World Financial Cycles

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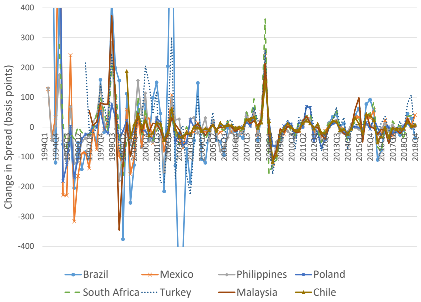
Motivation

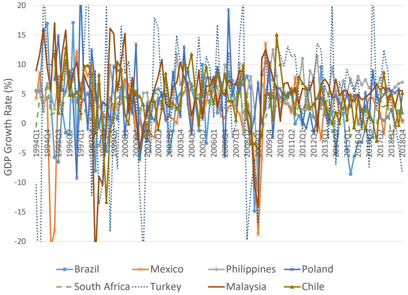
- Goal: understand determinants of spreads in emerging markets
- Existing literature on sovereign debt:
  - Output growth drives emerging markets bond spreads (Eaton Gersovitz 1981, Aguiar and Gopinath 2006, Arellano 2008)
- Empirically, volatile common component of spreads across emerging markets
  - World financial cycle drives emerging markets bond spreads (Longstaff, Pan, Pedersen, Singleton, 2011)
- Puzzle for existing literature:
  - Output growth is much less correlated than spreads
  - Hard to explain observed high correlation of spreads

Cross section of Spreads and Growth rates

Changes in spreads



GDP growth rates



- Puzzling for standard sovereign debt models

The World Financial Cycle

What drives the World Financial Cycle?

- Common shocks, other than output growth, in emerging countries?
- Shocks originating in developed countries?

Develop quantitative model of world financial cycle

- Allow for these types of shocks
- Use real and financial data to identify importance of each

Our analysis relevant for current heated debate on financial spillovers from North to South

Ingredients

- Large, patient country (north)
  and many impatient, small open economies (south)

- Incomplete financial markets:
  uncontingent long-term bonds with default risk

- Spreads affected by:
  - Growth rate shocks independent across South (standard)
  - Shocks to long run growth prospects and volatility correlated across South (new)
  - Shocks to long run growth prospects and volatility in North (new)

- All countries risk averse with Epstein-Zin preferences

Key Idea

- Common component of southern spreads increase when:
  - Long run growth prospects across Southern countries fall
  - Long run growth prospects in North fall
  - Volatility in North and South increases
- Important features of long run growth prospects and volatility:
  - Can be quite correlated without output being very correlated
- Identification: use model and data on North and South stock markets, growth rates and spreads to infer time series for shocks

Main Application

Use model to back out shocks that account for three episodes:

- 1998-2001: Emerging mkts crises

  High spreads, booming North stock market

- 2003-2007: Great spread moderation

  Declining spreads, stable North stock market

- 2008-2009: Great recession

  Spike in spreads, collapse in North stock market

Use the backed out patterns of shocks to evaluate the key drivers of the world financial cycle

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: Rey (2013), Longstaff, Pan, Pedersen, Singleton, (2011), Morelli, Perez and Ottonello (2019)

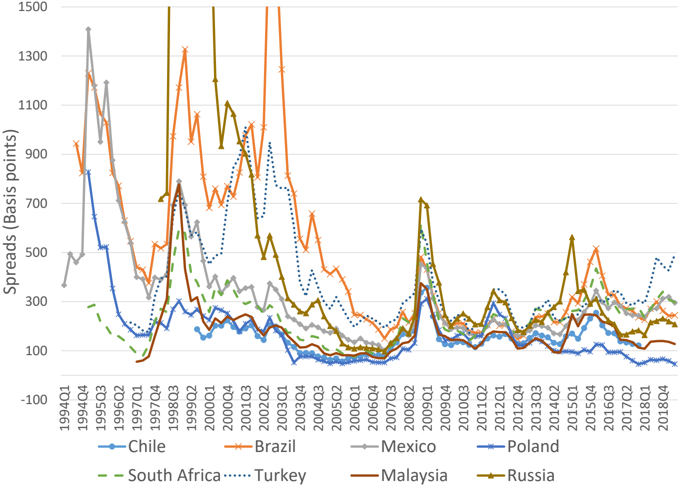
Roadmap

- Data
- Model
- Show model can match key features of data
- Assessing the role of world cycle in three episodes:
    - Emerging mkts crises (1998-2001)
    - Great spreads moderation (2003-2007)
    - Great recession (2008-09)

