World Financial Cycles

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Preliminary and incomplete

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Macroeconomics Within and Across Borders

Motivation

- Quantitative literature on sovereign debt (Eaton Gersowitz, 1981, Arellano, 2008...):
  - Local shocks drive emerging markets bond spreads

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- Data:
  - Emerging markets spreads appear tightly connected to a world/US financial factor: the world financial cycle (Longstaff, Pan, Pedersen, Singleton, 2011)

Objective

- Develop quantitative theory of emerging mkts spreads to assess the importance of both factors
- Relevant in light of current debate on desirability of world capital mkts access and on relation between domestic policies and spreads

Ingredients

- GE/SOE: large, patient, country (north) and continuum of impatient, small open economies (south)
- Incomplete financial markets: uncontingent long-term bonds with default risk
- Output growth in each country is sum of:
  - Idiosyncratic shocks independent across all countries
  - Long-run risk shocks correlated across all countries
- Both countries risk averse with Epstein-Zin preferences
- Long Run risk an EZ -> North SDF prices stocks well

Key Idea

- Long run risk with EZ preferences affects financial conditions in the north (world financial cycle)
- Pricing of risky long run debt responds to world financial cycle
- South countries respond to changes in prices of risk and local fundamentals
- Equilibrium local spreads determined by local fundamentals, local policies and world financial conditions

Literature

- Long Run Risk: Bansal and Yaron (2004), Colacito and Croce (2011)
- Sovereign default: Eaton and Gersowitz (1981), Aguiar-Gopinath (2006), Arellano (2008), Aguiar, Chatterjee, Cole, and Stangebye (2016)
- Investor risks: Borri and Verdelhan (2011), Lizarazo (2013), Tourre (2016)
- Global Financial Cycles: Rey (2013), Longstaff, Pan, Pedersen, Singleton, (2011)

