Internet Appendix for "A Macro-Finance Approach to Sovereign Debt Spreads and Returns"*

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[Link to latest draft and main paper]

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This internet appendix contains a detailed empirical discussion on sovereign credit spreads and returns. While past empirical work on this topic has leveraged sovereign bond price data, I will instead use credit default swap data to provide additional support for several known facts. First, I will show that investors in hard currency sovereign debt markets do not behave in a risk-neutral fashion. I will then provide suggestive evidence that investors' level of risk-aversion is time-varying, and is positively correlated with measures of US credit or equity market risk. Finally, I will provide evidence on the term structure of sovereign credit spreads and returns, which will inform the construction, estimation and validation of the model developed in the main paper.

1 The Level of Sovereign Spreads

My analysis is focused on a set of 27 emerging market[1] economies: Argentina, Brazil, Bulgaria, Chile, Colombia, Dominican Republic, Ecuador, Egypt, El Salvador, Hungary, Indonesia, Kazakhstan, Malaysia, Mexico, Pakistan, Panama, Peru, Philippines, Poland, Russia, Serbia, South Africa, Turkey, Ukraine, Uruguay, Venezuela, and Vietnam. For each of these

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[1]The definition of "emerging market" varies vastly across the literature; here, I will loosely define emerging market an economy whose real GDP per capita is below a certain threshold.

countries, I collect bond spread data[2], credit default swap ("CDS") data[3], bond issuance data[4], credit ratings data[5] as well as macroeconomic data[6]. I describe at a high level the mechanics of a CDS in section A.1.1.

1.1 Market-Implied vs. Historical Default Frequencies

I first illustrate the fact that historical default frequencies are significantly smaller than default intensities implied by credit spreads (whether bond spreads or CDS), supporting the idea that creditors in foreign currency sovereign debt markets do not behave in a risk-neutral fashion. Given the rare-event nature of sovereign defaults, the task of estimating sovereign default frequencies is notoriously difficult. Tomz and Wright (2013) for example focus on 176 sovereign entities over a 200-year time-period, and estimate an unconditional default probability of 1.7% per year[7]. A more informative measure of historical default frequency is a measure of conditional default frequency – in other words, the probability of default over a specific time horizon of a government, conditional on all the information available at a given time. Rating agencies provide such measure of conditional default frequency. While different rating agencies use different methodologies, their analyses can be reduced to an assessment of a country's expected default frequency conditional on all observables – such as the country's debt-to-GDP ratio, its current account balance, the size of its foreign currency reserves, or its stock of foreign currency vs. local currency debt [8]. In table 1, in columns "Moody's Cum. Default Rates", I reproduce calculations from Tudela et al. (2012). In their article, using a panel of 114 countries over the time period 1983 – 2012H1, the authors estimate issuer-weighted cumulative default frequencies over different time horizons of the sovereign issuers in their dataset, conditional on the credit rating. Next to each time-horizon T, I calculate

[2] The data on bond spreads comes from the JPMorgan EMBI Global Index. The credit spread of a given country is a weighted average of the country's USD denominated bonds' swap spreads (where a bond's credit spread is computed as the difference between the bond's yield to maturity and the relevant USD interest rate swap benchmark). Eligibility criteria for inclusion of a particular bond of a particular country into the EMBI Global Index are described in more details in Morgan (1999); at a high level, a sovereign bond is included in the index if its aggregate issuance is above $500mm, and if its remaining life is above 2.5 years.

[3] The CDS data comes from WRDS, which itself collects the data from Markit.

[4] For all countries in the data-base I construct, I download all bonds listed on Bloomberg and issued by such country. I only keep in my data-base "hard-currency" bonds, i.e. bonds denominated in either EUR, GBP, USD, JPY or DEM. I also exclude bonds whose original notional amount is less than USD 100mm, whose original term is less than 1 year or greater than 50 years, or bonds with non-fixed coupon rates. The list of remaining bonds is available upon request.

[5] I focus on Moody's foreign currency issuer ratings, collected from Moody's website.

[6] The data on GDP and external debt comes from the Global Financial Development Database.

[7] By restricting their sample to governments that defaulted at least once, the authors compute an unconditional default frequency of 3% per year for the time period 1945-1980, and 3.8% per year for the time period 1980-2012.

[8] See Bhatia (2002) for a detailed evaluation of Moody's, S&P and Fitch sovereign rating methodologies.

the equivalent yearly historical default intensity λ_T, assuming a constant hazard rate:

$$\Pr(\tau < T) = 1 - e^{-\lambda_T T} \quad (1)$$

Rating Category	Moody's 5yr Cum. Default Rate	Moody's 5yr Default Intensity	Moody's 10yr Cum. Default Rate	Moody's 10yr Default Intensity	Bond Implied Default Intensity	5y CDS Implied Default Intensity
A	1.29%	0.26%	4.29%	0.44%	1.72%	1.20%
Baa	1.59%	0.32%	2.01%	0.20%	3.27%	2.17%
Ba	6.14%	1.27%	14.37%	1.55%	5.81%	3.86%
B	11.16%	2.37%	18.54%	2.05%	9.81%	8.43%
Caa-C	40.93%	10.53%	40.93%	5.26%	18.30%	15.04%

Table 1: Historical vs. Market Implied Default Rates

Using my data on bond spreads and CDS premia, I then construct time-series of weighted average market-implied default intensities for each rating category. I describe the procedure in details in section A.1.2. I plot the resulting market-implied default intensities in figure 1 and figure 2. From the plot, one notices that market implied default intensities – whether implied by bond prices or CDS premia – are consistently greater than Moody's implied default intensities. Early 2007 is the only time period during which those two measures of default intensities almost coincide. Column "Bond-Implied" and "CDS-Implied" default intensities in table 1 show unconditional mean default intensities computed from bond and CDS prices. For example, bond-implied default intensities are between 1.46% and 7.77% greater than their Moody's counterparts [9]. Of course, if sovereign CDS and bond investors were risk-neutral, the implied hazard rates of default priced into those financial instruments should be closed to the historical frequencies of default; figure 1 and figure 2 thus suggest that investors are instead risk-averse.

1.2 Time-Variation in Market-Implied Default Intensities

The second observation from these time series is that there is significant time variation in the spread between market-implied intensities and historical intensities, and that this variation

[9] One may argue that the Moody's sample goes further back in time than the time period for which my spread data is available: Moody's sample starts in 1983, and no Moody's rated sovereign bond defaults until 1998, while my CDS sample starts in 2001 and my bond spread sample starts in 1994; if I was to double the Moody's implied default intensities in order to correct for this potential bias, bond-implied default intensities would be between 1.20% and 5.07% greater than their Moody's counterparts, excluding "Caa" rated sovereign, for which the Moody's implied default intensities, after correction, would be higher than the market-implied counterparts.

is related to a variety of measures of global credit or equity market risks. To illustrate this time variation, I estimate the following panel regression:

$$\hat{\lambda}_{it}(T) = \sum_{r} \beta_r^T 1_{\{r_{it}=r\}} + \beta_s^T s_t + \epsilon_{it} \tag{2}$$

$\hat{\lambda}_{it}(T)$ is country i's market implied spot default intensity (extracted from T-maturity CDS contracts) in quarter t, r_{it} is the Moody's rating category of sovereign i at time t, and s_t is either the CDX[10] or VIX index at time t. I display the result of those linear regressions in table 2 for $T = 5$ years. In column (1), only the credit rating categories are used as regressors, while I use the CDX index in column (2), and the VIX index in column (3). Column (1) indicates that sovereign market-implied default intensities do vary with country fundamentals, as summarized by their credit ratings: the worst the credit rating, the higher the market-implied default intensity. Even after controling for the level of the CDX (or the VIX) index, estimated coefficients for credit ratings remain statistically and economically significant. However, factors not directly related to a sovereign's fundamentals also seem to contribute to explaining the level of sovereign market-implied default intensities. For example, controling for fundamentals, a 1bp increase in the level of US investment grade corporate credit spreads is accompanied by a 4.8bps increase in 5y CDS-implied default intensities. This observation suggests that creditors' attitude towards risk may be time-varying: indeed, controlling for a given country's fundamentals, the differential between market-implied and historical default intensities varies over time, and this variation is related to measures of global credit and equity market risks in a positive way: a deterioration of US credit markets (as reflected by a widening in CDX levels), or an increase in US equity uncertainty (as reflected by increases in the VIX index) widens the gap between market-implied and historical default intensities.