Data

- 23 Emerging countries with at least 15 yrs of monthly spread data (EMBI Global) and quarterly GDP over 1994-2019
- 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.
- Similar data as Longstaff et al. (2011) and Aguiar et al. (2016)

Spreads in 8 Emerging Markets



- Suggest important role of common component

3 stylized facts hard to explain with standard models

- Spreads higher than default frequency
- High volatility of spreads
- Across emerging markets spreads co-move much more than GDP

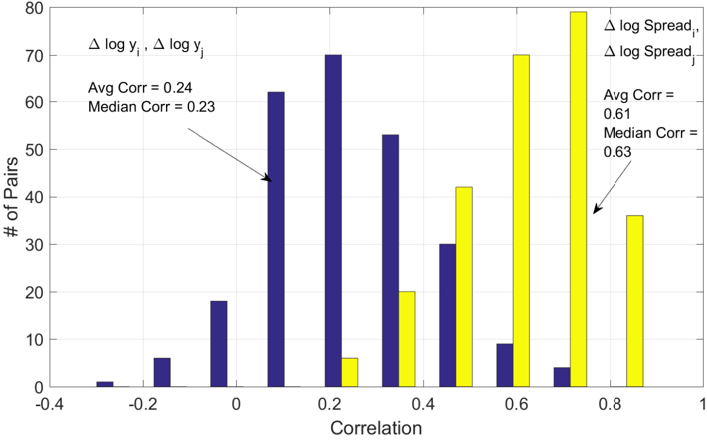
1 & 2: Average spreads, defaults and Spreads Volatility

	Mean Across i	Median Across i
• Average Spread	480 bp	350 bp

- Default frequency $= \frac{\text{\# years with at least 1 default}}{\text{total yrs in sample}} = 210$ bp

- Standard Deviation of spreads: $\geq 2\%$

3. 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

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 (uncorrelated across countries)
- persistent long run risk shocks (correlated across countries)
- volatility shocks (for now perfectly correlated across countries)

$$g_{Yt} \equiv \log Y_t - \log Y_{t-1} = X_{Nt} + \sigma_{t-1}\varepsilon_{Yt}$$

$$X_{Nt} = \rho X_{Nt-1} + \sigma_{t-1}\varepsilon_{XNt}$$

$$g_{yit} \equiv \log y_{it} - \log y_{it-1} = X_{St} + \sigma_{t-1}\varepsilon_{yit}$$

$$X_{St} = \rho X_{St-1} + \sigma_{t-1}\varepsilon_{XSt}$$

$$\rho_{XNS} = corr(\varepsilon_{XN}, \varepsilon_{XS})$$

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$$\log \sigma_t = (1 - \rho_\sigma)\bar{\sigma} + \rho_\sigma \log \sigma_{t-1} + \sigma_\sigma \varepsilon_{\sigma t}$$

$$\rho_{XNS} = corr(\varepsilon_{XN}, \varepsilon_{XS})$$

Stocks

- Segmented stock markets
- Stocks are claims to risky country specific dividend streams
- Dividends risk loads on long run risk X and volatility σ_{t-1}
- Dividends

$$g_{Dt} \equiv \log D_t - \log D_{t-1} = \alpha_D X_{Nt} + \sigma_{t-1} \varepsilon_{Dt}$$

$$g_{dit} \equiv \log d_{it} - \log d_{it-1} = \alpha_{DS} X_{St} + \sigma_{t-1} \varepsilon_{dit}$$

$$\rho_D = corr(\varepsilon_Y, \varepsilon_D), \quad \rho_{DS} = corr(\varepsilon_{yi}, \varepsilon_{di})$$

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

Debt and Default

- South borrow from North because of impatience ($\beta_N > \beta_S$) and when has good growth prospects ($\varepsilon_{XSt} > 0$)