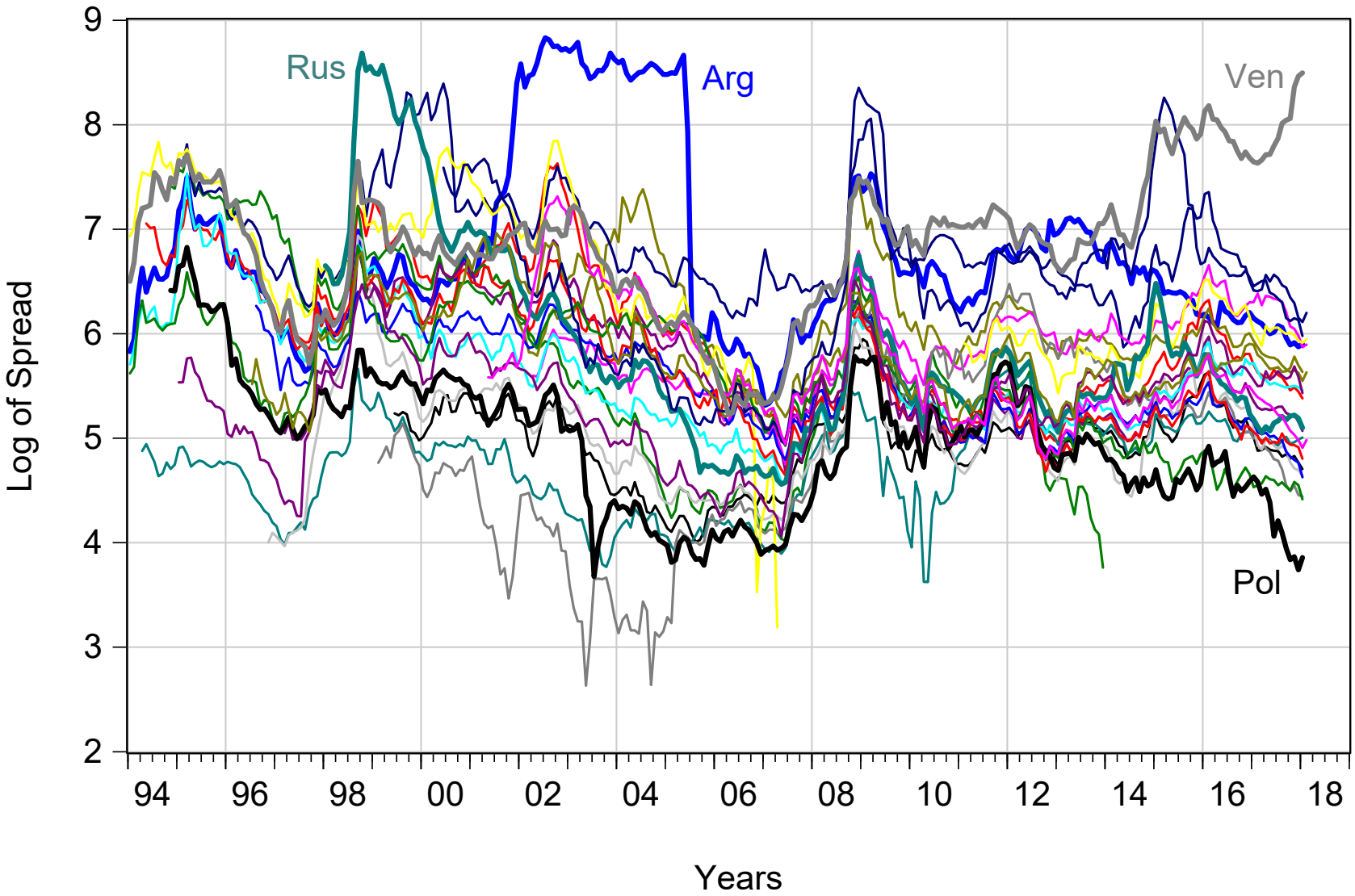
Outline

- Data
- Model
- Calibration
- Results

Data

- 23 Emerging countries with at least 15 yrs of monthly spread data (EMBI Global) and quarterly GDP over 1994-2017
- Argentina, Brazil, Bulgaria, Chile, China, Colombia, Dominican Republic, Ecuador, El Salvador, Hungary, Malaysia, Mexico, Nigeria, Panama, Peru, Philippines, Poland, Russia, South Africa, Turkey, Ukraine, Uruguay, Venezuela.
- Very similar exercise as in Longstaff et al. (2011) and Aguiar et al. (2016)

Emerging Markets Spreads



- Idiosyncratic factors play a role, but strong evidence of a common component

3 stylized facts hard to explain with standard models

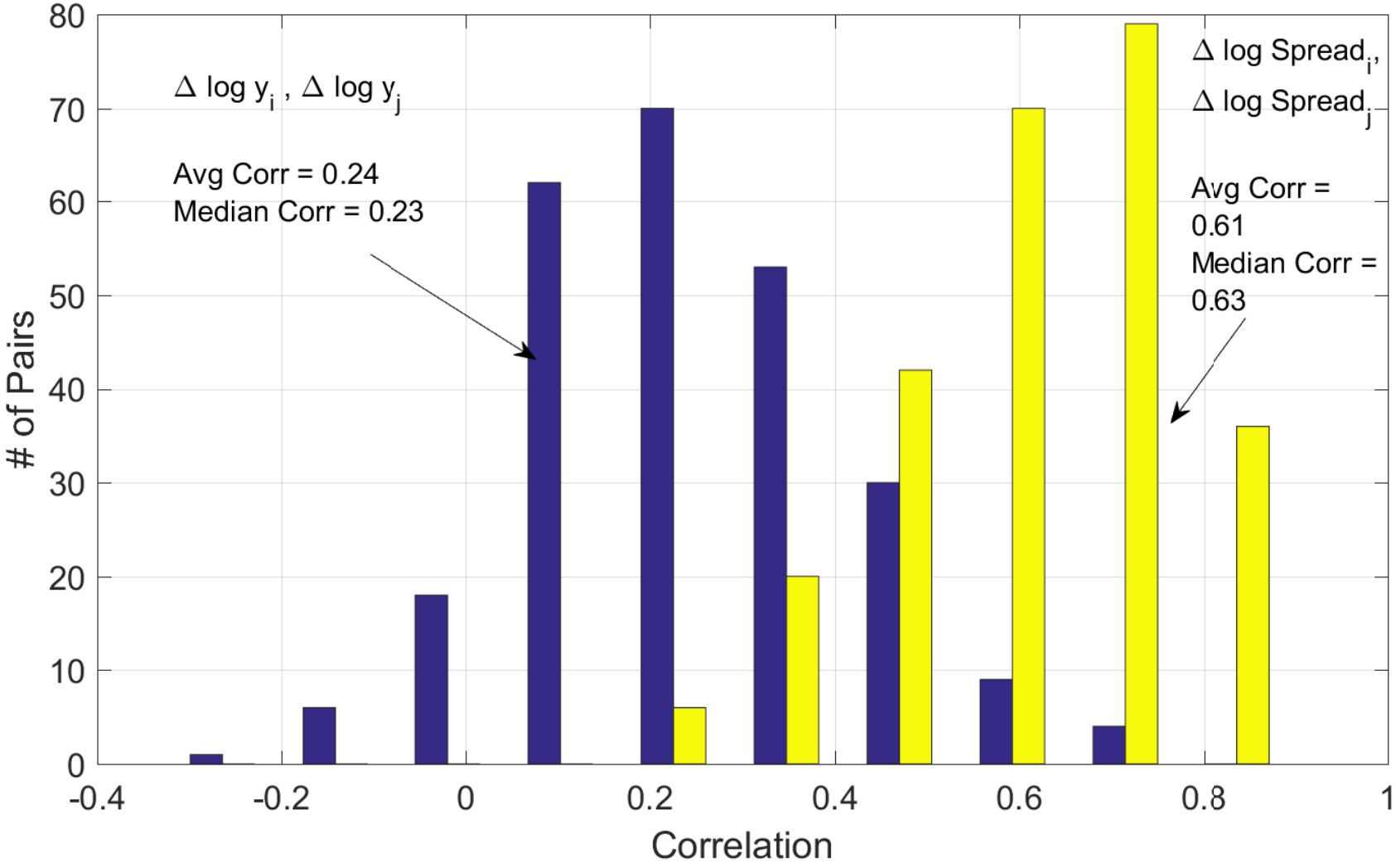
- Spreads higher than default frequency
- Across emerging markets spreads co-move much more than GDP
- When US stock market returns are low, spread in all southern countries high

