World Financial Cycles

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Motivation

What drives the cross section of sovereign spreads in emerging markets?

- Standard view (Eaton Gersovitz 1981, Arellano 2008, and many others)
  - EM shocks (quantity of EM risk)

- Global cycle view (Longstaff et al. 2011, Rey 2013, and many others)
  - Shocks in the “North" (price of EM risk)

The contribution

- Develop a framework that encompasses both views
  - A model of price of risk in the North (Bansal Yaron +)
  - A model of default risk in EMs (Arellano +)
  - Spillovers from North to EMs
- Use model plus real and financial data from US (North) and several EMs to identify shocks that drive EM spreads

Findings

- Pre 2008 crisis: large role of EM specific shocks
- 2008-1019: large role of North (Global Cycle)
- COVID: South again

Literature

- Long Run Risk domestic and international: Bansal and Yaron (2004), Colacito and Croce (2011), Lewis and Liu (2015), David, Henricksen and Simonovska (2016)
- Sovereign default: Eaton and Gersovitz (1981), Aguiar and Gopinath (2006), Arellano (2008), Chatterjee and Eyigungor (2012), Aguiar, Chatterjee, Cole, and Stangebye (2016)
- Investor risks: Borri and Verdelhan (2011), Lizarazo (2013), Tourre (2016)
- Global Financial Cycles: Longstaff, Pan, Pedersen and Singleton (2011), Rey (2013), Gilchrist, Wei, Yue, and Zakrajsek (2021), Morelli, Ottonello, and Perez (2022)

Outline

- Data
- Framework
- Show framework can match key features of data
- Identifying shocks

Data

- 11 Emerging countries with at least 15 yrs of monthly spread data (EMBI Global) and quarterly GDP over 1994-2022
- Similar data as Longstaff et al. (2011) and Aguiar et al. (2016)

3 Regularities Hard to Explain with Standard Models

1. Spreads higher than default frequencies

	Median Across i
Spread	3.0%
Default frequency	1.9%

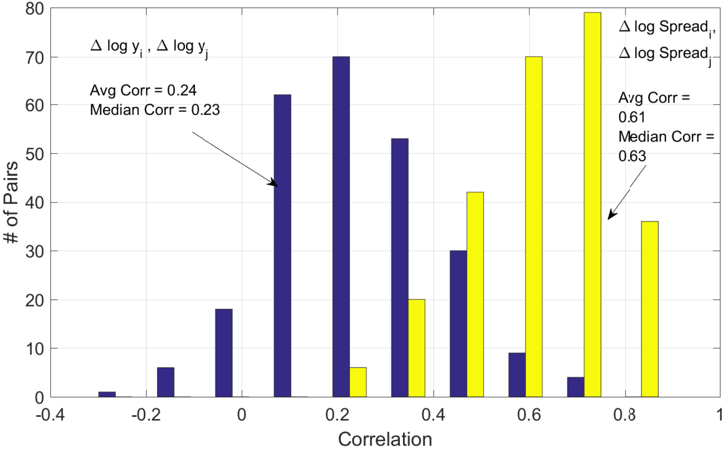
Default frequency = $\frac{\text{\# years with at least 1 default}}{\text{total yrs in sample}}$

2. High volatility of spreads

standard deviation of spreads: $\geq$ 2 percentage points

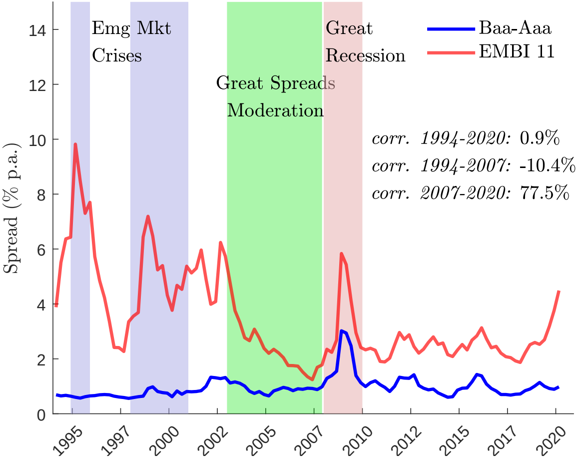
3. World financial cycles: high cross-section correlation of spreads
   - Across emerging markets, spreads co-move much more than GDP
   - EM spreads co-move with US corporate spreads after 2007

Cross Correlation of Δ Spreads$_i$ and Δ GDP$_i$



- Average corr. of spreads 61% but average corr. of Δy only 24%
- All pairs of emerging mkts feature positive comovement

Emerging Markets Spreads and US Corporate Spreads



▸ Stock ▸ GDP

Model

Overview

- A continuum of small Southern countries and one North country
- North: production economy with corporate default risk
- South: pure exchange economy with sovereign default risk
- All countries have Epstein-Zin preferences

$$\log(V_{jt}) = (1-\beta_j)\log(C_{jt}) + \frac{\beta_j}{1-\gamma}\log\left(E_t V_{jt+1}^{1-\gamma}\right)$$