- 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 ($Y_t, y_{it}, ...$) with Y_{t-1} and y_{it-1} respectively (from now on all variables are stationary)

- Southern country states: $\{b, \varepsilon_y, \kappa\} = \{b, m\}$

- Aggregate state variables are $S = (X_N, X_S, \sigma, \varepsilon_{XN}, \varepsilon_{XS}, \varepsilon_\sigma, \varepsilon_Y)$

South Problem

- At beginning of period chooses whether to default or not

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

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

- Default value:

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

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

- Consumption after default $c_d(m, S) = f(g_y(m, S), \kappa) g_y(m, S)$

South Problem: Repaying

- Repaying value

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

subject to

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

- $q(m, S, b')$ 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

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

- Pricing of long term bonds

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

South Small in World Economy

- Assume South as a whole is a small in the world economy
- In resource constraint, take limit as a ratio of South consumption to North consumption goes to zero, so no feedback from South to North
- Can solve for the North SDF independently from the south

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

- SOE with correlation between North SDF and south endowment (through X_N, X_S, and σ)

Price-Dividend Ratio for South

- Price using southern pricing kernel $Q^S(s, s')$
- Southern dividend depends on long-run risk of South

$$p(s) = \sum \sum_{\varepsilon'_d} Q^S(s; s') \left[\exp(g_d(\sigma', X'_S, \varepsilon'_d))(1 + p(s'))\right]$$

where

$$g_d(\sigma, X_S, \varepsilon_d) = \alpha_{DS} X_S + \sigma \varepsilon_d$$

$$Q^S(s, s') = \pi(m', S'|S)\beta_N (g_y)^{-\rho} \left(\frac{c(s')}{c(s)}\right)^{-\rho} \left\{\frac{v(s')}{\left[Ev(s')^{1-\theta}\right]^{\frac{1}{1-\theta}}}\right\}^{\rho-\theta}$$

Price-Dividend Ratio for North

$$p^N(X_N, \sigma) = \sum Q(S, S') \left[\exp(g_D(\sigma', X_N', \varepsilon_D'))(1 + p^N(X_N', \sigma'))\right]$$

where

$$g_D(\sigma, X_N, \varepsilon_D) = \alpha_D X_N + \sigma \varepsilon_D$$

Parameterization

Assigned	
$1/\gamma$, North and South IES	1.5
θ, North and South risk aversion	10.0
μ, North and South mean growth rate	0.5%
Endogenously chosen	
Volatility shock	
$\bar{\sigma}$, mean volatility shock	1%
ρ_σ, persistence of volatility shock	98.2%
σ_σ, s.d. volatility innovation	1.1%
North Country Parameters	
β_N, discount factor	0.997
σ_X, s.d. long-run risk innovation	0.03%
ρ, persistence of long-run risk	98%
σ, s.d. idiosyncratic growth innovation	0.7%
α_D, loading of dividend on long-run risk	12
σ_D, s.d. of dividend idiosyncratic innovation	15%
ρ_D, corr. of dividend innovation and idiosyncratic growth innovation	85.5%

Parameterization

Endogenously chosen	
South Country Parameters	
β_S, discount factor	0.97
σ_{SX}, s.d. long-run risk innovation	0.03%
	98%
σ_S, s.d. idiosyncratic innovation	1.2%
α_S, loading of growth on long-run risk	1.7
α_{DS}, loading of dividend on long-run risk	15
σ_{DS}, s.d. of dividend idiosyncratic innovation	20%
ρ_{DS}, corr. of dividend innovation and idiosyncratic growth innovation	22%
Debt and default parameters	
ϕ, decay of long-term debt	0.05
a_0, default cost parameter	0.06
a_1, default cost parameter	14
σ_κ, s.d of default cost shock κ	2%
Cross-Correlations, North and South	
ρ_{XNS}, Corr. of long-run risk innovations	0.4

- Default cost function

$$f(g_y, \kappa) = \kappa y \left(1 - a_0 g_y^{a_1}\right)$$

Standard Model

- No long run risk, correlated (across south) growth shocks
- Risk neutral North
- Default cost recalibrated to match default frequency
- Long run debt

