

# **The Empirical Determinants of Local-Currency-Denominated Corporate Spreads in Emerging Economies: Evidence from South Africa\***

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## **Abstract**

This paper analyzes and quantifies the importance of sovereign risk in determining corporate yield spreads in emerging economies. It also investigates the extent to which the practice by rating agencies and banks of not rating companies higher than their sovereign (“country or sovereign ceiling”) is reflected in the spreads of South African local-currency-denominated corporate bonds. The main findings are: (i) sovereign risk appears to be the single most important determinant of corporate spreads in South Africa; (ii) the sovereign ceiling does not apply in the spreads of the industrial multinational companies in the sample; and (iii) consistent with rating agency practice, the sovereign ceiling appears to apply in the spreads of most financial companies in the sample.

Keywords: sovereign risk, corporate default risk, spread, sovereign ceiling

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## 1. INTRODUCTION

Emerging market borrowers able to issue debt securities in their local currency generally pay a considerable premium over comparable risk-free assets such as U.S. Treasury securities. Conceptually, this premium (or interest rate differential) can be decomposed into three components. The first one is the *currency premium*, which reflects expected depreciation of the domestic currency plus the foreign exchange risk premium. The second component is the *credit (or yield) spread*.<sup>1</sup> The credit spread reflects expected default loss, i.e., the risk that the borrower is unable (or unwilling, in the case of a government) to service the debt in full and on time, but also differences in taxes, liquidity effects, and a credit risk premium. The third component of the total interest differential is the *jurisdiction premium* which is caused by differences between domestic financial regulations and international or foreign legal standards. When the borrower in question is the government itself, the yield spread is called the *sovereign (yield) spread* and reflects *sovereign risk*. The sum of the sovereign spread and the jurisdiction premium is often called *country premium* or simply *country risk*.

The purpose of this paper is to investigate the importance of *sovereign risk* in determining *corporate yield spreads* in emerging economies. South Africa is used as a case study for reasons explained below. The main question addressed is whether sovereign risk is a source of systematic risk in emerging economies and, hence, priced in local-currency corporate spreads. In assessing the impact of sovereign risk on corporate yield spreads, we control for the expected default loss determinants (leverage, firm-value volatility, remaining time to maturity, and risk-free interest rate volatility) implied by the well-known "contingent-claims" approach pioneered by Merton (1974). A second issue addressed is the extent to which the practice by rating agencies and internationally active banks of imposing a rating ceiling ("country or sovereign ceiling") on sub-sovereign bond issues is reflected in corporate spreads. The crucial policy issue in this context is the extent to which corporate debt costs could be lowered when public sector solvency improves.

A simple theoretical framework is developed to show how sovereign risk and indirect sovereign risk (defined in section 3.2) can be thought to affect a company's default risk. The term "the sovereign (or country) ceiling in the spread of a firm applies" is defined as an instance where indirect sovereign risk equals 100 percent, meaning that whenever the sovereign defaults on its debt, the firm defaults on its debt as well. To test empirically whether the sovereign ceiling applies in the spreads of our sample firms, we use a result obtained by Durbin and Ng (1999). They show in a simple theoretical model that if the sovereign ceiling applies, the elasticity of corporate spreads with respect to sovereign spreads should be greater than or equal to one. The other relevant determinants of the corporate credit spread are derived from the contingent claims approach *à la* Merton (1974) and Shimko, Tejima, and Van Deventer (1993). Relying on this theoretical framework and using a monthly panel covering four industrial and five

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<sup>1</sup> In this paper, the terms *credit spread*, *yield spread*, or simply *spread* are used as synonyms.

financial firms in South Africa during the period July 2000–May 2003, we estimate the impact of sovereign risk, firm-specific variables, and other controls on the corporate spread.

The main findings are that, first, sovereign risk appears to be the single most important determinant of corporate spreads in South Africa. For all firms analyzed, sovereign risk is statistically and economically the most important determinant of their yield spread. Second, the sovereign ceiling (in local-currency terms) does not apply in the spreads of the industrial multinational companies in the sample, in the sense that the elasticity of their spreads with respect to sovereign spreads is significantly lower than one (between 0.42 and 0.83). However and consistent with rating agency practice, the sovereign ceiling appears to apply in the spreads of most of the financial companies, with elasticities that are statistically not different from one (between 0.78 and 0.98). And third, the determinants of expected default loss derived from the contingent claims approach (leverage, firm-value volatility, remaining time to maturity, and risk-free interest rate volatility) are also statistically significant, contrary to the findings by Durbin and Ng (1999); economically, however, their importance is minor.

From a policy perspective, it is interesting to note that although the traditional expected loss factors are significant in explaining the premium investors demand to hold corporate debt, a much more important part of this premium can be attributed to sovereign risk. Macroeconomic policies oriented toward reducing sovereign default risk, and hence improving a government's credit rating, can result in a significant reduction in the cost of debt capital for corporate borrowers, which in turn can stimulate investment and economic growth.

The study contributes to the literature in at least four dimensions: (i) to the best of our knowledge, it is the first to theoretically postulate and empirically investigate the impact of sovereign risk on local-currency-denominated corporate credit spreads in emerging economies; (ii) contrary to existing empirical studies in the field, it also controls for company-specific variables; (iii) it uses an as-yet unexploited dataset from the Bond Exchange of South Africa (BESA); and (iv) in light of the growing importance of local-currency bond issuances in emerging markets, it provides a methodology for further research on the impact of sovereign default risk on corporate spreads.

South Africa was selected as a case study for essentially three reasons. First, South Africa is one of few emerging markets to have a corporate bond market in local currency (i.e., the rand) for a considerable number of years.<sup>2</sup> Admittedly, this market is (still) very small: during our sample period (July 2000–May 2003), there were only nine

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<sup>2</sup> In the terminology of Eichengreen and Hausmann (1999), South Africa is one of the few emerging markets that did not suffer from the “Original Sin” problem. A country suffers from Original Sin if it cannot borrow abroad in its own currency (the international component) and/or if it cannot borrow in local currency at long maturities and fixed rates even at home (the domestic component).

South African private sector firms that had a total of 12 bonds outstanding (Table 1).<sup>3</sup> Second, our empirical study uses an as-yet unexploited dataset provided by BESA. Third, the nine corporate issuers mentioned above are important South African companies. Looking at the prospective development of South Africa's corporate bond market, we think the experience of these borrowers could help inform the decisions made by other potential issuers to resort to the local bond market as an alternative source of finance.

The rest of the paper is organized as follows. Section 2 reviews the related literature. Section 3 introduces the theoretical framework from which the determinants of corporate spreads are derived. The description and operationalization of the corporate yield spread and its determinants follow in section 4. Section 5 sets forth the empirical methodology to estimate their relative importance and presents and discusses the econometric results. Section 6 concludes and draws some lessons for economic policy and banks' country risk management.

## 2. SOVEREIGN RISK, THE SOVEREIGN CEILING, AND RELATED LITERATURE

Historically, a high correlation between sovereign defaults and company defaults has been observed in emerging economies. In other words, it has been 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 has meant that the debt of a company in a given country could not be rated higher than the debt of its government because the default probability of a firm would always be higher than that of its government. The economic rationale behind the sovereign rating ceiling for *foreign-currency* debt obligations is *sovereign intervention risk*, more commonly called *transfer risk*. The term *transfer risk* refers to the probability that a government with (foreign) debt servicing difficulties imposes 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. The rationale behind the sovereign rating ceiling for *domestic-currency* debt obligations is what Standard & Poor's calls "economic or country risk" (Standard & Poor's (2001), p. 1), which we prefer to call *indirect sovereign risk*. *Indirect sovereign risk* is the equivalent of transfer risk in domestic-currency obligations. It refers to the probability that a firm defaults on its domestic-currency debt as a result of distress or default of its sovereign. Both transfer risk and indirect sovereign risk are closely related to (*pure*) *sovereign risk*.<sup>4</sup> It is *indirect sovereign risk* that we are primarily concerned about in this paper. Section 3.2 elaborates on how sovereign risk and indirect sovereign risk can be thought to influence corporate credit risk.

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<sup>3</sup> In addition to the bonds listed in Table 1, Imperial Group, ISCOR, and Standard Bank had a second bond outstanding, namely IPL2, IS57, and SBK4.

<sup>4</sup> *Sovereign risk* refers in principle to the probability that a government defaults on its debt. The terms *sovereign risk*, *indirect sovereign risk*, and *transfer risk* are, however, often used interchangeably, as for instance in Obstfeld and Rogoff (1996), p. 349.

Until 2001, the three main rating agencies, Moody's Investors Service, Standard & Poor's, and Fitch Ratings, 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 (2001b), Standard & Poor's (2001), Fitch Ratings (2001)). 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” (See Moody's Investors Service (2001a), p.1).

Under specific and very strict conditions, rating agencies now allow firms to obtain a higher rating than the sovereign of their incorporation (or location). These conditions are stricter for “piercing” the sovereign *foreign*-currency rating than the sovereign *local*-currency rating. 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. Table 2 shows that among the nine firms analyzed, which had a rating by Moody's or Standard & Poor's, eight were rated at or below the government. The only—temporary—exception was Sasol, a globally operating oil and gas company. It was assigned a BBB foreign-currency credit rating by Standard & Poor's on February 19, 2003—about three months before the government's foreign-currency rating was itself upgraded to BBB (May 7) from BBB minus. All other rated firms in our sample were rated at or below the sovereign ceiling for both foreign- and local-currency ratings. Moreover, as the table indicates, four of the five banks or financial firms (ABSA Bank, Investec Bank, Nedcor, and Standard Bank) have always been rated at the sovereign ceiling.

One of the two objectives of this study is to analyze the extent to which a sovereign ceiling can be observed in rand-denominated corporate credit spreads.<sup>5</sup> This entails, in a first step, verifying whether the credit spreads of the firms analyzed are always higher than comparable spreads of government bonds. Figure 1 shows that this is the case for the nine South African corporate bonds analyzed in this paper (all *excess* corporate spreads are positive). However, corporate spreads exceeding comparable government spreads are only a necessary but not sufficient condition for the existence of a sovereign ceiling in corporate spread data: the spread of a given firm may be higher than a comparable government spread because the firm, on a stand-alone basis (i.e., independently of the creditworthiness of the government in whose jurisdiction it is located), has a higher default probability than that government. Thus, whenever we

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<sup>5</sup> In terms of spreads, the sovereign *ceiling* (in ratings) translates into a sovereign *floor*. We stick to the “ceiling” terminology to be consistent with the literature in this field.

observe rand-denominated corporate spreads that exceed comparable government spreads, we will have to find out whether these observations are due to a high stand-alone default probability of the firm or to high indirect sovereign risk. Section 3.2 provides a framework to disentangle the different risks.

Confronted with this identification problem, we will resort to a result obtained by Durbin and Ng (1999) and Durbin and Ng (2001). They show in a simple theoretical model that the rating agencies' main justification for the sovereign ceiling rule—namely, that whenever a government defaults, firms in the country will default as well (i.e., transfer risk is 100 percent)—implies that a 1 percent increase in the government spread should be associated with an increase in the firm spread of at least 1 percent. They test this hypothesis empirically by regressing corporate spread changes on corresponding sovereign spread changes: if the estimated beta-coefficient is greater than or equal to one, the sovereign ceiling in spreads applies; if beta is smaller than one, the sovereign ceiling does not apply. They find that when the “riskiness” of the country of origin is not controlled for, the beta-coefficient is indeed slightly larger than one. However, when the riskiness of the country of origin is taken into account, they find that the beta-coefficient is significantly smaller than one for corporate bonds issued in “low-risk” and “intermediate-risk” countries but significantly higher than one in “high-risk” countries.<sup>6</sup> They conclude that in relatively low-risk countries, market participants judge transfer risk to be less than 100 percent, that is, “they do not believe the statement that firms will always default when the government defaults.” (Durbin and Ng (2001), p. 19)

Although the present study is similar to Durbin and Ng (1999) in many respects, the main differences are threefold. First, while Durbin and Ng (1999) analyze the relationship between corporate and sovereign yield spreads on *foreign*-currency bonds in emerging markets, we study this relationship between corporate and sovereign yield spreads on *domestic*-currency bonds. Second, Durbin and Ng (1999) work with a broad cross-section of over 100 firm bonds from various emerging markets, while we work with all domestic-currency-denominated and publicly traded firm bonds available in one particular emerging economy, South Africa.<sup>7</sup> Third, we also control for the “traditional” default risk determinants (e.g., leverage and asset volatility) and other factors in our assessment of the impact of sovereign risk on corporate yield spreads, while this is not the case in Durbin and Ng (1999).

Apart from Durbin and Ng (1999), the empirical literature on the determinants of corporate spreads *in emerging markets* is scant. We know of no other theoretical or empirical study that investigates the relationship between sovereign risk and corporate

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<sup>6</sup> The 13 countries for which U.S.-dollar-denominated corporate bond yields were available have been ranked by average government spreads; the “low-risk” group is composed of the five countries with the lowest spreads, the “intermediate-risk” group of the next five countries, and the “high-risk” group of the three with the highest spreads. See Durbin and Ng (2001), p. 30.

