Emerging Markets Finance & Trade, 53:1217–1240, 2017

ISSN: 1540-496X print/1558-0938 online
DOI: 10.1080/1540496X.2016.1174853

Routledge
Taylor & Francis Group

Corporate Credit Spreads and the Sovereign Ceiling in Latin America

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ABSTRACT: We exploit a panel of 72 US dollar-denominated bonds issued by Latin American publicly listed firms between 1996 and 2004, a period of regional financial crises, to answer the following three questions: (1) Is sovereign risk a statistically and economically significant determinant of the corporate credit spread, controlling for firm- and bond-specific characteristics? (2) If yes, do market participants apply the sovereign ceiling rule adopted by rating agencies in the pricing of our bond market data? And (3) how do market views compare with the rating agencies ceiling policy for each corporate bond? We find strong evidence of an economically and statistically significant effect of sovereign risk on corporate spreads across different panel econometric specifications and bonds. Moreover, markets do not apply the ceiling rule in 77–90% of the bonds we sample and these findings are consistent with rating agencies' policies toward the latter for about 50% of the firms. These results are robust to the inclusion of firm- and bond-specific variables derived from the structural approach to credit risk and to the business cycle in each country.

KEY WORDS: Corporate bond spreads, credit risk models, emerging bond markets, Latin America, sovereign ceiling

JEL Codes: F34, G0, G1, G2.

Introduction and Literature Review

Bond finance is becoming a more prominent source of funding for corporations in emerging and developing countries seeking out new investment opportunities, the expansion of their production capacity, and to match the increasing demand for risky bond securities worldwide. The cost of bond financing is acknowledgedly a strategic variable for businesses when making capital budgeting decisions. As corporate bond markets develop in emerging economies (IMF 2009) not only does the volume but also the cost of bond financing and in particular the spread of this cost attributable to firm- or country-specific risks become pervasive. One key issue is to what extent sovereign risk or the returns on sovereign bond in excess of a comparable risk-free rate in a given country affects the corporate bond spread over that rate and therefore the firm´s cost of financing.

Now, what is the economic rationale for sovereign risk to be a determinant of corporate default risk in foreign-currency terms? Empirically, there has been a high correlation between sovereign defaults and company defaults (Durbin and Ng 2005). That is, it has been very difficult for companies to avoid default once the sovereign of their jurisdiction has defaulted. This historical regularity has been used by all major rating agencies to justify their country or sovereign ceiling policy, which usually means that the debt of a company in a given country cannot be rated higher than the debt of its government. The economic rationale behind the sovereign rating ceiling for foreign-currency debt obligations is direct sovereign intervention risk, also called transfer and inconvertibility risk. The term transfer risk is

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usually only used in a foreign-currency context. It refers to the probability that a government with (foreign) debt servicing difficulties will impose foreign exchange payment restrictions (e.g., debt payment moratoria) on otherwise solvent companies and/or individuals in its jurisdiction, forcing them to default on their own foreign-currency obligations.

Until 2001, the "big three" main rating agencies, Moody's Investors Service, Standard & Poor's, and Fitch Ratings—these latter two de facto—followed their country or sovereign ceiling policy more or less strictly. They amended it, however, under increasing pressure from capital markets after the (ex post) zero-transfer-risk experience in Russia (1998), Pakistan (1998), Ecuador (1999), and Ukraine (2000) (see Moody's Investors Service 2001, Standard & Poor's 2001, Fitch Ratings 2001 or more recently Moody's Investors Service 2006). Moody's—the last among the big three to abandon the strict sovereign ceiling rule—justified the policy shift as follows:

> This shift in our analytic approach is a response to recent experience with respect to transfer risk in Ecuador, Pakistan, Russia, and Ukraine). Over the past few years, the behavior of governments in default suggested that they may now have good reasons to allow foreign currency payments on some favored classes of obligors or obligations, especially if an entity's default would inflict substantial damage on the country's economy.

Under specific and very strict conditions, rating agencies now allow firms to obtain a higher rating than the sovereign of their incorporation (or location). The conditions for "piercing" the sovereign foreign-currency rating are stricter than for the sovereign local-currency rating (Moody's Investors Service 2006). Bank ratings are almost never allowed to exceed the sovereign ceiling (in both foreign and domestic currency terms) because their fate tends to be closely tied to that of the government. As a result, the default risk of any firm is likely to be a positive function of sovereign risk. By contrast, markets may price or not the sovereign ceiling depending on a number of factors.

In this article, we use Latin America as a case study in order to investigate the relevance of sovereign risk in the pricing of corporate bonds in hard currency. Latin America is a suitable case because of the occurrence of sovereign debt defaults during our sample period, 1996–2004, including the largest sovereign default in history—Argentina 2002. We aim to answer the following three questions: (1) Is sovereign risk a statistically and economically significant determinant of the corporate credit spread,[1] controlling for firm- and bond-specific characteristics? (2) If yes, do market participants apply the sovereign ceiling rule adopted by rating agencies in the pricing of our bond market data? And (3) how do market views compare with the rating agencies ceiling policy for each corporate?

While there is a wealth of literature on the determinants of corporate bond spreads in mature markets,[2] the question of what determines emerging markets corporate spreads, including the role of sovereign spreads as a major explanatory variable and the test for the sovereign ceiling hypothesis, has only been recently investigated. To the best of our knowledge, Durbin and Ng (1999; 2005), Grandes and Peter (2005), and Cavallo and Valenzuela (2010) are the only contributions to this literature. A related strand of the literature on emerging market corporate creditworthiness (Ferri, Majnoni, and Chiuri (2002) or Borensztein, Cowan, and Valenzuela (2006)) has researched the determinants of corporate ratings instead of looking at market prices and yield spreads.

Durbin and Ng (1999, 2005) study the relationship between secondary market spreads of foreign currency bonds issued by emerging market firms and by their countries. They span 108 bonds issued by 85 firms in 14 countries, including Latin American, Asian, and Eastern Europe over the period 1995–2000. Durbin and Ng find that market participants do not fully apply the sovereign ceiling, in contrast to the policy followed at the time by the rating agencies, in particular Standard & Poor´s. The limitation of their study is that they can only evaluate the proposition that "firms are always riskier than governments" and not the origin of risk transferred from the government to the firm. Moreover, they do not control for firm-idiosyncratic determinants or global push factors such as risk aversion, liquidity, or stock market volatility which could drive both corporate and sovereign spreads if omitted in the relevant econometric model.

Grandes and Peter (2005) study the importance of sovereign risk in explaining corporate spreads using a sample of nine domestic currency bonds issued by nine large South African firms in 2000–2003. They control for firm-specific variables and find that sovereign risk is the most significant and economically relevant variable to account for corporate spreads on South African local currency bonds. Furthermore, these authors find that the sovereign ceiling applies to banks and not to firms in other sectors such as oil and gas or mining. Notwithstanding this latter finding, the authors do not include international foreign currency bonds issued by the same firms wherever possible, and limit their study to a short sample without offering additional evidence on other emerging market corporations having recently issued local currency bonds domestically and globally.[3]

Cavallo and Valenzuela (2010) estimate the determinants of corporate bond spreads for 139 firms in 10 emerging market economies, 6 from Latin America and 4 from East Asia. Using quarterly data of Option-adjusted spreads (OAS) extracted from Bloomberg in the period from June 1999 to June 2006, they find that corporate bond spreads are mainly determined by firm-specific variables (i.e., profitability, equity volatility, etc.), bond characteristics (time to maturity), and to a lesser extent by sovereign risk and global factors (e.g., US "junk" bonds yield spreads, Treasury yields). Cavallo and Valenzuela also confirm the sovereign lite theory (Borensztein, Cowan, and Valenzuela 2006) which points out that there should be an asymmetric impact of sovereign spreads on corporate default risk when spreads go up compared to when they decrease. A shortcoming of their contribution is that they fail to control for the term structure of sovereign risk. They use the EMBI+ indicator of sovereign risk across all firms/bonds in a given country at a given time instead of matching corporate bonds with sovereign bonds according to their maturity or duration, or even their coupon structure. Besides this, the authors do not test for the sovereign ceiling hypothesis

In related literature, Ferri, Majnoni, and Chiuri (2002) evaluate the sensitivity of corporate rating changes to sovereign ones. They find the pass-through to be greater in low-income countries and particularly for downgrades. Borensztein, Cowan, and Valenzuela (2006) also examine the link between corporate and sovereign ratings in foreign currency. In addition to emerging market borrowers also including advanced economies issuers over the past decade and conclude that the sovereign risk effect is pervasive and robust to macroeconomic conditions and firm financial strength indicators, nonlinear and stronger on banks than on industrial firms.

This study makes a threefold contribution to the literature on the pricing of emerging-market corporate bonds and the application of the sovereign ceiling policy. First, we create a new panel of 22 firms and 72 global dollar-denominated bonds—most of them issued by industrial firms over the period 1996–2004. The period chosen is one when several financial crises happen including Ecuador (1999), Argentina (2001), and Brazil (2002) (there were no sovereign defaults in Latin America later on). Second, we introduce an adjusted test for the sovereign ceiling hypothesis and compare our results to previous findings in the literature (i.e., Durbin and Ng 1999, Grandes and Peter 2005); and third we compare the "market views" stemming from our sovereign ceiling test with rating agencies´ sovereign ceiling policies firm-wise.

The remainder of this article is organized as follows. First we set out the theoretical framework. Then we describe our panel data features and explains how we measure the dependent variable (Latin American corporate bond spreads) and one of its determinants, the sovereign bond spreads. It also operationalizes the control variables of corporate bond spreads. Following, we present the descriptive statistics and discusses the results of the panel econometric regressions. Finally, we conclude.

