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World Financial Cycles[1]

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VERY PRELIMINARY AND INCOMPLETE

Abstract

Data shows that, in the cross section of emerging countries, sovereign spreads are highly correlated, much more so than local economic conditions. However, in standard models of sovereign default the main drivers of sovereign spreads are local conditions. This paper proposes a mechanism that can explain, at the same time, the high correlation of spreads and the low correlation of local conditions. The model features a large developed economy, which lends to a large number of developing economies, using long run bonds that can be defaulted on. The key feature of the model is the presence of long run risk (as in Bansal and Yaron, 2005). We first show that the model can account for the dynamics of several real variables and of sovereign spreads in the cross section of developing economies. We then use the model for examining how much of the fluctuations in spreads in developing economies arise from the changes in long risk in the developed economy (the price of risk), v/s changes in long run risk in the developing economies themselves (the quantity of risk). We find that 2/3 of fluctuations in spreads are explained by the quantity of risk. Our conclusion is that world financial cycle is largely driven by a world-wide, low frequency long run risk component, rather than simply by fluctuations in the price of risk driven that shocks in developed countries that alter their willingness to lend.

KEYWORDS: Long Run Risk, Sovereign Default
JEL CLASSIFICATION CODES: F41,G15

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1 Introduction

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2 Empirical Analysis

In this section we use data for 23 emerging countries with at least 15 years of monthly spread data (EMBI Global) and quarterly GDP over the period 1994-2017. We use the data to document the following three stylized facts. [2]

- Spreads on sovereign bonds are higher than default frequency. In our sample the frequency of default is 2.7%, while the average spread on bonds is over 4%. (See also Meyer et al. 2019)
- Across emerging markets spreads co-move much more than GDP (See Longstaff et al. 2011). Figure 1 and 2 show the high comovement of spread and the fact that the comovement in spreads is much higher than the one in GDP.
- When US stock market returns are low, spread in all southern countries high

These facts are hard to explain using a standard sovereign default model à-la Eaton-Gersowitz (1981) or Arellano (2008).

3 A World Economy

We consider a large North country and a continuum of small Southern countries, indexed by i. We focus on the small open economy case in which the Southern countries taken as a whole are small in the world economy.

[2] The countries in our sample are 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 and Venezuela.