<sup>7</sup> We actually take all publicly traded bonds of South African firms whose shares are quoted on the Johannesburg Stock Exchange (JSE).

debt pricing in an emerging market environment. This lack is most likely due to the shallowness or absence of corporate bond markets in these countries.

There are, however, two related literature strands. The first literature, which is very recent and small but closest in spirit to the present study, assesses the impact of sovereign (foreign currency) credit *ratings* on firm (foreign currency) credit *ratings* (Ferri, Liu, and Majnoni (2001), Ferri and Liu (2003), and Borensztein, Cowan, and Valenzuela (2005)). The main results of this literature are that sovereign FX ratings have a statistically and economically significant impact on firm FX ratings and that this impact is larger (i) for firms in emerging markets and developing countries than for industrial country firms, (ii) for banks than non-financial corporations, and (iii) for rating downgrades than upgrades.

Second, there is a wealth of theoretical and empirical studies on the determinants of corporate spreads *in industrial countries* or, more specifically, in the United States.<sup>8</sup> This literature suggests that corporate spreads are a function of expected default loss (determined, in turn, by leverage, asset volatility, maturity, and the dynamics of risk-free interest rates), taxes, liquidity, bond indenture provisions (e.g., presence of a sinking fund, embedded call options) and a potential credit risk premium. However, the distinguishing feature of industrial countries—and the United States in particular—is that government bonds are risk-free (i.e., sovereign risk is zero). This is in sharp contrast to emerging markets where—almost by definition—government bonds are not risk-free. In an emerging market, the corporate yield spread above an equivalent government bond yield does *not* reflect corporate default risk. It merely reflects corporate default risk *in excess* of sovereign default risk. Hence, it appears that in emerging economies there could be a crucial additional determinant of corporate default risk: the default risk of the government, i.e., sovereign risk. Sovereign risk is precisely what the rating agencies' sovereign ceiling rule is all about. Section 3.2 elaborates on this idea.

### 3. THEORETICAL FRAMEWORK: DETERMINANTS OF THE CORPORATE CREDIT SPREAD

The theoretical literature on the pricing of defaultable fixed-income assets—also called credit risk pricing literature—can be classified into three broad approaches: (i) the *classical* or *actuarial approach*; (ii) the *structural approach*, or *firm-value* or *option theoretic approach*, sometimes also referred to as *contingent claims approach*; and (iii) the *reduced-form* or *statistical* or *intensity-based approach*. The basic principle of the ***classical approach*** is to assign (and regularly update) credit ratings as measures of the probability of default of a given counterparty, to produce rating migration matrices, and to estimate (often independently) the value of the contract at possible future default dates. Typical users of this approach include the rating agencies (at least in the traditional

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<sup>8</sup> Examples are Fisher (1959), Merton (1974), Cook and Hendershott (1978), Ho and Singer (1984), Athanassakos and Carayannopoulos (2001), Elton, Gruber, Agrawal, and Mann (2001), Collin-Dufresne, Goldstein, and Martin (2001), Amato and Remolona (2003), King and Khang (2005), Longstaff, Mithal, and Neis (2005).

part of their operations) and the credit risk departments of banks.<sup>9</sup> The **structural approach** is based on Black and Scholes (1973) and Merton (1974). It relies on the balance sheet of the borrower and the bankruptcy code to endogenously derive the probability of default and the credit spread, based on no-arbitrage arguments and making some additional assumptions on the recovery rate and the process of the risk-free interest rates. The **reduced-form approach** models the probability of default as an exogenous variable calibrated to some data. The calibration of this default probability is made with respect to the data of the rating agencies or to financial market series acting as state variables.<sup>10</sup>

We adopt a simple version of the structural approach – the Shimko, Tejima, and Van Deventer (1993) model – as the starting point for the theoretical framework of our empirical investigation, as the classical approach is both too subjective and too backward-looking and the reduced-form approach is a-theoretical with respect to the determinants of corporate credit spreads. In a second step, we relax the assumption that government bonds of emerging market sovereigns are risk-free. We introduce (in an admittedly ad hoc fashion) sovereign risk (proxied by the sovereign credit spread) as an emerging-market specific additional determinant of corporate credit spreads. In the third step, we briefly consider some potential further determinants that result once the frictionless market assumption is relaxed or specific bond indenture provisions are taken into account. A final subsection synthesizes and summarizes the determinants identified.

### 3.1. Starting Point: The Shimko, Tejima, and Van Deventer (1993) Model

Integrating the Vasicek (1977) term-structure-of-interest-rates model into the Merton (1974) corporate debt pricing model, Shimko, Tejima, and Van Deventer (1993) find that the corporate credit spread  $s$  is essentially a function of four important determinants:<sup>11</sup> (i) firm leverage (measured by the ratio of the present value of the bond

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<sup>9</sup> For a survey of these methods, see for instance Caouette, Altman, and Narayanan (1998).

<sup>10</sup> For surveys of this approach, see Cossin and Pirotte (2001) and Bielecki and Rutkowski (2002).

<sup>11</sup> The Shimko et al. model hinges on a number of critical assumptions. They are: (i) competitive and frictionless markets; (ii) the firm holds a single type of liability: a non-callable zero-coupon bond; (iii) the value of the firm follows a geometric Brownian motion process,  $dV_t/V_t = \mu dt + \sigma_V dZ_{1,t}$ , where  $\mu$  is the instantaneous expected rate of return on the firm value,  $\sigma_V^2$  is the instantaneous variance of the return on the firm value  $V$  per unit of time (called “asset return volatility” or simply “firm-value volatility”), and  $dZ_{1,t} = \varepsilon_1 \sqrt{dt}$  is a standard Gauss-Wiener process; (iv) firm management acts to maximize shareholder wealth; (v) there is perfect antidilution protection (i.e., there are neither cash flow payouts, nor issues of new securities during the life the bond); (vi) perfect bankruptcy protection (i.e., firms cannot file for bankruptcy except when they are unable to make the required payments); (vii) the Modigliani-Miller theorem holds (i.e., the firm’s value,  $V_t$  is independent of its capital structure; it is equal to the market value of equity,  $E_t$  plus the market value of the noncallable zero-coupon debt contract,  $D_t$ ); and (viii) the short-term risk-free interest rate follows a (stationary) Ornstein-Uhlenbeck process of the form  $dr = \alpha(\gamma - r)dt + \sigma_r dZ_{2,t}$ , where  $\gamma$  is the long-run mean which the short-term interest rate  $r$  is reverting to,  $\alpha > 0$  is the speed at which this convergence occurs,  $\sigma_r$  is the instantaneous variance (volatility) of the

(continued...)

over the current value of the firm, called “quasi”-debt ratio,  $d$ );<sup>12</sup> (ii) firm-value volatility  $\sigma_V$ ; (iii) remaining time to maturity of the bond  $\tau$ ; and (iv) interest rate volatility  $\sigma_r$ ,

$$s_t = f(d, \sigma_V, \tau, \sigma_r),^{13} \quad (1)$$

where  $s_t \equiv y_t - r_t$ , with  $y_t$  being the yield to maturity on the risky zero-coupon bond and  $r_t$  the yield to maturity on the zero-coupon bond of the same maturity.

What is the impact on the corporate credit spread  $s$  of changes in these four determinants? These impacts are complex and highly non-linear. However, Shimko, Tejima, and Van Deventer (1993) show through simulations that the spread  $s$  is a positive function of firm leverage  $d$  and firm-value volatility  $\sigma_V$  (i.e.,  $\partial s / \partial \sigma_V^2 > 0$  and  $\partial s / \partial d > 0$ ), but can be either an increasing or decreasing function of interest rate volatility  $\sigma_r$  (i.e.,  $\partial s / \partial \sigma_r < 0$ ) and remaining time to maturity  $\tau$  (i.e.,  $\partial s / \partial \tau < 0$ ), depending on the size of  $\alpha$  (the speed of convergence of the risk-free rate  $r$  to its long-run mean  $\gamma$ ),  $\rho$  (the correlation between shocks to the firm-value returns and interest rate shocks),  $\tau$ ,  $\sigma_r$ ,  $\sigma_V$ , and  $d$ . The economic intuition of these effects is as follows:

- **Firm leverage** ( $\partial s / \partial d > 0$ ): 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 spread.
- **Firm-value volatility** ( $\partial s / \partial \sigma_V^2 > 0$ ): The higher the day-to-day fluctuations in the value of the firm’s assets ( $\sigma_V$ ), 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 a higher spread.

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interest rate, and  $dZ_{1,t} = \varepsilon_1 \sqrt{dt}$  is a (second) standard Gauss-Wiener process, whose correlation with the stochastic firm value factor,  $dZ_{2,t}$ , is equal to  $\rho$ , i.e.,  $dZ_{1,t} \cdot dZ_{2,t} = \rho dt$ .

<sup>12</sup> “Quasi” because the present value of the bond is calculated by discounting the promised cash-flows of the bond at the *risk-free* (instead of the risk-adjusted) rate.

<sup>13</sup> Strictly speaking, the corporate yield spread  $s_t$  is also function of (i) the correlation  $\rho$  between the stochastic factor  $dZ_1$  of the firm value process  $V$  and the stochastic factor  $dZ_2$  of the interest rate process  $r$ , and (ii)  $\alpha$ , the speed of convergence of the risk-free rate  $r$  to its long-run mean  $\gamma$ . For the present exercise, however, these two parameters are assumed to be constant over the sample period. Based on this assumption, we obtain  $\alpha = 0.70$  and  $\rho = 0$ .  $\alpha$  is obtained by estimating equation (30) in Vasicek (1977), p. 187, applied to our proxy for the short-term interest rate (three-month Bankers’ acceptance rate, see Table 3) during January 1996–May 2003. To estimate  $\rho$ , we calculate the correlations between first differences in the short-term interest rate and firm-value returns for each of the nine firms in the sample;  $\rho$  is significantly negative (-0.42) for IPL1 and significantly positive (0.33) for HAR1 but insignificantly different from zero for the seven other firms; hence, we assume  $\rho = 0$  in our sample.

- **Interest rate volatility** ( $\partial s/\partial \sigma_r \lessgtr 0$ ): The corporate spread can be an increasing or decreasing function of interest rate volatility  $\sigma_r$ , depending on the firm's leverage  $d$ , its asset volatility  $\sigma_v$ , the correlation between asset return shocks and interest rate shocks  $\rho$ , and the term structure of interest rates (represented by the parameters  $\alpha$ ,  $\tau$ , and  $\sigma_r$ ). However, Shimko et al. (1993), p. 59) note that “the credit spread is an increasing function of [interest rate volatility] for reasonable parameter values”. To find out whether this is the case in our data sample, we proceed as follows. First, we estimate the parameter values of  $\alpha$  and  $\rho$  implied by our data.<sup>14</sup> Then, we simulate the impact of changes in  $\sigma_r$  on  $s$  for various combinations of sample values for  $d$ ,  $\sigma_v$ , and  $\tau$  (Table 4). The simulations show that for all combinations of sample values for  $d$ ,  $\sigma_v$ , and  $\tau$ , the corporate spread either stays constant (for small  $d$ ,  $\sigma_v$ , or  $\tau$ ) or increases as interest rate volatility rises (i.e.,  $\partial s/\partial \sigma_r \geq 0$ ). Moreover, the higher leverage  $d$ , the stronger the impact of a change in  $\sigma_r$  on  $s$ . To control for this dependence, we will also include the interaction term  $\sigma_r d$  in the (linearized) estimating equation;<sup>15</sup> we expect its coefficient to be positive.
- **Time to maturity** ( $\partial s/\partial \tau \lessgtr 0$ ): The corporate default spread can also be an increasing or decreasing function of remaining time to maturity  $\tau$ , depending on the same parameters as the impact of changes in interest rate volatility. More precisely, the Shimko, Tejima, and Van Deventer model produces a term structure of credit spreads that is similar to the one obtained in the Merton model, except that now it is not only the result of the dependence on leverage  $d$  but also  $\sigma_v$ : for small values of  $d$  or  $\sigma_v$ , the spread increases when time to maturity  $\tau$  lengthens; for intermediate values of  $d$  or  $\sigma_v$ , the spread first increases sharply, then reaches a maximum, and finally declines gradually as  $\tau$  increases (“hump-shaped”); for high  $d$  or  $\sigma_v$ , 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 but 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 with the same leverage (or asset return volatility) will have to increase earnings and reduce leverage and, hence, the lower its default risk and spread. As before with  $\sigma_r$ , we run simulations to check whether the spectrum of values for  $d$ ,  $\sigma_v$ , and  $\tau$  in our sample produces such a complex term structure of credit spread or whether it is simpler. The simulations show again a strong dependence of  $\partial s/\partial \tau$  on leverage  $d$ : at the mean values of

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<sup>14</sup> We obtain  $\alpha = 0.70$  and  $\rho = 0$ , see footnote 16.