Theoretical Framework

Sovereign Risk Effect on Corporate Credit Spreads and the Sovereign Ceiling

The main argument in this article is that in an emerging market context, sovereign (default or credit) risk has to be factored into the corporate default premium equation as an additional determinant. All structural models of corporate credit risk pricing implicitly assume that government bonds are risk-free, i.e., that sovereign risk is absent. As these models are implicitly placed in a context of an AAA-rated country (typically the US or the European Union), this assumption seems justified. In analyzing emerging bond markets, however, the "zero-sovereign-risk" assumption does not hold.

To test whether the sovereign ceiling applies in our dollar-denominated corporate spreads data, we resort to a result obtained by Durbin and Ng (1999). In a simple theoretical model similar to the framework used in this section, Durbin and Ng (1999) show that a 100% transfer risk implies that a 1% increase in the government spread should be associated with an increase in the firm spread of at least 1%. In other words, in a regression of corporate spread changes on corresponding sovereign spread changes, 100% transfer risk implies that the beta-coefficient (point estimate associated with sovereign spreads) should be greater than or equal to one. In the logic of their model, the size of this estimated coefficient can be interpreted as the market's appreciation of transfer risk: a coefficient that is larger than one would imply that the market prices in transfer risk of 100%; a coefficient statistically and significantly smaller than one would imply that the market judges transfer risk to be less than 100%.

In the Empirical Results section, we will first test whether the sovereign spread can be considered as an additional determinant of corporate credit spreads. We would expect the associated beta-coefficient ($\partial s/\partial s^{sov}$) to be positive, as increasing sovereign risk should be associated with higher corporate risk as well. Then, if the sovereign spread turns out to be a significant explanatory factor for corporate spreads, the size of the coefficient $\partial s/\partial s^{sov}$ will be a test of whether the sovereign ceiling applies or not: If $\partial s/\partial s^{sov} \geq 1$, the sovereign ceiling in spreads applies; $\partial s/\partial s^{sov} < 1$, the sovereign ceiling does not apply. In the Econometric Results section, we will present two tests of the sovereign ceiling hypothesis, one similar to the one performed by Durbin and Ng (1999; 2005) or Grandes and Peter (2005), and the other a conditional test which improves the accuracy of the results and hence avoids potential biases in the conclusions about the transferability of sovereign default risk to corporate default risk.

Firm and Bond-Idiosyncratic Control Variables

To control for firm- or bond-specific factors, we follow the structural approach to pricing defaultable fixed income securities (see Black and Scholes 1973, Merton 1974, Shimko, Tejima, and Van Deventer 1993 or Longstaff and Schwartz 1995).[4]

In particular, Shimko, Tejima, and Van Deventer (1993) find that the corporate default premium *corpspread t* or s is essentially a function of four determinants: (i) firm leverage (measured by the quasi-debt ratio d); (ii) firm-value volatility σ_V; (iii) remaining time to maturity of the bond τ; and (iv) interest rate volatility σ_r (extending the Merton–Black and Scholes framework)[5]

$$corpspread_t = s_t = f(d, \sigma_V, \tau, \sigma_r). \tag{1}$$

It can be shown that the spread s is a positive function of firm leverage d and firm-value volatility σ_V, but can be either an increasing or decreasing function of interest rate volatility σ_r and remaining time to maturity τ, depending on the size of α (the speed of convergence of the risk-free rate r to its long-run mean γ), ρ, (the correlation between shocks to the firm-value returns and risk-free interest rate shocks), τ, σ_r, σ_V, and d in a complex and nonlinear fashion.[6] The economic intuition of these effects is as follows:

- ***Firm leverage:*** The higher a firm's debt in relation to the value of its assets (d), other things equal, the lower its net worth and, hence, the closer it is to default (i.e., bankruptcy) at any given moment in time. To be compensated against the higher probability of default (and, hence, expected loss), investors will ask a higher default premium (i.e., spread).
- ***Firm-value volatility:*** The higher the day-to-day fluctuations in the value of the firm's assets (σ_V), other things equal, the higher the probability that—purely by chance—the asset value is smaller than the value of the debt on the day the debt is due, that is, that the firm defaults. To be compensated against the resulting higher default probability and expected loss, investors will ask for a higher spread.

- ***Interest rate volatility:*** The corporate spread can be an increasing or decreasing function of interest rate volatility σ_r, depending on the firm's leverage d, its asset volatility σ_V, the correlation between asset return shocks and interest rate shocks ρ, and the term structure of interest rates. However, Shimko, Tejima, and Van Deventer (1993) note that "the credit spread is an increasing function of (interest rate volatility) for reasonable parameter values."[7] Moreover, the stronger the impact of σ_r on s the higher leverage is. To control for this dependence, we will also include the interaction term $\sigma_r d$ in the (linearized) estimated equation (see the Econometric Framework section). We expect its coefficient to be positive.
- ***Time to maturity:*** The corporate default spread can also be an increasing or decreasing function of remaining time to maturity τ, depending on the same parameters as the impact of changes in interest rate volatility. on leverage d and σ_V: For small values of d or σ_V, the spread increases when time to maturity τ lengthens; for intermediate values of d or σ_V, the spread first increases sharply, then reaches a maximum and finally declines gradually as τ increases (producing a hump-shaped curve like in Sarig and Warga 1989a); for high d or σ_V, the spread declines as maturity increases. The economic intuition behind this theoretical result is as follows: If there is only a short time to go before maturity and leverage or firm-value volatility is high, the risk of default (and, hence, the spread) is high; the more time there is to go before maturity, the more opportunities the firm will have, with the same leverage (or asset return volatility), to increase earnings and reduce leverage and, hence, the lower its default risk and spread will be. To control for this dependence in the simplest possible way, we will also include the interaction term $\tau\, d$ in the linearized estimating equation, along with time to maturity τ. We expect the coefficient of maturity alone to be positive because our average leverage values are relatively low (0, 11, see Table 3) and the one on the interaction term to be negative.[8]

Other Potential Determinants

These include liquidity, differential taxation of corporate and risk-free bonds, differences in liquidity of corporate and risk-free bonds, business cycle (macroeconomic) conditions, temporary bond market imbalances, and specific bond indenture provisions, such as when call options are embedded in corporate bonds or there is a presence of a sinking fund provision.[9]

Taxation differentials between corporate and government bonds shall be reflected in the fixed or random effect of our panel model as they have stayed constant over the period we analyze. For instance, interests on domestic government bonds are exempt from income tax in Argentina, Brazil, Mexico, and Peru. However, in Chile, they are subject to income tax as well as corporate bonds. The latter are exempt from income tax in Argentina when publicly placed but are taxable in Brazil and Peru ((Grosz 2009).

As we rule out corporate bonds including call options or sinking fund provisions and we are unable to estimate temporary bond market imbalances given the available information, only potential differences in liquidity are controlled for explicitly in the present study. Liquidity refers to the ease with which a bond (issue) can be sold without a significant price discount. One might expect the risk-free bond issues to be larger (and more frequently traded) and thus more liquid than the corporate issues, such that the liquidity premium on corporate bonds will be larger than the one on comparable risk-free bonds. As a result, we would expect that the higher the liquidity, l, of a given corporate bond relative to that of a comparable risk-free bond, the lower the corporate spread would be. Finally, we control for (macroeconomic) business cycle conditions to avoid potential endogeneity bias.

In sum, the corporate default premium is a function of (i) sovereign risk, (ii) leverage, (iii) firm-value volatility, (iv) interest rate volatility, (v) remaining time to maturity, and (vi) liquidity, that is,

$$Corpspread_{\mathrm{t}} = s = f(\overset{+}{s_t^{sov}}, \overset{+}{d}, \overset{+}{\sigma_V}, \overset{+/-}{\sigma_r}, \overset{+/-}{\tau}, \overset{-}{l}). \tag{2}$$

The plus- or minus-signs on top of each of the right-hand-side variables indicate how each of these determinants is expected to influence the corporate default premium (or spread) according to the theory. In the Econometric Results section, we estimate a linearized version of Equation (2).

Data and Econometric Framework

Data Set, Variable Operationalization, and Measurement Issues

We build an unbalanced panel using quarterly observations for the period 1996–2004 using bond market data extracted from Thomson Financial DataStream and balance-sheet data from Economatica. The actual number of corporate bonds is constrained by the intersection between the former two data sets and other qualitative considerations. In other words, we rule out any corporate bonds issued by state-owned firms, bonds floated by nonlisted companies, illiquid (very low% of trading days) and/or bonds issued by firms with poor or missing balance sheet data. Initially, we looked for corporate bonds from Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela. However, we were forced to drop Colombian, Peruvian, and Venezuelan bonds because of inaccurate data and/or missing balance sheet information. As a result we get 72 corporate bonds issued by 22 different firms from Argentina, Brazil, Chile, and Mexico listed in at least one stock market. [10]

Table 1 summarizes our corporate bond database. It reports the number of issuers, splitting them into industrials and financials, and reports the number of corporate bonds for each country. Note that most issuers and bonds are from Mexico (roughly 50% of the sample), followed, in order, by Brazil, Chile, and Argentina.

Dependent Variable: How Corporate Default Spreads Are Measured

We first collect yield to maturity data for Latin American corporate bonds. Although it would be desirable to restrict the sample only to zero-coupon bonds, as theory prescribes, we mainly end up collecting yield to maturity observations on coupon-paying corporate bonds.[11] This is because there are a small number of zero-coupon bonds issued by Latin American firms precisely because some of the default risk is translated into a regular coupon payment.

We attempt to circumvent the inexistence of firm zero-coupon bonds by finding the yield to maturity of the sovereign bond with the same coupon and the same maturity as the corporate borrower. Then, if there is coupon-specific risk in our dependent variable, it will also show up in our independent variable, namely sovereign risk. The problem is that such exactly corresponding sovereign bonds do not exist, except by chance. Therefore, we choose those liquid corporate bonds whose maturity dates and coupons are closest to the maturity dates of the sovereign bonds. As for the risk-free bond we need in order to compute the corporate yield spread, we use US Treasury bonds in US dollars.