1.3 Linking Sovereign Spreads to Fundamentals

In the model developed in the main paper, a country's market implied default intensity and credit spread will be a function of (i) its debt-to-GDP ratio (the "fundamental" variable), as well as debt investors' price of risk (loosely speaking, a measure of investors' risk-aversion). This function will be increasing and convex in the country's debt-to-GDP ratio and increasing in the market price of risk. To test the prediction of the model, I estimate the following panel

[10]The CDX index is a credit derivative contract referencing a basket of 125 single-name US investment grade corporate credits.

regression:

$$\varsigma_{it} = \alpha_i + \beta_1 x_{it} + \beta_2 x_{it}^2 + \beta_s s_t + \epsilon_{it}$$

ς_{it} is the quarterly average spread of country i in quarter t, α_i is a country fixed effect, x_{it} is country i's debt-to-GDP ratio, and s_t will be a measure of global market risk – either the CDX index or the VIX index. Since the data on CDS prices only goes back to 2003, I instead use EMBI spread data, which are available for most countries since 1994. Column (1) of table 3 shows that a 1% increase in a country's debt-to-GDP ratio contributes to a 15bps increase in the country's bond spreads. The hypothesis of convexity of the bond spread as a function of the debt-to-GDP ratio is however rejected – the estimate $\hat{\beta}_2$ turns out to be negative in all the specifications tested. Columns (3) and (4) suggests that levels of equity and credit market risks (used as proxy for the investor's price-of-risk) also contribute positively in explaining sovereign bond spreads; Results in column (3) for example suggest that a 1bps increase in the CDX index contributes to a 3.1bps increase in the sovereign bond spreads, after controling for the debt-to-GDP ratio.

1.4 Short Term Default Intensities

The third observation relates to short term market-implied default intensities, and the fact that they are statistically greater than zero. Table 4 shows estimates of equation (2) for $T = 1$ – in other words, using spot default intensities implied by 1-year CDS premia[11]. Column (1) shows the outcome of regressing 1-year default intensities on rating category dummies, and column (2) includes a control for the CDX index. Those results are consistent with the regression results obtained using 5-year default intensities. Moody's estimated historical default frequencies at the 1-year horizon (see Tudela et al. (2012)) are however negligible: 0% for rating categories of "Baa" and above, 0.64% for "Ba" rated countries and 2.72% for "B" rated countries. As argued in the paper, a large class of models, inspired by Black and Scholes (1973) and Merton (1974), assumes that defaults occur when some stochastic process with continuous sample paths hits a barrier (the so-called "hitting-time" models). In this class of models, very short term spreads and default intensities are zero, since the probability for the stochastic process to hit the barrier is zero over short horizons. This class of models is thus inconsistent with the data on short term sovereign spreads, which appear to be meaningfully larger than zero at short horizons.

[11]Note: it is likely that the data on 1-year CDS premia is polluted with measurement error, since the market for short dated CDS contracts is less liquid than the market for the more standard 5-year CDS contract. Any measurement error though would bias my estimates downwards.

1.5 The Term Structure of Credit Spreads

My last observation relates to the slope of the default intensity term structure. In table 4, I regress (a) the difference between 5-year and 1-year CDS-implied spot default intensities on (b) rating dummies and the CDX index.

$$\hat{\lambda}_{it}(5) - \hat{\lambda}_{it}(1) = \sum_r \beta_r 1_{\{r_{it}=r\}} + \beta_s s_t + \epsilon_{it} \tag{3}$$

Column (3) shows regression results without the CDX index; column (4) includes the CDX index as a regressor; column (5) excludes the rating dummies and instead uses country fixed-effects. The intensity slope exhibits a "tent" shape, as a function of credit rating: the slope is lowest (and negative) for distressed countries (rated "Caa" to "C"), or for countries with very good fundamentals (ratings "Aa" and "A"). It is the highest for countries that are neither distressed, nor with good fundamentals (countries rated "Baa", "Ba" and "B"). The intuition for the negative default intensity slope of a "distressed" country is as follows: since the fundamentals of such country are bad, it is likely that it will default in the short term. However, conditional on such country surviving such period of bad fundamentals, its survival prospects improve, leading to a downwards sloping term structure of intensities. Loosely speaking, credit markets price a country's sovereign debt as if its fundamentals were exhibiting some form of mean-reversion *conditional on survival*. Finally, specifications (4) and (5) illustrate an additional aspect of the term structure of default intensities: increases in measures of US risk (as represented by the CDX index) lead to decreases in the intensity slope. This feature of the data will also be present in the model developed in the paper.

2 Expected Excess Returns

I then turn my attention to foreign currency sovereign debt and sovereign CDS returns and excess returns. Let $dR_{it}(T) - r_t^f dt$ be the instantaneous excess return of being invested into country i's T-maturity CDS contract at time t for a dt time period[12]. I explain in section A.1.3 how to compute those returns using CDS premia. In practice, I will focus my analysis on 1-week time periods.

[12] The (excess) return realized by a protection seller between t and $t+dt$ is equal to (a) the premium accrual (at rate $CDS_{it}(T)$) over the dt time period plus (b) the change in the price of the premium leg between t and $t+dt$ minus (c) the change in the price of the loss leg between t and $t+dt$. The "premium leg" refers to the value of receiving a premium stream equal to $CDS_{it}(T)$ over an horizon $\tau_i \wedge T$, and the "loss leg" refers to the value of receiving $1-R$ at time τ_i if $\tau_i < T$.