<sup>15</sup>  $\partial s/\partial \sigma_r$  is also a positive function of maturity  $\tau$  and firm-value volatility  $\sigma_v$ , but less pronouncedly over the range of values available in our sample. Thus, we do not include corresponding interaction terms to keep the empirical model as simple as possible and because of potential multicollinearity problems.

$\sigma_v$  (= 23.4 percent) and  $\sigma_r$  (= 1.0 percent), the spread increases with maturity for values of  $d$  between 0.1 and about 0.7; it first increases and then decreases with maturity for  $d$  between about 0.7 and 0.85; and it decreases with maturity for  $d$  above 0.85.<sup>16</sup> To control for this dependence in the simplest possible way, we also include the interaction term  $\tau d$  in the linearized estimating equation, along with maturity  $\tau$ . We expect the coefficient of maturity alone to be positive and the one of the interaction term to be negative.

### 3.2. Integrating Sovereign Risk

The central argument in this paper is that in an emerging market context, sovereign default risk has to be factored into the corporate spread 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 a AAA-rated country (typically the United States), this assumption seems justified. In analyzing emerging bond markets, however, the “zero-sovereign-risk” assumption has to be relaxed. In the international ratings business, the importance of sovereign risk for the pricing of all corporate obligations has given rise to the concept of the sovereign ceiling, the rule that the rating of a corporate debt obligation (in foreign- but also domestic-currency terms) can usually be at most as high as the rating of government obligations.

What is the economic rationale for sovereign risk to be a determinant of corporate default risk *in domestic-currency terms*? Unlike in foreign-currency obligations where the influence of sovereign risk is essentially due to *sovereign intervention (or transfer) risk* and hence relatively straightforward,<sup>17</sup> the impact of sovereign risk in domestic-currency obligations is more indirect. When a sovereign is in distress or default, economic and business conditions are likely to be hostile for most firms: the economy will likely be contracting, the currency depreciating, taxes increasing, public services deteriorating, inflation escalating, and interest rates soaring, and bank deposits may be frozen. In particular, the banking sector is more likely than any other industry to be directly or indirectly affected by a sovereign in payment problems. The banks’ vulnerability is due to their high leverage (compared to other firms), their volatile valuation of assets and liabilities in a crisis, their dependence on depositor confidence, and their typically large direct exposure to the sovereign. As a result, default risk of any firm is likely to be a positive function of sovereign risk. We will call this type of risk *indirect sovereign risk*. An interesting observation in this context is that Elton et al. (2001) find that – even in the United States – corporate spreads incorporate a significant risk premium because a large

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<sup>16</sup> There is also a small positive dependence of  $\partial s/\partial \tau$  on firm-value volatility  $\sigma_v$  over the range of sample values. However, to keep the empirical model tractable, we refrain from including  $\sigma_v \tau$  as an additional interaction term.

<sup>17</sup> See section 2 for a discussion of these concepts.

part of the risk in corporate bonds is systemic rather than diversifiable. One could argue that in emerging markets, a major source of systemic risk is (indirect) sovereign risk.

Let us formalize these considerations in a simple framework. First, recall that the corporate spread  $s_t$  on a firm bond (equation 1) is essentially a compensation that a (risk-neutral) investor requires for the expected loss rate ( $EL$ ) on that investment, whereby  $EL = P(F) \cdot LGD$ , with  $P(F)$  the probability of default of the firm and  $LGD$  the loss-given-default rate (See Cossin and Pirotte (2001), p. 23). Assuming for simplicity that (i)  $LGD$  is equal to one (i.e., when the firm defaults, the entire investment is lost) and (ii) the bond matures one period later (i.e., there is no term-structure of default risk), the expected loss rate becomes equal to the probability of default,  $EL = P(F)$ , and the corporate spread is only function of the company's probability of default,

$$s_t = f[P(F)]. \quad (2)$$

Next, we have a closer look at the firm's probability of default,  $P(F)$ , in the presence of sovereign risk. Using simple probability theory and acknowledging that the firm's default probability is dependent on the sovereign's probability of default, one can show that the following probabilistic statement holds:

$$\begin{aligned} P(F) &= P(F \cap S^c) + P(F \cap S) \\ &= P(S^c) \cdot P(F / S^c) + P(S) \cdot P(F / S) \\ &= P(F / S^c) + P(S)[P(F / S) - P(F / S^c)], \end{aligned} \quad (3)$$

where the different events are defined as follows: (i) event  $F$  : firm  $i$  defaults; (ii) event  $S$  : the sovereign where firm  $i$  is located defaults; (iii) event  $S^c$  (= complement of event  $S$ ): the sovereign does not default.

Inspecting equation (3), we see that the probability of default of the firm,  $P(F)$ , is the result of a combination of three other probabilities:

- (i)  $P(F / S^c)$  is the probability that the firm defaults given that the sovereign does not default. We can interpret this probability as the firm's default probability in "normal" times, as opposed to a "(debt) crisis" period. We call this probability the *stand-alone default probability of the firm*;
- (ii)  $P(S)$  is the default probability of the sovereign (*sovereign risk*);
- (iii)  $P(F / S)$  is the probability that the firm defaults given that the sovereign has defaulted. We can interpret this as the probability that the sovereign "forces" the firm – which would not otherwise default – into default. In other words,  $P(F / S)$  can be interpreted as *sovereign intervention (or transfer) risk* in foreign-currency obligations, or what we have called *indirect sovereign risk* in domestic-currency obligations. To make equation (3) economically meaningful, the restriction  $P(F/S) \geq P(F/S^c)$  is required: the probability that the firm defaults given that the sovereign has defaulted must be at least as

high as the probability that the firm defaults given that the sovereign has not defaulted.<sup>18</sup>

Substituting equation (3) into equation (2) shows that once the zero-sovereign-risk assumption has been relaxed, the corporate credit spread becomes a positive function of sovereign risk:  $\partial s / \partial P(S) = \partial f / \partial P(F) \cdot [P(F/S) - P(F/S^c)] > 0$ . Moreover, higher indirect sovereign risk  $P(F/S)$  increases the impact of a change in sovereign risk on the spread, *ceteris paribus*, while a higher standalone default probability of the firm  $P(F/S^c)$  weakens this impact.

In light of these considerations, we add sovereign risk  $P(S)$  as an additional determinant to our estimating equation (1). We proxy sovereign risk by the sovereign yield spread,  $s_t^{sov} \equiv y_t^{sov} - R_t$ , with  $y_t^{sov}$  the yield to maturity on the (risky) government discount bond and  $R_t$  the yield to maturity on the risk-free discount bond with the same maturity. Thus, the first main question to be investigated is:

**Question 1:** Is sovereign risk a significant determinant of the yield spreads of the firms in our sample, i.e. is  $\beta_i = \partial s_i / \partial s^{sov} > 0$  for each firm  $i$ ?

Next, we define the term “the sovereign ceiling applies”, referring to equation (3):

**Definition 1:** In the context of a firm’s default probability, its credit rating, or its credit spread, the phrase “the sovereign ceiling applies” refers to the case when indirect sovereign risk (or transfer risk in foreign-currency obligations) is 100 percent, that is, when  $P(F/S) = 1$ . When indirect sovereign risk is 100 percent, the firm’s default probability equals

$$P(F) = P(S) + [1 - P(S)] \cdot P(F/S^c),$$

implying that the firm’s (overall) default probability  $P(F)$  will always be *at least as high* as the default probability of its sovereign,  $P(S)$ , independently of how low its stand-alone default probability  $P(F/S^c)$  is. In other words, when indirect sovereign risk (transfer risk) is 100 percent, the sovereign default probability (and, hence, the sovereign spread) acts as a *floor* to the firm’s default probability (and its spread). In terms of credit ratings (where low default probabilities are mapped into high ratings, and high default probabilities into low ratings), this floor translates into a *ceiling*, hence the concept of sovereign ceiling. When indirect sovereign (or transfer) risk is smaller than 100 percent ( $P(F/S) < 1$ ), the firm’s overall default probability (spread) can be lower than the

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<sup>18</sup> In terms of credit ratings (which are nothing other than estimates of default probabilities), the four probabilities  $P(F)$ ,  $P(F/S^c)$ ,  $P(S)$ , and  $P(F/S)$  have direct correspondents. In Moody’s case, for instance, a bank’s “domestic currency issuer rating” would correspond to  $P(F)$ , which itself can be interpreted as the result of the combination of its “bank financial strength rating”,  $P(F/S^c)$ , of the “domestic currency issuer rating” of its sovereign of incorporation (or location),  $P(S)$ , and of the indirect sovereign risk applicable in its case,  $P(F/S)$ .

sovereign's default probability (spread) if its stand-alone default probability is sufficiently small.

To test whether the sovereign ceiling applies in our rand-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 100 percent transfer risk (i.e., the sovereign ceiling applies) implies that a one-percent increase in the government spread should be associated with an increase in the firm spread of at least one percent.<sup>19</sup> In other words, in a regression of corporate spread changes on corresponding sovereign spread changes, 100 percent indirect sovereign risk implies that the beta-coefficient 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 indirect sovereign risk: a coefficient that is larger than one would imply that the market factors in an indirect sovereign risk of 100 percent; a coefficient statistically smaller than one would imply that the market judges indirect sovereign risk to be less than 100 percent. It will be interesting to compare our own estimates for *domestic-currency-denominated* (i.e., rand) corporate bond spreads with the results obtained Durbin and Ng (1999) for *foreign-currency-denominated* corporate bond spreads. They found, among other things, that the coefficient was significantly smaller than one for the low-risk country group of which South Africa was a part (together with Czech Republic, Korea, Mexico, and Thailand). Thus, the second main question to be investigated is:

**Question 2:** Does the sovereign ceiling apply in the credit spreads of our firms, i.e., is  $\beta_i = \partial s_i / \partial s^{sov} \geq 1$  for each firm  $i$ ?

### 3.3. Other Potential Determinants

Once the assumption of frictionless markets is relaxed and/or particular bond indenture provisions are allowed, other determinants of the corporate spread have to be taken into account. These include differential taxation of corporate and risk-free bonds, differences in liquidity of corporate and risk-free bonds, business cycle (macroeconomic) conditions, temporary demand for and supply of bonds imbalances, and specific bond indenture provisions, such as call options embedded in corporate bonds or the presence of a sinking fund provision.<sup>20</sup>

Among all these factors, only potential differences in liquidity are controlled for explicitly in the present investigation. Liquidity refers to the ease with which a bond

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<sup>19</sup> Additional assumptions to obtain this result are: (i) the firm's idiosyncratic default risk is not negatively correlated with the government's default risk (Durbin and Ng, 2001, p. 12); (ii) the recovery rate on the sovereign bond is greater than or equal to the recovery rate on the corporate bond (Durbin and Ng, 1999, p. 13).

<sup>20</sup> These factors are dealt with in the literature on corporate default risk in mature markets, in particular the U.S. corporate bond market. See footnote 14.

(issue) can be sold without a significant price discount. One might expect the risk-free bond issues to be larger 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. Thus, we expect  $\partial s / \partial l$  to be negative.

With the exception of short-run demand and supply imbalance, which have to be omitted for lack of appropriate data, all other factors are implicitly controlled for: taxation of bond returns (i.e., interest payments and capital gains) is the same for all types of bonds in South Africa (unlike in the United States); macroeconomic conditions will be controlled for insofar as they are reflected in sovereign spreads; embedded call options are controlled for by working with yields-to-next-call (instead of yield-to-maturity) for the one bond<sup>21</sup> that contains such a call option, the eight other corporate bonds do not contain any such features; and sinking fund provisions are absent in all nine corporate bonds we analyze.

### 3.4. Synthesis

According to the theoretical framework laid out in this section, the corporate credit spread 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,

$$s = f(s_r^{sov}, d, \sigma_v, \sigma_r, \tau, l). \quad (4)$$

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 spread according to the theory.

In section 5, we estimate a linearized version of equation (4). Motivated by the results of the Shimko, Tejima, and Van Deventer model, we will also consider two interaction terms: one between interest rate volatility and leverage ( $\sigma_r d$ ), and the other between maturity and leverage ( $\tau d$ ). These will help us to unambiguously determine the expected signs of the coefficients involving  $\sigma_r$  and  $\tau$ : we expect the coefficient of  $\sigma_r d$  to be positive, as the impact of interest rate volatility on spreads appears to be increasing with leverage; the coefficient of  $\sigma_r$  alone could be positive or insignificant because the spread (and hence the influence of any determinant) vanishes as leverage tends toward zero. The coefficient of  $\tau d$ , on the other hand, is expected to be negative, along with a positive coefficient for maturity  $\tau$  alone because the spread increases with maturity when leverage is small, whereas it declines with maturity when leverage is high.

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<sup>21</sup> NED1, see section 4.1.

#### 4. OPERATIONALIZATION OF VARIABLES AND DATA

This section first discusses how the corporate spread is calculated and how the firm bonds to be studied are selected. It then presents a summary of how the explanatory variables (sovereign risk and other determinants identified in section 3) are operationalized. The data sources as well as the sample characteristics are also briefly summarized.