The firm's bonds, their main features, and the corresponding sovereign bonds used to calculate both corporate and sovereign default premia are available from the authors upon request.

Concerning corporate yield to maturity data, as mentioned before, we use daily observations from the period of August 1996 to December 2004.

As for US Treasury yields, we work with the US Treasury historical matrix of yield curves.[12] Since the matrix only reports the observations at 1, 3, and 6 months, and 1, 2, 3, 5, 7, 10, 20, and 30 years maturity, we run a regression on a daily frequency basis in order to get an approximation of the yield curve and extrapolate the exact yield corresponding to the maturity of interest at each day.[13]

The corporate spreads are computed as follows:

Table 1. Sample issuers and issues by country.

Country	Number of firms	Industrials or utilities	Financials	Total number of corp. bonds
Argentina	3	3	0	10
Brazil	5	4	1	14
Chile	5	5	0	14
Mexico	9	9	0	34
Full sample	22	21	1	72

Table 2. Data sources and measurement of variables.

Determinant		Subcomponents		
Variable	**Measurement**	**Symbol**	**Explanation**	**Source**
Corporate credit spread (*corpspread*) (Dependent Variable)	$corpspread_{j,M-t} = corpyield_{j,M-t} - USrate_{j,M-t}$	*corpyield*	Yield to maturity of corporate bond. Sample is restricted to US dollars denominated bonds.	Thomson Financial Datastream
		USrate	Risk-free interest rate proxied by the yield to maturity of a US Treasury bond. (Using the US Treasury yield curve data)	US Treasury
Sovereign credit spread (*sovspread*)	$sovspread_{j,M-t} = sovyield_{j,M-t} - USrate_{j,M-t}$	*sovyield*	Yield to maturity of a government bond. For each corporate bond in the sample, a government bond is selected according to its maturity and coupon characteristics in order to match as close as possible corporate bond characteristics. See Table 9	Thompson Financial Datastream
Leverage (quasi-debt-to-firm-value ratio) (d_t)	(1) $D1 = B1/V1$ where $V1 = E + PT1$	*B1, B2*	Face value of total firm debt (B2 includes customer deposits for the financial institutions)	Economatica
	(2) $D2 = B2/V2$ where $V2 = E + PT2$	*PRF*	Price of risk-free bond that pays one dollar at maturity.(assuming a coupon equal to the one of the corporate bond)	Calculation
		E	Market value of firm equity. We use total market capitalization.	Economatica.
		PT	Market price of traded debt	Economatica
		V1, V2	Value of the firm	Own calculation
Firm-value volatility (σ_V)	$\sigma_V = Stdev\left(log\left(\frac{V_t}{V_{t-1}}\right)\right)$ over 8-quarters rolling windows		Standard deviation of the log return of the firm value, calculated over 2-year rolling windows. V1 or V2 values of the firm are used, respectively, for each firm as explained above	Own calculation
Interest rate volatility (σ_r)	$\sigma_r = \sqrt{Var(\Delta r)} * 2$ over 8-quarters rolling windows	*R*	Instantaneous standard deviation of the risk-free rate. Calculation follows Shimko, Tejima, and Van Deventer (1993), where Δr stands for the (absolute) quarterly change. We use the US yield curve with fixed maturity of 3 months.	US Treasury
Time to maturity (τ)	*M*		Number of days from settlement date until maturity date (expressed in years)	Thompson Financial Datastream
Liquidity (l)			This is the percentage of trading days with transactions (with reported price and volume)	Economatica

$$corpspread_{j,M-t} = corpyield_{j,M-t} - USrate_{j,M-t} \tag{3}$$

where j indicates each bond and *M-t* indicates each bond's remaining time to maturity expressed in years or fractions of years. Since we use quarterly data in our econometric exercise, we proceed to compute quarterly averages of these yield spreads.

Explanatory Variables

Sovereign Default Premium. For this variable, we also collect daily yield to maturity for the period August 1996–December 2004. We proceed as in the case of corporate default spreads, that is,

$$sovspread_{j,M-t} = sovyield_{j,M-t} - USrate_{j,M-t} \tag{4}$$

Note that the risk-free rate is the same in the calculation of both corporate and sovereign spreads. Again, as we use quarterly data in our econometric exercise, we proceed to compute quarterly averages of these yield spreads.

Other Determinants. Table 2 sums up the operationalization, measurement, and subcomponents of these firm- or bond-specific determinants.[14]

Econometric Framework

Using a linearized version of Equation (2), we now examine the statistical and economic relevance of the main structural determinants of corporate bond spreads in our sample of Latin American bonds.

Following Grandes and Peter (2005), the estimating equation can be written as:

$$\begin{aligned} &corpspread_{i,M-t} = \alpha_i + \beta_i sovspread_{i,M-t} + \sum_{j=1}^{k} \gamma_j X_{j,it} + \varepsilon_{i,t}; \\ &i = 1, 2, \ldots, N; j = 1, 2, \ldots, k \end{aligned} \tag{5}$$

where $corpspread_{j,M-t}$ is the corporate spread of firm bond i at the end-month t; $sovspread_{j,M-t}$ is the sovereign spread which best matches $corpspread_{j,M-t}$ (see 3–1-1 and 3–1-2); $X_{1,it}, \ldots, X_{k,it}$ is the following set of k = 8 firm or bond control variables (including their interaction terms), and $\varepsilon_{i,t}$ is the model error:

1. Quasi-debt-to-firm-value (or leverage) ratio $d*_t$
2. 2-Year rolling firm value volatility σ_V
3. 2-Year rolling volatility of the 3-month US T-bond yield to maturity (*USTB-yield volatility*) σ_r[15]
4. Years to maturity τ
5. Liquidity (% of day with transactions) l
6. Interaction 1: between years to maturity and *leverage* τd
7. Interaction 2: between *USTB-yield volatility* and *leverage*; $\sigma_r d$ (8) (Macroeconomic) Business cycle conditions

α_i denotes the (unobservable) firm bond-specific effect (not included in OLS pooled regressions); β_i (with $\beta_i = \beta$ when specific sovereign spread coefficients are not allowed), and $\gamma_1, \gamma_2, \ldots, \gamma_8$ are regression coefficients to be estimated; and ε_{it} are the regression residuals.

Ideally, we would want to estimate the coefficients α_i and β_i as well as separate γ_j-coefficients (i.e., $\gamma_{1,i}, \gamma_{2,i}, \ldots, \gamma_{8,i}$ for i = 1,. . ., N) in individual time-series regressions for each of the different N = 72 bonds. However, with 36 >T >1 observations per bond (9 years times 4 observations per year), it would be difficult to obtain efficient and unbiased estimates. To reduce collinearity problems and increase the degrees of freedom and the efficiency of estimation, we pool the time series of our 72 bonds. However, pooling data amounts to imposing restrictions on the parameters. In a fully pooled model, for instance, we assume that the parameters α_i, β_i, and $\gamma_{1,i}, \gamma_{2,i}, \ldots, \gamma_{8,i}$ are the same across all bonds, i.e., that $\alpha_i = \alpha, \beta_i = \beta$, and $\gamma_{j,i} = \gamma_j$ for all $i = 1, \ldots, N$ bonds and $j = 1, \ldots, k$ control variables. However, we can also have less restrictive pool-specifications, like the one proposed in Equation (5), where the intercepts α_i and the slope coefficients β_i of $sovspread_{j,M-t}$ are allowed to vary across the bonds. Letting β_i vary across bonds and firms enables us to give an answer to two of the three main questions we aim to answer in this study, namely:

- Is sovereign default risk an economically relevant and statistically significant factor to account for the cross-country and time-series variation in the corporate spreads of the firms in our sample?
- If yes, do bond market participants apply the sovereign ceiling rule to Latin American firms' bonds?

A caveat before estimating Equation (5): A common way to deal with omitted variable bias is to introduce dummy variables for time units (in addition to space units like in our model). These "fixed time effects" greatly reduce (but do not completely eliminate) the chance that a relationship is driven by an omitted variable. Time effects are very popular, and some econometricians seem to like to introduce them to the maximum extent possible. However, the cost of reducing omitted variable problems is that we throw away a lot of the signal in the data. Admittedly, the inclusion of time effects increases the noise-to-signal ratio (Schularick and Solomouwth 2011). In our model, they would possibly increase collinearity with two of our independent variables, namely the volatility of the risk-free rate and the business cycle.

Based on the "triangulation" or sensitiveness approach,[16] we regress Equation (5) resorting to 8 alternative estimators, namely ordinary least squares (OLS), random effects (RE), fixed effects (FE), fixed effects corrected for serial correlation (FE-AR), first difference (FD), random effects corrected for serial correlation (RE-AR), and generalized least squares (GLS-RE and GLS-FE) estimators which remedy both serial correlation and heteroskedasticity.

The residual and specification tests we perform help pin down the "best" estimator although these tests do not come without shortcomings of diverse nature and extent. Indeed, (1) we test for both global significance (for all covariates) and potentially significant, unobserved individual heterogeneity (pooled vs. fixed effects), (2) we conduct the standard Haussman (1978) test to check whether the RE estimator is consistent or not, (3) we test for pooled and panel serial correlation applying the Breusch and Godfrey (1978) and the Wooldridge (2002) statistics, respectively, (4) we perform a modified Wald test for group-wise residual heteroskedasticity (see Green 2003), (5) we test for independent specific slopes in sovereign spreads (a Wald-chi^2 test after seemingly unrelated regressions (SUR)), and 6) we also test for the hypothesis of the existence of either a global or specific bond sovereign ceiling (using again a Wald-chi^2 test with linear restrictions).