- Discount factor for North β_N, for South β_S, with $\beta_S < \beta_N$
- Segmented stock market (home bias puzzle), consolidated bond market
  - North prices both corporate and sovereign bonds and own stocks
  - South prices own stocks
- South, individually and as a whole, is small in the world economy

North

North

- Representative household own all securities and collect income

- A continuum of firms issuing long-term debt with default risk

  similar to Gourio (2013), Gomes-Jermann-Schmid (2016)

- Long-term debt with decay rate φ, sequence of payments given by

$$\varphi, \varphi(1-\varphi), \varphi(1-\varphi)^2, ...$$

- After default,
  - Existing shareholders receive zero value
  - Debt holders become owners but lose fraction $1-\theta$ of firm value (rebated back to households)

- Government subsidizes firm debt issuance using lump-sum tax
  - One unit of issuance, firm gets $\chi > 1$ unit

North Production and Shocks

- Each Northern firm produces with capital K and labor N

$$Y_{jt} = (A_{Nt}N_{jt})^{1-\alpha_k} K_{jt}^{\alpha_k} - z_{jt}K_{jt}$$

- Common prod. shock A_{Nt} governed by growth prospect x_{Nt}, volatility σ_{Nt}

$$\begin{aligned}
\triangle a_{Nt+1} &= \mu_N + x_{Nt} + \sigma_{Nt}\nu_{Nt+1} \\
x_{Nt+1} &= \rho_{xN} x_{Nt} + \phi_{xN}\sigma_{Nt} v_{xNt+1} \\
\sigma^2_{Nt+1} &= (1-\rho_{\sigma N})\sigma^2_N + \rho_{\sigma N}\sigma^2_{Nt} + \phi_{\sigma N}\sigma_{Nt} v_{\sigma Nt+1}
\end{aligned}$$

  where $\triangle a_{Nt+1} \equiv \log A_{Nt+1} - \log A_{Nt}$

  - Idiosyncratic shocks $(\nu_{Nt}, \nu_{xNt}, \nu_{\sigma Nt})$ has world components
  - σ_N std of short-run innovation
  - ϕ_{xN} std of long-run innovation relative to short-run
  - $\phi_{\sigma N}$ std of vol innovation relative to short-run

- Idiosyncratic shock $z_{jt} \sim N(0, \sigma_z^2)$ with cdf $\Psi(z)$

Firm Problem

- Default choice (suppress aggregate state)

$$J_t(K_{jt}, B_{jt}, z_{jt}) = \max\{0,\ J_{rt}(K_{jt}, B_{jt}, z_{jt})\}$$

- Repayment value: choose $(N_{jt}, K_{jt+1}, B_{jt+1})$

$$J_{rt}(K_{jt}, B_{jt}, z_{jt}) = \max \left\{ (A_{Nt}N_{jt})^{1-\alpha_k} K_{jt}^{\alpha_k} - z_{jt}K_{jt} - w_t N_{jt} - (K_{jt+1} - (1-\delta)K_{jt}) \right.$$
$$- \varphi B_{jt} + Q_{jt}(K_{jt+1}, B_{jt+1})[\chi B_{jt+1} - (1-\varphi)B_{jt}]$$
$$\left. + E_t M_{Nt,t+1} \int J_{t+1}(K_{jt+1}, B_{jt+1}, z)\, d\Psi(z) \right\}$$

where $M_{Nt,t+1}$ stochastic discount factor

- There exists a default cutoff z^*_{jt}: default iff $z_{jt} > z^*_{jt}$

$$J_{rt}(K_{jt}, B_{jt}, z^*_{jt}) = 0$$

- Let $\Psi(z^*)$ denote the repayment probability

Financial Intermediaries

- Competitive, owned by households
- Borrow from households and lend to firms and southern countries
- Firms' bond price schedule reflects default losses

$$Q_{jt}B_{jt+1} = E_t M_{Nt,t+1} \Bigg\{ \Psi(z^*_{jt+1})[\varphi + (1-\varphi)Q_{jt+1}]B_{jt+1} + \int_{z^*_{jt+1}} \theta \underbrace{\Big[J_{rt+1} + \varphi B_{jt+1} + (1-\varphi)Q_{jt+1}B_{jt+1}\Big]}_{\text{firm value}} d\Psi(z) \Bigg\}$$

Bond and Stock Prices

- Corporate bond spread

$$spr_{Nt} = \log\left(\frac{\varphi + (1-\varphi)Q_{Nt}}{Q_{Nt}}\right) - \log\left(\frac{\varphi + (1-\varphi)Q_{ft}}{Q_{ft}}\right)$$

Q_{ft}: bond w/ same payoffs as corporate bond but no default risk

- Stock (claim to firm's dividend stream) price-dividend ratio

$$\frac{P_{Nt}}{D_{Nt}} = \frac{\int_0^1 [J_{jt}(z) - D_{jt}(z)]dj}{\int_0^1 D_{jt}(z)dj}$$

with dividend

$$D_{jt} = \pi_{jt} - (K_{jt+1} - (1-\delta)K_{jt}) - \varphi B_{jt} + Q_{Nt}[\chi B_{jt+1} - (1-\varphi)B_{jt}]$$

and operating profit $\pi_{jt} = (A_{Nt}N_{jt})^{1-\alpha_k} K_{jt}^{\alpha_k} - z_{jt}K_{jt} - w_t N_{jt}$