1. Average spreads and defaults

	Mean Across i	Median Across i
• Average Spread	492 bp	353 bp

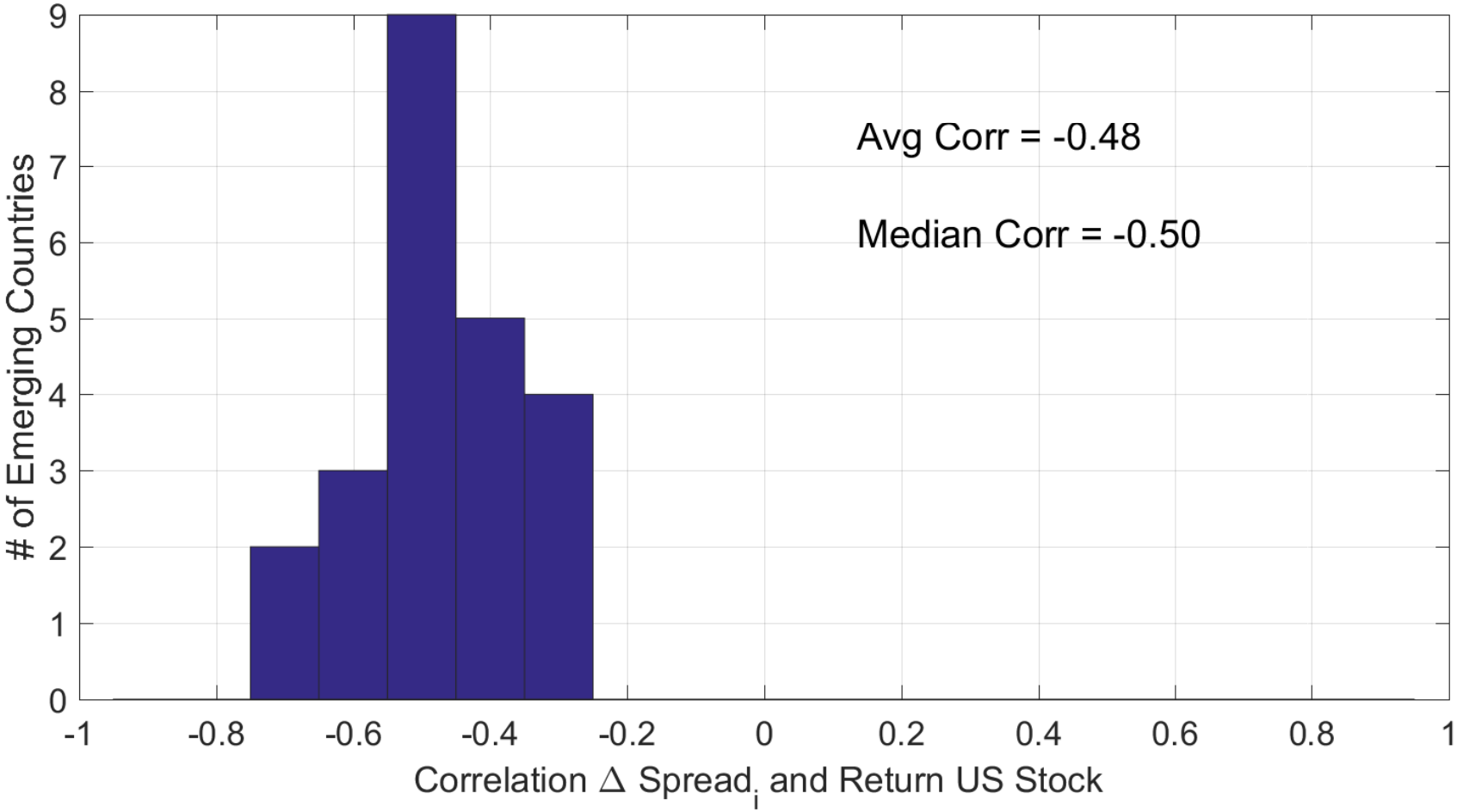
- Default frequency = $\frac{\text{\# years with at least 1 default}}{\text{total yrs in sample}}$ = 273 bp

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



- Across emerging mkts much stronger co-movement in spreads than GDP!
- All pairs of emerging mkts feature positive comovement!

3. Correlation of Δ Spreads$_i$ and Return on SP 500



- When US stock market returns low, all emerging spreads high!

Model

- One North country and a continuum of small South Countries
- One good, pure exchange economy
- Discount factor for North β_N, for South β_S with $\beta_N > \beta_S$
- All countries have Epstein-Zin preferences

$$W_{it} = \left\{ (1-\beta) c_{it}^{1-\rho} + \beta_i \left[E(W_{it+1}^{1-\theta}) \right]^{\frac{1-\rho}{1-\theta}} \right\}^{\frac{1}{1-\rho}}$$

  - θ controls risk aversion
  - $1/\rho$ controls IES

Endowment Processes

- i.i.d growth shocks
- Long run risk: low variance but very persistent changes in growth. Impact 1 on North, $\alpha \geq 1$ on South (Aguiar and Gopinath, 2007)
- Growth spillover, τ, from North to South (keeps distribution of relative output stationary)

$$
\begin{aligned}
g_{Yt} &\equiv \log Y_t - \log Y_{t-1} = X_t + \varepsilon_{Yt} \\
g_{yit} &\equiv \log y_{it} - \log y_{it-1} = \alpha X_t - \tau(y_{it-1} - Y_{t-1}) + \varepsilon_{yt} \\
X_t &= \rho X_{t-1} + \varepsilon_{Xt}
\end{aligned}
$$