Empirical Results

Data

In Table 3, we show the mean, standard deviation, and the median of the corporate bond spread, the corresponding sovereign spread, and its structural determinants by country and for the entire sample (pooled data). Note that the average, median, and standard deviation values of the 2-Year rolling volatility of the 3-month UST-bond yield (USTB-yield vol) should be the same across countries but they differ slightly because the panel is unbalanced.

Mean corporate bond spreads are slightly higher (and generally more volatile) than their corresponding sovereign spreads with the exception of Chile, where corporate spreads are more than two times higher than sovereign spreads, and Argentina, where corporate spreads are almost 400 basis points lower than sovereign spreads over the relevant period due to the sovereign debt default and later restructuration. Corporate bonds are traded between 22% and 53% (Argentina) of the calendar working days and display a large standard deviation.

The average time to maturity expressed in years is roughly 10. In Table 4, we present further evidence on the term-structure distribution across countries. We observe an unconditional, unadjusted for credit-quality negative correlation between corporate spreads and time to maturity that can be fitted using all available observations in our sample. Figure 1 displays the fitted curves by country and subperiods. We can see there is a significantly negative (unconditional) correlation between corporate spreads and time to maturity but, (1) it is highly unstable over time and (Figure 1, panel a), (2) it

Table 3. Descriptive statistics by country 1996–2004: Simple averages.

Variable	Country	Mean	Std. dev.	Median
Corporate spread (basis points)	Argentina (1996q3-2004q3)	736.07	1762.48	352.15
Sovereign spread (basis points)		1143.25	1413.11	624.61
Liquidity (% of day with transactions 1 = 100%)		0.53	0.45	0.68
Quasi-debt to firm value ratio		0.07	0.07	0.04
Years to maturity		3.96	2.98	3.47
2-Year rolling yield volatility of the 3-month US T-bond (USTB-yield vol)		0.62	0.40	0.50
2-Year rolling firm value volatility		0.14	0.06	0.12
Corporate spread (basis points)	Brazil (1996q4-2004q3)	481.06	441.12	447.41
Sovereign spread (basis points)		461.79	297.10	397.22
Liquidity (% of day with transactions 1 = 100%)		0.26	0.41	0.00
Quasi-debt to firm value ratio		0.32	0.09	0.34
Years to maturity		7.86	5.53	7.46
2-Year rolling yield volatility of the 3-month US T-bond (USTB-yield vol)		0.64	0.41	0.50
2-Year rolling firm value volatility		0.29	0.08	0.29
Corporate spread (basis points)	Chile (2002q3-2004q3)	295.89	225.93	310.14
Sovereign spread (basis points)		124.84	89.55	126.16
Liquidity (% of day with transactions 1 = 100%)		0.34	0.44	0.00
Quasi-debt to firm value ratio		0.10	0.10	0.07
Years to maturity		14.50	16.36	10.97
2-Year rolling yield volatility of the 3-month US T-bond (USTB-yield vol)		0.67	0.42	0.51
2-Year rolling firm value volatility		0.15	0.10	0.13
Corporate spread (basis points)	Mexico (1996q3-2004q3)	355.53	601.04	266.16
Sovereign spread (basis points)		340.12	499.72	260.01
Liquidity (% of day with transactions 1 = 100%)		0.22	0.40	0.00
Quasi-debt to firm value ratio		0.06	0.05	0.05
Years to maturity		10.03	6.11	9.69
2-Year rolling yield volatility of the 3-month US T-bond (USTB-yield vol)		0.66	0.42	0.51
2-Year rolling firm value volatility		0.20	0.08	0.18
Corporate spread (basis points)	Full sample (1996q3-2004q3)	417.57	832.55	300.75
Sovereign spread (basis points)		424.41	656.33	283.78
Liquidity (% of day with transactions 1 = 100%)		0.27	0.41	0.00
Quasi-debt to firm value ratio		0.11	0.11	0.06
Years to maturity		9.96	8.76	9.17
2-Year rolling yield volatility of the 3-month US T-bond (USTB-yield vol)		0.66	0.42	0.51
2-Year rolling firm value volatility		0.19	0.09	0.17

Table 4. Years to maturity distribution across countries.

Percentil	Argentina	Brazil	Chile	Mexico	Full sample
1%	0.04	0.06	0.33	0.16	0.10
5%	0.23	0.39	1.83	1.17	0.83
10%	0.58	0.89	3.42	2.48	1.83
25%	1.55	2.90	6.75	5.27	4.59
50%	3.33	7.59	10.72	9.17	8.79
75%	5.52	12.35	16.43	12.72	12.84
90%	8.29	15.45	27.64	16.71	16.97
95%	10.04	16.60	92.94	18.76	22.14
99%	12.04	18.30	99.69	32.31	91.27

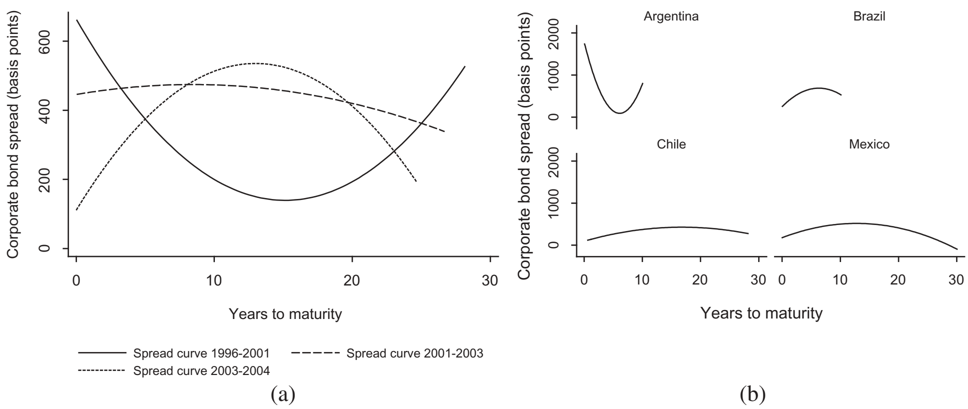

Figure 1. Unconditional spread to maturity curves by period and country. A second-order polynomial approximation.

appears to be mainly driven by cross-country differences (Figure 1, panel b), and (3) in general these curves lend support to the standard hump-shaped credit spread-to-maturity curves predicted by Merton (1974) or Shimko, Tejima, and Van Deventer (1993) and tested by Sarig and Warga (1989b) in the case of risky bonds.

Econometric Results

In this section, we estimate Equation (5) over the full sample (667 observations in 1996–2004) using eight different estimators, and we perform a number of specification and residual tests as said above (Tables 5, 6, and 7). Then we present and discuss the econometric output of the multivariate analysis of the determinants of Latin American corporate spreads and the sovereign ceiling test, emphasizing their statistical and economic significance in that order.

From Tables 5, 6, and 7 (with and without allowing for specific sovereign spread coefficients, respectively), we can see that the relatively "best-performing" estimator is the GLS-RE.[17] As we are primarily interested in assessing the idiosyncratic effect of sovereign spreads on corporate spreads, we limit our results discussion to the regressions with bond-specific sovereign spread coefficients (Table 7). One important caveat though is the existence of some potential endogeneity due to the omission of the business cycle as an explanatory variable without which the estimators could be spurious. Table 6 shows the GLS-RE (and also the GLS-FE) are robust to the inclusion of the business cycle in the baseline panel regression. Moreover, we do not expect any reverse causality from corporate/banking default risk to sovereign default like in the US financial crisis in 2008–2009

Table 5. The determinants of corporate bond spreads in Latin America: Econometric results—full sample.

Covariate	(1)OLS	(2)FE	(3)RE	(4)FD	(5)FE-AR	(6)RE-AR	(7)GLS-RE	(8)GLS-FE
Sovereign spread (in basis points)	0.079***	–0.043	0.059	0.06	0.069	0.055	0.122***	0.082***
	(0.022)	(0.070)	(0.065)	(0.062)	(0.063)	(0.063)	(0.020)	(0.026)
Liquidity: % of day with transactions	–2.436	–7.876***	–5.060***	–2.624***	–1.940**	–3.067***	–0.630***	–1.137***
	(4.504)	(1.806)	(1.822)	(0.878)	(0.944)	(0.959)	(0.220)	(0.372)
Quasi-debt to firm value ratio (as % of firm value)	48.068**	119.579***	49.488***	–12.425	–3.632	6.105	6.029*	9.920*
	(21.354)	(14.617)	(9.957)	(9.373)	(9.772)	(8.328)	(3.128)	(5.564)
Years to maturity	–27.853***	–91.894***	–21.749***	4,832.983***	–301.808***	–32.983***	2.155	–12.601
	(5.001)	(29.048)	(8.008)	(1,834.180)	(113.559)	(10.442)	(6.736)	(10.717)
2-Year rolling yield volatility of the 3-month US T-bond (USTB-yield volatility)	280.146***	199.171*	220.497*	49.297	39.405	32.541	28.872	46.539
	(78.227)	(112.533)	(113.657)	(93.574)	(98.042)	(99.150)	(20.879)	(28.531)
2-Year firm value volatility	42.673	–6.611	–160.124	436.624	281.142	283.617	205.738***	173.671*
	(464.939)	(532.481)	(474.326)	(335.441)	(362.819)	(341.096)	(75.628)	(96.916)
Interaction 1: Quasi-debt to firm value—Years to maturity	–0.943	–8.116***	–2.934***	0.069	–1.173	–0.869	–0.253	–1.218***
	(1.189)	(1.096)	(0.809)	(0.790)	(1.039)	(0.694)	(0.229)	(0.438)
Interaction 2: Quasi-debt to firm value—USTB-yield volatility	–24.444**	0.21	–9.669	7.689	14.389**	6.507	1.087	7.074**
	(11.126)	(8.397)	(7.939)	(6.154)	(6.779)	(6.313)	(2.187)	(3.067)
Constant	318.328	604.406**	419.727*	1,248.939***	1,962.393***	709.469***	226.829***	3,109.61
	(313.339)	(277.997)	(214.823)	(456.328)	(51.964)	(184.299)	(57.455)	(1,983.237)
Observations	667	667	667	574	591	667	662	662
Number of bonds	76	76	76	71	71	76	71	71
R-squared	0.17	0.203	0.16	0.09	0.05	0.14		
Log likelihood							–3993.95	–4206.66
Prob > F (GLOBAL SIGNIFICANCE)	0.00							
Prob > chi2—(SOV-CEILING)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Prob > F (POOLED SERIAL CORRELATION)	0.00							
Prob > F—(POOLED OLS VS. FIXED EFFECTS)		0.00						
Prob > chi2—(HETEROSKEDASTICITY)							0.00	
Prob > F—(SERIAL CORRELATION)					0.00			
Prob > chi2—(FIXED VS RANDOM EFFECTS)			0.00					