##### 4.1. Dependent Variable: How Is the Corporate Credit Spread Measured?

Before the corporate spread can be calculated, appropriate corporate and risk-free securities need to be identified. This task is complicated by the absence of corporate zero-coupon bonds and the fact that bonds issued by the South African government cannot be considered risk-free.

We circumvent the absence of corporate zero-coupon bonds by using coupon-paying bonds to calculate spreads. According to the Merton-Shimko framework, we should calculate the spread as the difference between the yield to maturity on a zero-coupon corporate bond (called corporate spot rate) and the yield to maturity on a zero-coupon risk-free bond of the same maturity (risk-free spot rate).<sup>22</sup> However, we find that there are no zero-coupon bonds available for South African firms. An attempt to circumvent the nonexistence of firm discount bonds by estimating the spot rates—for instance, by the procedure suggested by Nelson and Siegel (1987)—fails owing to the lack of a sufficient number of outstanding bonds per firm.<sup>23</sup> Given the impossibility of estimating spot rates, the next best alternative would be to work with spreads calculated as the difference between the yield to maturity of the coupon-paying firm bond and the yield to maturity of the risk-free bond with the *same coupon* and the *same maturity*. The problem is that such corresponding risk-free bonds generally do not exist because the corporate credit spread is also reflected in the size of the coupon so that the risk-free coupon bond with a similar maturity tends to have a lower coupon. Again, estimating yields to maturity of equivalent risk-free coupon bonds is rendered impossible by the absence of appropriate risk-free zero-coupon bonds.<sup>24</sup> Therefore, our second best (or third

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<sup>22</sup> This way of calculating the spread, 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 bond, is also stressed by Elton et al. (2001), pp. 251–52. They give three reasons for this argument: (i) arbitrage arguments hold with spot rates, not with yield to maturity on coupon bonds; (ii) yield to maturity depends on coupon; so if yield to maturity is used to define the spread, the spread will depend on the amount of the coupon; and (iii) calculating the spread as the difference in yield to maturity on coupon-paying bonds with the same maturity means that one is comparing bonds with different duration and convexity.

<sup>23</sup> Most South African companies have only one or two bonds outstanding.

<sup>24</sup> Athanassakos and Carayannopoulos (2001) suggest a procedure to construct the equivalent risk-free bonds using the coupon strips of U.S. treasury bonds (the risk-free bonds in their study). The problem with this procedure is that while our corporate bonds are of rather medium-term maturity, the risk-free zero-coupon bonds available to us (see next section) are only of very long maturities (2017 to 2029), so that it would be impossible to estimate the shorter end of the yield curves with any degree of accuracy.

best, actually) strategy to compute the corporate yield spreads is to take the yield to maturity of a given corporate bond and to subtract the yield to maturity of a risk-free bond that has a maturity and coupon amount as close as possible to that of the corporate bond. As a result, the spreads we calculate will fail to completely isolate the "pure" corporate credit spread. That is, due to slightly different maturities and coupon sizes, they will also include some term structure effects, as is the case in most other empirical investigations of credit spreads (see Durbin and Ng (1999); Kamin and Von Kleist (1999); Eichengreen and Mody (1998); or Edwards (1986)).

The second issue – that South African government bonds cannot be considered risk-free<sup>25</sup> – is dealt with by taking rand-denominated bonds issued by supranational organizations as our risk-free benchmark instruments. As we are interested in isolating the "pure" credit spreads, the risk-free bonds should be denominated in the same currency and should be issued in the same jurisdiction as the corporate bonds. This poses a problem because no South African companies issue bonds abroad in U.S. dollars, nor do riskless borrowers issue ZAR- (i.e., rand-) denominated bonds onshore (i.e., in Johannesburg). However, triple-A-rated supranational organizations like the European Investment Bank (EIB), the International Bank for Reconstruction and Development (IBRD, usually known as the World Bank), and the European Bank for Reconstruction and Development (EBRD) are issuing ZAR-denominated bonds in offshore markets. In the absence of more appropriate alternatives, we will calculate the corporate spreads using the ZAR-denominated corporate bonds traded on the Bond Exchange of South Africa and these ZAR-denominated "supranational" bonds traded in offshore markets as our risk-free benchmarks. As a result, the calculated spreads will include a jurisdiction premium. However, the presence of this jurisdiction premium in our measure of spreads should not bias the results because the jurisdiction premium very likely remained constant over the sample period (July 2000–May 2003) as there were no significant changes in the legal environment or the capital controls regime.

Once these two issues are clarified, we start collecting end-month yield to maturity data for corporate and supranational bonds from Thomson Financial Datastream (DS) and BESA. We have to resort to both sources because DS contains no data for ZAR-denominated South African corporate bonds prior to August 28, 2000, while BESA contains no data on the supranational bonds that we have selected as risk-free benchmarks. Thus, for the period starting on August 28, 2000, we gather the yields for all South African firm bonds from DS. For the period preceding this date, we take the yields

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<sup>25</sup> At the end of our sample period (May 2003), the Republic of South Africa's foreign currency debt was rated BBB by Standard & Poor's (S&P) and Baa2 by Moody's (i.e., the same rating); local currency debt was rated A by S&P and A2 by Moody's. See Table 2 in Appendix III for the history of South Africa's ratings by the two rating agencies.

for these bonds from the BESA database.<sup>26</sup> For the risk-free supranational bonds, all yield data is from DS.<sup>27</sup>

Next, we clear from our database potential anomalies or data that might bias the results of our econometric estimation. First, we drop all public companies (known as parastatals) from the sample because they are regarded as belonging to the same risk class as the sovereign, the Republic of South Africa (RSA). Second, for some firms we eliminate outlier data due to inconsistent price or yield to maturity quotes at certain points in time. Third, we only take the bonds of those firms whose shares are listed on the Johannesburg Stock Exchange (JSE) because our empirical investigation requires stock price data. Fourth, we eliminate all floating rate bonds as they are priced differently. And fifth, we work with only one bond per firm to facilitate the empirical analysis and interpretation of the results.<sup>28</sup> If a firm has more than one bond outstanding, we select the more liquid one;<sup>29</sup> if several bonds display similar liquidity, we chose the one with the longer time series available.

After this elimination procedure, we end up with nine corporate bonds issued by five banking and four industrial firms. The nine firms, their bonds, the bonds' main features, the corresponding risk-free benchmark bonds (i.e., supranational bonds), and the RSA bonds that will be used to calculate the comparable sovereign spreads (see section 4.2) are summarized in Table 1. For instance, "HARMONY GOLD 2001 13 percent 14/06/06 HAR1" means that Harmony Gold issued a bond in 2001 (code: HAR1) that pays a 13 percent coupon and matures on June 14, 2006. Seven of the nine bonds have a fixed coupon rate and a fixed maturity date. The remaining two—NED1 and SBK1—have a fixed coupon rate until the date of exercise of the (first) call option. For these two bonds, the BESA database reports "yields to next call" instead of "yields to maturity," which we use for our analysis. Because of anomalous price behavior of some bonds after the penultimate coupon payment, we only use yield data series up to the date of the penultimate coupon payment for both corporate and risk-free bonds. Hence, the maximum data range of corporate and corresponding risk-free yield series extends from May 20, 1998 (starting date of the risk-free benchmark corresponding to IS59, i.e., EIB 1998 12 ¼ percent May 20, 2003) to June 4, 2003 (availability of BESA data). The last column of Table 1 specifies the data range for each firm bond.

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<sup>26</sup> Data have been purchased from BESA. At BESA, bonds are quoted and traded in yield. Bond Exchange of South Africa (2003) describes how daily bond yields are determined. Bond Exchange of South Africa (1997) lays out how yields are converted into prices.

<sup>27</sup> Since DS contains annualized yields compounded *annually* while BESA lists annualized yields compounded *semi-annually*, the latter are converted to an annual-compounding basis by applying the formula  $y_a = 100[(1+y_s/200)^2-1]$ , where  $y_s$  stands for "annualized yield (in percent) compounded semi-annually" while  $y_a$  stands for "annualized yield (in percent) compounded annually."

<sup>28</sup> An alternative would be to restrict the coefficient of each explanatory variable to be the same across different bonds of one firm in the subsequent regression analysis. However, such restrictions would unduly complicate the analysis.

<sup>29</sup> Liquidity is measured by the trading volume.

Finally, using EViews programming notation, the corporate credit spread,  $SCOR$ , is calculated as

$$s_t \equiv SCOR? = y? - rf?,$$

where  $y$  is the yield to maturity (or redemption yield) of the corporate bond;  $rf$  is the yield to maturity of the risk-free benchmark bond that corresponds as closely as possible to the corporate bond in terms of maturity and coupon (“the corresponding risk-free benchmark”); and “?” stands for each of the nine corporate bonds. We assign an identifier code to each of these bonds with the purpose of naming not only the dependent variable but also the explanatory variables associated with firm characteristics (see next section). These codes correspond to the BESA acronyms and are marked in bold in the third column in Table 1. They are: AB01, ABL1, HAR1, IPL1, IS59, IV01, NED1, SFL1, and SBK1. Figure 2 shows the resulting corporate spreads at monthly frequency and over the sample period actually used in this study (July 2000–May 2003).

## 4.2. Explanatory Variables

### *The Sovereign Credit Spread*

To assess the impact of sovereign default risk on corporate default risk, it is important that, for each corporate bond considered, the calculated sovereign credit spread corresponds exactly to the corporate credit spreads in terms of maturity and other bond-specific features. In particular, we should also use spot rates with the same maturity. However, since we had to use yields to maturity of coupon bonds for the calculation of the corporate spreads, we also use coupon bonds to calculate the corresponding sovereign spreads. For each corporate bond, we search for a coupon bond issued by the RSA that has maturity and coupon amount as close as possible to that of the corporate bond (and, hence, also to the risk-free bond selected in the previous section). The penultimate column in Table 1 lists the corresponding sovereign bonds selected.

Like for corporate bond yield data, we gather the yields to maturity of the corresponding sovereign bonds from the BESA database for the period up to July 2000, and from DS for the period thereafter. The corresponding sovereign spread,  $SSOV$ , is calculated as

$$s_t^{sov} \equiv SSOV? = sov? - rf?,$$

where  $sov$  is the yield to maturity of the sovereign bond corresponding to each of the nine corporate bonds represented by “?”, and  $rf$  is the same yield to maturity of the corresponding risk-free benchmark bond as identified in section 4.1. Note that for sovereign countries holding a AAA rating,  $SSOV$  would be zero because the sovereign bond is itself the risk-free benchmark asset, as implicitly assumed by Merton (1974) and later structural models.

A caveat: as is shown in Figure 3, sovereign spreads are sometimes zero or negative, i.e., the risk-free (supranational) bond yields are higher than or equal to RSA bond yields for a comparable maturity. At least two important reasons could account for the relatively high yields of the supranational bonds: (i) for the latter, liquidity tends to

dry up as they age; (ii) domestic investors are unable to buy Eurobonds (lack of full financial integration of ZAR-denominated bond markets).

### ***Other Determinants***

The empirical counterparts of the five theoretical determinants (and the two interaction terms) derived and discussed in section 3 are:

- (i) Quasi-debt-to-firm-value (or leverage) ratio ( $d_t$ ):  $D1?$ ,  $D2?$ , or  $D3?$
- (ii) Volatility of returns on the firm's value ( $\sigma_v$ ):  $SV1000D?$ ,  $SV12M?$ , or  $SV24M?$
- (iii) Volatility of risk-free interest rate ( $\sigma_r$ ):  $SIGSPOTM?$  or  $SIGRFM?$
- (iv) Time to maturity ( $\tau$ ):  $M?$
- (v) Liquidity, proxied by the trading volume ( $l$ ):  $TOVC?$
- (vi) Interaction between maturity and leverage ( $\tau \cdot d_t$ ); and
- (vii) Interaction between interest rate volatility and leverage ( $\sigma_r \cdot d_t$ );

Table 3 sums up the operationalization, measurement, and subcomponents of these firm- or bond-specific determinants.<sup>30</sup>

### **4.3. Sample and Data**

Our “sample” consists of an unbalanced panel of monthly data for nine corporate bonds ( $N = 9$ ) listed and traded on the BESA during the period July 2000 to May 2003. “Sample” because the four industrial and five financial corporate issuers of these bonds essentially constitute the population of South African firms with bonds outstanding. The beginning of the sample (July 2000) is constrained by the availability of BESA data on our liquidity proxy (trading volume,  $TOVC$ ). Observations are always as of end-month. The time-series dimension,  $T$ , of the panel varies between 21 and 35 months, i.e.,  $21 \leq T \leq 35$ . Data are from the Bond Exchange of South Africa (BESA), Datastream, and Bloomberg. Table 4 reports the descriptive statistics of the major variables used in this study.