Taking differences and defining $s_{it} \equiv \log y_{it} - \log Y_t$

$$
\begin{aligned}
s_{it} &= (1-\tau)s_{it-1} + (\alpha - 1)X_t + \varepsilon_{yt} - \varepsilon_{Yt} \\
g_{Yt} &= X_t + \varepsilon_{Yt} \qquad g_{yit} = \alpha X_t - \tau s_{it-1} + \varepsilon_{yt}
\end{aligned}
$$

Debt and Default

- South borrow from North because of impatience ($\beta_N > \beta_S$) and when has better income prospects ($\alpha > 1$ and $\varepsilon_{Xt} > 0$)
- Long run bond with coupon decaying at rate φ (Hatchondo, Martinez 2009) Sequence of payment is given by

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

($\varphi = 1$ is 1 period debt, $\varphi = 0$ is a consol)

- Default on debt carries two punishments:
  - Default cost (in terms of output) $y_{it} f(g_{yit}, \kappa_{it})$ with κ_{it} stochastic (i.i.d.), $f \geq 0, f_g > 0$ and $f_{gg} > 0$ (Default costs are low and default more likely when g_{yit} low, standard in sovereign debt models)
  - Exclusion from credit markets and with probability λ, defaulted countries regain access to markets

Detrending and Aggregate States

- Detrend non stationary north and south variables ($Y_{it}, y_{it}, C_t, ...$) with Y_{t-1} and y_{it-1} respectively (from now on all variables are stationary)
- Individual state variable are $\{b_i, s_{-1i}, \varepsilon_i, \kappa_i\} = \{b_i, m_i\}$
- Aggregate state variables are $S = (X, \varepsilon, \Lambda(b, m))$, where Λ is the distribution of southern countries over b, m
- Note: $\varepsilon, \varepsilon_i$ are states because of detrending

South Problem

- At beginning of period chooses whether to default or not

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

Let $d(b,m,S) = 1$ if $w^D(m,S) < w^R(b,m,S)$

- Default value:

$$w^D(m,S) = \Bigg\{ (1-\beta)c_d(m)^{1-\rho}$$

$$+ \beta[g_{y_i}(m)]^{1-\rho}\left[E\left(\lambda w^R(0,m',S')^{1-\theta} + (1-\lambda)w^D(m',S')^{1-\theta}\right)\right]^{\frac{1-\rho}{1-\theta}} \Bigg\}^{\frac{1}{1-\rho}}$$

- Consumption after default $c_d(m) = f(g_{yit}(m), \kappa_{it})y_{it}$

South Problem: Repaying

- Repaying value

$$w^R(b,m,S) = \max_{c,b'} \left\{ (1-\beta)c^{1-\rho} + \beta[g_y(m)]^{1-\rho} \left[Ev(b',m',S')^{1-\theta} \right]^{\frac{1-\rho}{1-\theta}} \right\}^{\frac{1}{1-\rho}}$$

subject to

$$c + b \leq y + q(m,S,b') \left[b' g_y(m) - (1-\varphi)b \right].$$

- $q(m,S,b')$ is the bond price schedule faced by south

North

- Inhabited by a continuum of competitive agents with preferences

$$W(S) = \left\{ (1-\beta_N) C^{1-\rho} + \beta_N g_Y^{1-\rho} \left[E W(S')^{1-\theta} \right]^{\frac{1-\rho}{1-\theta}} \right\}^{\frac{1}{1-\rho}}$$

- Implies stochastic discount factor

$$Q(S,S') = \pi(S'|S) \beta_N g_Y^{-\rho} \left(\frac{C(S')}{C(S)} \right)^{-\rho} \left\{ \frac{W(S')}{[E W(S')^{1-\theta}]^{\frac{1}{1-\theta}}} \right\}^{\rho-\theta}$$

- Pricing of long term bonds

$$q(m,S,b') = EQ(S,S')(1-d(b',m',S'))[1+(1-\varphi) q(m',S',b'(m',S'))$$

Market Clearing

$$\mu(Y - C) = (1 - \mu) \int [1 - d_i(b, m, S)] \, [c_i(b, m, S) - y] s_{-1} d\Lambda$$

North has measure μ, South has measure $1 - \mu$

Solution Method

- Krusell-Smith method to solve the model with aggregate uncertainty
- Approximate the South distribution Λ with North consumption C
- Guess the law of motion for North consumption

$$\log(C') = \alpha_0 + \alpha_c \log(C) + \alpha_\varepsilon \log(\varepsilon) + \alpha_X \log(X) + \gamma_\varepsilon \log(\varepsilon') + \gamma_X \log(X')$$

- Update the coefficients $\alpha_0, \alpha_c, \alpha_\varepsilon, \alpha_X, \gamma_Y, \gamma_\varepsilon$ iteratively

A special case

- If $\mu = 1$ (North is large)
- Can solve for the North SDF independently from the south
- $$Q(S, S') = \pi(S'|S)\beta_N g_Y^{-\rho} \left(\frac{Y(S')}{Y(S)} \right)^{-\rho} \left\{ \frac{W(S')}{\left[EW(S')^{1-\theta} \right]^{\frac{1}{1-\theta}}} \right\}^{\rho-\theta}$$
- SOE with correlation between North SDF and south endowment (through X)
- Much easier to solve