Aggregate State and Stochastic Discount Factor

- Assume South as a whole is a small in the world economy
- Equilibrium

$$C_{Nt} + K_{t+1} - (1-\delta)K_t = Y_{Nt}$$

- Aggregate state $S_{Nt} = (x_{N_t}, \sigma_{N_t}, K_t, \omega_t)$
  - With CRS production, all firms choose the same leverage $\omega_t = \omega_{jt} = B_{jt}/K_{jt}$
  - firm distribution does not matter
- Can solve for the North SDF independently from the South

$$M_{Nt,t+1} = \beta_N \left(\frac{C_{Nt}}{C_{Nt+1}} \right) \left\{ \frac{V_{Nt+1}}{\left[EV_{Nt+1}^{1-\alpha} \right]^{\frac{1}{1-\gamma}}} \right\}^{1-\gamma}$$

Firm optimization

South

Endowment

- Exogenous endowment y_{jt} with growth $\triangle y_{jt+1} \equiv \log y_{jt+1} - \log y_{jt}$

- Output growth given by growth prospect x_{jt}, volatility σ_{jt}, iid shock ν_{jt}

$$
\begin{aligned}
\triangle y_{jt+1} &= \mu_S + x_{jt} + \sigma_{jt}\nu_{jt+1} \\
x_{jt+1} &= \rho_{xS}x_{jt} + \phi_{xS}\sigma_{jt}v_{xjt+1} \\
\sigma^2_{jt+1} &= (1-\rho_{\sigma S})\sigma^2_S + \rho_{\sigma S}\sigma^2_{jt} + \phi_{\sigma S}\sigma_{jt}v_{\sigma jt+1}
\end{aligned}
$$

- Idiosyncratic $(\nu_{jt}, \nu_{xjt}, \nu_{\sigma jt})$ have common South components

Debt and Default

- Long-term bond decays at rate φ
- Country can default on coupon and on fraction $1 - \theta_S$ of remaining debt
- Default leads to temporary financial autarky and lower output
  - Remaining units of debt outstanding is $\theta_S B_{jt}$
  - Excluded from financial markets, reenter with probability λ
  - Output in financial autarky

$$Y_{jt}^d = \left(1 - a_0 e^{a_1 X_{jt}}\right) e^{\kappa_{jt}} Y_{jt}$$

    with $\kappa_{jt} \sim N(0, \phi_\kappa^2)$, $a_0 > 0$
  - Default costs low when growth prospects X_{jt} low if $a_1 > 0$

South Problem

- State variable (B, κ, S) with $S = (X_N, \sigma_N, K, \omega; X, \sigma) = (S_N; X, \sigma)$
- Default choice:

$$v(B, \kappa, S) = \max\left\{w^R(B, S), w^D(B, \kappa, S)\right\}$$

default $d(B, \kappa, S) = 1$ if $w^D(B, \kappa, S) > w^R(B, S)$

- Default value

$$\log(w^D(B, \kappa, S)) = (1 - \beta_S)\log(Y_d(\kappa)) + \beta_S \log\left(G_d(B, S)\right)$$

where $G_d(B, S)^{1-\gamma} = E\Big\{(1-\lambda)[w^D(B, \kappa', S')]^{1-\gamma} + \lambda[v(\theta_S B,\ \kappa',\ S')]^{1-\gamma}\Big\}$

South Problem

- Repaying value

$$\log(w^R(B,S)) = \max_{C,B'} \left\{ (1-\beta)\log C + \beta \log \left(\left[Ev(B',\kappa',S')^{1-\gamma} \right]^{1/(1-\gamma)} \right) \right\}$$

subject to

$$C + \varphi B \leq Y + Q(B',S)\left[B' - (1-\varphi)B\right]$$

- Default cutoff: default iff $\kappa \geq \kappa^*(B,S)$

$$w^R(B,S) = w^D(B,\kappa^*,S)$$

Bond Price Schedule

- Bond price schedule

$$Q\left(B',S\right)B' = EM(S_N,S_N')\Psi\left(\kappa^*\left(B',S\right)\right)\left[\varphi+(1-\varphi)Q\left(B'',S'\right)\right]B' + EM(S_N,S_N')\left[1-\Psi\left(\kappa^*\left(B',S\right)\right)\right]\Omega\left(B',S'\right)$$

  with debt recovery

$$\Omega\left(B,S\right) = \lambda Q\left(\theta_s B,\ S\right)\theta_s B + (1-\lambda)EM(S_N,S_N')\Omega\left(B,S'\right)$$

- Bond price schedule shaped by default risk, North SDF, and debt recovery

- North long run prospect X_N and volatility σ_N show up in price of risk

Stocks

- Segmented stock markets

- Exogenous dividend process in South

$$\Delta d_{jt+1} = \mu_S + \alpha_{dS} x_{jt} + \phi_{dS} \sigma_{St} \left(\delta_N \nu_{Nt+1} + \delta_S \nu_{jt+1} + \delta_d \nu_{djt+1} \right)$$