## **5. EMPIRICAL METHODOLOGY AND RESULTS**

In this section, we first run a battery of tests to determine an appropriate empirical specification of equation (4) and we make some robustness tests. Then the main estimation results are discussed. The focus of our attention is on whether the sovereign spread is a significant determinant of corporate spreads (Question 1, see section 3.2), and if so, whether the associated coefficient is larger or smaller than one (Question 2, see section 3.2). A coefficient smaller than one would imply that the sovereign ceiling does not apply for the firm concerned; an estimated coefficient larger than or equal to one would mean that the sovereign ceiling applies for that firm.

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<sup>30</sup> A methodological note discussing in detail the operationalization and measurement of these determinants can be obtained from the authors upon request.

### 5.1. The Econometric Model: Fixed Effects with Different Slopes for Sovereign Risk

The linearized version of equation (4) that we estimate takes the form of a fixed effects (FE) model:

$$SCOR_{it} = \alpha_i + \beta_i SSOV_{it} + \sum_{j=1}^k \gamma_j X_{j,it} + \varepsilon_{it} \quad i = 1, 2, \dots, N; t = 1, 2, \dots, T, \quad (5)$$

where  $SCOR_{it}$  is the corporate spread of firm bond  $i$  at end-month  $t$ , as defined in section 4.1;  $SSOV_{it}$  is the sovereign spread which best matches  $SCOR_{it}$  in terms of maturity and coupon amount (see section 4.2);  $X_{1,it}, \dots, X_{k,it}$  is the set of  $k = 7$  control variables (including their interaction terms) defined in section 4.2;  $\alpha_i$  denotes the (unobservable) firm-specific effect, assumed time-invariant in the present context (“fixed effect”);  $\beta_i$  and  $\gamma_1, \gamma_2, \dots, \gamma_7$  are the coefficients to be estimated; and  $\varepsilon_{it}$  is a normally distributed error term with zero mean,  $E(\varepsilon_{it}) = 0$ .

The specification of equation (5) is the outcome of a series of tests of progressively less restrictive pool specifications. Ideally, we would want to estimate the coefficients  $\alpha_i$  and  $\beta_i$  as well as separate  $\gamma_j$  coefficients (i.e.,  $\gamma_{1,i}, \gamma_{2,i}, \dots, \gamma_{7,i}$  for  $i = 1, \dots, N$ ) in individual time-series regression for each of the  $N = 9$  firms. However, with  $21 \leq T \leq 35$  observations per firm, it would be difficult to obtain efficient and unbiased estimates for the nine firm-specific coefficients for each of the nine firms (i.e., 81 coefficients). To reduce collinearity problems and increase the degrees of freedom and the efficiency of estimation, we wish to pool the time series of our nine firm bonds together. However, pooling data amounts to imposing restrictions on the parameters. In a fully pooled model, for instance, we assume that the parameters  $\alpha_i$ ,  $\beta_i$ , and  $\gamma_{1,i}, \gamma_{2,i}, \dots, \gamma_{7,i}$  are the same across all nine firms, i.e., that  $\alpha_i = \alpha$ ,  $\beta_i = \beta$ , and  $\gamma_{j,i} = \gamma_j$  for all  $i = 1, \dots, N$  firms and  $j = 1, \dots, k$  control variables. The specification of equation (5) is the least restrictive possible (it allows for different intercepts  $\alpha_i$  and different slope coefficients  $\beta_i$  for our main variable of interest,  $SSOV$ , across all nine firms) and the result of a series of pooling tests (see Hsiao (1986), pp. 12–18), and Baltagi (1995), pp. 50–54). Robustness tests with the different measures for leverage ( $D2$  and  $D3$  instead of  $D1$ ), firm-value volatility ( $SV12M$  and  $SV24M$  instead of  $SV1000D$ ), and interest rate volatility ( $SIGMARF$  instead of  $SIGSPOTM$ ) led to the same conclusion.

For the sake of completeness, columns (1) to (4) of Table 5 give the estimation results of the four progressively less restrictive specifications tested: (1) separate OLS regressions for all nine firms (slope-coefficients for  $SSOV$  only); (2) pooled OLS; (3) fixed effects (FE); and (4) FE with different slopes for sovereign risk (equation 5) before any corrections. In column (1), most of the firm-specific  $SSOV$ -coefficients are significant and all of them are smaller than one, implying that the sovereign ceiling does not apply for any of the nine firms. Most of the other determinants (not reported) however are not significant while the  $R^2$  are all very high—a typical indication of

multicollinearity. In the pooled OLS regression (column 2), on the other hand, the (unique) *SSOV*-parameter is significantly larger than one, implying that the sovereign ceiling applies for the average South African firm, while it is significantly smaller than one in the FE regression (column 3), implying that that sovereign ceiling does not apply for the average South African firm. In the FE model with different slopes for *SSOV* (column 4), finally, the firm-specific coefficients are larger than one for four firms (ABSA Bank, African Bank, SASOL, and Standard Bank) and smaller for the five others (Harmony Gold, Imperial Group, ISCOR, Investec Bank, and Nedcor Bank). In all three pooled regressions, however, the very low Durbin-Watson statistic indicates serious misspecification (autocorrelation).

Heteroscedasticity, autocorrelation, and contemporaneous correlation tests indicate that a feasible least squares (FGLS) estimator correcting for heteroscedasticity and second-order autocorrelation would be appropriate to estimate equation 5.<sup>31</sup> Column 6 in Table 5 reports the results (column 5 shows FGLS results correcting only for heteroscedasticity but not autocorrelation). This choice is robust to the inclusion into the regressions of our alternative measures for leverage (*D2* and *D3* instead of *D1*), firm-value volatility (*SV12M* and *SV24M* instead of *SV1000D*), and interest rate volatility (*SIGMARF* instead of *SIGSPOTM*). We work with leverage *D1*, firm-value volatility *SV1000D*, and interest rate risk *SIGSPOTM* as our controls because we obtain the most significant results with them.

## 5.2. Robustness Tests

We also make a series of robustness tests. First, we estimate a first difference equation to make our results comparable to those of Durbin and Ng (1999).<sup>32</sup> Taking first differences of equation (5), we obtain

$$\Delta SCOR_{it} = \beta_i \Delta SSOV_{it} + \sum_{j=1}^k \gamma_j \Delta X_{j,it} + u_{it} \quad i = 1, 2, \dots, N; t = 1, 2, \dots, T, \quad (6)$$

where  $\Delta$  is the first-difference operator,  $u_{it} = \varepsilon_{it} - \varepsilon_{it-1}$ , and all other components are as defined in equation (5). Note that the individual (or fixed) effects  $\alpha_{it}$  in equation (6) are eliminated by taking first-differences. As a result, estimation of equation (6) will be a regression through the origin (i.e., without intercept). Also note that we will have to expect (negative) autocorrelation in the error term. Going through the same testing procedure as for the level equation, we find that an FGLS estimator correcting for heteroscedasticity and first-order autocorrelation should be used. Column 7 in Table 5

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<sup>31</sup> To test for heteroscedasticity, we use the Lagrange multiplier (*LM*) test and the approximate likelihood ratio (*LR*) test (Greene (1993), pp. 328-9). Autocorrelation is tested by means of the *LM* test for first-order serial correlation in a fixed effects model, suggested by Baltagi (1995); then, we also apply the Breusch-Godfrey (*BG*) *LM* test (Greene, 2003, p. 269) to test for the presence of higher-order autocorrelation. To test for contemporaneous cross-section correlation, we apply the Breusch-Pagan *LM* test (Greene, 2003, p. 327).

<sup>32</sup> Their estimating equation does not include any other corporate spread determinants however.

reports the estimates. An essential first observation is that size and significance of the estimated coefficients are very similar to the estimates of the level equation (6).

Second, starting from the first-difference equation we also control for global shocks, for potential endogeneity (simultaneity) of *SSOV*, and we allow for asymmetric effects of changes in *SSOV*. We control for global shocks, such as a change in global risk appetite for emerging market assets or changes in global liquidity, by including changes in the State Street Investor Confidence Index and in U.S. interest rates (3-month U.S. T-bill rate and 10-year US T-bond yield) in the regression. We address the potential simultaneity bias by estimating equation (6) with Two-Stage Least Squares, instrumenting sovereign risk (*SSOV*) with Moody's local currency sovereign credit rating, manufacturing growth, the gap between actual inflation and the inflation target<sup>33</sup>, the above mentioned investor confidence index, and U.S. interest rates. Finally, we allow increases in *SSOV* to have a different impact on corporate credit spreads (*SCOR*) than decreases in *SSOV*.

These robustness tests show that all of our results discussed below remain qualitatively and quantitatively similar. Thus, the details of the regressions are not included in the paper but can be obtained from the authors upon request. As regards the potentially asymmetric impact of changes in *SSOV* on *SCOR*, it might be interesting to note, however, that we find an asymmetric impact for two of the nine bonds: For African Bank (ABL1) and Imperial Group (IPL1), the impact of an increase in *SSOV* is significantly larger than the impact of the decline in *SSOV*. For the other seven bonds, increases in *SSOV* have statistically the same impact on *SCOR* as decreases.

### 5.3. Discussion of Results

Table 5 summarizes the estimation results from the different specifications and estimators discussed in the previous two sections. Column 6 contains the final estimates of the level-equation (6), after correction for heteroscedasticity and serial correlation. To give an idea of the robustness of these estimates, column 7 also reports the estimated coefficients from the first-difference-equation (6).

Overall, we observe that the coefficients of most of the theoretical determinants (sovereign risk, firm-value volatility, leverage,<sup>34</sup> and interest rate volatility<sup>35</sup>) have the expected sign and are statistically significant at conventional levels. This result is in contrast with the mostly insignificant coefficients in the study by Durbin and Ng (1999). Only one control variable is clearly not significant: the monthly bond trading volume

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<sup>33</sup> An increasing "inflation gap" could reduce sovereign default risk on *local* currency debt, while a declining (or even negative) inflation gap could increase sovereign default risk on local currency debt, *ceteris paribus*.

<sup>34</sup> In the level equation only.

<sup>35</sup> Particularly in interaction with leverage, but less so on its own.

(*TOVC*), our proxy for a bond's liquidity. The fit of the model is surprisingly good: in the level equation, the adjusted R-squared is 96 percent, that is, 96 percent of the variation in corporate spreads is accounted for by the variation in the explanatory variables (and fixed effects), while the standard error of the model is 0.001, that is, 10 basis points. In the first-difference equation, the adjusted R-squared is 75 percent with a similar standard error of 10 basis points.

Is **sovereign risk (SSOV)** a significant determinant of the credit spreads of the firms in our sample (Question 1)? Sovereign risk turns out to be a highly significant determinant of corporate spreads in most cases. In the level regression, the sovereign risk coefficient of only one firm –Harmony Gold (HAR1) – is marginally not significant at the five-percent level (although it is significant at the 10 percent level). In the first-difference equation, it is only the *SSOV*-coefficient of African Bank (ABL1) that is marginally not significant at the 5 percent level (but also significant at the 10 percent level). The size of these coefficients varies between 0.42 for Nedcor Bank (NED1) and 0.96 for ABSA Bank (AB01), implying that a 100 basis-point increase in the sovereign spread is associated with an increase in corporate spreads of between 42 and 96 basis points.

Does the **sovereign ceiling** apply in the credit spreads of our firms (Question 2)? According to the analytical framework of section 3.2, the finding that there is a less than one-to-one correspondence between sovereign and corporate spreads for all firms (i.e.,  $\partial s_t / \partial s_t^{sov} < 1$ ) would be taken as evidence that the sovereign ceiling does not apply for these firms.<sup>36</sup> But are the estimated *SSOV*-coefficients statistically different from one? We address this question formally by means of Wald tests.<sup>37</sup>

According to these Wald tests (Table 6), there is evidence that the sovereign ceiling does not apply for the three large industrial companies. For Imperial Group (IPL1, a large, diversified, multinational firm) and ISCOR (IS59, the largest steel producer on the African continent), the null hypothesis that  $\beta_i = 1$  is rejected at the one-percent level in both the level and first-difference regressions. With *SSOV*-coefficients of 0.61 and 0.42, respectively, there is clear evidence that the sovereign ceiling in spreads does not apply. For SASOL (SFL1), a large chemicals and fuels multinational, there is also some evidence, with a *SSOV*-coefficient (0.83) significantly smaller than one at the nine-percent level in the level equation and at the five-percent level in the first-difference equation. In terms of equations (3), the fact that the bond spreads of these companies are

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<sup>36</sup> Definition 1 in section 3.2 defines the concept of the sovereign ceiling.

<sup>37</sup> An equivalent test would involve testing the null of  $\beta_i - 1 = 0$  in a regression where the dependent variable is the spread of the firm bond yield over the sovereign bond yield (i.e., the corporate-over-sovereign premium  $y_{it} - sov_{it}$ ), while all RHS variables would be as in equation (5). Formally, the equation to be estimated would be  $(y_{it} - sov_{it}) = \alpha_i + (\beta_i - 1)SSOV_{it} + \sum_{j=1}^k \gamma_j X_{j,it} + \varepsilon_{it}$ . If the sovereign ceiling in terms of spreads does not apply, we would expect  $\beta_i - 1 < 0$ . A disadvantage of using the transformed equation is that the theory laid out in section 3 does not tell us much about the determinants of the corporate-over-sovereign premium.

generally higher than comparable sovereign spreads (Figure 1) can therefore not be due to 100 percent indirect sovereign risk  $P(F/S)$  (i.e., the application of the sovereign ceiling) but must be due to relatively high stand-alone default risk  $P(F/S^c)$ . Higher firm stand-alone risk, in turn, is accounted for by expected default loss variables.