Figure 1: Spread in 23 Emerging countries

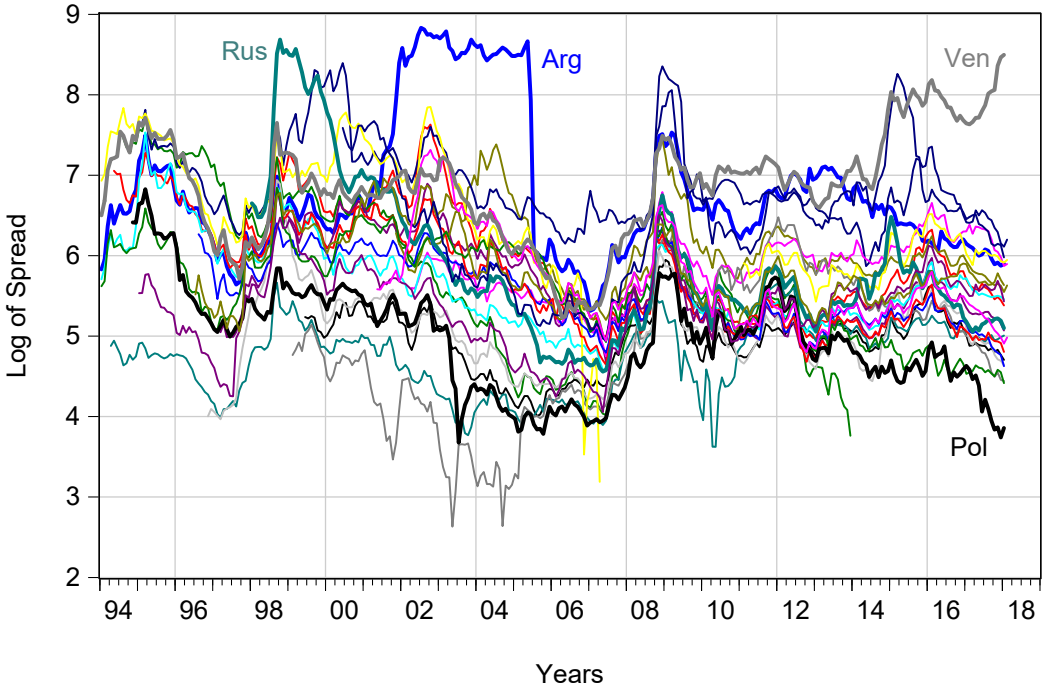


Figure 2: Correlation between spreads and between GDP

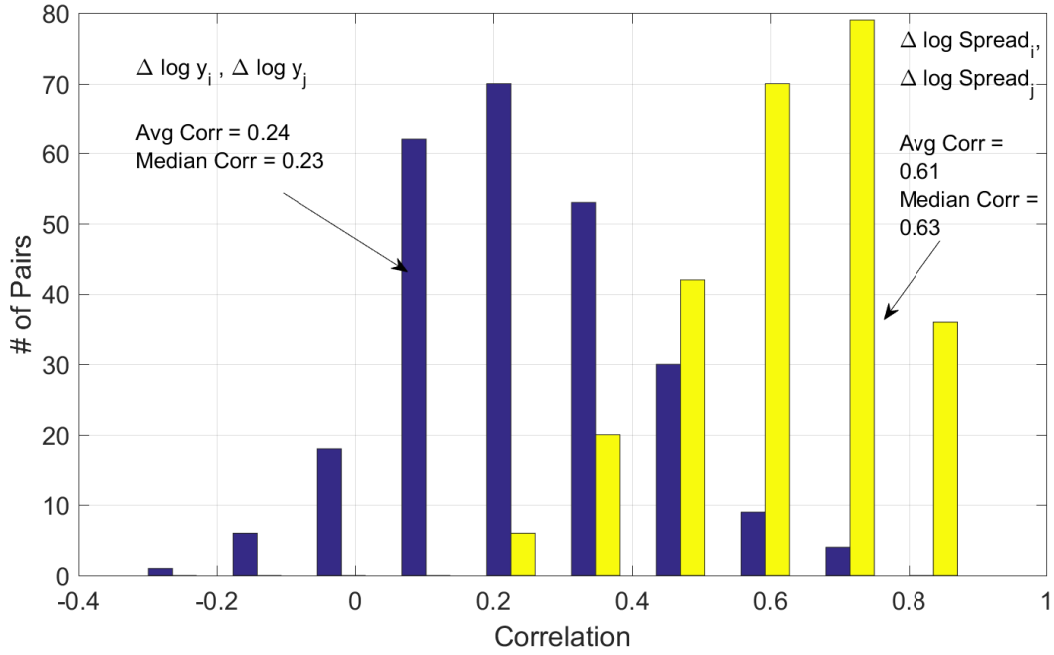
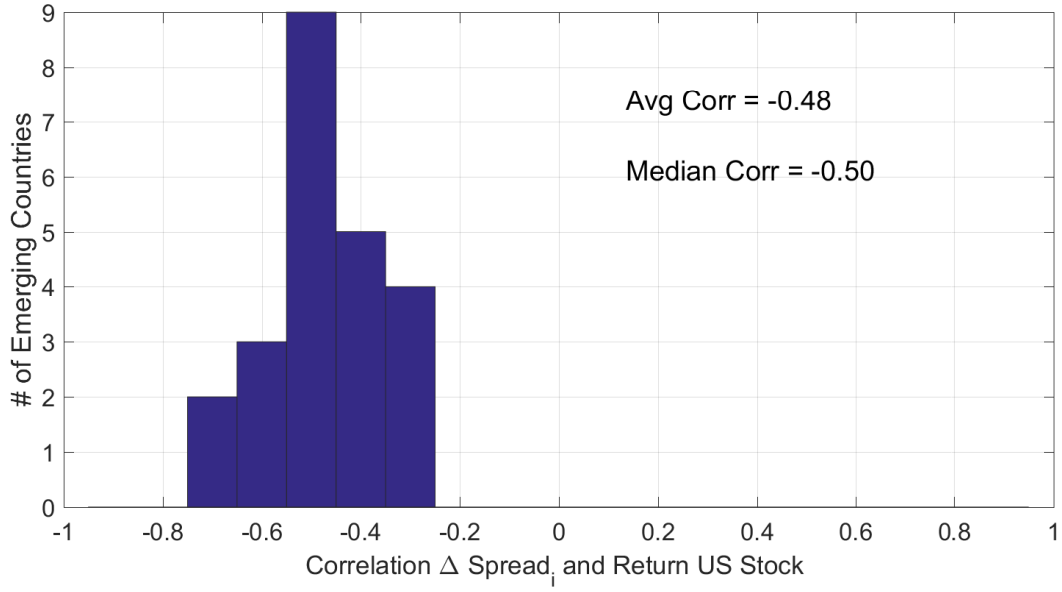