2.1 Expected Excess Returns From "Pure Sovereign Credit Risk"

My first empirical observation relates to the presence of expected excess returns in foreign currency sovereign credit markets. Table 6 shows unconditional average excess returns for (a) 5-year CDS contracts as well as (b) the basket of bonds in the JPMorgan EMBI index. Except for Ecuador, all 5y CDS excess returns' unconditional averages are positive, with varying degrees of statistical significance[13]. At the same time, country-specific EMBI expected excess returns are also all statistically different from zero, some at the 1% confidence level, some at the 5% confidence level. It might come as a surprise to the reader that the EMBI expected excess returns are significantly larger than the excess returns computed from 5y CDS contract prices. This difference does not come from the different sample time periods – when I restrict the time period of EMBI returns to match the time period for which CDS prices are available, the large difference persists (those EMBI expected excess returns are showed in the second column of table 7). This difference is also unlikely to come either (a) from the bond-CDS basis (such basis stayed near zero before 2008, and only exceeded 2% per annum in 2009, as documented in Bai and Collin-Dufresne (2013)), or (b) the fact that the EMBI portfolios include bonds with durations that differ from the duration of 5-year CDS contracts (in an unpublished analysis, I obtain comparable return differentials when using 10-year CDS contracts). Instead, I argue that this difference comes from the fact that EMBI returns are computed using a portfolio of mostly fixed rate bonds – thus, those bonds are exposed not only to a sovereign's default risk, but also to long-term US interest rates. Table 7 shows that the differential between EMBI excess returns and 5-year CDS excess returns is consistently between 4% and 5%. Over the same time period, 5-year US treasuries had average excess returns of 2.5%, while 10-year treasuries had average excess returns of 5%. I also regress, for each country, the EMBI excess return onto (a) the 5-year CDS excess return (estimated regression coefficient $\hat{\beta}_{CDS}$), (b) the 5-year US zero coupon treasury excess return (estimated regression coefficient $\hat{\beta}_{ZC}$), and (c) a constant (estimated regression coefficient $\hat{\alpha}$). The point estimates and standard errors, indicated in table 7, show that the loading on the 5-year zero coupon US treasury excess return is in almost all cases statistically significantly different from zero at the 1% confidence level, and that the intercept is not statistically different from zero (meaning that once EMBI excess returns have been projected onto CDS and US treasury returns, no excess return is left unaccounted for). In other words, I suspect that a substantial portion of the expected excess returns computed by Borri and Verdelhan (2011) stem from term premia, as opposed to sovereign credit premia[14].

[13]Note however that I cannot reject the hypothesis that expected excess returns are zero for a majority of those countries

[14]Borri and Verdelhan (2011) look at portfolios of sovereign bonds, grouped by ratings and market beta. Using those portfolios, they compute expected excess returns from 3% for low beta low risk countries to 14%

2.2 Expected Excess Returns vs. Fundamentals

I then illustrate the fact that expected foreign currency sovereign excess returns relate positively to the "riskiness" of a country, as encoded by such country's Moody's credit rating. In table 8, I run the following panel regressions:

$$dR_{it}(T) - r_t^f dt = \sum_r \beta_r^T 1_{\{r_{it}=r\}} + \epsilon_{it} \tag{4}$$

I first use the excess return of the EMBI portfolios, and then use excess returns of 1-year, 5-year and 10-year sovereign CDS contracts. Results are displayed in table 8. Irrespective of the type of data used, the worse the Moody's ratings (in other words, the worse a country's fundamentals are), the higher the expected excess return. This empirical regularity will have a close theoretical counterpart. In my model, expected excess returns earned by investors buying the sovereign debt of a given country will be equal to the product of (a) a risk-exposure, and (b) a risk price. The closer the sovereign's fundamentals are from an endogeneously-determined boundary, the greater the sovereign bond's risk-exposure.

2.3 Expected Excess Returns vs. Time-to-Maturity

When varying the time-to-maturity of the CDS contract of interest, I also notice in table 8 that expected excess returns increase with the time horizon. For example, a creditor taking exposure to a "Baa"-rated country will be expected to earn 0.80% per annum for a 1-year credit exposure, 1.70% per annum for a 5-year credit exposure and 2.20% per annum for a 10-year credit exposure. My model will enable me to price CDS contracts of different maturities, and I will show that the longer the maturity of the CDS contract, the greater the risk-exposure – rationalizing the empirical fact that, for a given level of risk-prices, CDS expected excess returns increase with the time-to-maturity of such contract.

2.4 Time-Series and Cross-Sectional Asset Pricing Tests

I end this section by focusing on potential stochastic discount factors that can price sovereign debt excess returns. I look at whether the US equity market excess returns $dR_{US,t} - r_t^f dt$ can explain the cross-section of expected excess returns of sovereign bonds by running the

for high beta high risk countries. Broner, Lorenzoni, and Schmukler (2013) instead obtain lower expected excess returns since they use fixed rate sovereign bond returns but substract comparable maturity US treasury returns in order to back-out excess returns; in this latter study, authors find excess returns between 2% and 3% for "stable" countries and between 2% and 7% for "volatile" countries.

following time-series regressions (one per country):

$$dR_{it}(T) - r_t^f dt = \alpha_i + \beta_i \left(dR_{US,t} - r_t^f dt \right) + \epsilon_{it} \tag{5}$$

Under the null hypothesis, the regression intercepts α_i are equal to zero. As table 9 indicates, for each sovereign taken separately, I cannot reject the null hypothesis. I thus fail to reject the hypothesis that *all* the intercepts are jointly equal to zero (at the 5% confidence level). I also run a cross-sectional asset pricing test in order to assess whether different sovereign credit exposures to US equity market shocks can explain the variation in sovereign credit expected excess returns. To do this, I use the betas obtained from the time series regression equation (5), and then run the cross-section regression:

$$\frac{1}{N} \sum_{t=1}^{N} \left[dR_{it}(T) - r_t^f dt \right] = \beta_i \nu + \epsilon_i$$

Both regressions are nested into a GMM estimation, as described in Cochrane (2009). The R-square of my second stage estimation is large (81%), while the pricing errors (i.e. the errors ϵ_i in the second stage cross-section regresion) are in the order of 1% per annum except for a handful of countries (Argentina and Pakistan having the largest pricing errors). The risk-price estimate $\hat{\nu} = 14\%$, with a 90% confidence interval of [-6%, 34%], which prevents me from rejecting the hypothesis that the risk-price is zero. The chi-square test statistic for the second-stage pricing errors all equal to zero is 8.3, which does not allow me to reject the null that all the pricing errors are equal to zero. Figure 3 is a plot of predicted vs. realized (weekly) expected excess returns, using weekly 5y CDS excess returns and the US equity market returns as a factor. These results provide some supporting evidence that any stochastic discount factor pricing foreign currency sovereign debt must be directly or indirectly related to US equity market returns.

3 Spread and Return Comovements

I end my empirical work by focusing on the joint behavior of sovereign spreads (bond and CDS) and excess returns across countries. As highlighted in the past by several studies (see for example Augustin and Tédongap (2014), who perform a principal component analysis of the level of spreads or Longstaff et al. (2011), who focus on spread *changes*), there is a high degree of commonality in the level of spreads for my panel of countries of focus. More precisely, daily data for my panel of 27 countries, the first principal component of the level of CDS (resp. the level of EMBI bond spreads) accounts for 78.5% (resp. 81.7%) of the total variance in the data. Those principal components are also highly correlated with measures of US credit market risk, as well as measures of US equity market volatilities, as figure 4 illustrates: the first principal component of CDS for example has 82% correlation with the VIX index and 88% correlation with the CDX index. When I focus on credit risk returns, a similar picture emerges. The first principal component of 5y CDS excess returns (resp. EMBI bond returns) accounts for 60% (resp. 69%) of the total variance of the data, and such first principal component has a 66% (resp. 50%) correlation with US equity market returns.