Statistics

	Data	Bench	Standard
Annual output growth			
Standard deviation, North	2.4	2.7	2.7
S.d. output growth, South	4.2	6.2	6.2
Serial corr of output growth, N	34.0	31.0	0.4
Serial corr of output growth, S	43.1	26.7	0.6
Corr of output growth, N and S	17.3	2.1	1.0
Corr of output growth across S	16.5	5.5	20.0
Interest rate, default rate, and spreads			
Mean spread	4.4	6.0	3.1
S.d. spread	2.1	2.6	0.3
Mean default rate	2.1	2.0	2.3
Mean risk free rate	1.3	1.4	1.4
S.d. risk free rate	1.0	0.6	0.0
Correlations with spread			
Corr of spreads across S	51.6	41.8	20.0
Corr (S growth, S spreads)	-36.3	-26.3	-62.0
Corr (S stock returns, S spreads)	-9.2	-10.2	-5.6
Corr (N stock returns, S spreads)	-11.0	-11.3	0.0

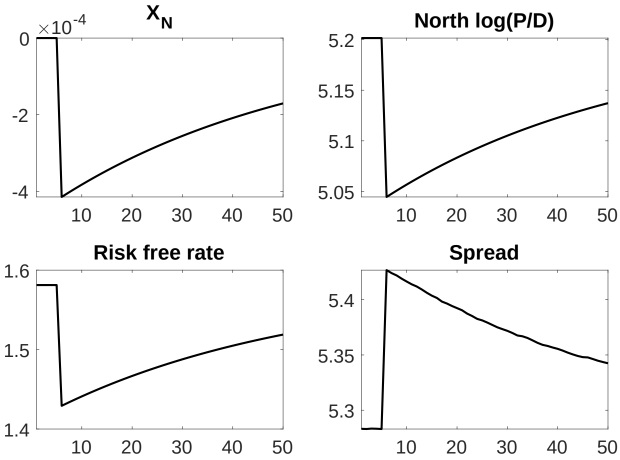
- Benchmark model can get high, correlated and volatile spreads

Statistics

	Data	Bench
Stock returns		
Volatility of stock returns North	32.1	37.2
Volatility of stock returns South	67.0	66.7
Average stock return North	5.5	5.5
Average stock returns South	9.0	9.7
Corr of stock returns across South	30.9	37.2
Corr of stock returns, S and N	41.7	18.8
Corr (stock returns, output growth), S	11.6	12.3
Corr (stock returns, output growth), N	40.2	43.8
Equity premium, North	4.2	4.0
Equity premium, South	8.0	13.1
Current accounts		
Volatility of CA/GDP, South	2.1	1.5
Corr of CA/GDP across South	11.0	9.3
Corr(CA/GDP, GDP) (HP filtered)	-52.0	-29.7