Parameterization

After default

$$c_d = \exp(\kappa) y (1 - a_0 g_y^{a_1})$$

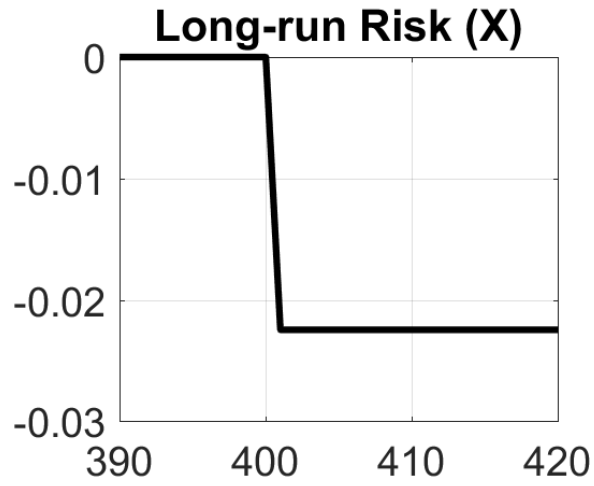
Assigned Parameters		
Risk aversion	$\theta = 10$	Standard
IES	$1/\rho = 1.5$	Standard
Return probability	$\lambda = 0.2$	Standard
North discount factor	$\beta_N = 0.97$	Risk free rate 2.5%
Debt Duration	$\varphi = 0.05$	Debt duration 5 yrs
North size	$\mu = 1$	SOE
Parameters from Moment Matching		
Long-run risk persistence	$\rho = 0.95$	Jointly match:
Long-run risk std	$\sigma_X = 0.007$	Std and ser. corr. of GDP growth: N & S
North std	$\sigma_Y = 0.0162$	Corr output growth corr. btwn N & S
South std	$\sigma_y = 0.03$	Serial corr. and std. dev. of s_{it}
Growth spillover	$\tau = 0.01$	
Long Run Risk South impact	$\alpha = 1.2$	
South discount factor	$\beta_S = 0.92$	Jointly match:
Output loss	$a_0 = 0.03$	South mean and volatility of spreads
Output loss	$a_1 = 6$	South mean debt service to GDP
Std dev. of default costs	$\sigma_k = 5\%$	

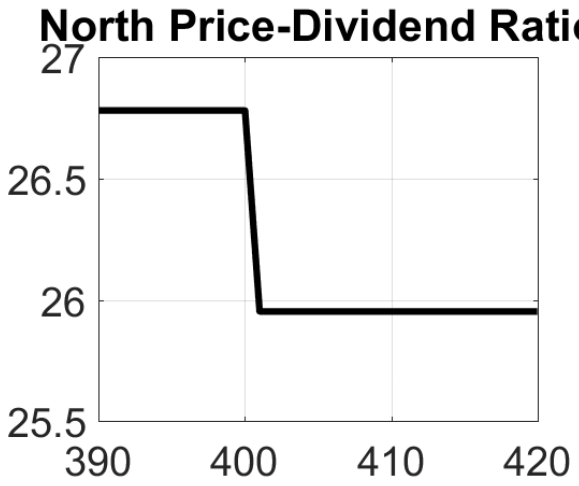
Statistics

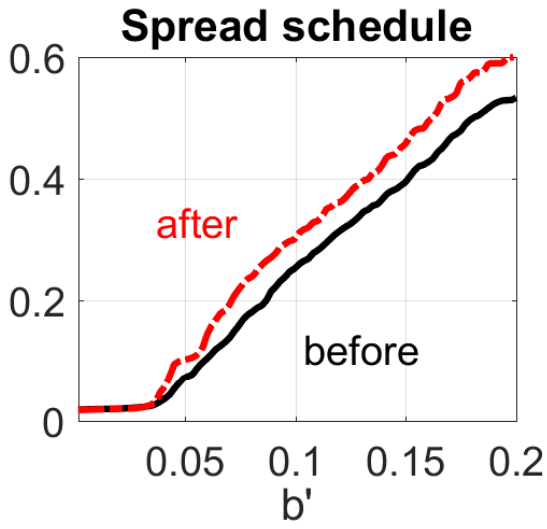
	Data	Standard	Benchmark
Default frequency	2.73	2.47	2.34
Spreads (Avg. across emg mkts)			
Mean	4.92	3.05	6.20
Std Dev	3.89	0.48	1.09
Comovements			
Spreads across Emg Mkts	0.61	0.05	0.47
Y Growth Across Emg Mkts	0.24	0.2	0.2
Stock returns across Emg Mkts		0.0002	0.31
Emg Mkts Spreads & North Stock	-0.48	0.0	-0.45
Emg Mkts Spreads & own growth	-0.37	-0.62	-0.50
Emg Mkts Stock & North Stock		-0.003	0.43
Emg Mkts Stock & own growth		0.89	0.96
North Equity Premium	4.80	0.0	1.18