Notes. The dependent variable is the corporate bond spread. Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. OLS, RE, FE, FD, FE-AR, RE-AR, GLS-RE, and GLS-FE stand for ordinary least squares, random effects, fixed effects, first differences, fixed effects with serial correlation corrections, random effects with serial correlation corrections, generalized least squares with random effects, and generalized least squares with fixed effects estimators, respectively.

because of the specific nature and causes of the Latin American crises occurred in 1996–2004, i.e., sovereign debt defaults (Ecuador, Argentina) followed by corporate debt distress and defaults. However, the reverse causality remains a relevant and locally feasible theoretical issue, particularly when "too big to fail" banks or industrial corporations experience debt repayment troubles (i.e., Lehman Brothers in 2008 or General Motors in 2009).

Statistical Significance of Sovereign Spreads and the Sovereign Ceiling Test

The coefficient associated with the *sovereign spread* becomes extremely statistically significant when bond-idiosyncratic slopes are allowed, as Table 7 shows (with each specific coefficient displayed in Table 9). The use of different slopes for sovereign spreads is supported by the result of the joint-Wald test for different slopes across bonds. We strongly reject the null hypothesis of nonsignificant differences across slopes, i.e., we conclude the point estimates associated with sovereign spreads are significantly and statistically different. In addition, we can see from Table 7 that allowing for different slopes in sovereign spreads sizably increases the adjusted-R^2.

Notwithstanding the statistically significant positive impact of sovereign risk on corporate bond spreads, Figures 2 and 3 and Table 8 show that market participants seem not to be applying the sovereign ceiling rule for most Latin American bonds/firms included in our sample. The test is performed over the GLS-RE estimator. Table 8 presents two alternative methodologies to test for the sovereign ceiling hypothesis. First, we use the approach followed by Durbin and Ng (2005) and Grandes and Peter (2005): the null hypothesis of sovereign ceiling cannot be rejected when the sovereign spread coefficient (β_1) is positive and Prob. (β_1 =1) >0.05 or Prob. (β_1 =1)<0.05 and β_1 >1. These results are presented in Column (b) of Table 8. In Column (a) we introduce the additional (but reasonable) constraint that Prob. (β_1 =0) must be lower than 0.05 to avoid sovereign ceiling rejection when we should not reject it (otherwise, we would not only be able to reject that $\beta_1 \geq 1$, but it would also be impossible to reject that β_1 =0). When we follow the methodology adopted by Grandes and Peter (2005), rejection rates range from 0.38 in Chile to 0.8 in Argentina. However, when we introduce this adjusted test specification, rejection rates fluctuate between 0.77 and 0.9, i.e., market participants do not assess transfer risk as binding in 77% to 90% of the bonds. Overall, our results are in line with Durbin and Ng (2005), who also use US dollar-denominated bonds issued in jurisdictions such as New York or London.

The new sovereign ceiling test yields the following results when contrasted with the actual rating ceilings adopted by Standard and Poor's. First, it is not surprising that the sovereign ceiling hypothesis is rejected most of the time because nearly all firms (21) in our sample are industrial, and most are multinational and tradable good producing corporations. This is a necessary, but not sufficient condition for firms to pierce the sovereign ceiling, as explained in Durbin and Ng (2005), Grandes and Peter (2005), or Moody's Investors Service (2006). For seven of these firms (38 bonds), the market views appear consistent with the successive relaxations of the rating ceiling policy for some subperiods or over the full sample, namely YPF SA (Argentina) in 1997–2004, Telenorte (Brazil) from June 2003 until November 2003, Televisa Group (Mexico) from June 2004 until January 2005, Kimberley Clark (Mexico) from July 1999 until November 2005, America Movil (Mexico) from August 2002 until January 2005, Coca Cola Femsa (Mexico) from October 1996 to date, and CEMEX (Mexico) from November 1997 until January 2005.[18]

Second, Unibanco, a Brazilian financial corporate, has bonds for which the sovereign ceiling hypothesis holds (2) and some (7) for which it does not. We would have expected the sovereign ceiling to be applied across all bonds issued by Unibanco, as banks and financial companies are typically more exposed to government risk, and generally to systemic risk. To our surprise, we realize that Unibanco pierced the rating ceiling for a short period of time, i.e., June 2003–November 2003. The bond market participants may regard Unibanco as unconstrained overall by the ceiling, despite viewing that the rule is applicable to two bonds around the period 2002–2004 which post the highest relative liquidity records (26% and 23.5% of days with transactions). This result may have to do with the shortness of the sample.

Table 6. Sensitivity analysis of corporate bond spreads main determinants: Full sample results with GDP cycle correction.

Variables	OLS	FE	RE	FD	FE-AR	RE-AR	RE-GLS	FE-GLS
Sovereign spread (in basis points)	0.084*	–0.077	0.018	0.040	0.041	0.041	0.110***	0.061**
	(0.051)	(0.075)	(0.069)	(0.064)	(0.066)	(0.066)	(0.021)	(0.027)
Liquidity: % of day with transactions	–2.412	–8.039***	–5.255***	–2.642***	–1.902**	–1.902**	–0.655***	–1.321***
	(2.093)	(1.810)	(1.823)	(0.877)	(0.943)	(0.943)	(0.227)	(0.377)
Quasi-debt to firm value ratio (as % of firm value)	47.820***	121.480***	50.539***	–12.076	–3.731	–3.731	7.214**	10.782*
	(8.887)	(14.690)	(9.963)	(9.372)	(9.755)	(9.755)	(3.154)	(5.669)
Years to maturity	–27.679***	–76.825**	–22.369***	5,155.33***	–284.973**	–284.973**	0.759	–6.843
	(5.311)	(31.462)	(8.012)	(1,850.518)	(113.979)	(113.979)	(6.117)	(10.794)
2-Year rolling yield volatility of the 3-month US T-bond	288.185**	171.618	192.889*	35.350	21.003	21.003	28.695	35.634
(USTB-yield volatility)	(127.758)	(114.643)	(114.617)	(94.159)	(98.537)	(98.537)	(21.725)	(28.613)
2-Year firm value volatility	61.841	–101.217	–244.965	393.906	285.260	285.260	201.817**	76.853
	(469.384)	(537.643)	(476.255)	(336.924)	(362.195)	(362.195)	(79.366)	(99.312)
Interaction 1: Quasi-debt to firm value—Years to	–0.917	–8.307***	–3.033***	0.009	–1.141	–1.141	–0.284	–1.431***
maturity	(0.669)	(1.106)	(0.810)	(0.791)	(1.038)	(1.038)	(0.230)	(0.446)
Interaction 2: Quasi-debt to firm value—USTB-yield	–24.419***	0.310	–9.635	7.961	14.956**	14.956**	0.872	7.531**
volatility	(8.214)	(8.394)	(7.927)	(6.154)	(6.777)	(6.777)	(2.268)	(3.121)
GDP Business cycle	5.037	–17.747	–22.505*	–16.123	–23.079	–23.079	–3.488	–9.792***
	(14.136)	(14.273)	(13.141)	(12.644)	(14.329)	(14.329)	(3.126)	(3.301)
Observations	667	667	667	574	591	591	662	662
Number of Bonds	76	76	76	71	71	76	71	71
R-squared	0.177	0.205	0.154	0.045		0.0970		
Prob > F (GLOBAL SIGNIFICANCE)	0.00							
Prob > chi2—(SOV-CEILING)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Prob > F (POOLED SERIAL CORRELATION)	0.00							
Prob > F—(POOLED OLS VS. FIXED EFFECTS)		0.00						
Prob > chi2—(HETEROSKEDASTICITY)							0.00	
Prob > F—(SERIAL CORRELATION)					0.00			
Prob > chi2—(FIXED VS RANDOM EFFECTS)			0.00					

Notes. The dependent variable is the corporate bond spread. Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. OLS, RE, FE, FD, FE-AR, RE-AR, GLS-RE, and GLS-FE stand for ordinary least squares, random effects, fixed effects, first differences, fixed effects with serial correlation corrections, random effects with serial correlation corrections, generalized least squares with random effects, and generalized least squares with fixed effects estimators, respectively.

Table 7. The determinants of corporate bond spreads in Latin America. Econometric results—full sample—allowing for different slopes in sovereign spreads.