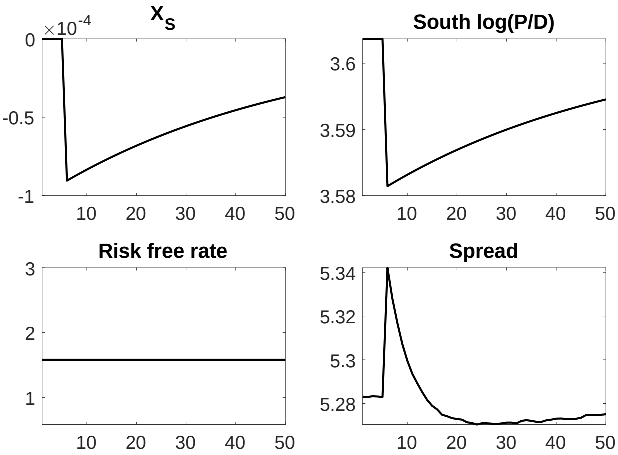
Impulse Responses

Impulse Response to North LRR shock



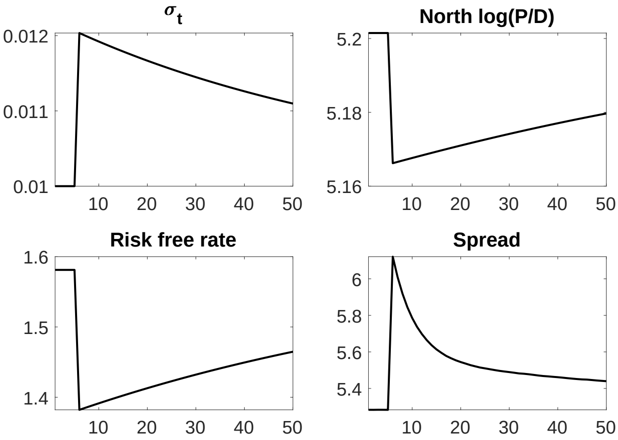
- Large response of (p/D) (15%), small response spreads (15bp)
- $\frac{\Delta Spread}{\Delta log(P/D)_N} \simeq 1$
- Implies X_N mainly targets $(p/D)_N$

Impulse Response to South LRR



- $\frac{\Delta Spread}{\Delta log(p/D)_S} \simeq 3$
- Implies X_S mainly targets $(p/D)_S$

Impulse Response to Volatility



- Small response in $(p/D)(3\%)$, large response in spreads (60bp)
- $\frac{\Delta Spread}{\Delta(p/D)_N} \simeq 20$
- Implies σ mainly targets spreads

Summary

- Long run risk in North
  - Large impact on stock market in North
  - Small impact on spread
- Long run risk in South
  - Large impact on stock market in South
  - Small impact on spread
- Volatility shock
  - Small impact on stock market in North and South
  - Large impact on spread

Important for understanding how model identifies shocks

What Drives Common Component of Spreads

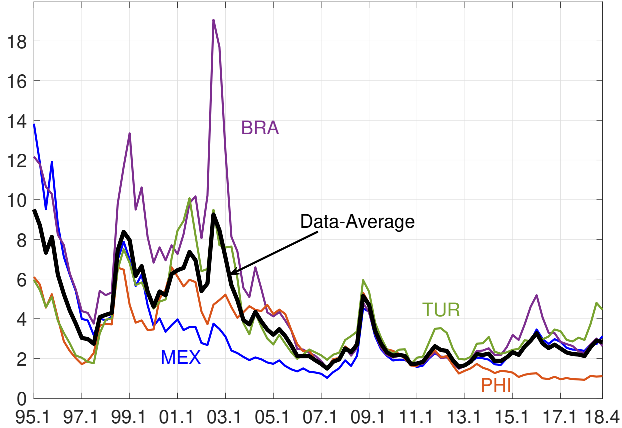
- Analyze what drives common component of spreads
  - Long run risk in the North, X_{Nt}?
  - Long run risk in the South, X_{St}?
  - World volatility, σ_t?
- Also look at idiosyncratic patterns of country spreads

Decomposing Spreads Using Particle Filter

Counterfactual on 1994Q1-2018Q4 period

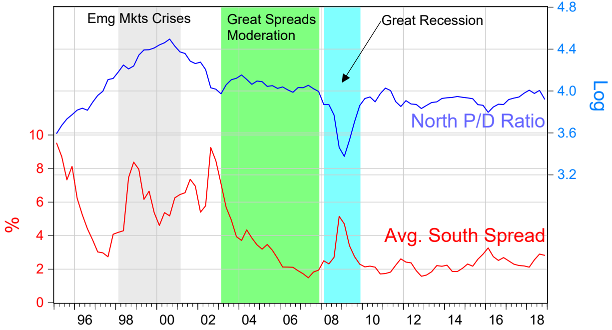
- Countries: U.S., Mexico, Brazil, Philippines, Turkey
- Observables: $Z_t = [(p/D)_N, (p/D)_S, g_Y, \{g_{yi}, spr_i\}_{i=1}^4]$
  price-dividend ratio U.S., median price-dividend ratio South, output growth of all countries, spreads of southern countries
- Conditional on Z^t, use model to filter historical sequence of shocks
  - 11 observables discipline 8 shocks
  - $\{\sigma_t, X_{Nt}, X_{St}, \varepsilon_{Yt}, \{\varepsilon_{yit}\}_{i=1}^4\}$
- Contribution of each aggregate shock
  - Compare model with all shocks to model with one shock dropped
  - Focus on drop X_N, drop σ