This is good news for these three companies: some day in the future when financial markets judge them to be sufficiently strong (i.e., when their stand-alone default probability  $P(F/S^c)$  is sufficiently low), their overall default probability  $P(F)$  could fall below sovereign default risk  $P(S)$ . As a result, they might obtain (local currency) credit ratings that are lower than those of the South African government (i.e., they might “pierce the sovereign ceiling”) and thus raise debt finance at lower cost than their government.

For the banks in the sample, the sovereign ceiling in spreads seems to apply in general. The sovereign risk coefficients of ABSA Bank (AB01; 0.96 and 0.98 in the level and first-difference equations, respectively) and African Bank (ABL1; 0.92 and 0.93, respectively) are statistically not different from one. The *SSOV*-coefficients of Standard Bank (SBK1; 0.89 and 0.92) and Investec Bank (IV01; 0.78 and 0.88) are also not significantly different from one in the first-difference equation. In the level equation, however, SBK1’s coefficient is marginally smaller than one (at the 8 percent level) and IV01’s significantly so (at the two-percent level). The sovereign risk coefficient of Nedcor Bank (NED1) is a surprising anomaly that would merit further investigation: at about 0.40 in both equations, it is the smallest *SSOV*-coefficient in the sample.<sup>38</sup> In terms of the model in section 3.2, *SSOV*-coefficients equal to one mean that bond markets judge indirect sovereign risk for these banks to be 100 percent (i.e.,  $P(F/S) = 1$ ), which implies that the default probabilities  $P(F)$  of these firms and, hence, spreads will be at least as high as those of the government (equation 3). Thus, the fact that these banks’ spreads are generally higher than the comparable sovereign spreads (Figure 1), is due to the application of the sovereign ceiling rather than to higher stand-alone default risk  $P(F/S^c)$ . In other words, even if the stand-alone default probabilities  $P(F/S^c)$  of these banks were much lower than the government’s default probability  $P(S)$ , their overall default probabilities  $P(F)$  and spreads would still be higher than those of their government because of the application of the sovereign ceiling. The finding that bond markets seem to price into spreads of banks a kind of sovereign ceiling is consistent with rating agency practice of generally not rating financial institutions higher than their sovereign.

The determinants derived from the contingent-claims approach are also found to significantly affect corporate spreads.<sup>39</sup>

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<sup>38</sup> This result might be due to an incomplete or wrong specification of the bond’s indenture characteristics in Datastream and/or the BESA database.

<sup>39</sup> The discussion focuses on the results from the level equation.

- **Firm-value volatility (*SV1000D*).** An increase in the volatility (standard deviation) of returns on the firm's assets by 10 percentage points will increase corporate spreads by 48 basis points.
- **Firm leverage, as measured by the quasi-debt-to-firm-value ratio (*DI*).** The effect of a change in leverage on corporate spreads is reinforced by interest rate volatility, as expected; but it does not seem to depend on remaining time to maturity. This means that the higher interest rate risk is, the stronger the impact of a change in leverage on spreads. Quantitatively, if interest volatility were zero, an increase in a firm's leverage ratio by 0.5—for instance, from 0.3 to 0.8—would increase its spread by approximately 95 basis points; if interest rate risk is at its sample mean instead (1.01 percent per annum, see Table 4), the same 0.5 increase in the quasi-debt ratio would raise spreads by about 114 basis points.
- **Interest rate volatility (*SIGSPOTM*).** The volatility of the risk-free interest rate is a highly significant determinant of spreads in interaction with leverage, as expected; on its own, however, it is only marginally significant (at the seven percent level) and has the wrong sign. Considering the influence of interest rate volatility on its own as insignificant, we obtain the result implied by theory, namely that the impact of a change in this volatility on spreads depends positively on leverage and vanishes if leverage tends towards zero. Quantitatively, an increase in interest rate volatility by one-percentage point will increase the credit spread of our firms by about 19 basis points if their leverage stands at the sample mean (0.51); if leverage stood at the sample minimum (0.08), a one percentage point increase in interest volatility would increase corporate spreads by only three basis points. If we considered the estimated parameter of interest rate volatility in isolation as significant instead, the overall effect on spreads would still be positive for all leverage levels above 0.41. Under this assumption, a change in volatility by one percentage point would increase spreads still by about four basis points if leverage were at the sample mean.
- **Time to maturity (*M*).** Remaining time to maturity is also a statistically significant determinant of corporate credit spreads, but seems to have the wrong (negative) sign. In addition, the interaction term with leverage is not significant. Quantitatively, an increase in remaining time to maturity by one year decreases corporate credit spreads by about 30 basis points. This result is less counterintuitive than it might appear at first: It suggests that during our sample period (July 2000–May 2003), the term structure of credit spreads of our nine firms has been downward sloping on average, independently of their leverage.<sup>40</sup> According to the theoretical model, the credit spread term structure of a firm is downward sloping if the firm's leverage and/or its asset return volatility are relatively high. On the one hand, it is very well possible that the average term structure of credit risk of our nine firms has been downward sloping during July 2000–May 2003. On the other hand, this outcome might be spurious and due

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<sup>40</sup> A similar result has been found by Min et al. (2003) for 11 emerging market sovereign bonds (Argentina, Brazil, China, Columbia, Indonesia, Korea, Malaysia, Mexico, the Philippines, and Venezuela) and by Fons (1994) for low-rated corporate bonds in the U.S.

to pooling the data of the nine firms. In other words, if we had had sufficient data to run separate regressions for the nine firms, it is possible that the firms with relatively low leverage and asset volatility would have shown an upward-sloping term structure, whereas only those with relatively high leverage and asset volatility would have displayed a downward-sloping credit risk term structure.

Our **proxy for a corporate bond's liquidity (*TOVC*)**, the ZAR amount traded during the month, is not significant.<sup>41</sup> This result suggests that *TOVC* is not a good proxy for liquidity. One potential reason is that *TOVC* does not measure the liquidity relative to the risk-free bonds. We would ideally want to use the ratio of corporate bond turnover over risk-free bond turnover; but turnover data for the risk-free benchmark bonds were not available. Another reason could be that we are faced with a timing problem: the dependent variable—the corporate spread—is observed on the *last day* of the month, whereas *TOVC* is the total amount traded *during* the month; that is, the latter might not be a good proxy for liquidity on the last day of the month.

Finally, how important is sovereign risk compared to the "standard" corporate spread determinants? A variance decomposition of the corporate credit spreads confirms earlier findings that aggregate (systemic) factors appear to be much more important than all other factors in determining these spreads (Table 7). Using the estimated parameters of the level and first-difference equations (Columns 6 and 7 in Table 5), we decompose the levels and changes of the corporate spreads into the four components (i) sovereign risk (the systemic factor), (ii) fixed effects (only for corporate spread levels), (iii) all other determinants, and (iv) the residuals. The data show that in both the level and the first-difference equations, the variation in sovereign risk (a systemic factor) explains about 12 to 13 times more of the total variation than the variation in the "standard" spread determinants derived from the contingent claims approach *à la* Merton-Shimko. In the level equation, 13 percent of the variation in corporate spreads is explained by the variation in sovereign risk, while only one percent of total variation is explained by the standard determinants.<sup>42</sup> In the first-difference equation, sovereign risk explains 61 percent of total variation, while the standard determinants explain only 5 percent, with 34 percent of total variation remaining unexplained.

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<sup>41</sup> If we include the transformation  $\ln(1+TOVC)$  instead given that the range of monthly turnover values is very large (between ZAR 0 and ZAR 4.08 billion), liquidity is significant but has the wrong (positive) sign, while all other coefficients remain essentially unchanged.

<sup>42</sup> Not surprisingly for a level regression, the largest part of the variance (93 percent) is explained by the fixed effects, that is, the "between-variation" (i.e., the variation between the nine spread series) is much more important than the "within-variation" (i.e., the variation within each of the nine spread series).

## 6. CONCLUSIONS AND POLICY IMPLICATIONS

The purpose of this paper was to answer two questions. First, does sovereign risk affect corporate credit spreads in an emerging market economy like South Africa? And if so, how important is sovereign risk compared to the "standard" corporate spread determinants derived from the contingent claims approach? Second, does the "sovereign ceiling" apply in the corporate spreads of South African firms, in the sense that do market participants believe that the firms always default on their debt when the government defaults on its own debt?

Using monthly data on a panel of four industrial and five financial firms in South Africa during the period July 2000–May 2003, the paper finds that:

- (i) Sovereign risk appears to be the single most important determinant of corporate credit spreads in South Africa. For almost all firms analyzed, sovereign risk is statistically and economically the most important determinant of their credit spreads. Sovereign risk explains 12 to 13 times more than determinants derived from the contingent claims approach *à la* Merton and Shimko. This preponderance of the sovereign risk component is consistent with the dominance of systemic risk over idiosyncratic risk observed in many emerging market economies.
- (ii) The determinants derived from the contingent claims approach (leverage, firm-value volatility, remaining time to maturity, and risk-free interest rate volatility) are also statistically significant determinants of corporate spreads, contrary to the findings by Durbin and Ng (1999). However, a variance decomposition reveals that they are relatively unimportant, at least at a monthly frequency, explaining together only about one to five percent of total variation in corporate spread levels.
- (iii) The sovereign ceiling (in local-currency terms) does not apply in the spreads of the four large multinational industrial companies in the sample but consistent with rating agency policy, the sovereign ceiling appears to apply in the spreads of four of the five financial companies. This implies that bond market participants believe that the four South African industrial companies would not default when the government does, while the four financial companies likely would.

Provided that these results can be generalized to other emerging markets (i.e., they are not specific to South Africa), they have important implications for economic policy. First, in light of the importance of sovereign risk in determining corporate credit spreads, macroeconomic policies oriented toward reducing sovereign default risk (see Peter (2002))—and hence improving a government's credit rating—can result in a significant reduction in the cost of debt capital for corporate borrowers, which in turn can help stimulate investment and economic growth. Second, the preponderance of sovereign risk over idiosyncratic risk in emerging economies should be taken into account by the respective supervisory agencies when assessing risks in their financial systems (and, in particular, in the banking sector).

The methodology developed in this paper could be used by rating agencies and banks to strengthen their process of rating companies in emerging markets. In particular, internationally active banks might find the methodology useful to estimate probabilities of default (*PD*) of corporate and bank exposures in emerging markets in the context of the internal ratings-based (IRB) approach of the new Basel Capital Accord (“Basel II”).<sup>43</sup> The method is applicable to both local- and foreign-currency exposures, provided appropriate and reasonably liquid firm and sovereign bonds are available in the respective currencies. According to this methodology, the necessary ingredients to calculate a counterpart’s *PD* for a foreign-currency (FX) debt exposure would be: (i) the default probability associated with the counterpart’s stand-alone FX rating, labeled  $P(F / S^c)$ ;<sup>44</sup> (ii) the sovereign default probability associated with the FX credit rating of the sovereign in which the counterpart is located, labeled  $P(S)$ ; and (iii) the probability associated with direct sovereign intervention (“transfer risk”), labeled  $P(F / S)$ . An estimate of the latter – direct sovereign intervention (or transfer) risk – can be obtained by estimating the elasticity of the counterpart’s credit spreads with respect to the credit spreads of its sovereign of incorporation/location, controlling for all other relevant spread determinants. If the estimated elasticity is significant and greater than or equal to 1,  $P(F / S)$  is equal to 1; if it is significant but smaller than 1, it can be directly used as rough estimate of  $P(F / S)$ . The counterpart’s overall *PD* on the foreign-currency debt exposure is then given by equation (3):  $PD = P(F / S^c) + P(S)[P(F / S) - P(F / S^c)]$ .

The findings of the paper suggest some topics for further research. First, similar empirical studies of other emerging market economies could be conducted to find out whether the strong relationship between sovereign and corporate financing costs is specific to South Africa or a more general phenomenon. The generally strong relationship between corporate and sovereign credit *ratings* in emerging markets would suggest that it is a quite general phenomenon. Second, more theoretical work needs to be devoted to studying the interaction between corporate credit risk and sovereign (credit) risk, presumably in a general equilibrium framework. Existing theoretical models of corporate default risk (i.e., the contingent-claims approach) predict that – besides interest rate risk – firm-specific factors should drive corporate credit spreads. However, our results confirm for an emerging market what has been found by Collin-Dufresne et al. (2001) in the United States, namely that aggregate (systematic) factors – sovereign risk in our case – appear to be much more important than firm-specific factors in determining corporate default spreads. Thus, they highlight an important shortcoming of the existing structural models of default risk.