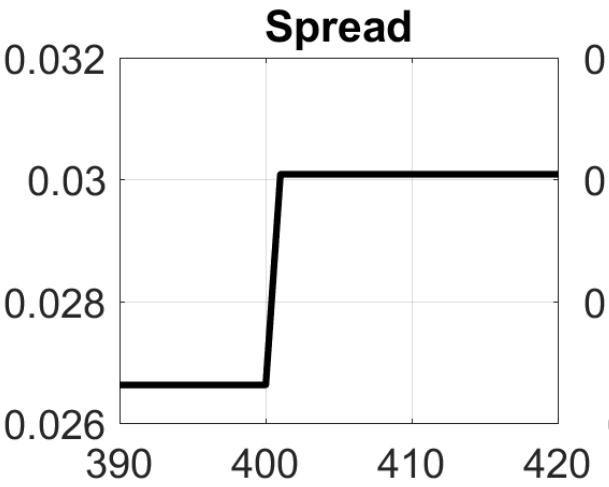
- Standard model has long-term debt, but not EZ shock and linear lender

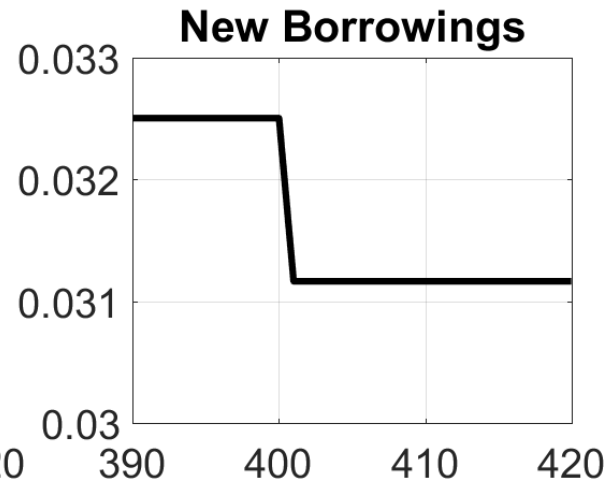
Responses to a long run risk shock

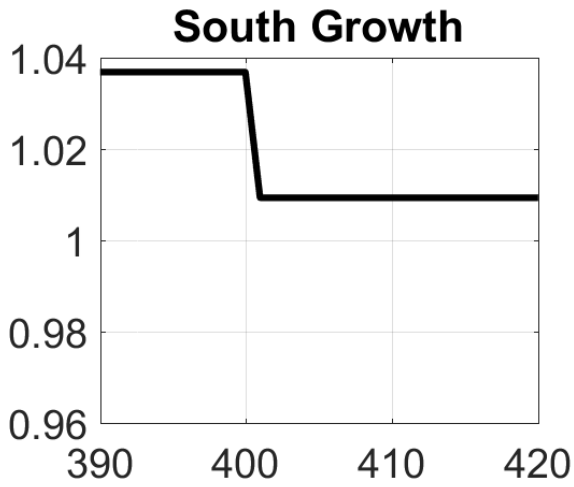




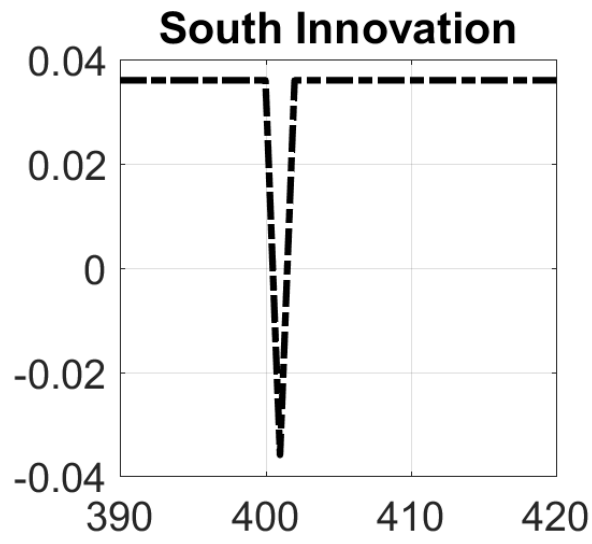


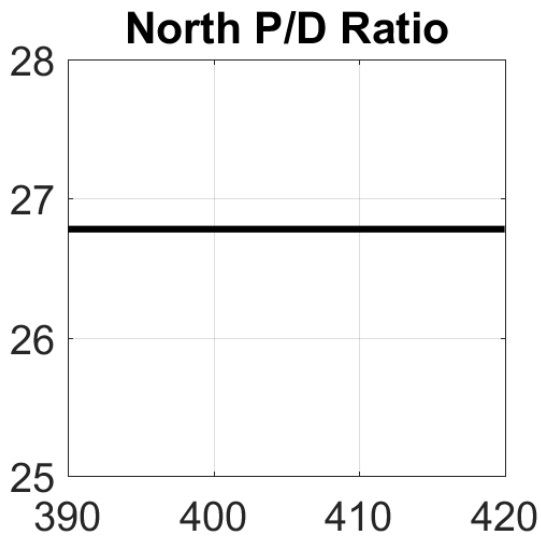


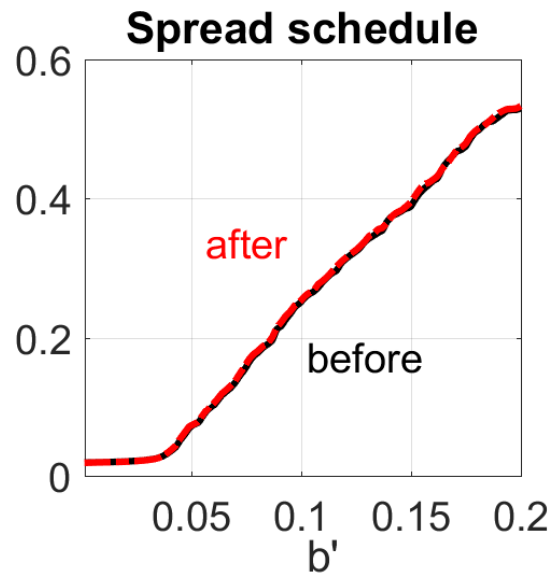


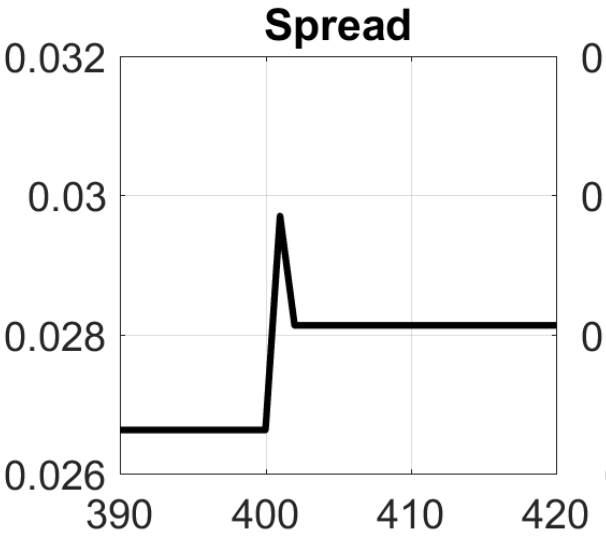


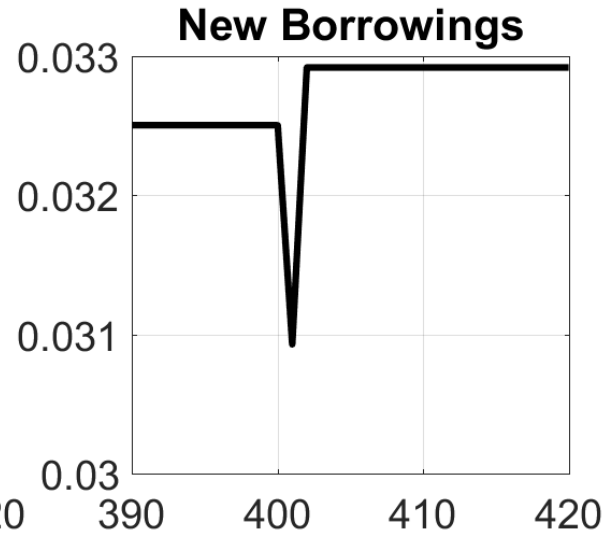
Responses to a South growth shock

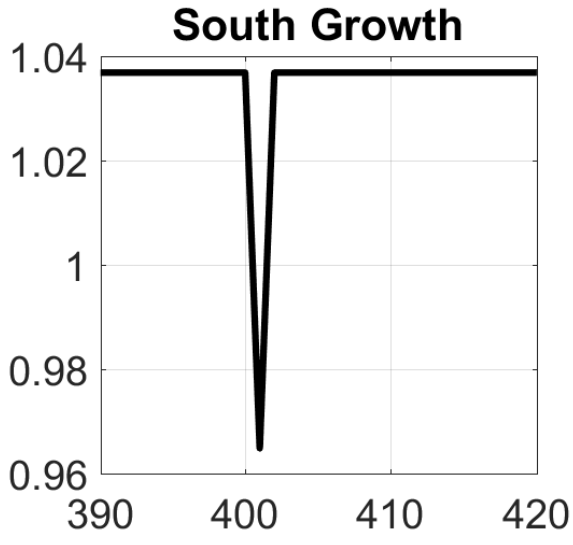




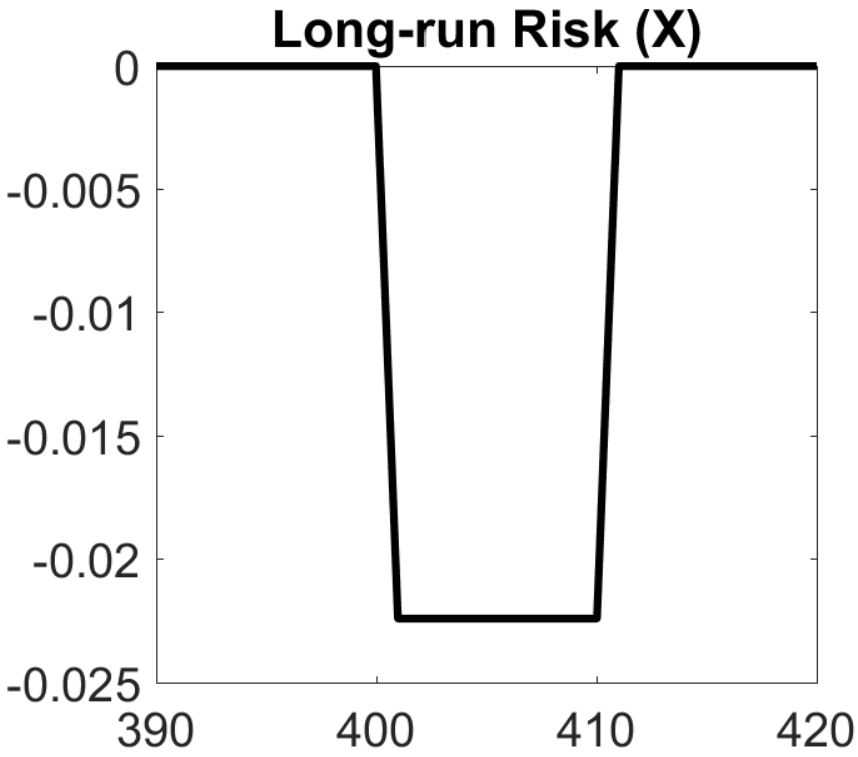


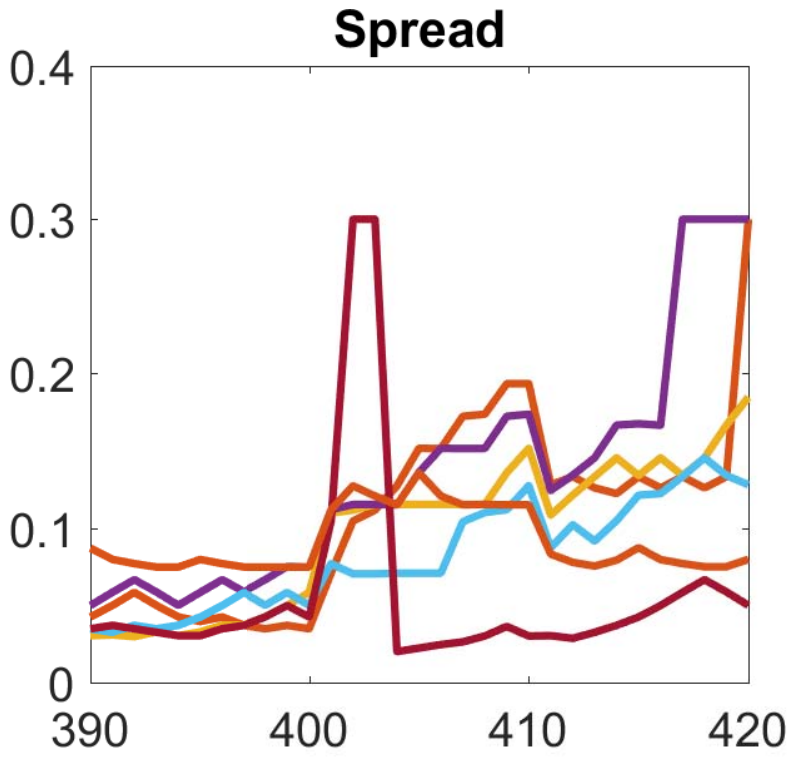






A World Financial Cycle





Takeaways

- Standard model cannot get:
  - Spread more correlated than output across countries
  - Spread much higher than default probs
  - North Stock market correlated with spread
- Benchmark model addresses all these issues!
- Still capturing the role of local shocks (negative corr between own growth and spread)

Takeaways

- Standard model cannot get:
  - Spread more correlated than output across countries