Data Spreads



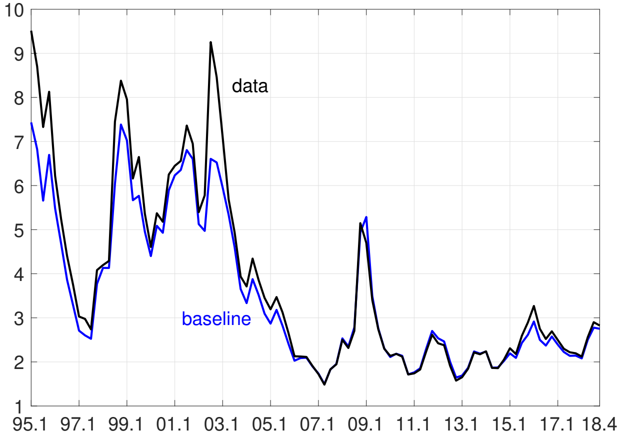
- Large common component of spreads in the data

Episodes



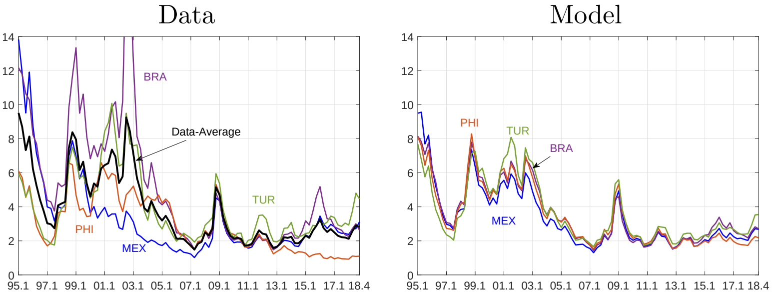
- 1998-2001: Emerging Mkts Crises: High Spds, High $(P/D)_N$
- 2003-2007: Great Spreads Moder: Falling Spds, Stable $(P/D)_N$
- 2008-2009: Great Recession: Spike in Spds, Collapse $(P/D)_N$

Average Spreads: Data and Model



- Model matches fairly well averages

Cross section of Spreads: Data and Model



- Model does not capture well the cross sectional dispersion of spreads
- Only country specific shock: iid growth rate shocks
- Need more idiosyncratic shocks (e.g. X_{it}, σ_{it})

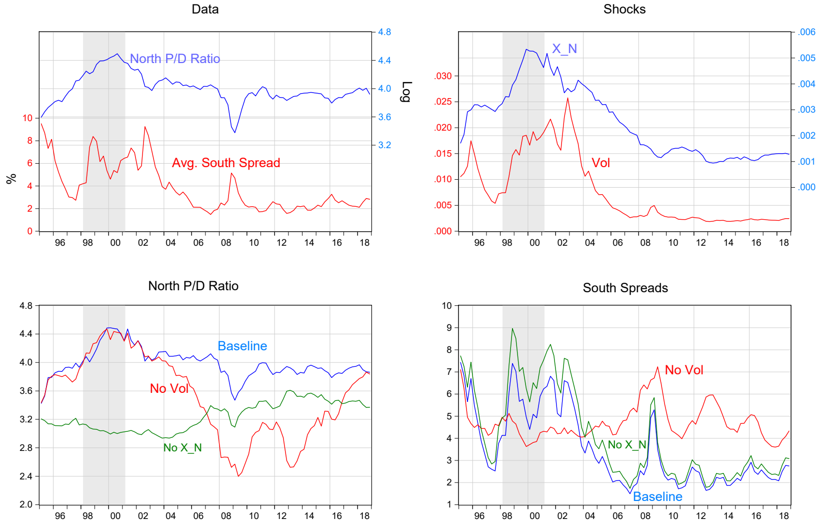
Accounting for Common Component of Spreads

- Long run risk in North, or volatility?
- Answer using counterfactual experiments: compare baseline to
  - Model without X_N shocks
  - Model without σ shocks
- Summary
  - Volatility plays the biggest role, in particular in explaining the great spread reduction in 2002-2007
  - Long risk in the North contributes to lower spreads in 1998-2001, higher spreads during the Great Recession