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<sup>43</sup> See Basel Committee on Banking Supervision (2004), pp. 55–56.

<sup>44</sup> For details, see section 3.2.

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Table 1. South African Corporate Bonds: Issuers, Main Features, and Corresponding Benchmark Instruments

Firm	Activity	Firm Bond	Principal Amount Outstanding (ZAR million)	Percent of Debt Traded 2/	Issue Date	Risk-free Benchmark	Corresponding RSA Government Bond	Data Range
ABSA Bank	Banking	ABSABANK LTD. 2000 15% 01/03/05 <b>AB01</b>	1250	29% (Rest: AB02 ZARm 3100 since 22/3/02)	01/03/00	EIB 1999 13% 03/06/05	RSA 1984 13% 15/07/05 R124	Jul 00 to May 03
African Bank	Specialty & Other Financial Activities	AFRICAN BANK 2001 12.5% 28/02/05 <b>ABL1</b>	1000	100%	12/10/01	EIB 1999 13% 03/06/05	RSA 1984 13% 15/07/05 R124	Oct 01 to May 03
Harmony Gold	Mining	HARMONY GOLD 2001 13% 14/06/06 <b>HARI</b>	1200	100%	11/06/01	EIB 2001 11% 28/12/06	RSA 1996 12.50% 21/12/06 R184	Jun 01 to May 03
Imperial Group (PTY)	Diversified Industry	IMPERIAL GP.(PTY.) 2001 11% 14/03/06 <b>IPL1</b>	800	50% (Rest: IPL2 ZARm 800)	14/09/01	EIB 2001 11% 28/12/06	RSA 1996 12.50% 21/12/06 R184	Sep 01 to May 03
ISCOR	Steel & Other Metals	ISCOR 1983 12.50% 01/03/03 <b>ISS9</b> (penultimate coupon: 27/08/02)	0.2	3% (Rest: IS57 ZARm 7.5)	01/02/83	EIB 1998 12 1/4% 20/05/03 (pen. coupon: 15/05/02)	RSA 1981 12.5% 01/09/03 R106 (penultimate coupon: 25/02/03)	Jul 00 to Feb 02
Investec Bank	Specialty & Other Financial Activities	INVESTEC BANK LTD. 2000 16% 31/03/12 <b>IV01</b>	2016	67% (Rest: IV02 ZARm 1000 since 31/3/03)	17/06/00	EIB 1999 13% 31/08/10	RSA 1989 13% 31/08/09-11 R153	Jul 00 to May 03
Nedcor Bank	Banking	NEDCOR BANK LTD.2001 11.3% 20/09/06 <b>NED1</b> 3/	2000	33% (Rest: NED2 ZARm 4000 since 01/07/02)	20/09/01	EIB 2001 11% 28/12/06	RSA 1996 12.50% 21/12/06 R184	Sep 01 to May 03
SASOL	Chemicals & Fuels	SASOL FINANCING 2000 14% 30/06/03 <b>SFL1</b> (penultimate coupon: 23/12/02)	900	100%	24/06/00	EIB 1998 12 1/4% 20/05/03 (penultimate coupon: 15/05/02)	RSA 1981 12.5% 01/09/03 R106 (penultimate coupon: 25/02/03)	Jul 00 to Feb 02
Standard Bank	Banking	STANDARD BANK SA. 2000 15.5% 01/06/05 <b>SBK1</b> 4/	1200	21% (Rest: SBK2 ZARm 1500, SBK3 ZARm 2000, SBK4 ZARm 1000)	31/05/00	EIB 1999 13% 03/06/05	RSA 1984 13% 15/07/05 R124	Jul 00 to May 03

Sources: Datastream; Bond Exchange of South Africa; annual reports.

Notes:

1/ End-May 2003, except for IS59 and SFL1: end-December 2000. Principal amount outstanding at that time was equal to amount issued for all bonds.

2/ End May 2003, except for IS59 and SFL1: end-December 2000.

3/ 20/09/06 is the exercise data of the first call option, not the maturity date; maturity date is 20/09/2011.

4/ 01/06/05 is the exercise date of the first call option, not the maturity date (as wrongly indicated in Datastream), which is 01/06/2010. See BESA website (list of corporate bond issues and "Static Data" files) and Standard Bank Group (2002), p. 137), for the details of this bond.

Table 2. History of Credit Ratings by the Republic of South Africa and Firms Analyzed  
(Until May 31, 2003)

Issuer	Date	Standard & Poor's		Date	Moody's	
		Local Currency Credit Rating (Issuer)	Foreign Currency Credit Rating (Issuer)		Domestic Currency Bond Rating (Senior Unsecured)	Foreign Currency Bond Rating (Senior Unsecured)
		Long Term/Outlook	Long Term/Outlook		Long Term/Outlook	Long Term/Outlook
Republic of South Africa	May 7, 2003 Nov. 12, 2002  Feb. 25, 2000  March 6, 1998  Nov. 20, 1995 Oct. 3, 1994	A/stable A-/positive  A-/stable  BBB+/stable  BBB+/positive	BBB/stable BBB-/positive  BBB-/stable  BB+/stable  BB+/positive BB/positive	Feb. 26, 2003 Nov. 29, 2001 Oct. 12, 2001 Feb. 7, 2000 Oct. 2, 1998 Jul. 17, 1998 Mar. 7, 1997 Nov. 20, 1995 Oct. 3, 1994	A2/stable A2/stable Baa1/rev. for up Baa1/positive Baa1/stable Baa1/rev. for down Baa1/negative Baa1	Baa2/positive Baa2/stable Baa3/rev. for up Baa3/positive Baa3/stable Baa3/rev. for down Baa3/negative -- Baa3
ABSA Bank	Nov. 16, 1998	BBBpi 2/		Feb. 27, 2003 Dec. 6, 2001 Oct. 17, 2001 Feb. 8, 2000 Oct. 2, 1998 Jul. 17, 1998 Jan. 22, 1996		Baa2/positive 1/ Baa2/stable 1/ Ba1/rev. for up 1/ Ba1/positive 1/ Ba1/stable 1/ Ba1/rev. for down 1/ Ba1 1/
African Bank						
Harmony Gold						
Imperial Group						
ISCOR						
Investec Bank				Feb. 27, 2003 Dec. 6, 2001 Oct. 17, 2001 Feb. 8, 2000 Oct. 2, 1998 Jul. 17, 1998 Dec. 11, 1996		Baa2/positive 1/ Baa2/stable 1/ Ba1/rev. for up 1/ Ba1/positive 1/ Ba1/stable 1/ Ba1/rev. for down 1/ Ba1 1/
Nedcor	Nov. 16, 1998	BBBpi 2/		Feb. 27, 2003 Dec. 6, 2001 Oct. 17, 2001 Feb. 8, 2000 Oct. 2, 1998 Jul. 17, 1998 Jan. 22, 1996		Baa2/positive 1/ Baa2/stable 1/ Ba1/rev. for up 1/ Ba1/positive 1/ Ba1/stable 1/ Ba1/rev. for down 1/ Ba1 1/
Sasol	Feb. 19, 2003		BBB/stable			
Standard Bank	Nov. 16, 1998	BBBpi 2/		Feb. 27, 2003 Dec. 6, 2001 Oct. 17, 2001 Feb. 8, 2000 Oct. 2, 1998 Jul. 17, 1998 Jan. 22, 1996		Baa2/positive 1/ Baa2/stable 1/ Ba1/rev. for up 1/ Ba1/positive 1/ Ba1/stable 1/ Ba1/rev. for down 1/ Ba1 1/

Sources: Websites of Moody's Investors Service and Standard & Poor's

Notes:

1/ Long-Term Bank Deposit Ratings. These ratings are all equal to the Country Ceiling for Foreign Currency Bank Deposits.

2/ "pi" = Public information Rating. Ratings with a "pi" subscript are based on an analysis of an issuer's published financial information, as well as additional information in the public domain. They do not, however, reflect in-depth meetings with an issuer's management and are therefore based on less-comprehensive information than ratings without a "pi" subscript.

Table 3. Data Sources and Measurement of Variables

Determinant		Sub-components		Source
Variable	Measurement	Symbol	Explanation	
Corporate spread ( $s_t$ )	$SCOR = y - rf$	$y$	Yield to maturity of corporate bond	BESA
		$rf$	Yield to maturity of corresponding risk-free (supranational) bond	Datastream
Sovereign default spread ( $s_t^{sov}$ )	$SSOV = sov - rf$	$sov$	Yield to maturity of the corresponding government bond	BESA
Leverage (quasi-debt-to-firm-value ratio) ( $d_t$ )	(1) $D1 = B1 \cdot PRF / V1$ , where $V1 = E + PT \cdot B1$	$B1, B2$	Face value of total firm debt (B2 includes customer deposits for the financial institutions)	Bloomberg
		$PRF$	Price of risk-free bond	Datastream
		$E$	Market value of firm equity	Datastream
		$PT$	Market price of traded debt	Datastream
		$V1, V2, V3$	Value of the firm	Calculated
Firm-value volatility ( $\sigma_v$ )	(1) $SV1000D$ , where $SV1000D$ is solution of $\sigma_v$ in $\sigma_E = \sigma_v \frac{V1\Phi(h_1)}{E}$ , with $h_1 = \frac{-\ln(D1) + \frac{1}{2}\sigma_v^2\tau}{\sigma_v\sqrt{\tau}} \cdot 1/$	$\sigma_E = stdev(u_t)\sqrt{261}$ where $u_t$ is the daily log-return on the stock, and $stdev$ is the rolling standard deviation over the preceding 1000 trading days.	Annualized equity volatility over the preceding 1000 trading days	Datastream

Interest rate volatility ( $\sigma_r$ )	(1) $SIGSPOTM = stdev(\Delta r)\sqrt{12}$ .  (2) $SIGRFM = stdev(\Delta rf)\sqrt{12}$ .	$r$	3-month Bankers' Acceptance rate (proxy for short-term interest rate)	Datastream
Time to maturity ( $\tau$ )	$M = LFFL(-3)$	LFFL	Number of days from settlement date until maturity date (expressed in years)	Datastream
Liquidity ( $l$ )	$TOVC$		Amount traded (of a given bond) during month	BESA

Note:  $1/\sigma_v$  is solved for numerically.

Table 4. Descriptive Statistics of Variables

Variable	Corporate Spread (SCOR)	Firm-Value Volatility (SV1000D)	Time to Maturity (M)	Leverage Ratio (D1)	Liquidity (Turnover Value, TOVC)	Interest Rate Volatility (SIGSPOTM)	Sovereign Spread (SSOV)
	(Basis points)	(Percent)	(Years)	-	(ZAR million)	(Percent)	(Basis points)
Mean	154.02	23.35	4.15	0.51	203.00	1.01	22.43
Median	140.53	21.12	3.42	0.55	72.15	1.02	23.70
Maximum	413.26	53.02	11.67	0.91	4080.00	1.73	112.05
Minimum	-26.47	0.59	0.75	0.08	0.00	0.25	-105.09
Std. Dev.	75.26	14.50	2.74	0.23	486.00	0.34	32.91
Observations	237	237	237	237	237	237	237
Cross-sections	9	9	9	9	9	9	9

Source: Authors' calculations.