Figure 3: Correlation between change in spreads and returns on SP500



3.1 Preferences and Endowments

The preferences of any country Southern country i is of the Epstein-Zin form

$$W_{it} = \left\{(1-\beta_S)c_t^{1-\rho} + \beta_S \left[E(W_{it+1}^{1-\theta})\right]^{\frac{1-\rho}{1-\theta}}\right\}^{\frac{1}{1-\rho}}. \tag{1}$$

where β_S is the common discount factor in the South. The preferences of the North has the same form as (1) but with discount factor β_N. All the Southern countries and the North have common parameters ρ and θ, where $1/\rho$ is the elasticity of intertemporal substitution and θ controls risk aversion.

The process for the endowment of the North, Y_t, follows a process similar to that in Bansal and Yaron (2004), in which the growth rate of output is the sum of a serially correlated component, X_t, referred to as long run risk and an i.i.d North specific component ε_t, referred to as idiosyncratic risk. Specifically, this process is given by

$$\log Y_t - \log Y_{t-1} = \mu + \log X_{t-1} + \varepsilon_t \tag{2}$$

where

$$\log X_t = \rho \log X_{t-1} + \varepsilon_{Xt} \tag{3}$$

where ε_t and ε_{Xt} are independent Normal random variables with zero means and standard deviations σ_N and σ_X. The constant μ determines mean growth for the process. The process for a Southern country i is given by

$$\log y_{it} - \log y_{it-1} = \mu + \alpha \log X_{t-1} + \varepsilon_{it} \tag{4}$$

where ε_{it} is Normal random variable with standard deviation σ_S, and is independent from all other shocks. In this specification all of the Southern countries have a common loading on long run risk component, given by the parameter α.

3.2 Financial Markets

As does Hatchondo and Martinez (2009), we assume that the only asset that is traded across countries is a long-term state-uncontingent bond for which countries may default. One unit of a bond in time t is a promise to a payment of 1 in period $t+1$, $(1-\phi)$ in period $t+1$, $(1-\phi)^2$ in period $t+2$, and so on. Note that if $\phi = 1$ the bond is a standard one-period bond and if $\phi = 0$ it is a consol.

If country i chooses to default on its debt in period t it faces two punishments. First, it enters financial autarky in period $t+1$ and in each period after that it is regains access to financial markets with probability λ. We let $f \in (n, d)$ denote the financial state where n denotes the country is in *normal times* with access to credit markets and d denote the country is *in default*, in that has defaulted and not yet regained access to financial markets. Second, during the period in which it is in financial autarky its output is reduced by $y_{it} f(g_{it}, \kappa_t)$ where g_{it} is the growth rate of output of country i and κ_t is an iid shock to the cost of default.

We also want to price stocks in each country. These stocks of any given country can be held only by consumers in that country. As in Bansal and Yaron (2004), we models stocks as claims to dividends. The process for dividends in the North are given by

$$\log D_t - \log D_{t-1} = \alpha_d \log X_{t-1} + \pi \varepsilon_t + \varepsilon_{dt}$$

and for a South country i are given by

$$\log d_{it} - \log d_{it-1} = \alpha_{dS} \log X_{t-1} + \pi_S \varepsilon_{it} + \varepsilon_{dit}.$$

In any country consumers can buy or sell these claims which are in zero net supply. Since consumers in each country are identical, these claims are not traded in equilibrium, and so are priced so that any consumer in the country is indifferent to holding them or not. Because these claims are in zero net supply we do not explicitly include them in consumers' budget constraints.

3.3 Consumer Problems

At the beginning of period t, the economy inherits the long run risk X_{t-1} and the current period shocks are realized. These include the long run risk shock, ε_{Xt}, the idiosyncratic shock ε_t in the North and the idiosyncratic shocks ε_{it} for each Southern country i. Given our small open economy assumption, the aggregate state $S_t = (X_{t-1}, \varepsilon_{Xt}, \varepsilon_t)$.