Explaining 1998-2001: High stock prices and spreads

- High stock prices (High $(P/D)_N$) justified by good growth prospects (High X_N)
- High spreads justified by high risk (High σ)
- Possible because X_N and σ have differential effect on stock prices and spreads
- X_N mostly affects stock prices, σ spreads

Explaining 1998-2001: High stock prices and spreads

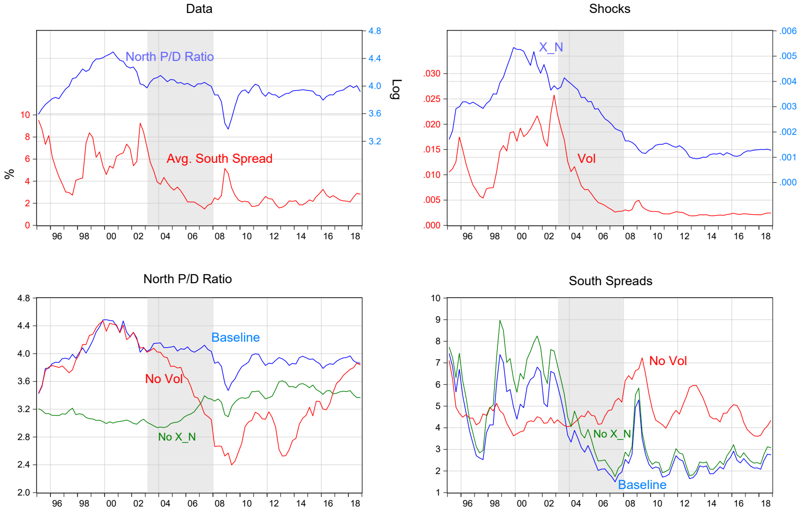


- High X_N: justifies high stocks, pushes spreads down a bit
- High σ: justifies high spreads, little effect on stocks

Explaining 2003-2007
Declining Spreads, Stable $(P/D)_N$

- Falling spreads justified by large decline in (σ)
- Stable stock prices $(P/D)_N$) because mild decline in growth prospects (X_N)

Explaining 2003-2007
Declining Spreads, Stable $(P/D)_N$



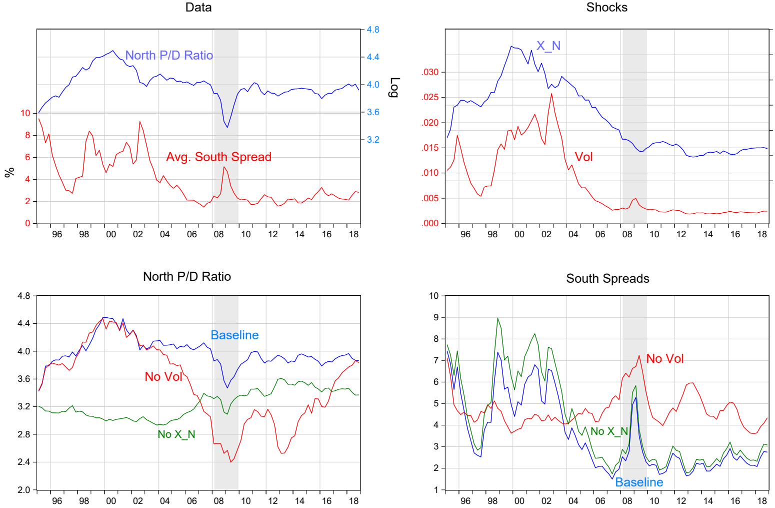
- The great spread moderation mostly accounted by falling volatility