A Appendix

A.1 Data Construction

A.1.1 Credit Default Swaps

Credit Default Swaps ("CDS") are derivatives contracts that resemble insurance. A CDS is entered into between two parties: a protection buyer, and a protection seller. A CDS contract needs to specify a reference credit (for example "Brazil"), which will be the key credit risk transacted between the buyer and the seller of protection. The contract also specifies a maturity (5 years being the most liquid maturity), a notional amount (effectively, the size of the "bet"), and a premium to be paid by the buyer of protection to the seller of protection on a regular basis for the entire term of the transaction (or until a credit event occurs, whichever comes first). Under a CDS, if a "credit event" happens within the term of the transaction, the seller of protection agrees to pay the buyer of protection the loss-given-default on "deliverable obligations" (typically hard-currency bonds). In the context of sovereign CDS, "credit events" are either (a) a "failure-to-pay", (b) a "repudiation/moratorium", or (c) a "restructuring". It is worthwhile noting that CDS contracts transacted between dealers are always collateralized/margined on a daily basis, meaning that there is no counterparty risk for such contracts[15]. In addition, the CDS quotes I obtain from WRDS (and indirectly from Markit) are quotes obtained for inter-dealer trades, i.e. quotes for which no counterparty risk is priced in.

A.1.2 CDS-Implied Default Intensities

When using CDS data, I extract CDS-implied spot default intensities as follows. For country i and time t, I observe the credit default swap premium $CDS_{it}(T)$ for a T maturity contract. I also observe its "assumed" recovery rate R – in other words conditioned on a credit event, $1-R$ is the expected payment that a \$1-notional protection writer owes a protection buyer[16]. I then extract the spot hazard rate implied by this T-maturity CDS contract for country i

[15] The one counterparty risk that one might argue exists is the "gap" risk related to a default of a counterparty, and an adverse intra-day movement in the price of the CDS on the day of default.

[16] The recovery rate R is provided by Markit. It is unclear whether Markit uses market data on recovery swaps (if any such contracts were to trade at the time) to populate this recovery data set. I verify that my empirical analysis is robust to the recovery rates used to compute market-implied default intensities.

at time t as follows:

$$CDS_{it}(T) = \frac{\mathbb{E}\left[e^{-r\tau_i}1_{\{\tau_i<T\}}(1-R)|\mathcal{F}_t\right]}{\mathbb{E}\left[\int_0^{T\wedge\tau_i} e^{-ru}du|\mathcal{F}_t\right]} = \frac{L_{it}(T)}{P_{it}(T)} \tag{6}$$
$$= \hat{\lambda}_{it}(T)(1-R)$$

In the above, τ_i is the (random) default time of country i, assumed to follow a Poisson process with a constant arrival rate $\hat{\lambda}_{it}(T)$. Equation (6) can be interpreted as follows: the CDS premium is the ratio of (i) $L_{it}(T)$, the (risk-neutral) expected present value of future losses of the contract over (ii) $P_{it}(T)$, the (risk-neutral) expected present value of future CDS premia paid on the contract. I perform a similar calculation using bond spreads.

A.1.3 CDS Returns

In order to compute returns on CDS contracts, I take advantage of the full term structure of interest rates and credit spreads. Imagine that at a certain time and for a given sovereign government (omitting the subscript i for the country's identity and the subscript t for the time at which the prices are observed – both for notational simplicity), I observe the spread of CDS contracts $CDS(T_1), ..., CDS(T_n)$ and US treasury zero coupon bond prices $B(T_1), ..., B(T_n)$. I extract the full term structure of forward default intensities $\{\lambda_k\}_{k\leq n}$ (where λ_k is the forward default intensity between T_{k-1} and T_k) and forward interest rates $\{f_k\}_{k\leq n}$ (where f_k is the forward interest rate between T_{k-1} and T_k) by using the following bootstrapping procedure:

$$B(T) = e^{-\int_0^T f_u du}$$
$$P(T) = \mathbb{E}\left[\int_0^{\tau\wedge T} e^{-\int_0^t f_s ds}dt\right]$$
$$L(T) = \mathbb{E}\left[1_{\{\tau<T\}}e^{-\int_0^\tau f_s ds}\right]$$

In the above, the expectations are taken over the random default time, whose hazard rate is assumed piece-wise constant on intervals of the type $[T_i, T_{i+1}]$. By using $T = T_1, ..., T_n$, I can extract recursively the risk-neutral forward interest rates and forward default intensities. Note for example that for any k, I have:

$$B(T_k) = e^{-\sum_{j=1}^k f_j(T_j - T_{j-1})}$$

For default intensities, note that the coupon and loss legs P and L satisfy, for $k \geq 1$ and using the convention that $T_0 = 0$:

$$\begin{aligned}
P(T_{k+1}) &= P(T_k) + \Pr(\tau \geq T_k)\, \mathbb{E}\left[\int_{T_k}^{\tau \wedge T_{k+1}} e^{-\int_0^t f_s ds} dt | \tau \geq T_k\right] \\
&= P(T_k) + \frac{e^{-\sum_{j=1}^{k}(f_j+\lambda_j)(T_j - T_{j-1})}}{f_{k+1} + \lambda_{k+1}} \left(1 - e^{-(f_{k+1}+\lambda_{k+1})(T_{k+1}-T_k)}\right) \\
L(T_{k+1}) &= L(T_k) + \mathbb{E}\left[(1-R)1_{\{T_k < \tau \leq T_{k+1}\}} e^{-\int_0^\tau f_s ds}\right] \\
&= L(T_k) + \frac{(1-R)\lambda_{k+1} e^{-\sum_{j=1}^{k}(f_j+\lambda_j)(T_j - T_{j-1})}}{f_{k+1} + \lambda_{k+1}} \left(1 - e^{-(f_{k+1}+\lambda_{k+1})(T_{k+1}-T_k)}\right)
\end{aligned}$$

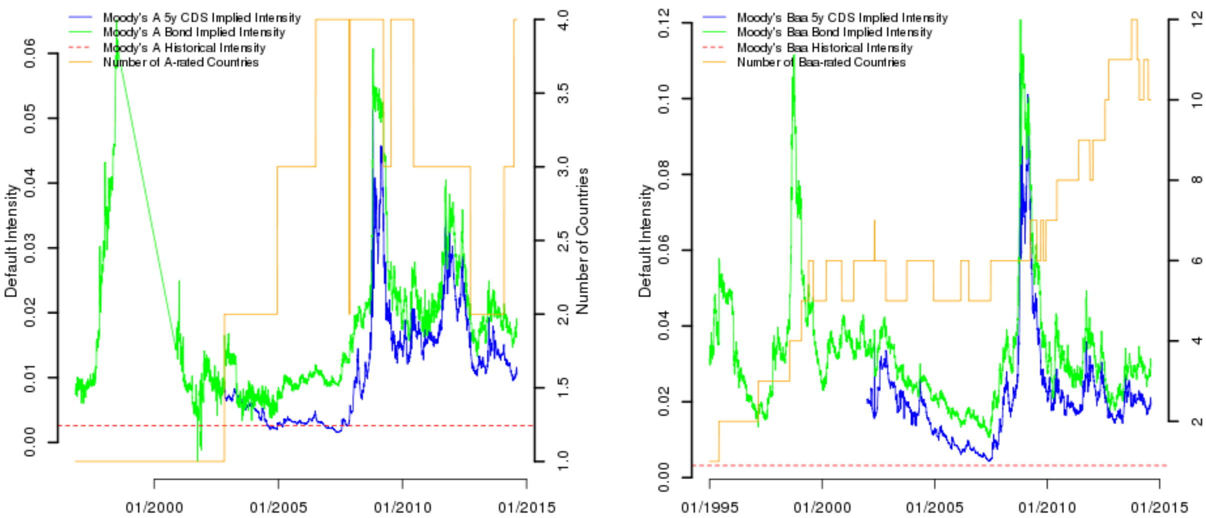
Excess returns on a T maturity CDS contract for country i between t and $t + dt$ is then computed by repricing at time $t + dt$ both the loss and the coupon legs, using forward default intensities computed using CDS contract prices at time $t + dt$:

$$dR_{it}(T) = CDS_{it}(T)dt + P_{i,t+dt}(T - dt) - L_{i,t+dt}(T - dt)$$

$CDS_{it}(T)dt$ is the carry earned on the contract between t and $t + dt$. $P_{i,t+dt}(T - dt)$ is the price at time $t + dt$ of a coupon leg of $T - dt$ years; $L_{i,t+dt}(T - dt)$ is the price at time $t + dt$ of a loss leg of $T - dt$ years; none of these prices are observed, instead they are computed using the term structure of forward interest rates and default intensities bootstrapped at time $t + dt$. □