Covariate	(1)OLS	(2)FE	(3)RE	(4)FD	(5)FE-AR	(6)RE-AR	(7)GLS-RE	(8)GLS-FE
Liquidity: % of day with transactions	–5.889***	–9.220***	–5.889***	–2.565***	–2.114**	–3.683***	–0.764**	–149.21***
	(1.920)	(1.892)	(1.920)	(0.947)	(1.061)	(1.038)	(0.353)	(0.000)
Quasi-debt to firm value ratio (as % of firm value)	29.489***	108.782***	29.489***	–15.299	–15.049	9.306	17.645***	
	(11.029)	(16.332)	(11.029)	(10.499)	(11.646)	(9.906)	(3.660)	
Years to maturity	–7.124	–64.725*	–7.124	–1,155.58	–441.749***	–10.715	6.499**	
	(13.699)	(35.991)	(13.699)	(2,038.226)	(144.804)	(14.199)	(3.121)	
2-Year rolling yield volatility of the 3-month US T-bond (USTB-yield volatility)	73.758	70.167	73.758	7.92	3.513	–16.248	25.841	
	(127.677)	(131.924)	(127.677)	(95.273)	(101.510)	(107.560)	(27.627)	
2-Year rolling firm value volatility	–252.972	–79.699	–252.972	341.223	161.506	115.549	85.928	
	(534.130)	(571.684)	(534.130)	(368.741)	(410.613)	(379.962)	(94.792)	
Interaction 1: Quasi-debt to firm value—Years to maturity	–3.967***	–8.340***	–3.967***	–0.133	–0.92	–1.658**	–1.501***	
	(0.929)	(1.231)	(0.929)	(0.867)	(1.138)	(0.797)	(0.378)	
Interaction 2: Quasi-debt to firm value—USTB-yield volatility	19.046*	16.418*	19.046*	10.966*	15.055**	10.479	2.545	
	(9.976)	(9.958)	(9.976)	(6.372)	(7.095)	(7.119)	(2.865)	
Constant	682.568***	836.002**	682.568***	–234.011	2,507.221***	723.585***	145.309***	
	(224.571)	(354.898)	(224.571)	(507.506)	(50.226)	(206.911)	(46.552)	
Observations	667	667	667	574	591	667	662	662
Number of bonds	76	76	76	71	71	76	71	71
R-squared	0.525	0.383	0.53	0.08	0.11	0.3		
Log likelihood							–4175.76	–80382.1
Prob > F (GLOBAL SIGNIFICANCE)	0.00							
Prob > chi2—(EQUAL SLOPES FOR SOV. SPREAD)	0.00							
Prob > F (POOLED SERIAL CORRELATION)	0.00							
Prob > F—(POOLED OLS VS. FIXED EFFECTS)		0.00						
Prob > chi2—(HETEROSKEDASTICITY)							0.00	
Prob > F—(PANEL SERIAL CORRELATION)					0.00			
Prob > chi2—(FIXED VS. RANDOM EFFECTS)			0.00					

Notes. The dependent variable is the corporate bond spread. Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. OLS, RE, FE, FD, FE-AR, RE-AR, GLS-RE, and GLS-FE stand for ordinary least squares, random effects, fixed effects, first differences, fixed effects with serial correlation corrections, random effects with serial correlation corrections, generalized least squares with random effects, and generalized least squares with fixed effects estimators, respectively.

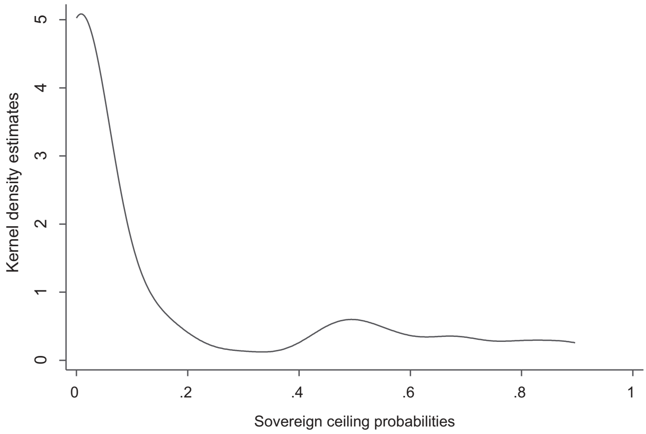

Figure 2. Sovereign ceiling probability distribution. Whole sample kernel density estimates for the probability of specific sovereign spread coefficients being equal to 1.

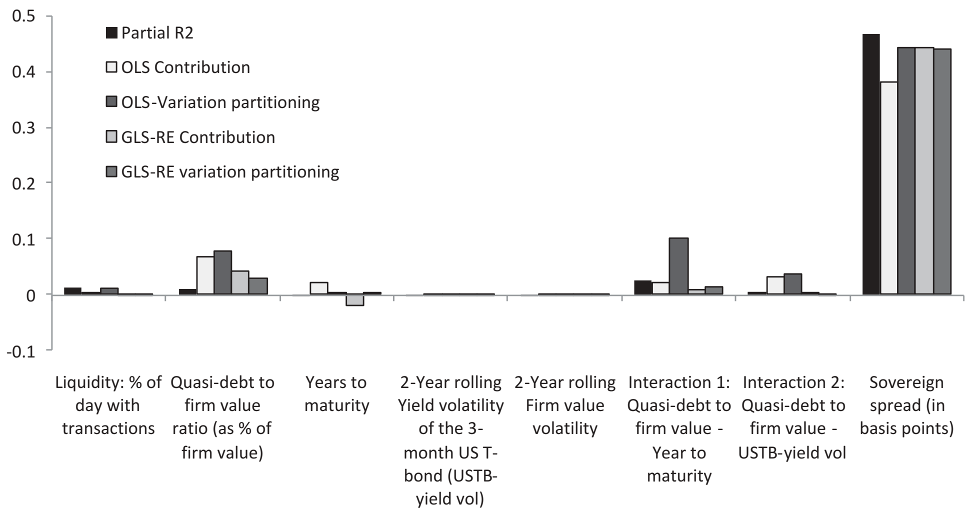

Figure 3. Economic significance of corporate spread structural determinants. Different approaches to variance decomposition.

Third, besides Unibanco, there are other firms for which there is mixed evidence regarding the rejection of the sovereign ceiling hypothesis: Comercial del Plata (an Argentinean industrial holding, the ceiling binds in one out of three bonds), Enersis (a private Chilean utility, the ceiling binds in one out of six bonds), Andina (a Chilean food and beverage producer, the ceiling binds in two out of three bonds), and Hylsamex (a Mexican steel and metal manufacturer, the ceiling binds in two out of three bonds). There are no episodes of actual piercing of the rating ceiling for any of these firms. Regarding Andina and Hylsamex, we think that these seemingly counterintuitive results may be explained by the different number of observations available for each bond, and sometimes by the corresponding sovereign bond with which the matching could be suboptimal (different coupon size, diverging maturities, etc.). Still, if we picked their most liquid bonds, the conclusion would be to accept the null of the applicability of the sovereign ceiling. The case of Enersis is different because the ceiling binds in one out of six bonds and because we reject the null of sovereign ceiling when we keep its most liquid bond (44% of days with transactions). Finally, for bonds associated with the longest span

Table 8. Rejection rates of the sovereign ceiling hypothesis.

	Sov. ceiling (a)	Sov. ceiling (b)
Whole sample	**0.83**	0.62
Argentina	**0.90**	0.80
Brazil	**0.79**	0.64
Chile	**0.77**	0.38
Mexico	**0.85**	0.65

Notes. Rejection rates in Column "Sov. Ceiling (a)" have been calculated assuming that the sovereign ceiling hypothesis cannot be rejected when the corporate spread coefficient (β_1) is positive and Prob. ($\beta_1 = 0$)<0.05 and Prob. ($\beta_1 = 1$) >0.05, or Prob. ($\beta_1 = 1$)<0.05 & $\beta 1 > 1$. Rejection rates in column "Sov. Ceiling (b)" are calculated as in "Sov. Ceiling (a)" but without introducing the Prob. ($\beta_1 = 0$) < 0.05 constraint.

(1996q3–2001q1) and the highest liquidity (20.55% of days with transactions), the markets also apply the ceiling rule to Comercial del Plata.

Summing up, sovereign risk is a very statistically significant factor to explain corporate bond spreads (we will see later that indeed it is the single most important explanatory variable), but the sovereign ceiling hypothesis does not generally hold.

Statistical Significance of Firm and Bond-Idiosyncratic Determinants

Liquidity is the most statistically significant variable, with a negative impact on corporate spreads which is significant at 5%. A 10 percentage point increase in the number of days with transactions reduces corporate bond spreads by 8 basis points. This result contrasts with Grandes and Peter (2005), who found that liquidity is not significantly correlated to South African corporate spreads in local currency. However, our result is in line with Longstaff, Mithal, and Neis (2005:2247), who find "… a significant non-default component in corporate spreads … (which) is strongly related to measures of bond-specific illiquidity".

The *quasi-debt to firm-value (leverage) ratio* is also very significantly statistically correlated to corporate spreads Its ultimate impact on corporate spreads depends on the interaction with the *risk-free interest rate volatility* and, mainly, with the remaining *time to maturity.* The stand-alone effect is positive: one percentage point increase in our leverage ratio (d rises by 0.01) increases the dependent variable by 0.17 basis points. The *interaction effect with the risk-free interest rate volatility* is positive but insignificant while the *interaction with time to maturity* is negative and very statistically significant.

The stand-alone effect of maturity on corporate spreads is positive and very significant but is unusually high and inconsistent across the estimators. When interacted with leverage, we notice however a consistently negative impact on corporate risk meaning that for increasingly leveraged firms (i.e., for a representative firm with a quasi-debt to firm ratio value equal to the whole sample average (0, 11)), 1-year increase in time to maturity will reduce required corporate bond spreads by 80 basis points, that is the interaction term effect will counter the stand-alone positive (but not robust) effect.

The other structural determinants (risk-free interest rate volatility and firm-value volatility) are not statistically significant.

Table 9. Sovereign spread-specific slopes and sovereign ceiling test results for the GLS-RE estimator.

