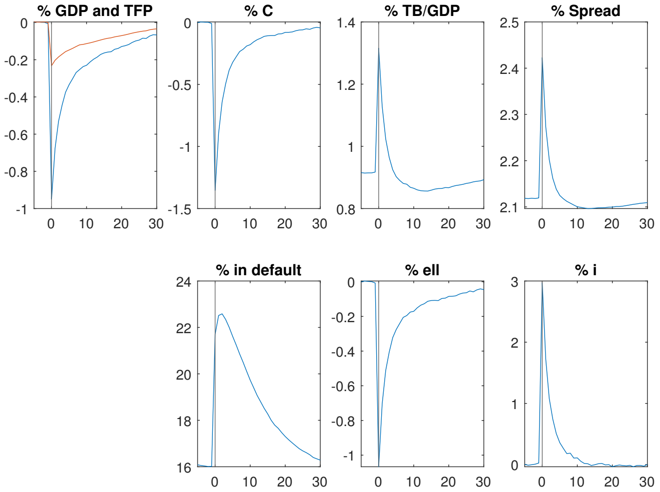
# Calibration

| | Value | Comment |
|---|---|---|
| $\beta$ | 0.97 | Discounting |
| $\delta$ | 0.05 | Macaulay duration |
| $1/\mu$ | 2.0 | Frisch elasticity |
| $\theta$ | 1.0 | Working capital |
| $\lambda_0$ | $-0.40$ | Penalty, linear |
| $\lambda_1$ | $+0.43$ | Penalty, quadratic |
| $\lambda$ | 0.0625 | 4 year exclusion |
| $\phi$ | 0.65 | Recovery rate |
| $\xi$ | 0.3 | Recovery cap |
| $\rho_x$ | 0.90 | Autocorr $x_t$ |
| $\rho_A$ | 0.93 | Autocorr $A_t$ |
| $\sigma$ | 0.0015 | Cond Var $x_t$ |
| $\sigma_y$ | 0.0025 | Cond Var $A_t$ |
| $\rho_D$ | $3e^{-5}$ | Default shock |
| $\rho_B$ | $1e^{-5}$ | Borrowing shock |

| | Argentina | Brazil | Mexico | Model |
|---|---|---|---|---|
| Spread (EMBI) | | | | |
| Mean | 7.1 | 2.7 | 2.3 | 2.2 |
| Sd | 3.8 | 0.9 | 0.9 | 0.8 |
| Volatility | | | | |
| Y | 2.8 | 1.9 | 1.9 | 2.1 |
| C | 3.1 | 1.7 | 1.9 | 2.5 |
| Debt/Y | 88.8 | 87.8 | 53.3 | 26.0 |
| Correlation | | | | |
| Y & $Y_{-1}$ | 0.80 | 0.81 | 0.85 | 0.82 |
| Y & C | 0.88 | 0.88 | 0.95 | 0.97 |
| Y & Sp | $-0.23$ | $-0.46$ | 0.01 | $-0.42$ |
| TB/Y & Sp | $-0.12$ | $-0.15$ | 0.24 | 0.60 |

Data: 2005Q1-2019Q4

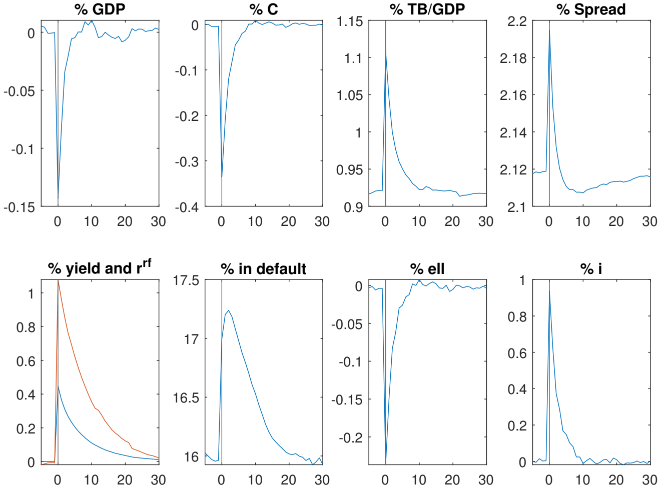
# IRF to TFP ($A_t$)




Low TFP

- Depresses labor input
- Tightens domestic financial conditions
- Causes defaults and/or high spreads
- Current Account reversal

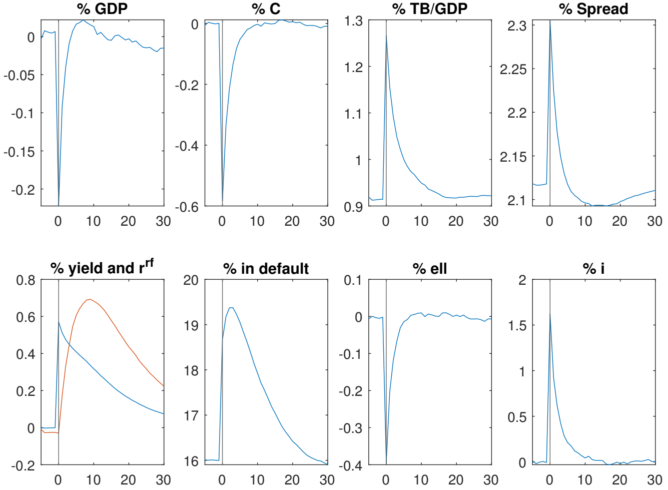
# IRF to Risk-free Rate ($x_t$)




High short-term risk-free rate

- Depresses labor input
- Tightens domestic financial conditions
- Causes defaults and/or high spreads
- Current Account reversal

# IRF to Expected Rates ($\nu_t$)




A "tightening cycle"

- Depresses labor input
- Tightens domestic financial conditions
- Causes defaults and/or high spreads
- Current Account reversal

# Conclusions & Work in Progress

- "Tightening cycles" *can*...
  - raise default risk,
  - be recessionary, and
  - induce Current Account reversals

  in *near* standard models.

- Ambiguous response of spread to risk-free rate: role of shock persistent, news.

- Our approach:
  - Market segmentation: international vs sovereign vs domestic rates.
  - Working capital constraint on production.
  - "1 factor" exponential affine pricing kernel with news.

- Work in progress:
  - Estimate nominal US pricing kernel with particle filter,
  - Embed in quantitative model & calibrate.

# Appendix

# Nominal Pricing Kernel

Augment with statistical model of inflation for estimation…

$$
\begin{aligned}
-\log m_{t+1} &= x_t + 0.5 \cdot \lambda^2 + \lambda \varepsilon_{t+1} \\
x_{t+1} &= (1-\rho)\nu_t + \rho x_t + \sigma \varepsilon_{t+1} \\
\nu_{t+1} &= \begin{cases} \nu_t, & \text{w.p. } p \\ \hat{\nu}_{t+1} \sim G(\nu_t), & \text{otherwise} \end{cases}
\end{aligned}
$$

$$
\pi_{t+1} = \overline{\pi} + \iota_x x_t + \iota_\nu \nu_t + A(L)\epsilon_{t+1}
$$

Nominal yield curve:

$$
q_t^n = \mathbf{E}_t \left\{ \frac{m_{t+1}}{\pi_{t+1}} \cdot q_{t+1}^{n-1} \right\}
$$

Back