A.2 Tables and Plots

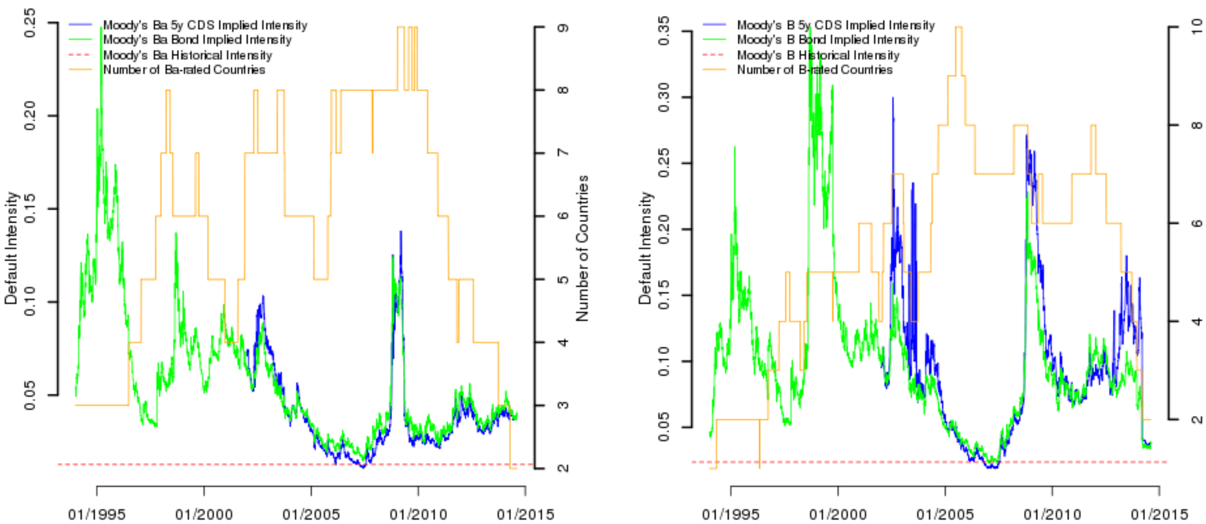
Figure 1: Historical vs. Market-Implied Default Intensities (“A” and “Baa” countries)



(a) A-rated Countries

(b) Baa-rated Countries

Figure 2: Historical vs. Market-Implied Default Intensities (“Ba” and “B” countries)



(a) Ba-rated Countries

(b) B-rated Countries

Table 2: Market-Implied Intensities vs. Ratings and US-based Factors

	Dependent variable: $\hat{\lambda}_{it}(5)$		
	(1)	(2)	(3)
Moody's "Aa"	0.012	-0.030^{***}	-0.030^{***}
		(0.010)	(0.008)
Moody's "A"	0.013^{***}	-0.029^{***}	-0.034^{***}
	(0.001)	(0.010)	(0.009)
Moody's "Baa"	0.022^{***}	-0.019^{**}	-0.023^{***}
	(0.001)	(0.009)	(0.008)
Moody's "Ba"	0.038^{***}	-0.009	-0.010
	(0.003)	(0.009)	(0.009)
Moody's "B"	0.083^{***}	0.036^{***}	0.040^{***}
	(0.011)	(0.008)	(0.009)
Moody's "Caa"	0.160^{***}	0.107^{***}	0.085^{***}
	(0.047)	(0.034)	(0.010)
Moody's "Ca"	0.924^{***}	0.720^{***}	0.867^{***}
	(0.014)	(0.023)	(0.019)
CDX		4.830^{***}	
		(1.123)	
VIX			0.002^{***}
			(0.0004)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 3: Spreads vs. Debt-to-GDP Ratio

	Dependent variable: ς_{it}			
	(1)	(2)	(3)	(4)
(debt-to-gdp)	0.156^{*}	0.292^{***}	0.265^{*}	0.290^{**}
	(0.080)	(0.113)	(0.157)	(0.113)
(debt-to-gdp)^2		-0.083^{**}	-0.089	-0.086^{**}
		(0.042)	(0.055)	(0.042)
CDX			3.182^{***}	
			(0.816)	
VIX				0.001^{***}
				(0.0003)
Country fixed effects	yes	yes	yes	yes
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 4: Short Term Intensities and Intensity Slope

	Dependent variable:				
	$\hat{\lambda}_{it}(1)$		$\hat{\lambda}_{it}(5) - \hat{\lambda}_{it}(1)$		
	(1)	(2)	(3)	(4)	(5)
Moody's "Aa"	0.005	−0.045***	0.007***	0.014***	
		(0.012)	(0.000)	(0.003)	
Moody's "A"	0.006***	−0.044***	0.007***	0.015***	
	(0.0003)	(0.012)	(0.001)	(0.003)	
Moody's "Baa"	0.011***	−0.036***	0.011***	0.017***	
	(0.001)	(0.012)	(0.001)	(0.003)	
Moody's "Ba"	0.021***	−0.031***	0.017***	0.021***	
	(0.004)	(0.011)	(0.002)	(0.003)	
Moody's "B"	0.072***	0.018	0.011**	0.018***	
	(0.014)	(0.011)	(0.004)	(0.004)	
Moody's "Caa"	0.165***	0.098**	−0.003	0.008	
	(0.056)	(0.039)	(0.012)	(0.008)	
Moody's "Ca"	1.316***	0.889***	−0.379***	−0.170***	
	(0.039)	(0.029)	(0.026)	(0.007)	
CDX		5.694***		−0.838**	−0.704**
		(1.401)		(0.333)	(0.291)
Note:					*p<0.1; **p<0.05; ***p<0.01

Table 5: CDS and EMBI Data Availability

Country	CDS Time-Period	EMBI Time Period
Argentina	2002-2014	1994-2016
Brazil	2002-2016	1994-2016
Bulgaria	2002-2016	1994-2016
Chile	2002-2016	1999-2016
Colombia	2002-2016	1997-2016
Dominican Republic	2003-2016	2001-2016
Ecuador	2003-2009	1994-2016
Egypt	2002-2016	2001-2016
El Salvador	2003-2016	2002-2016
Hungary	2012-2016	1999-2016
Indonesia	2002-2016	2004-2016
Kazakhstan	2004-2016	2007-2016
Malaysia	2002-2016	1996-2016
Mexico	2002-2016	1994-2016
Pakistan	2004-2016	2001-2016
Panama	2002-2016	1994-2016
Peru	2002-2016	1994-2016
Philippines	2002-2016	1994-2016
Poland	2002-2016	1994-2016
Russia	2002-2016	1994-2016
Serbia	2006-2016	2005-2016
South Africa	2002-2016	1995-2016
Turkey	2002-2016	1996-2016
Ukraine	2002-2014	2000-2016
Uruguay	2002-2016	2001-2016
Venezuela	2002-2016	1994-2016
Vietnam	2002-2016	2005-2016