  (ν_{Nt}, ν_{jt}) short-run shock of North and South
  ν_{djt} is standard normal, iid, and independent of other shocks

- Main purpose: use P/D data to identify X_{St}

$$\frac{P_{jt}}{D_{jt}} = EM_{jt,t+1} \exp\left(\triangle d_{jt+1}\right) \left(1 + \frac{P_{jt+1}}{D_{jt+1}}\right)$$

Intuition for Correlation of North and South Spreads

- Assume:
    - One-period bond, default probability Ψ_t^*
    - North SDF M_{Nt+1} and $M_{Nt+1}\Psi_{t+1}^*$ log-normally distributed
- Risk-free and risky bond prices

$$Q_{ft} = E_t M_{Nt+1}, \qquad Q_{rt} = E_t M_{Nt+1}[1 - \Psi_{t+1}^*]$$

- Spread

$$spr_{rt} = \log(Q_{ft}) - \log(Q_{rt}) = \log E_t \Psi_{t+1}^* + cov_t \left(\log(M_{Nt+1}), \log(\Psi_{t+1}^*)\right)$$

- North and South spreads correlated if:
    - Correlated North and South defaults
    - North and South default when North SDF is high
    - Time-varying northern price of risk

Quantitative Analysis

- Calibrate the model to U.S and 11 emerging economies' output growth, spreads, and stock returns
  - Mean and volatility of spreads discipline default cost parameters $(\chi, \theta, \sigma_z;\ a_0, a_1, \sigma_\kappa)$
  - Vol and corr. (output, spreads, stock) discipline shock parameters
- Impulse response functions illustrate key identification
- Decompose sovereign spreads with particle filter on 1994Q1-2020Q1

What drives common component of sovereign spreads: North or South shock?

Summary of Stochastic Process

North

$$\Delta a_{Nt+1} = \mu_N + x_{Nt} + \sigma_{Nt} \boldsymbol{u_{Nt+1}}, \quad x_{Nt+1} = \rho_{xN} x_{Nt} + \phi_{xN} \sigma_{Nt} \boldsymbol{u_{xNt+1}}$$

$$\sigma^2_{Nt+1} = (1-\rho_{\sigma N})\sigma^2_N + \rho_{\sigma N}\sigma^2_{Nt} + \phi_{\sigma N}((1-\iota)\sigma_N + \iota\sigma_{Nt})\boldsymbol{u_{\sigma Nt+1}}$$

South: for each country j

$$\Delta y_{jt+1} = \mu_S + x_{jt} + \sigma_{jt} \boldsymbol{v_{jt+1}}, \quad x_{jt+1} = \rho_{xS} x_{jt} + \phi_{xS} \sigma_{jt} \boldsymbol{v_{xjt+1}}$$

$$\sigma^2_{jt+1} = (1-\rho_{\sigma S})\sigma^2_S + \rho_{\sigma S}\sigma^2_{jt} + \phi_{\sigma S}((1-\iota)\sigma_N + \iota\sigma_{jt})\boldsymbol{v_{\sigma jt+1}}$$

The composite South shocks include common component

$$\boldsymbol{v_{jt}} = u_{jt} + \alpha_S \boldsymbol{u_{St}}, \qquad \boldsymbol{v_{xjt}} = u_{xjt} + \alpha_{xS} \boldsymbol{u_{xSt}}, \qquad \boldsymbol{v_{\sigma jt}} = u_{\sigma jt} + \alpha_{\sigma w} \boldsymbol{u_{\sigma St}}$$

- North shock $\{u_{Nt}, u_{xNt}, u_{\sigma Nt}\}$, common South shock $\{u_{St}, u_{xSt}, u_{\sigma St}\}$, South iid shock $\{u_{jt}, u_{xjt}, u_{\sigma jt}\}$ all follow Normal distributions
- All composite shocks have unit variance

Parameterization and Key Moments

Sample of 11 emerging countries and US

1994Q1 $\sim$ 2020 Q1

Parameters: Assigned

		North	South
γ	North and South risk aversion	10	10
μ	North and South mean growth rate	.005	.005
α	North capital share	.3	–
δ	North depreciation rate	.08	–
$1/\varphi$	average debt duration	20	20
$1/\lambda$	average exclusion afte default	–	3

Quarterly frequency

Parameters: Endogenously chosen

		North	South
β	discount factor	.99	.98
σ	short-run volatility	.0074	.0111
ω	leverage adjustment cost parameter	.85	.20
h	capital adjustment cost parameter	4	–
χ	borrowing subsidy	1.005	–
θ	loss during default	.6	.45
$\sigma_z(\sigma_\kappa)$	s.d of idiosyncratic shock z or κ	.07	.26
a_0	default cost mean	–	.3
a_1	default cost elasticity	–	20
ρ_x	persistence of long-run shock	.97	.96
ϕ_x	s.d. long-run shock	.0015	.0022
ρ_σ	persistence of volatility shock	.999	.999
σ_σ	s.d. volatility shock	2.8e-6	2.8e-6
α_{dS}	exogenous loading of dividends on x	–	.5
ϕ_{dS}	exogenous scale dividend volatility	–	9.0
δ_N	exogenous loading of dividend on u_N	–	2.7
δ_S	exogenous loading of dividend on u_S	–	0