Bond Id	Firm	Sector	Available obs.	% of days with transactions	Mean corp. spread	Mean corresponding sorp. spread	Sov. spread coeff. (β1)	Prob. β1 = 0	Prob. β1 = 1	Sov. ceiling (a)	Sov. ceiling (b)
ARGENTINA											
101	Alpargatas	Textile	1996q3-1996q4	2.20	3423.50	446.51	6.03	0.211	0.297	0	1
105	Comercial del Plata	Others	1996q3-1998q3	14.03	349.28	284.04	0.09	0.803	0.01	0	0
106			1996q3-1998q1	9.47	274.75	313.21	–0.28	0.293	0	0	0
107			1996q3-2000q1	20.55	922.00	289.60	10.37	0.024	0.041	1	1
108	YPF	Oil & Gas	2001q2-2002q1	8.69	438.70	511.20	0.18	0.114	0	0	0
109			2001q4-2002q1	5.77	147.69	511.20	0.13	0.653	0.002	0	0
110			1997q4-2004q3	52.18	256.73	1800.52	0.09	0	0	0	0
111			2000q2-2004q3	44.10	394.66	4107.73	0.09	0	0	0	0
112			1999q1–2003q3	43.87	304.29	697.01	0.06	0.333	0	0	0
113			1998q2-2002q1	28.65	330.64	512.40	0.46	0.044	0.02	0	0
BRAZIL											
202	Braskem	Chemical products	2004q1-2004q3	15.76	654.01	627.91	0.97	0	0.896	1	1
205	Gerdau Met	Steel & Metals	1996q4-2001q2	30.52	951.37	287.81	0.72	0.283	0.671	0	1
206			2001q2-2003q4	45.46	691.77	621.45	0.07	0.641	0	0	0
207	Tele Norte Celular	Tele communication	2003q4-2004q3	16.26	449.77	483.61	0.45	0.139	0.067	0	1
212			1999q3-2000q3	16.73	430.26	304.37	–1.1	0.187	0.011	0	0
213			2000q3-2001q4	11.52	228.68	284.97	–1.08	0.162	0.007	0	0
214			2000q2-2001q4	11.78	222.69	286.29	–1.4	0.041	0	0	0
215			2000q3-2001q4	8.57	164.42	287.48	–1.09	0.116	0.003	0	0
216	Unibanco	Finance & Insurance	2001q2-2001q4	8.47	234.14	284.54	–1.22	0.249	0.036	0	0
217			2002q2-2004q3	25.77	647.09	363.03	0.91	0	0.67	1	1
219			2003q1-2004q3	23.57	618.04	363.03	0.95	0	0.8	1	1
220			2004q1-2004q3	15.54	457.84	483.60	0.3	0.299	0.013	0	0
221			2004q1-2004q3	8.66	50.52	725.43	–1.02	0.002	0	0	0
222	Usiminas	Steel & Metals	2003q4-2004q3	8.51	39.56	427.76	–1.16	0.332	0.071	0	0
CHILE											
301			2002q3-2002q4	44.44	327.84	203.37	–1.92	0.052	0.003	0	0
302			2003q1-2004q3	32.01	639.78	97.93	3.41	0	0.003	1	1
303	Enersis	Electricity	2003q1-2004q3	24.86	132.72	–40.79	–1.55	0.732	0.573	0	0
304			2003q4-2004q3	16.67	304.43	136.78	0.32	0.793	0.579	0	1
305			2003q4-2004q3	16.81	323.19	136.78	0.42	0.634	0.515	0	1

307	Embonor	Food & Beverages	2002q3-2004q3	29.82	379.15	127.85	0.17	0.733	0.089	0	1
308	Andina	Food & Beverages	2002q3-2004q3	44.12	474.95	87.91	1.88	0	0.008	1	1
309			2003q1-2004q3	41.23	434.21	–56.29	–2.32	0.04	0.003	0	0
310			2003q1-2004q3	34.91	–381.20	–2828.01	1.02	0	0.801	1	1
311	Endesa	Electricity	2003q4-2004q3	17.44	275.86	116.03	0.83	0.502	0.891	0	1
312			2003q4-2004q3	17.57	264.16	142.89	0.65	0.491	0.707	0	1
314	QC	Telecommunication	2002q3-2004q3	38.29	279.31	116.76	0.36	0.265	0.046	0	0
315			2002q3-2004q3	39.85	181.75	135.40	–0.37	0.66	0.104	0	0
MEXICO											
501	Commercial Mexicana	Whosale & retail trade	1996q3-1997q2	10.29	271.25	152.43	0.59	0.314	0.486	0	1
502			1999q3-2004q3	36.38	1352.52	197.75	2.28	0.181	0.452	0	1
508	Posadas Gpo	Others	1997q1-2001q3	28.71	556.88	216.45	1.33	0.005	0.477	1	1
511	Televisa GPO	Others	1996q3-1997q3	7.73	126.99	517.11	–0.22	0.045	0	0	0
512			2001q3-2004q3	25.53	84.86	190.72	0.67	0.192	0.511	0	1
513			2000q3-2004q2	28.68	256.84	190.72	0.59	0.244	0.425	0	1
514			2002q1-2004q3	28.11	321.16	243.25	0.46	0.006	0.001	0	0
515			2002q2-2004q3	25.93	297.69	243.25	0.49	0.009	0.007	0	0
518	Hylsamex	Steel & Metals	1997q1–1998q1	9.02	167.22	178.89	–2.43	0.001	0	0	0
519			2003q2-2004q3	19.62	900.32	270.99	4.52	0	0	1	1
520			1999q1-2004q3	43.18	1933.98	312.19	3.75	0	0.001	1	1
522	Kimberly Clark Mex	Paper & pap. related prod.	2001q1-2004q3	33.35	283.60	595.53	0.1	0.268	0	0	0
523			1999q3-2004q3	41.38	422.58	595.53	0.28	0.014	0	0	0
526	Vitro	Nonmetallic minerals	2003q4-2004q3	17.25	893.63	180.69	2.67	0	0.001	1	1
527			2003q4-2004q3	16.90	928.06	180.69	2.84	0	0	1	1
532	America Movil	Telecommunications	2004q1-2004q3	14.55	184.88	177.66	0.01	0.994	0.126	0	1
533			2004q2-2004q3	15.13	202.19	177.66	0.07	0.923	0.181	0	1
539			2004q2-2004q3	13.00	–16.92	385.33	–0.56	0.184	0	0	0
542	Coca Cola Femsa	Food & Beverages	1997q3-2004q3	54.46	263.88	390.19	0.05	0.705	0	0	0
543			1996q3-1997q2	5.88	144.51	551.36	–0.09	0.457	0	0	0
544	Cemex S.A.	Nonmetallic minerals	1996q3-1999q4	18.78	258.82	282.70	0.17	0.393	0	0	0
545			1996q3-2000q3	23.41	259.41	236.48	0.27	0.282	0.003	0	0
546			1996q3-1998q1	10.81	196.18	170.73	–0.06	0.834	0	0	0

(*Continued*)

Table 9. Sovereign spread-specific slopes and sovereign ceiling test results for the GLS-RE estimator. (Continued)

Bond Id	Firm	Sector	Available obs.	% of days with transactions	Mean corp. spread	Mean corresponding sorp. spread	Sov. spread coeff. ($\beta 1$)	Prob. $\beta 1 = 0$	Prob. $\beta 1 = 1$	Sov. ceiling (a)	Sov. ceiling (b)
547			1996q3-2001q1	29.64	253.27	215.29	0.19	0.388	0	0	0
548			1996q3-2000q2	22.95	257.99	244.72	0.28	0.236	0.002	0	0
549			2001q2-2004q3	31.70	216.35	84.31	0.21	0.567	0.035	0	0
550			2001q1-2004q3	57.14	344.34	84.31	0.41	0.273	0.11	0	1
551			1999q3-2002q2	17.42	185.70	210.79	–0.06	0.899	0.022	0	0
552			2000q3-2004q3	35.53	306.44	295.38	0.35	0.117	0.003	0	0
553			2001q1-2004q3	32.14	347.09	295.38	0.4	0.021	0.001	0	0
554			2000q1-2004q3	39.38	320.52	295.38	0.43	0.001	0	0	0
555			2001q1-2002q3	14.62	181.69	187.38	–0.21	0.81	0.157	0	0
556			2000q3-2002q3	17.30	192.74	187.38	–0.05	0.95	0.184	0	0
557			1996q3-1997q3	7.69	265.86	519.95	0.17	0.414	0	0	0

Notes. In Column "Sov. Ceiling (a)," the sovereign ceiling hypothesis cannot be rejected (1; while 0 stands for rejection) when $\beta 1 > 0$ & Prob. $\beta 1 = 0 < 0.05$ & (Prob. $\beta 1 = 1 > 0.05$ or (Prob. $\beta 1 = 1 < 0.05$ but $\beta 1 > 1$)). In Column "Sov. Ceiling (b)," the Prob. $\beta 1 = 0 < 0.05$ constraint is no longer introduced. Detailed characteristics of each bond can be obtained from Ex.

Economic Significance

Here we compute the part of the explained variance of corporate bond spreads that is accounted for by each determinant. Performing three alternative variance decomposition methods based on OLS and GLS-RE estimators, and the R-squared coefficient (see Wooldridge 2002), we find that that the *sovereign spread is the major determinant* of corporate bond spreads in our sample (Figure 3) explaining on average 40% of the corporate spread fitted variance. This result is similar to that obtained by Grandes and Peter (2005) and (to some extent) Collin-Dufresne, Goldstein, and Martin (2001). However, it disagrees with Cavallo and Valenzuela (2010) where firm-specific factors account for the largest share of corporate default risk, followed by industry and country fixed effects.