Table 6: Annualized Excess Returns

Country	5y CDS Exp. Excess Return	5y CDS Std. Error	5y CDS Return Vol	EMBI Global Excess Return	EMBI Global Std. Error	EMBI Return Vol
Argentina	36%**	(16.8%)	54.2%	4.5%	(5.5%)	25.7%
Brazil	6.2%*	(3.6%)	13.1%	9.6%***	(3.6%)	16.6%
Bulgaria	3%*	(1.8%)	6.7%	9.8%***	(3.6%)	16.5%
Chile	0.8%	(1%)	3.8%	5.5%***	(1.7%)	6.9%
Colombia	4.2%*	(2.4%)	8.8%	7.4%***	(2.8%)	12.1%
Dominican Republic	8.5%**	(4.3%)	14.8%	9.5%**	(4.1%)	15.1%
Ecuador	−3.7%	(9.6%)	22.1%	11.6%*	(6.2%)	28.8%
Egypt	3.1%	(2%)	7.1%	7%***	(2.2%)	8%
El Salvador	1.6%	(1.9%)	6.5%	6.4%***	(2.5%)	8.9%
Hungary	8.6%***	(3.1%)	5.7%	4.9%**	(2.3%)	9.2%
Indonesia	4.2%	(3.1%)	10.7%	9.5%*	(5%)	16.7%
Kazakhstan	2.5%	(3.1%)	10.6%	8.1%	(7.1%)	20%
Malaysia	0.9%	(1.5%)	5.4%	4.9%***	(1.9%)	8.2%
Mexico	1.7%	(1.9%)	6.8%	6.5%***	(2.4%)	11.2%
Pakistan	5.9%	(5%)	16.7%	8%*	(4.6%)	17.1%
Panama	3.1%	(1.9%)	6.9%	10%***	(3.5%)	16.3%
Peru	3.6%*	(2.2%)	8%	10.2%***	(3.9%)	18.1%
Philippines	4%*	(2.2%)	8%	7.7%***	(2.6%)	12%
Poland	1%	(1.1%)	4%	6.2%***	(2.3%)	10.7%
Russia	3.7%	(2.7%)	10%	12.5%**	(6.1%)	28.4%
Serbia	2%	(2.2%)	6.7%	6.9%**	(3.5%)	11%
South Africa	1.8%	(1.7%)	6.3%	6.8%***	(2.1%)	9.4%
Turkey	4.8%*	(2.6%)	9.7%	9.1%***	(3.2%)	13.8%
Ukraine	6.2%	(6.9%)	22.8%	9.4%*	(5%)	19.4%
Uruguay	9.8%	(9.7%)	33.5%	9.4%*	(5.1%)	19.3%
Venezuela	9.9%	(7.5%)	27.5%	9.1%*	(4.7%)	22%
Vietnam	3.7%	(2.8%)	9%	6.7%	(4.2%)	13%

Note: *p<0.1; **p<0.05; ***p<0.01

Table 7: Excess Return Differentials

Country	EMBI Global Excess Return	Excess Return Diff.	$\hat{\beta}_{CDS}$	$\hat{\beta}_{CDS}$ s-e	$\hat{\beta}_{ZC}$	$\hat{\beta}_{ZC}$ s-e	$\hat{\alpha}$	$\hat{\alpha}$ s-e	R^2
Argentina	7.9%	−28.1%	0.2**	(0.1)	−0.93***	(0.29)	0.001	(0.002)	16%
Brazil	10.2%	4%	0.97***	(0.07)	0.53***	(0.07)	0.001	(0)	76%
Bulgaria	4.5%	1.5%	0.27***	(0.08)	0.27***	(0.05)	0.001*	(0)	17%
Chile	5.2%	4.4%	0.45***	(0.07)	0.96***	(0.04)	0*	(0)	59%
Colombia	8.2%	4%	0.91***	(0.07)	0.59***	(0.06)	0.001	(0)	64%
Dominican Rep	10%	1.5%	0.34***	(0.11)	0.07	(0.15)	0.001	(0.001)	11%
Ecuador	1.7%	5.4%	0.83***	(0.2)	0.48	(0.37)	0.001	(0.002)	31%
Egypt	6.2%	3.1%	0.54***	(0.1)	0.21***	(0.07)	0.001**	(0)	26%
El Salvador	6.9%	5.3%	0.74***	(0.12)	0.27***	(0.08)	0.001*	(0.001)	29%
Hungary	14.7%	6.1%	1.29***	(0.09)	0.45***	(0.12)	0.001*	(0)	70%
Indonesia	9.5%	5.9%	1.38***	(0.08)	0.38***	(0.1)	0.001*	(0)	77%
Kazakhstan	8.1%	5%	1.06***	(0.18)	−0.07	(0.22)	0.001	(0.001)	45%
Malaysia	5.3%	4.4%	0.48***	(0.08)	0.83***	(0.05)	0.001**	(0)	54%
Mexico	6.6%	4.8%	1.05***	(0.05)	0.77***	(0.05)	0.001**	(0)	70%
Pakistan	8.8%	2.9%	0.28***	(0.06)	0	(0.14)	0.001	(0.001)	10%
Panama	8.5%	5.5%	0.98***	(0.08)	0.51***	(0.06)	0.001**	(0)	51%
Peru	8.4%	4.8%	0.92***	(0.07)	0.58***	(0.07)	0.001*	(0)	51%
Philippines	9.4%	5.3%	1.26***	(0.08)	0.45***	(0.08)	0.001**	(0)	70%
Poland	5.2%	4.3%	0.42***	(0.12)	0.8***	(0.06)	0.001**	(0)	39%
Russia	8.7%	5%	0.9***	(0.08)	0.53***	(0.07)	0.001***	(0)	72%
Serbia	7.9%	5.9%	0.73***	(0.2)	0	(0.13)	0.001	(0.001)	18%
South Africa	6.6%	4.8%	0.9***	(0.08)	0.64***	(0.05)	0.001**	(0)	60%
Turkey	9.3%	4.6%	1.04***	(0.05)	0.47***	(0.07)	0.001*	(0)	69%
Ukraine	6.8%	0.5%	0.66***	(0.07)	0.19*	(0.11)	0	(0.001)	61%
Uruguay	9.3%	−0.6%	0.21	(0.15)	0.18	(0.2)	0.001	(0.001)	16%
Venezuela	9.4%	−0.5%	0.69***	(0.05)	0.27**	(0.12)	0	(0.001)	74%
Vietnam	6.7%	4.1%	0.88***	(0.15)	0.47***	(0.17)	0.001	(0.001)	38%