Moments

Annual output growth	Data	Model
Standard deviation, N	1.2	1.2
Standard deviation, S	2.5	2.5
Serial corr of output growth, N	76.2	75.0
Serial corr of output growth, S	69.1	70.3
Corr of output growth N and S	10.6	0.3
Corr of output growth across S	14.1	14.0
South spreads, default rate		
Mean risk free rate	1.4	1.5
Mean default rate	2.0	2.0
Mean spread	3.0	3.2
S.d. spread	1.9	1.9
Serial correlation of spreads	97.5	98.1
Correlations with south spreads		
Corr of spreads across S	56.3	60.0
Corr (S spreads, S growth)	-34.3	-24.6
Corr (S spreads, N corporate spreads)	12.2	36.3

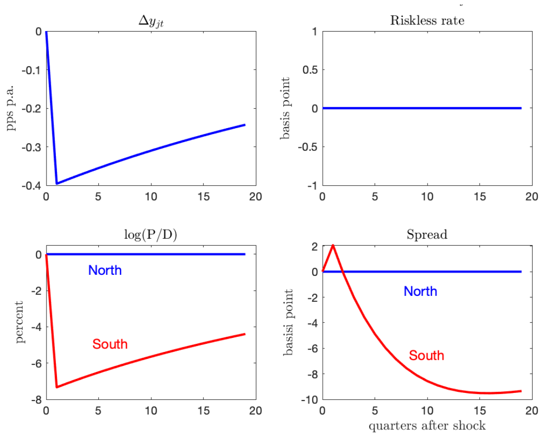
- Benchmark model can get high, volatile, and correlated sovereign spreads

Moments

	Data	Models
North spreads		
Mean default rate	0.5	0.5
Mean spread	1.0	1.0
S.d. spread	0.4	0.5
Serial correlation of spreads	95.8	98.9
Mean corporate leverage	0.72	0.72
North stocks		
Average P/D	4.0	3.1
Volatility of P/D	21.0	21.8
Serial corr of P/D	98.6	97.8
Corr (N P/D, N growth)	38.4	30.2
Corr (N P/D, N spreads)	-48.0	-26.1
South stocks		
Average P/D	3.7	2.4
Volatility of P/D	47.1	32.4
Serial corr of P/D	96.7	97.9
Corr (N P/D, S P/D)	17.4	-5.5
Corr (S P/D, S spreads)	-2.8	-7.7
Corr (S P/D, N spreads)	-21.8	-11.0

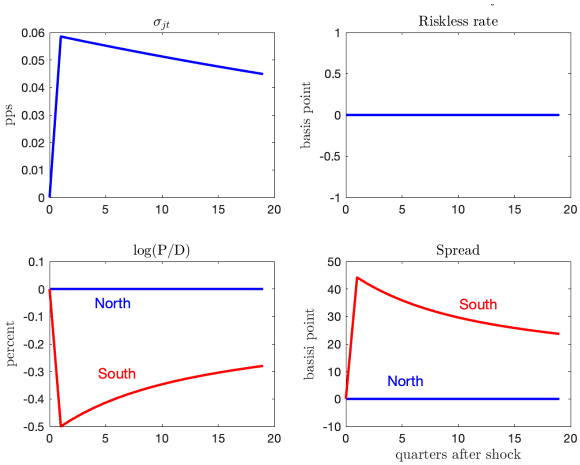
Impusle Response Functions

Impulse Response to South LRR (u_{xS})



- Low x_s lowers long-run output growth, S higher saving incentive
- Key results
  - S lower P/D and higher spread on impact

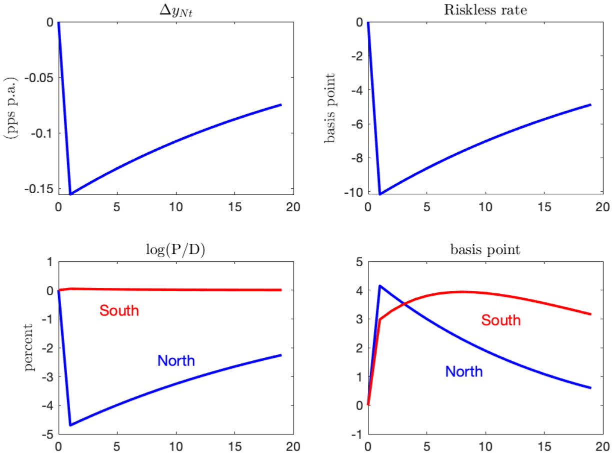
Impulse Response to South Volatility ($u_{\sigma S}$)



Increase in country specific volatility shock $u_{\sigma S}$:

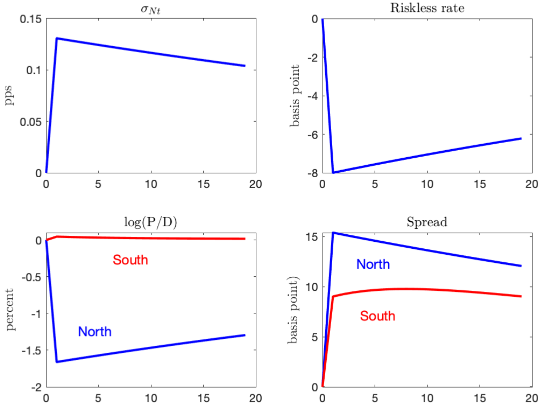
- Increase South default risk, reduce South incentive to hold risky asset
- Key results: S spread increases dramatically, P/D decreases