As for the control variables, we find that the *quasi-debt to firm-value (leverage) ratio is the most economically significant* structural determinant of corporate bond spreads. It accounts for 7–22% (adding up direct and interaction effects) of the corporate bond spread total variance, depending on the variance decomposition method and the econometric estimator. Among the other covariates, only *time to maturity* appears to have a significant (albeit indirectly through the interaction with the quasi-debt to firm-value ratio) economic impact on corporate bond spreads. Liquidity only accounts for less than 2% of the total variance in corporate spreads.

Conclusions

In this article, we built a new data set containing 72 US dollar-denominated corporate bonds issued by 22 Latin American firms—predominantly industrial—from Argentina, Brazil, Chile, and Mexico over the period 1996–2004, in order to answer three questions: (1) Is sovereign risk is a statistically and economically significant determinant of the corporate credit spread, controlling for firm- and bond-specific characteristics and the business cycle (macroeconomic) conditions? (2) If yes, do market participants apply the sovereign ceiling rule adopted by rating agencies in the pricing of our bond market data? And (3) how do market views compare with the rating agencies ceiling policy for each corporate?.

First, we find that sovereign risk is the most important determinant explaining up to 40% of the cross-section and time series variation of corporate bond spreads controlling for bond- and firm-specific variables. This is robust to the inclusion of the business cycle (macroeconomic) conditions. Moreover, we confirm the presence of different sovereign spreads coefficients/slopes on each corporate bond spread. This finding is in line with Grandes and Peter (2005) but differs from Cavallo and Valenzuela (2010), who, for a sample of emerging-market corporations (including Latin America) and time span (1999–2006), find that firm- and bond-specific variables explain the largest part of corporate spreads variability.

Now, do those sovereign spread coefficients or estimated “betas” imply the market is applying the sovereign ceiling rule adopted by rating agencies? In order to respond to this question we developed a new empirical test building on Durbin and Ng (2005) and Grandes and Peter (2005) and came up with strong evidence that market participants do not apply the “*sovereign ceiling rule.*” This means that that firms could avoid transfer risk partially or entirely over the period 1996–2004 based on the less than one-to-one response of corporate spreads to sovereign risk. The percentage of rejection of the sovereign ceiling rule ranges from 77% (Chile) to 90% (Argentina). In principle, this should not come as a surprise because 21 of the 22 sampled firms are industrial, multinational corporations, some of which have parent support and produce tradable goods, confirming some results in Durbin and Ng (2005). These types of companies are better suited to avoid foreign currency controls or capital account restrictions so they are less likely to default on their obligations when there is a sovereign debt crisis.

Notice we rejected the sovereign ceiling hypothesis even for most Chilean bonds/firms where we observed the largest positive differential between corporate and sovereign bond spreads (Table 3). This result is useful to recall that corporate bond spreads higher than sovereign spreads do not necessarily imply that bond market participants apply the sovereign ceiling rule. A firm may bear a relatively high stand-alone risk, which may be reflected in wider spreads and hence higher expected losses in case of default. These relatively higher corporate spreads might be the consequence of poor management and weak firm performance, rather than the result of a 100% sovereign transfer risk (1% increase in sovereign increase corporate spreads by the same amount).

Finally, we contributed to the literature by comparing the rating agencies ceiling practice with our market-data-based test for the existence of such a ceiling in the corporate bond spreads. As a result, we checked that in 7 out of 22 firms (representing 38 bonds), market views were consistent with the rating agencies' policy of allowing these corporations to pierce the sovereign ceiling for at least a subperiod within our sample.[19] As for the other firms, the only puzzling result was Unibanco (Brazil). Rating agencies allowed this bank to pierce the ceiling from June 2003 and until November 2003. Normally, banks are rated at or below the sovereign rating, yet we came up with mixed evidence from the market views pointing to the acceptance of the sovereign ceiling hypothesis in the case of the most liquid bonds (2 of 9) issued by Unibanco.

Acknowledgments

For invaluable comments or suggestions, the authors are grateful to Alberto Musalem, Silvina Vatnick, Daniel Marx, Marcelo Dabós as well as to participants at the LACEA 2008 and 2007 annual meetings, the 2009 annual meeting of AAEP and participants or discussants at conferences held at the 2011 World Finance Conference in Rhodes, Greece, Trinity College of Dublin, Université de Paris Dauphine, the Chinese Academy of Finance and Development, Nankai University, Universidad del CEMA, Pontificia Universidad Catòlica Argentina, the UN Business Forum, Ecole Normale Superieure (Lyon), and the Center for Financial Stability of Argentina.

Notes

1. This article will use interchangeably the terms "corporate bond spreads," "(corporate) credit risk," "credit yield spreads," and "corporate default premium."
2. For a survey of this literature, we refer the reader to Elton et al (2001) and Cossin and Pirotte (2001).
3. In a later unpublished version of their paper, Grandes and Peter (2006) are able to prove the robustness of their findings to the inclusion of global factors, namely the UST 10-year bond yield, the CBOE VIX measure of risk aversion, and the volatility of global (MSCI) equity.
4. Other theoretical frameworks are (1) the classical or actuarial (for a survey of these methods, see for instance Caouette, Altman, and Narayanan (1998), and (2) the reduced-form, statistical, or intensity-based approach. Readers interested in *reduced-form* models are referred to the works of Pye (1974), Litterman and Iben (1991), Fons (1994), Das and Tufano (1996), Jarrow and Turnbull (1995), Jarrow, Lando, and Turnbull (1997), Lando (1998), Madan and Unal (1998), Duffie and Singleton (1999), Collin-Dufresne and Solnik (2001), and Duffie and Lando (2001), most of which are surveyed and nicely put into a broader context by Cossin and Pirotte (2001), and Bielecki and Rutkowski (2002). We choose the structural approach because the classical approach is both too subjective and too backward looking and the reduced-form approach is atheoretical with respect to the determinants of default risk.
5. Shimko, Tejima, and Van Deventer (1993) assume that the short-term risk-free interest rates follow a stationary Ornstein–Uhlenbeck process of the form $dr = \alpha(\gamma - r)dt + \sigma_r dZ_{2,t}$,where γ is the long-run mean which the short-term interest rate r is reverting to, α > 0 is the speed at which this convergence occurs, σ_r is the instantaneous variance (volatility) of the interest rate, and $dZ_{2,t} = \varepsilon_2 \sqrt{dt}$ is a second standard Gauss–Wiener process, whose correlation with the stochastic firm value factor, $dZ_{1,t}$, is equal to ρ, i.e., $dZ_{1,t}.dZ_{2,t} = \rho dt$
6. Shimko, Tejima, and Van Deventer (1993) determine the signs of $\partial s/\partial d$, $\partial s/\partial \sigma_V$, $\partial s/\partial \tau$, and $\partial s/\partial \sigma_r$ through simulations.
7. Shimko, Tejima, and Van Deventer (1993), p. 59.
8. Also see Helwege and Turner (1999), who demonstrate through an experiment the existence of a positively sloped credit spread-to-maturity curve for speculative grade borrowers.
9. These factors are dealt with in the literature on corporate default risk in mature markets, in particular the US corporate bond market. See, for instance, Athanassakos and Carayannopoulos (2001).

10. In Thomson Financial Datastream, we found 171 firms having issued at least one bond. However, many of these bonds did not display yield to maturity and price data over the relevant period.

11. Elton et al. (2001) argue that one should use spreads calculated as the difference between yield to maturity on a zero-coupon corporate bond (called corporate spot rate) and the yield to maturity on a zero-coupon government bond of the same maturity (government spot rate) rather than as the difference between the yield to maturity on a coupon-paying corporate bond and the yield to maturity on a coupon-paying risk-free bonds.

12. Available at http://www.treas.gov/offices/domestic-finance/debt-management/interest-rate/yield.shtml

13. The econometric specification we applied is $y_i = \beta_1 + \beta_2 \log(t_i) + \beta_3 {t_i}^2 + \varepsilon_i$, where y denotes each bond yield and t denotes time to maturity. The specification fits well to the US Treasury estimation.

14. A methodological note discussing in detail the operationalization and measurement of these determinants can be obtained from the authors upon request.

15. We do not control for global risk aversion because the short-term volatility in US interest rates is highly correlated with the former. Moreover, global risk aversion as for instance measured by the VIX index and UST bond yields at both ends of the curve have been found to be significant determinants of sovereign spreads. Therefore, their potential effect on corporate bond spreads should already be captured by those sovereign spreads.

16. Following Hammersley and Atkinson (1983), we can state that what is involved in methodological triangulation is not the combination of different types of methodologies per se, but to correct the potential weaknesses that may limit the validity of the analysis. For Fielding and Fielding (1986), the conventional idea of triangulation is that if diverse types of data or methods sustain the same conclusion, the trustworthiness of the results is increased.

17. We make this choice despite rejecting the null of the Hausman test, which favors the FE estimator to RE as the latter is inconsistent but efficient under the alternative hypothesis, The Hausman's test may not be reliable under certain conditions. Given that GLS-RE remains an efficient and unbiased estimator and corrects for both serial correlation and heteroskedasticity, we prefer to retain this estimator.

18. Note that among the industrials firms, Braskem (Brazil) appears as the only inconsistent case. Although its credit rating pierced the sovereign ceiling from June 2003 until November 2003, market views seem to reflect the opposite, as we accept the null hypothesis that market participants apply the sovereign ceiling rule to the Braskem ´s bond.

19. These firms are YPF SA (Argentina) from 1997 to 2004, Telenorte (Brazil) from June 2003 until November 2003, Televisa Group (Mexico) from June 2004 until January 2005, Kimberley Clark (Mexico) from July 1999 until November 2005, America Movil (Mexico) from August 2002 until January 2005, Coca Cola Femsa (Mexico) from October 1996 to date, and CEMEX (Mexico) from November 1997 until January 2005.

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