Note: *p<0.1; **p<0.05; ***p<0.01

Table 8: Expected Excess Returns, Distance-to-Default, Time-to-Maturity

	Dependent variable: Excess Returns (annualized)			
	EMBI Global	1y CDS	5y CDS	10y CDS
Moody's "Aa"	0.054	0.003	0.010***	0.009***
			(0.000)	(0.00004)
Moody's "A"	0.040***	0.003***	0.008***	0.009***
	(0.009)	(0.001)	(0.003)	(0.003)
Moody's "Baa"	0.058***	0.007***	0.016***	0.024***
	(0.006)	(0.001)	(0.001)	(0.003)
Moody's "Ba"	0.081***	0.011***	0.038***	0.053***
	(0.007)	(0.002)	(0.006)	(0.010)
Moody's "B"	0.088***	0.054***	0.077***	0.077***
	(0.020)	(0.012)	(0.014)	(0.018)
Moody's "Caa"	0.150***	0.132***	0.187**	0.124***
	(0.040)	(0.026)	(0.084)	(0.045)
Moody's "Ca"	0.288	0.969***	2.148***	
	(0.194)	(0.076)	(0.169)	

Note: *p<0.1; **p<0.05; ***p<0.01

Table 9: Time Series Regressions

Country	$\hat{\alpha}$	$\hat{\alpha}$ s-e	$\hat{\beta}$	$\hat{\beta}$ s-e
Argentina	6.1%	(12.2%)	0.634***	(0.12)
Brazil	−0.5%	(1.5%)	0.257***	(0.064)
Bulgaria	0%	(2.1%)	0.239***	(0.04)
Chile	−0.8%	(0.9%)	0.142***	(0.033)
Colombia	0%	(1.3%)	0.264***	(0.061)
Dominican Republic	2.7%	(5.1%)	0.141**	(0.066)
Egypt	0.6%	(2.9%)	0.139***	(0.026)
El Salvador	0.2%	(2.2%)	0.132***	(0.036)
Indonesia	0.1%	(2.9%)	0.363***	(0.115)
Kazakhstan	0.4%	(4.3%)	0.336***	(0.084)
Malaysia	−0.3%	(1.2%)	0.156***	(0.05)
Mexico	−0.8%	(1.4%)	0.265***	(0.069)
Pakistan	4.4%	(8.4%)	0.143	(0.136)
Panama	−0.3%	(1.3%)	0.256***	(0.064)
Peru	−0.1%	(1.4%)	0.259***	(0.063)
Philippines	1.1%	(1.8%)	0.241***	(0.067)
Poland	0.1%	(1.3%)	0.149***	(0.021)
Russia	−0.8%	(2.9%)	0.331***	(0.075)
Serbia	1.1%	(2.3%)	0.095***	(0.026)
South Africa	−0.2%	(1.8%)	0.233***	(0.056)
Turkey	1.1%	(2%)	0.275***	(0.057)
Ukraine	4.1%	(9.6%)	0.395***	(0.118)
Uruguay	−0.4%	(3.1%)	0.22***	(0.076)
Venezuela	2.2%	(6.9%)	0.455***	(0.095)
Vietnam	0.7%	(2.3%)	0.229***	(0.074)
Note:	*p<0.1; **p<0.05; ***p<0.01			

Table 10: Bond Issuance Average Maturities

Country	Number of Bonds Included	Average Original Notional ($ mm)	Original Weighted Term (years)
Argentina	22	684	16.4
Brazil	60	1616	15.7
Bulgaria	18	696	10.1
Chile	14	925	11.2
Colombia	47	770	15.8
Dominican Republic	13	921	16.2
Egypt	7	1171	7.3
Hungary	31	1126	9.9
Indonesia	32	1368	16.2
Kazakhstan	8	962	15.8
Mexico	83	1559	17.8
Pakistan	10	630	8.5
Panama	17	915	18.4
Peru	13	1378	19.6
Philippines	38	1150	16.3
Poland	63	1224	11.2
Russia	24	2161	12.6
South Africa	28	832	11.9
Turkey	110	942	12.3
Ukraine	18	1113	7
Uruguay	31	627	19.9
Venezuela	39	1299	17.7
Vietnam	3	917	10.1
Average	32	1,155	13.8

Table 11: Country-Specific Macro Moments

Country	Time Period	GDP Growth Rate (% p.a.)	GDP Growth Volatility (% p.a.)	Correl with US GDP Growth (%)	Avg. Debt -to- GDP (%)	Stdev. Debt -to- GDP (%)
Argentina	1960-2014	2.7	5.6	3.5	42.5	26.7
Brazil	1960-2014	4.2	3.8	13.3	28.4	10.1
Bulgaria	1980-2014	1.7	4.7	21.7	71.1	34.4
Chile	1960-2014	4.1	4.5	30.1		
Colombia	1960-2014	4.2	2.1	17.6	30.9	7.5
Dominican Rep.	1960-2014	5	5	6.9	33.4	15
Ecuador	1960-2014	3.9	3	-8.3	44.2	22.6
Egypt	1965-2014	4.7	2.7	-5.8	55.9	34.8
El Salvador	1965-2014	2.3	4	41.6	39.3	12.5
Hungary	1991-2014	1.8	2.8	57.3	93.8	43.7
Indonesia	1960-2014	5.4	3.7	-10.7	50.6	24.7
Kazakhstan	1990-2014	2.7	7.5	-3.5	55.3	31.3
Malaysia	1960-2014	6.1	3.3	26	42	16.4
Mexico	1960-2014	3.9	3.5	33	32.9	15.1
Pakistan	1960-2014	5	2.3	14.9	43	9.5
Panama	1960-2014	5	4.3	-5.7	67.8	27.4
Peru	1960-2014	3.6	4.8	-7.5	54.8	20.8
Philippines	1960-2014	4.1	3	-1	54.9	20.2
Poland	1990-2014	3.6	2.9	47.2		
Russia	1989-2014	0.6	7	6		
Serbia	1995-2014	2.7	5	6.2	75.8	29.2
South Africa	1960-2014	3.1	2.5	25.2	23	6.5
Turkey	1960-2014	4.3	3.8	32.2	35.2	12
Ukraine	1987-2014	-1.6	9.2	10.1	47	27
Uruguay	1960-2014	2.3	4.3	-3.2		
Venezuela	1960-2014	2.6	5.1	16.6	40.2	19.2
Vietnam	1984-2014	6.2	1.5	13.5	85.4	97.5
Average		3.5	4.1		49.9	24.5

Table 12: Country-Specific Debt Price Moments

Country	Time Period	1-year CDS (% p.a.)	5-year CDS (% p.a.)	5-year CDS Vol. (% p.a.)	5-year CDS Excess Return (% p.a.)
Argentina	2002-2014	20.31	16.29	139.98	36.02
Brazil	2002-2016	2.46	3.91	41.56	6.18
Bulgaria	2002-2016	0.99	1.77	8.85	3.02
Chile	2002-2016	0.34	0.84	4.2	0.79
Colombia	2002-2016	1.08	2.61	16.68	4.19
Dominican Rep.	2003-2016	4.85	5.83	36.31	8.54
Ecuador	2003-2009	9.02	8.82	58.06	-3.69
Egypt	2002-2016	2.12	3.1	13.42	3.14
El Salvador	2003-2016	1.92	2.97	10.21	1.59
Hungary	2012-2016	1.43	2.73	9.56	8.59
Indonesia	2002-2016	1.19	2.37	9.38	4.17
Kazakhstan	2004-2016	1.28	2.1	13.63	2.49
Malaysia	2002-2016	0.37	0.91	4	0.88
Mexico	2002-2016	0.56	1.33	5.59	1.74
Pakistan	2004-2016	6.65	7.28	40.25	5.89
Panama	2002-2016	0.7	1.9	8.98	3.08
Peru	2002-2016	0.82	2.23	13.27	3.6
Philippines	2002-2016	1.02	2.41	10.62	4.04
Poland	2002-2016	0.42	0.85	5.21	0.98
Russia	2002-2016	1.41	2.24	11.13	3.74
Serbia	2006-2016	2.05	3.29	8.97	2.02
South Africa	2002-2016	0.71	1.55	6.02	1.82
Turkey	2002-2016	1.74	3.12	16.89	4.78
Ukraine	2002-2014	6.61	6.78	50.06	6.21
Uruguay	2002-2016	3.53	4.04	48.81	9.85
Venezuela	2002-2016	12.39	12.87	105.05	9.94
Vietnam	2002-2016	1.39	2.47	8.01	3.68
Average		3.23	3.95	26.1	5.08