Impulse Response to North LRR (u_{xN})



- Lower long run growth prospect $\rightarrow$ higher incentive to save
- Key results:
  - North with lower P/D, risk free rate, but higher spreads
  - S borrows more and has higher spread and slightly better P/D

Impulse Response to North Volatility ($u_{\sigma N}$)



- North households higher incentive to save and less willing to hold risky asset
- North firms face higher default rate
- Key results:
  - N risk free rate and P/D drop
  - Both N and S spreads increase, N by more

Sovereign Spreads: North or South Shock?

Strategy

- Sample of 11 southern countries and US
- Begin with North and aggregate of the South (U.S. South)
- Run decomposition over 1994q1-2022q2
  - include Covid period in counterfactuals
  - ► moments after 2020q1 affected by outliers
- Later: work with 12 countries (1 North and 11 South)
  - common parameterization across all 11 southern countries
  - different realizations attributed to luck

Decomposing Spreads Using Particle Filter

Counterfactuals on 1994Q1-2020Q1 period

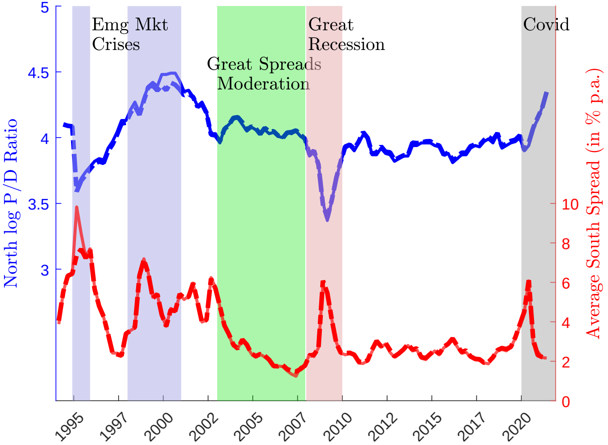
- Countries: US, cross-sectional average of 11 Southern countries
- Observables: $\{\Delta y_{Nt}, pd_{Nt}, spr_{Nt}\}$, $\{\Delta y_{St}, pd_{St}, spr_{St}\}$
- Use particle filter to reconstruct historical sequence of shocks
  - 6 observables discipline 6 shocks
  - $\{u_{Nt}, u_{xNt}, u_{\sigma Nt}\}$, $\{u_{St}, u_{xSt}, u_{\sigma St}\}$

How Model Identifies Shocks

- North is independent of South, so first back out northern shocks
  - short-run shocks u_N move mainly Δy_N
  - long-run shocks u_{xN} move both pd_N and spr_N
  - volatility shocks $u_{\sigma N}$ move mainly spr_N

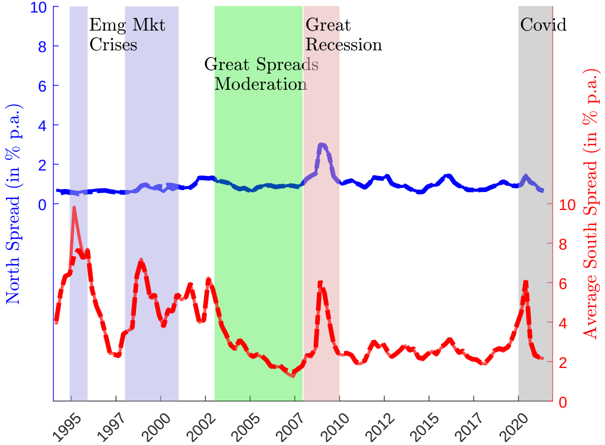
- Then plug North shocks in South and back out missing South shocks
  - short-run shocks move mainly Δy_S
  - shocks to x_S and σ_S move both pd_S and spr_S

Episodes and Predictions from Model



- 1998-2001: Emerging Mkts Crises: High Spds, High $(P/D)_N$
- 2003-2007: Great Spreads Moder: Falling Spds, Stable $(P/D)_N$
- 2008-2009: Great Recession: Spike in Spds, Collapse $(P/D)_N$

Episodes and Predictions from Model



- 1998-2001: Emerging Mkts Crises: High Spds in South, Not in North
- 2003-2007: Great Spreads Moder: Falling Spds in South, Stable in North
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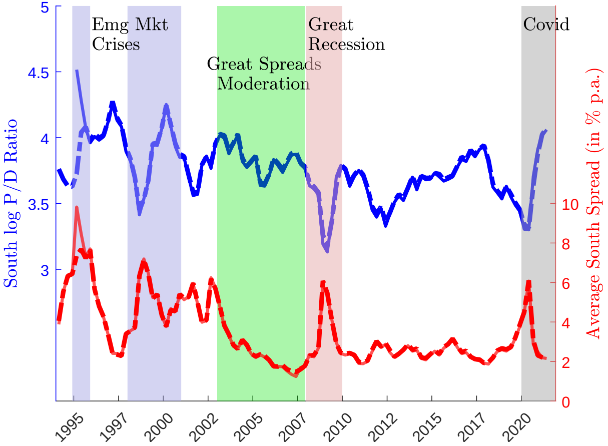
Episodes and Predictions from Model