From our small open economy problem, the allocations in the North are those of a closed economy with consumption at t equal to output at t, namely Y_t. Hence, using recursive notation, with $Y(S)$ and $Y(S')$ denoting output in current and the next period, the world stochastic discount factor is

$$Q(S, S') = \pi(S'|S)\beta_N \left(\frac{Y(S')}{Y(S)} \right)^{-\rho} \left\{ \frac{W(S')}{[EW(S')^{1-\theta}]^{\frac{1}{1-\theta}}} \right\}^{\rho-\theta}. \tag{5}$$

Pricing of long term bondsThe SDF of the north can then be used to price long term bonds as in

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

Consider the problem of a Southern country i in period t. At the beginning of period t the idiosyncratic endowment shock ε_{it} and the cost to default shock κ_{it} is realized, and, if that country was in default in period $t-1$, the re-entry shock is realized.

Consider country i after such shocks are realized that is currently in the normal state. This country decides current consumption and new borrowing. In this nonstationary environment,

all level variables will be nonstationary, so we find it convenient to divide the level variables for consumption, debt, and output by y_{it-1} and denote the resulting scaled values as c_{it}, b_{it}, and g_{it}. This country faces a bond price schedule $q(b_{it+1}|S_t, b_{it}, \varepsilon_{it})$ for issuing b_{it+1} units of (scaled) new bonds. Hence, in recursive notation its budget constraint is

$$c_i + b_i = g_i + q(b_i'|S, b_i, \varepsilon_i)\left[g_i b_i' - (1-\phi)b_i\right]. \tag{6}$$

If such a country is in normal times its state is $(S, b, \varepsilon_i, \kappa_i)$ whereas if it is in default its state is $(S, \varepsilon_i, \kappa_i)$. A country in normal times immediately decides whether or not to default on inherited debt. Let

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

denote maximum of the value of repaying $w^R(S, b, \varepsilon_i, \kappa_i)$ and the value of defaulting $w^D(S, \varepsilon_i, \kappa_i)$. The value of repaying is

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

subject to

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

$$\begin{aligned} w^D(S, \varepsilon_i, \kappa_i) = &\left[(1-\beta)c_d(m)^{1-\rho}\right](1-\beta)c_d(m)^{1-\rho} \\ &+ \beta[g_{y_i}(m)]^{1-\rho}\left[E\left(\lambda w^R(0, m', S')^{1-\theta} + (1-\lambda)w^D(m', S')^{1-\theta}\right)\right]^{\frac{1-\rho}{1-\theta}}\Bigg\}^{\frac{1}{1-\rho}} \end{aligned}$$

If it chooses not to default, it stays in normal times and faces the bond price schedule $q(b'|S, b, \varepsilon_i, \kappa_i)$.

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4 Calibration

Cost 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	$\sigma_k = 5\%$	

5 Results

In this section we present the statistics generated by a standard model, that is a model without long run risk, anc compare them with the long run risk model.

	Data	Standard	Benchmark
Default frequency	2.73	2.31	2.34
Spreads (Avg. across emg mkts)			
Mean	4.92	3.09	6.20
Std Dev	3.89	0.34	1.09
Comovements			
Spreads across Emg Mkts	0.61	0.2	0.47
Y Growth Across Emg Mkts	0.24	0.2	0.2
Emg Mkts Spreads & North Stock	-0.48	0.0	-0.45
Emg Mkts Spreads & own growth	-0.37	-0.62	-0.50
North Equity Premium	4.80	0.0	1.18

6 Conclusion

TO BE WRITTEN

References

[1] Arellano, C. (2008). Default Risk and Income Fluctuations in Emerging Economies. *American Economic Review*, 98 (3): 690-712.

[2] Bansal, R., and A. Yaron. (2005). Risks for the Long Run: A Potential Resolution of Asset Pricing Puzzles. *The Journal of Finance*, 59 (4), 1481-1509

[3] Eaton J. and M. Gersovitz (1981), Debt with Potential Repudiation: Theoretical and Empirical Analysis. *The Review of Economic Studies*, 48(2), 289-309

[4] Hatchondo, J., and L. Martinez. (2009). Long-duration bonds and sovereign defaults. *Journal of international Economics*, 79 (1), 117-125

[5] Longstaff, F., J. Pan, L. H. Pedersen, and K. J. Singleton. (2011). How Sovereign Is Sovereign Credit Risk? *American Economic Journal: Macroeconomics*, 3 (2): 75-103

[6] Meyer J. , C. Reinhart and C. Trebesch (2019). Sovereign Bonds since Waterloo, NBER Working paper 25543

[7] Rey, Hélène (2013). Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence, Federal Reserve Bank of Kansas City Economic Policy Symposium