Table 5. The Determinants of Corporate Spreads: Regressions Results

Dependent Variable:	(1) SCOR	(2) SCOR?	(3) SCOR?	(4) SCOR?	(5) SCOR?	(6) SCOR?	(7) d(SCOR?)
Method:	Separate OLS Regressions (for each firm)	Pooled OLS	Fixed Effects - OLS 1/	Fixed Effects - OLS 1/	Fixed Effects - FGLS 1/	Fixed Effects - FGLS with AR(2) 1/	Pooled FGLS with AR(1) 1/
	Coeff t-stat Prob	Coeff t-stat Prob	Coeff t-stat Prob	Coeff t-stat Prob	Coeff t-stat Prob	Coeff t-stat Prob	Coeff t-stat Prob
Explanatory Variables							
C	2/	-0.022 -3.82 0.00					
SV1000D?	2/	0.075 7.68 0.00	-0.019 -1.25 0.21	-0.050 -3.19 0.00	-0.059 -4.94 0.00	0.048 2.75 0.01	0.035 2.13 0.03
M?	2/	-0.003 -2.23 0.03	-0.002 -3.19 0.00	-0.002 -2.92 0.00	-0.002 -4.59 0.00	-0.003 -2.96 0.00	-0.002 -2.61 0.01
D1?	2/	0.035 4.55 0.00	-0.010 -0.95 0.34	-0.029 -2.61 0.01	-0.041 -5.26 0.00	0.019 2.18 0.03	0.012 1.38 0.17
TOVC?	2/	0.000 -1.15 0.25	0.000 -2.10 0.04	0.000 -2.03 0.04	0.000 -1.61 0.11	0.000 0.36 0.72	0.000 1.01 0.32
D1?*M?	2/	0.004 3.04 0.00	0.004 2.92 0.00	0.004 3.05 0.00	0.005 5.23 0.00	0.000 0.53 0.60	0.001 1.01 0.32
SIGSPOTM?	2/	0.475 2.15 0.03	-0.238 -2.12 0.04	-0.351 -3.31 0.00	-0.234 -2.21 0.03	-0.152 -1.80 0.07	-0.125 -1.61 0.11
SIGSPOTM?*D1?	2/	-1.087 -2.68 0.01	0.404 2.03 0.04	0.577 2.89 0.00	0.507 2.76 0.01	0.371 2.66 0.01	0.350 2.55 0.01
SSOV?		1.382 7.15 0.00	0.840 10.50 0.00				
SSOV_AB01	0.840 8.88 0.00			1.101 13.03 0.00	1.076 22.67 0.00	0.963 22.86 0.00	0.978 23.36 0.00
SSOV_ABL1	0.517 1.17 0.27			1.013 2.41 0.02	1.039 1.27 0.20	0.920 2.11 0.04	0.931 1.86 0.06
SSOV_HAR1	0.680 2.27 0.04			0.612 3.08 0.00	0.781 4.48 0.00	0.574 1.89 0.06	0.602 2.23 0.03
SSOV_IPL1	0.587 4.06 0.00			0.143 0.87 0.39	0.207 1.85 0.07	0.612 4.66 0.00	0.551 3.84 0.00
SSOV_IS59	0.596 3.04 0.01			0.112 0.75 0.45	0.101 0.70 0.48	0.419 2.07 0.04	0.405 2.34 0.02
SSOV_IV01	0.103 0.97 0.34			0.652 3.45 0.00	0.566 3.09 0.00	0.776 8.08 0.00	0.880 7.53 0.00
SSOV_NED1	0.507 4.16 0.00			0.517 2.25 0.03	0.359 2.27 0.02	0.405 3.84 0.00	0.404 3.91 0.00
SSOV_SFL1	0.652 4.21 0.00			1.082 8.09 0.00	1.188 7.06 0.00	0.834 8.43 0.00	0.823 9.08 0.00
SSOV_SBK1	0.897 7.29 0.00			1.205 13.24 0.00	1.140 19.93 0.00	0.894 14.73 0.00	0.924 14.90 0.00
AR(1)						0.746 14.35 0.00	-0.136 -2.89 0.00
AR(2)						0.124 2.67 0.01	
Adjusted R-squared	2/	0.376	0.920	0.931	0.904	0.963	0.754
Mean dependent var	2/	0.015	0.015	0.015	0.015	0.015	0.000
S.E. of regression	2/	0.006	0.002	0.002	0.002	0.001	0.001
Log likelihood	2/	882.950	1130.047	1152.676	1187.253	1207.740	1194.965
Durbin-Watson stat	2/	0.126	0.519	0.733	0.869	2.116	2.133
Sum squared resid	0.0002 3/	0.0081	0.0010	0.0008	0.0008	0.0003	0.0003
F-statistic	2/	18.763	387.942	214.137	149.950	217.264	42.669
Prob(F-statistic)	2/	0.000	0.000	0.000	0.000	0.000	0.000
Observations	237	237	237	237	237	219	219

Notes:

Dependent variables: SCOR = corporate default spread (level); d(SCOR) = corporate default spread (first difference).

Explanatory variables: SV1000D = firm value volatility; M = maturity; D1 = quasi-debt (leverage) ratio; TOVC = trading volume (liquidity); SIGSPOTM = interest rate volatility;

SSOV = sovereign risk (sovereign credit spread).

White heteroscedasticity-consistent standard errors and covariances are used in all regressions.

1/ Estimated fixed effects are not shown.

2/ Coefficients and summary statistics for the nine individual firm regressions are not reported.

3/ Sum of SSRs from nine individual regressions.

Table 6: Wald-Tests of  $\beta_i$ : Does the Sovereign Ceiling Apply for the Nine Firms?  
Null hypothesis:  $\beta_i - 1 = 0$

<b>A) Level Equation (5)</b>					
Firm bond	$\beta_i - 1$	Std. Err.	Wald Chi-square	df	Prob.
AB01	-0.037	0.042	0.793	1	0.37
ABL1	-0.080	0.436	0.034	1	0.85
HAR1	-0.426	0.303	1.967	1	0.16
IPL1	-0.388	0.131	8.757	1	0.00
IS59	-0.581	0.203	8.196	1	0.00
IV01	-0.224	0.096	5.473	1	0.02
NED1	-0.595	0.106	31.812	1	0.00
SFL1	-0.166	0.099	2.828	1	0.09
SBK1	-0.106	0.061	3.047	1	0.08

<b>B) First Difference Equation (6)</b>					
Firm bond	$\beta_i - 1$	Std. Err.	Wald Chi-square	df	Prob.
AB01	-0.022	0.042	0.280	1	0.60
ABL1	-0.069	0.501	0.019	1	0.89
HAR1	-0.398	0.271	2.161	1	0.14
IPL1	-0.449	0.143	9.803	1	0.00
IS59	-0.595	0.173	11.763	1	0.00
IV01	-0.120	0.117	1.054	1	0.30
NED1	-0.596	0.104	33.112	1	0.00
SFL1	-0.177	0.091	3.820	1	0.05
SBK1	-0.076	0.062	1.484	1	0.22

Source: Authors' calculations

Table 7. Variance Decompositions of Corporate Spreads in Levels and First Differences

(In Percent)

	Combined "Standard" Determinants	Sovereign Risk	Fixed Effects	Residuals	Total
Level	-1	13	93	-5	100
First Differences	5	61	-	34	100

Source: Authors' calculations.

Figure 1. South African *Excess* Corporate Bond Yield Spreads (Corporate Yield Spreads in Excess of Corresponding Sovereign Yield Spreads), July 2000–May 2003  
(In basis points, monthly data)

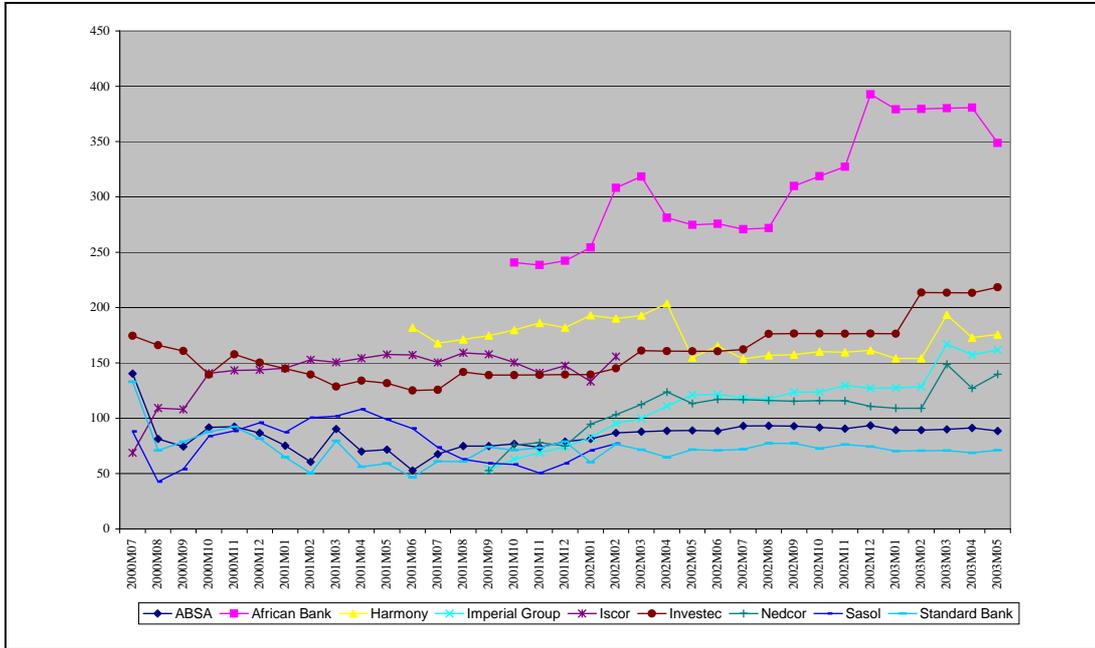
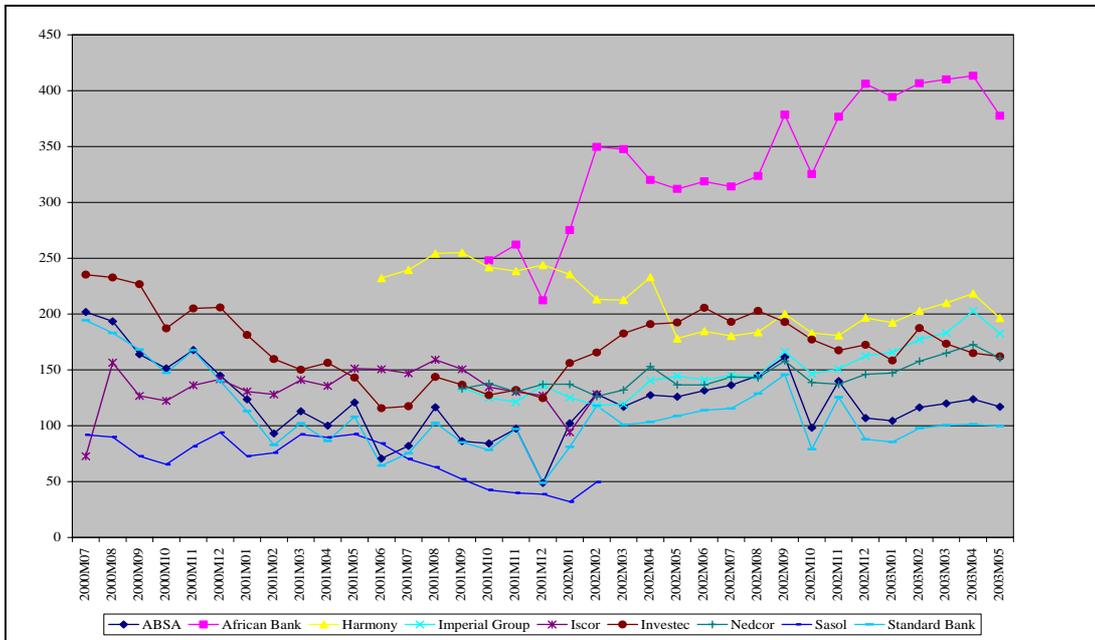
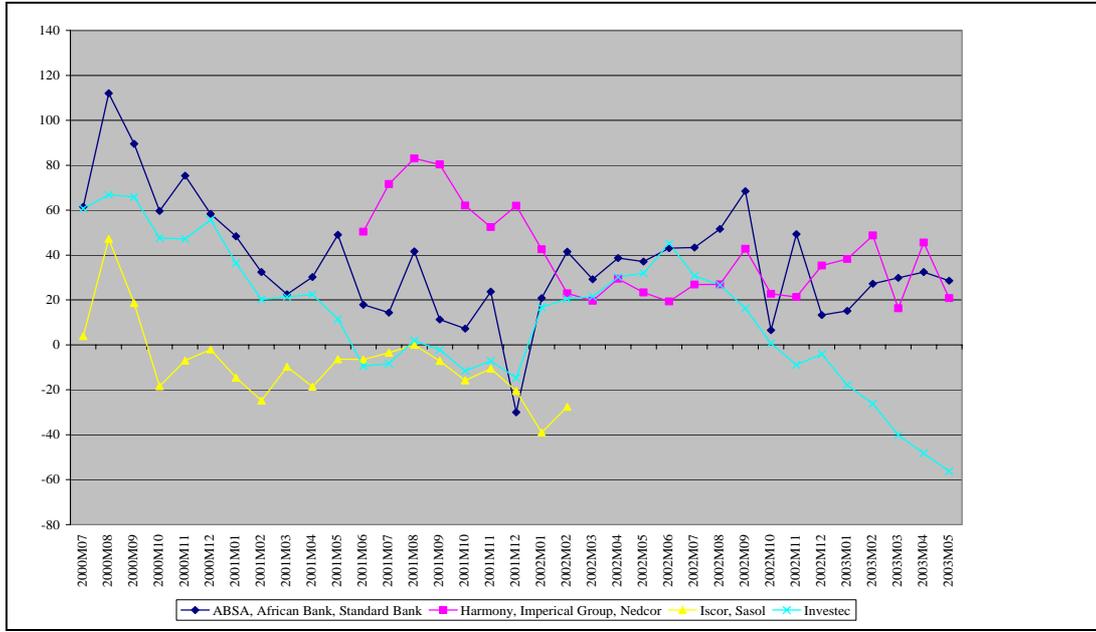


Figure 2. South African Corporate Yield Spreads, July 2000–May 2003  
(In basis points, monthly data)



Source: Authors' calculations based on data from Datastream and Bond Exchange of South Africa.

Figure 3. South African Sovereign Yield Spreads (Corresponding to the Respective Corporate Spreads in Fig. 2), July 2000–May 2003  
(In basis points, monthly data)



Source: Authors' calculations based on data from Datastream and Bond Exchange of South Africa.