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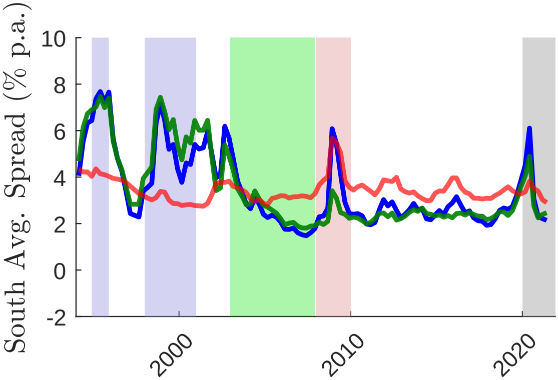
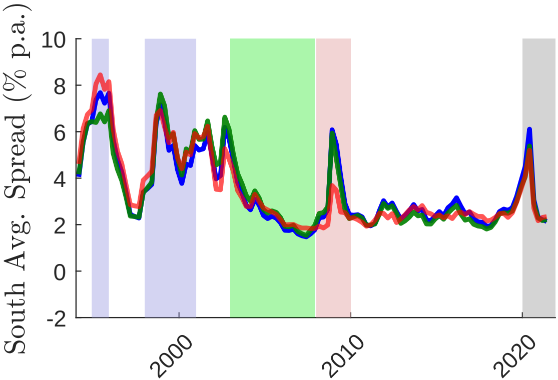
NPD-Nsp

Sovereign Spread: North vs South Shocks



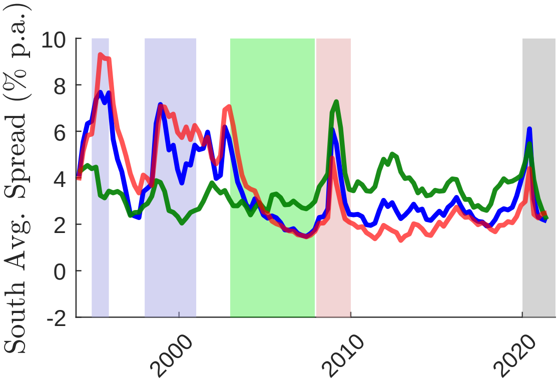
- Blue: bench, Red: only North, Green: only South
- North shocks contributes to sovereign spreads following GFC and subsequent recovery
- South shocks drive spreads before GFC

Sovereign Spreads: North LRR vs Volatility Shock



- Blue: bench, Red: no north σ_N, Green: no north x_N
- Sovereign spreads driven by volatility σ_N over 2008-2018

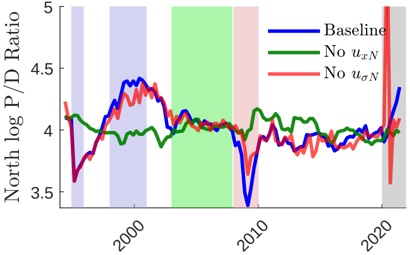
Sovereign Spreads: South LRR vs Volatility Shock

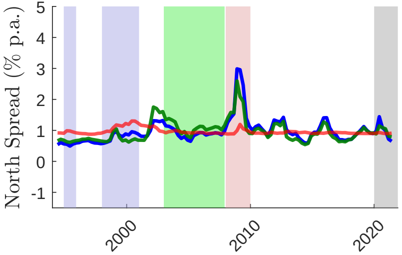


- Blue: bench, Red: no south σ_s, Green: no south x_s
- Southern spreads driven by both long-run risk x_S and volatility σ_S

S-stock

North Stock and Spread





- P/D in North driven by both long-run risk x_N and volatility σ_N
- US corporate spreads mainly driven by volatility σ_N

xshock vshock

Conclusion

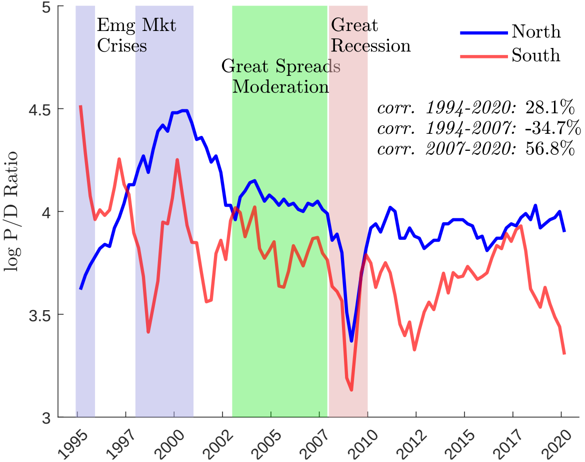
Two views on driving force of sovereign spreads

- Standard sovereign default: EM own output
- Global banks view: US shocks

Nuanced view:

- Pre-2007
  - EM patterns driven by world shocks
  - Global banks view failed
- Post-2007
  - Global banks view useful in Great Recession

World Comovement: Stock Markets



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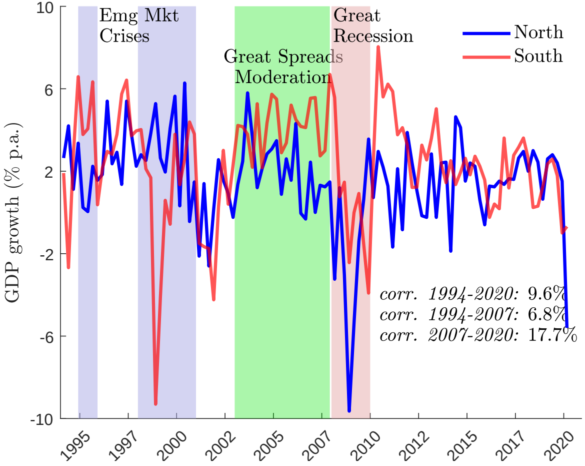
World Comovement: Real GDP



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Firm Optimization

- CRTS production implies all firms choose the same leverage $\omega = B/K$, distribution of firms does not matter in equilibrium
- Optimal choice of investment

$$1 = E_t M_{Nt,t+1}[R_{kt+1} + (1-\delta)](1 + \Gamma_{t+1})$$

$$\Gamma_{t+1} = (\chi - 1)[1 - \Psi(z^*_{t+1})]z^*_{t+1} - (1 - \chi\theta)\int^{z^*_{t+1}} z d\Psi(z)$$

- Optimal choice of leverage

$$0 = E_t M_{Nt,t+1}[\varphi + (1-\varphi)Q_{Nt+1}]\Big[(\chi - 1)(1 - \Psi^*_{t+1}) - \chi(1-\theta)\Psi'(z^*_{t+1})z^*_{t+1}\Big]$$
$$+ (1-\varphi)\left[\chi E_t M_{Nt,t+1}(1 - \Psi^*_{t+1})\frac{\partial Q_{Nt+1}}{\partial \omega_{t+2}}\frac{\partial \omega_{t+2}}{\partial \omega_{t+1}}\omega_{t+1}\right]$$

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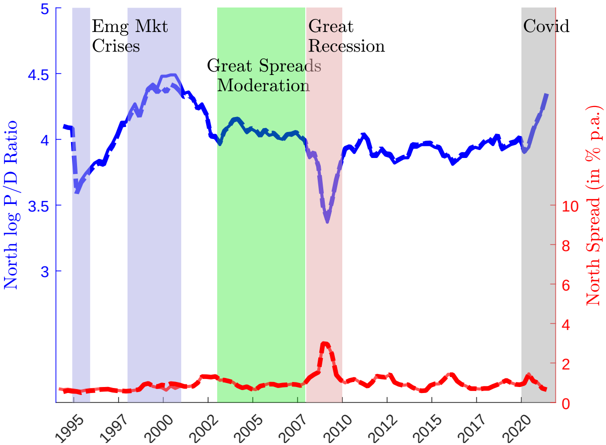
Episodes and Predictions from Model



- 1998-2001: Emerging Mkts Crises: Low US Spds, High $(P/D)_N$
- 2003-2007: Great Spreads Moder: Stable US Spds, Stable $(P/D)_N$
- 2008-2009: Great Recession: Spike in US Spds, Collapse $(P/D)_N$

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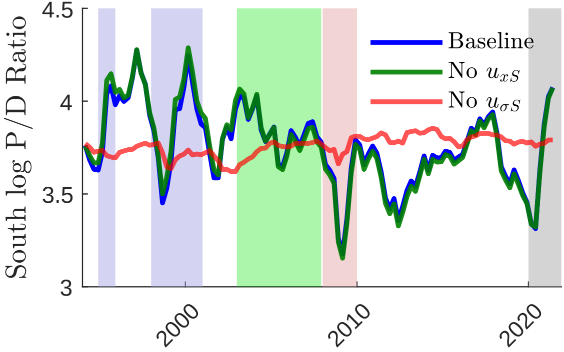
Sovereign Stock: South LRR vs Volatility Shock



- Blue: bench, Red: no south σ_s, Green: no south x_s
- South P/D mainly driven by σ_S, responds little to North shocks

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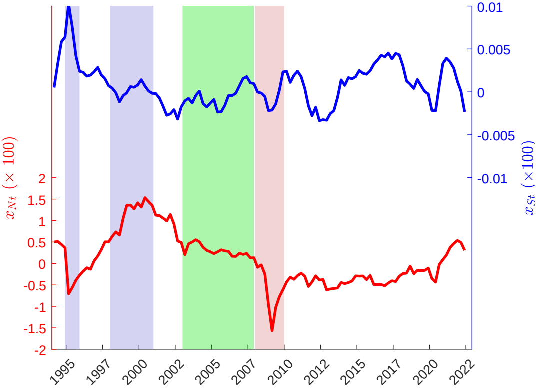
Long Run Risk Shocks from Particle Filters



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Volatility Shocks from Particle Filters

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