  - Spread much higher than default probs
  - North Stock market correlated with spread
- Benchmark model addresses all these issues!
- Still capturing the role of local shocks (negative corr between own growth and spread)
- Remaining Issues
- Equity premium still too low, volatility of spreads still too low, debt level still too low

Global or Local?

	Benchmark	Only LR X	Only south ε_i
Default frequency	2.34	1.56	0.11
Spreads (Avg. across emg mkts)			
Mean	6.20	5.23	3.38
Std Dev	1.09	0.82	0.32
Comovements			
Spreads across Emg Mkts	0.47	0.40	0.00
Y Growth Across Emg Mkts	0.20	1.00	0.0
Stock returns across Emg Mkts	0.31		
Emg Mkts Spreads & north Stock	-0.45	-0.48	0.0
Emg Mkts Spreads & own growth	-0.50	-0.19	-0.87
Emg Mkts Stock & north Stock	0.43		
Emg Mkts Stock & own growth	0.96		

- Global factor accounts for about 80% of model's spread volatility!

Price or quantity of risk?

	Benchmark	$\alpha_s = 0$	short debt
Default frequency	2.34	2.43	2.56
Spreads (Avg. across emg mkts)			
Mean	6.20	2.65	3.45
Std Dev	1.09	0.62	1.64
Comovements			
Spreads across Emg Mkts	0.47	0.07	0.55
Y Growth Across Emg Mkts	0.20	0.0	0.20
Stock returns across Emg Mkts.	0.31	0.36	0.30
Emg Mkts Spreads & north Stock	-0.45	-0.20	-0.33
Emg Mkts Spreads & own growth	-0.50	-0.66	-0.07
Emg Mkts Stock & north Stock	0.43	0.04	0.42
Emg Mkts Stock & own growth	0.96	0.99	0.95

- Discount factors recalibrated to match the default frequency
- Pricing of risk (i.e. long run risk only in north) can account for about 50% of model's spreads (over default prob) and their volatility
- Quantity of risk essential to explain growth and spread comovement
- Long term debt important for getting magnitude of spreads

Conclusion

Standard model

- Spreads driven by idiosyncratic shocks affecting small open economy

Data

- Credit spread driven by common world factor
- Even though countries' outputs not highly correlated

Results

- Model where long run risk drive SDF of lender (world factor) can reconcile model and data
- World factor can explain a large fraction of spread dynamics in emerging markets