Model explanation for Great Recession

2007-2009: Sharp decline stock prices and spike in spreads

- Data calls for decline growth prospects (X_N) and increase in risk

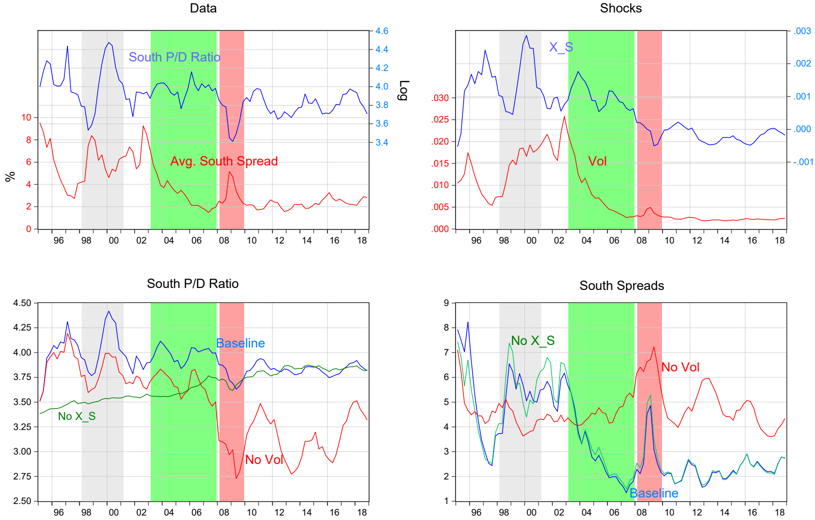
Explaining the Great Recession
Falling Stock Prices and Increasing Spreads



What About X_S? Estimated from Time Series in $(P/D)_S$

- Movements in X_S contribute to
  - More Volatile spreads in the 1998-2001 period
  - Not much else

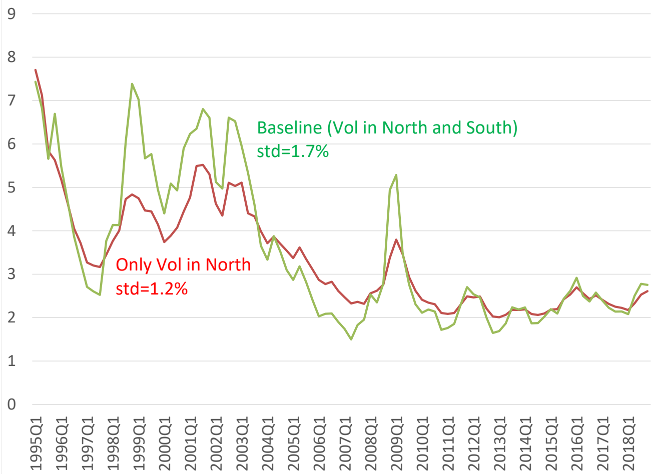
The role of long run risk in the South: X_S



Summarizing

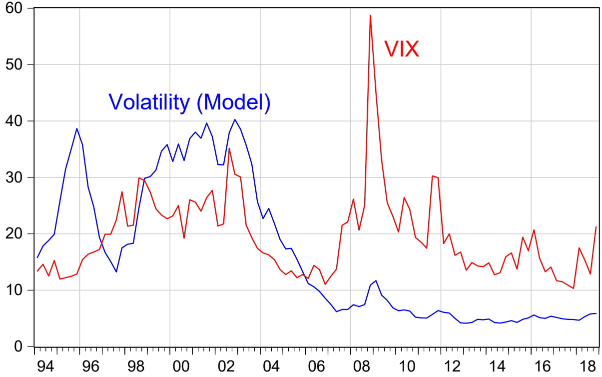
- Stock market data plus theory suggest time varying volatility plays a major role in explaining spreads
- Is it volatility in the South (quantity of Risk) or volatility in the North (price of Risk)?

Spreads
Volatility in N & S v/s Volatility only in N



- Without South Vol, model can only account for a fraction of volatility of spreads
- Suggest important role of South Vol (quantity of risk)

Volatility shocks and VIX



- Vol. shocks backed by model track VIX post 1998, not early on
- More evidence for importance of quantity of risk

Conclusions

Standard Sovereign debt models

- Spreads driven by idiosync. growth shocks affecting South SOEs

Data

- Spreads display volatile common component even though growth not highly correlated across South SOEs

Results

- Model and data suggest stochastic volatility key for dynamics of the common component of spreads
- Not just volatility in North (price of risk) but also volatility in the South (quantity of risk)

Next

- Welfare in emerging markets (need richer model of South)
- Interactions between price and quantity of Risk
- Compare to alternative theories of the co-movement of spreads (Contagion,Liquidity)