Figure 3: Predicted vs. Actual Expected Excess Returns

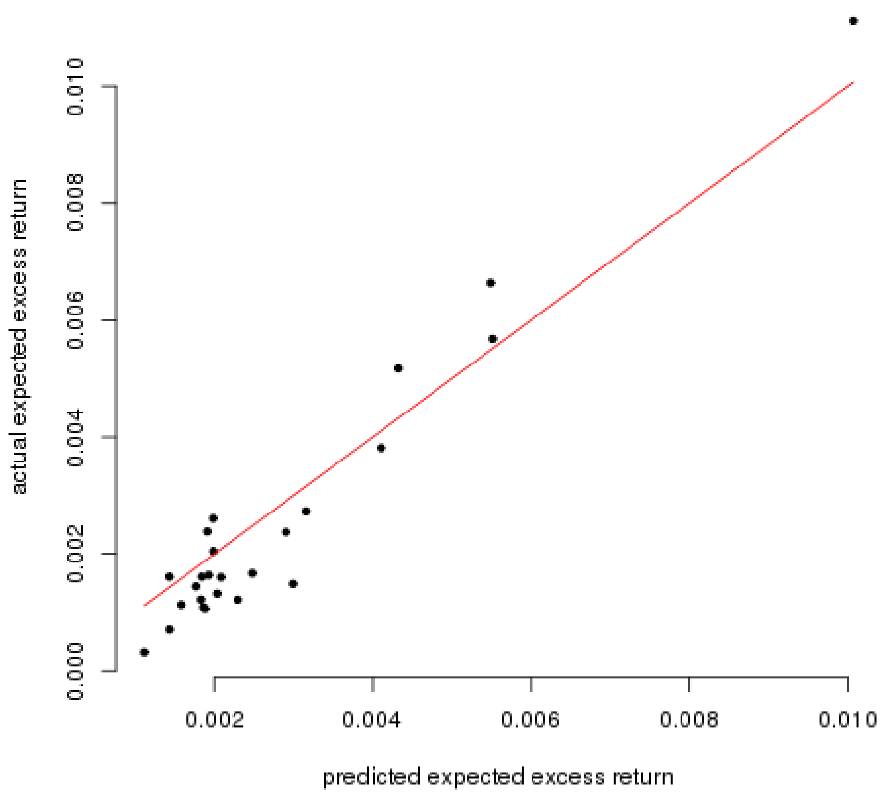
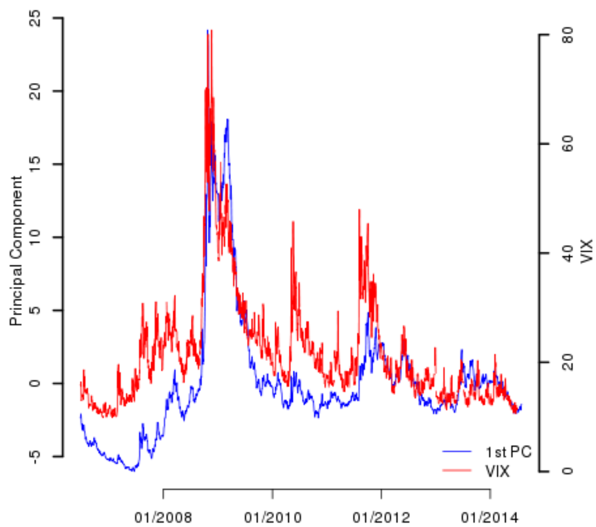
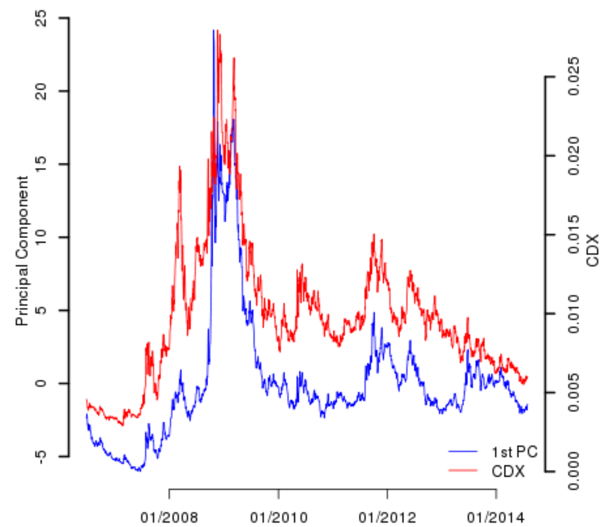


Figure 4: 1^{st} Principal Component 5y CDS vs. US Risks



(a) 1st PC of Sovereign CDS and the VIX



(b) 1st PC of Sovereign CDS and CDX

References

Augustin, Patrick and Roméo Tédongap. 2014. "Real economic shocks and sovereign credit risk." *Journal of Financial and Quantitative Analysis (JFQA), Forthcoming* .

Bai, Jennie and Pierre Collin-Dufresne. 2013. "The cds-bond basis." In *AFA 2013 San Diego Meetings Paper*.

Bhatia, Mr Ashok Vir. 2002. *Sovereign credit ratings methodology: an evaluation*. 2-170. International Monetary Fund.

Black, Fischer and Myron Scholes. 1973. "The pricing of options and corporate liabilities." *The journal of political economy* :637–654.

Borri, Nicola and Adrien Verdelhan. 2011. "Sovereign risk premia." In *AFA 2010 Atlanta Meetings Paper*.

Broner, Fernando A, Guido Lorenzoni, and Sergio L Schmukler. 2013. "Why do emerging economies borrow short term?" *Journal of the European Economic Association* 11 (s1):67–100.

Cochrane, John H. 2009. *Asset Pricing:(Revised Edition)*. Princeton university press.

Gibbons, Michael R, Stephen A Ross, and Jay Shanken. 1989. "A test of the efficiency of a given portfolio." *Econometrica: Journal of the Econometric Society* :1121–1152.

Longstaff, Francis A, Jun Pan, Lasse H Pedersen, and Kenneth J Singleton. 2011. "How sovereign is sovereign credit risk?" *American Economic Journal: Macroeconomics* 3 (2):75–103.

Merton, Robert C. 1974. "On the pricing of corporate debt: The risk structure of interest rates." *The Journal of finance* 29 (2):449–470.

Morgan, JP. 1999. "Introducing the JP Morgan emerging markets bond index global (Embi Global)." *Methodology Brief, JP Morgan, New York* .

Tomz, Michael and Mark LJ Wright. 2013. "Empirical research on sovereign debt and default." Tech. rep., National Bureau of Economic Research.

Tudela, Merxe, Elena Duggar, Albert Metz, and Bart Oosterveld. 2012. "Sovereign default and recovery rates, 1983-2012H1." *Moodys Investors Service* 132672.