Do Sovereign Bonds Benefit Corporate Bonds in Emerging Markets?

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Abstract

We analyze the impact of emerging-market sovereign bonds on emerging-market corporate bonds by examining their spanning enhancement, price discovery, and issuance effects. We find the effect of spanning enhancement is positive and large; over one-fifth of the information in corporate yield spreads is traced to innovations in sovereign bonds; and most of these effects are due to discovery and spanning of systematic risks. Further, issuance of sovereign bonds, controlling for endogeneity of market-timing decisions, lowers corporate yield and bid-ask spreads. Our results indicate that sovereign securities act as benchmarks and suggest they promote a vibrant corporate bond market.

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Corporations in emerging market countries, large or small, typically do not depend on bond markets to raise capital because emerging bond markets are extremely underdeveloped. To increase these corporations' access to external capital and to facilitate the growth of the bond market, many emerging market governments believe that they first need to establish an active sovereign bond market. Their argument is that sovereign bonds provide benchmarks against which to value corporate bonds, and hence serve as catalysts for the development of the country's corporate bond market (Fabella and Madhur (2003)). This claim is supported by the casual observation that the liquid corporate bond markets in developed countries are often accompanied by active government bond issuance and trading. Following this argument, on April 20, 1999, the Chilean government issued a dollar-denominated sovereign bond, its first in eight years. The issuance, a 500 million dollar ten-year global bond, was meant as a benchmark for Chilean corporate bonds, to facilitate the access of Chilean corporations to international capital markets.[1] Similarly, several developing east Asian governments with minimal government budget deficits, and hence minimal financing needs, are examining the possibility of issuing government bonds for the development of their corporate bond markets.[2]

Although these governments' claims seem plausible,[3] the academic literature suggests that the pricing impact of sovereign bonds is not so clear cut. Sovereign bonds represent *benchmark securities*; since these bonds are claims on the government of origin, their value depends only on factors systematic to the country.[4] In contrast, emerging market corporate bonds depend not only on these systematic factors, but also bear idiosyncratic risk specific to the company issuing the bond. The academic literature on benchmark securities suggests conflicting possibilities in terms of a sovereign bond issuance's impact on the existing bonds in the market. One argument, consistent with the aforementioned governments' intuition about their benefits, is that benchmark securities improve the market through making it more complete, reducing adverse selection costs, and improving liquidity by acting as hedging instruments (see Subrahmanyam (1991), Gorton and Pennacchi (1993), Shiller (1993), and Yuan (2005)).[5] However, the introduction of benchmark securities may also inhibit price discovery, crowding out the trading of all or a fraction of the existing securities (see Subrahmanyam (1991) and Gorton and Pennacchi (1993)). This is a real possibility in emerging markets, in which the sovereign issues typically have a higher credit rating than their counterparts. As a result, sovereign issues may be more attractive to international investors as a substitute to corporate bonds, reducing the liquidity in the corporate bond market. Further, the literature on financial innovation suggests that introduction of securities into an incomplete market may have negative welfare impacts (see Hart (1975), Elul (1994), Cass and Citanna (1998), Dow (1998), and Marín and Rahi (1998)).[6]

In this paper, we attempt to empirically distinguish whether the effect of sovereign issuance is beneficial or harmful to emerging bond markets.[7] We examine these issues by considering three channels in which the literature has suggested that benchmark securities such as sovereign bonds may affect the prices of other securities in the market. The first channel is the completion of an incomplete market. For example, Shiller (1993) points out that macro securities, i.e., securities that represent systematic risk factors, help to complete the market by allowing investors to hedge against major income risks. Yuan (2005) argues that in the presence of information asymmetry, even if investors are risk-neutral, benchmark securities help to complete the market and enhance the investment opportunity set by allowing heterogeneously informed investors to hedge against adverse selection. This mechanism is especially relevant for emerging financial markets, particularly those at the early stage of development, since these markets are characterized by severe incompleteness and intense information asymmetry. Furthermore, the volatility of exchange rates in these countries also suggests the presence of substantial systematic risks and, hence, the need to hedge these risks. Our results indicate that, in the majority of emerging markets that we analyze, sovereign bonds do indeed improve the opportunity set relative to corporate securities alone. The average annual Sharpe ratio improvement over all markets is 0.041 or, on an average percentage basis, approximately 54%.

The second channel by which benchmark securities may benefit existing securities in a market is price discovery. We examine whether the introduction of benchmark securities promotes price discovery by contributing to the price informativeness of existing securities. According to Yuan (2005), since investors are able to better hedge adverse selection costs with the addition of benchmark securities, these investors are encouraged to acquire more systematic and firm-specific information. As a result, the price informativeness of all securities improves. The degree of this price discovery is closely related to the number of benchmark securities in the market. However, under certain circumstances, theoretical evidence also indicates that benchmark securities may hamper the price discovery in existing securities. For example, Gorton and Pennacchi (1993) argue that the introduction of a benchmark security could crowd out the trading of all other securities; Subrahmanyam (1991) points out that only a fraction of the existing securities may experience increases in price informativeness.[8]

In our empirical work, we find that in most markets, innovations in yield spreads on sovereign bonds have a large impact on the volatility of corporate bond yield spreads. For example, in Argentina, the lower bound on the portion of the variability in corporate yield spreads attributed to innovations in sovereign yield spreads is 28%. Put differently, information does appear to flow from the sovereign market to the corporate market, implying that the presence of sovereign bonds enhances the price discovery process. Most of these gains in spanning and price discovery appear to be attributable to an improvement in capturing the effects of systematic risks.

The final mechanism by which benchmark securities may benefit a market is an increase in liquidity. That is, benchmark securities provide a liquidity service for existing securities. This liquidity service translates into reduced liquidity premiums and decreased bid-ask spreads. Subrahmanyam (1991), Gorton and Pennacchi (1993), and Yuan (2005) all point out that improved liquidity results directly from increased price informativeness following the introduction of benchmark securities.

We address this final issue by examining bid-ask and yield spreads on corporate bonds in excess of comparable treasuries, net of information contained in the default-free yield curve, the default risk, and exchange rates, controlling for the endogeneity coming from the market timing decision of governments. We do so by using the country's J.P. Morgan Emerging Market Bond Index (EMBI) spread as an instrument for the government's market timing decision. If the government is timing the market when issuing bonds, the timing effect should be present in the sovereign spread, as measured by the EMBI spread, as well. By stripping the EMBI spread from the corporate bond spreads, we are able to control for this market timing effect. We find that the issuance of a sovereign bond lowers both yield spreads and bid-ask spreads of existing corporate bonds. For example, the magnitude of reduction upon sovereign issuance is 1.89% for corporate stripped spreads, and 25.8% for corporate bid-ask spreads in Argentina using a [-7-week, +7-week] event window. This 1.89% exceeds the average bid-ask spread in the Argentinian corporate bond market, indicating the reduction in spread is economically significant and exceeds transaction costs. Thus, the evidence suggests a favorable impact of the issuance of a new sovereign bond on the price of existing corporate bonds.

These results have several implications for governments' bond issuance policy and the pricing impact of sovereign bonds. The development of a corporate bond market is, as documented in this paper, enhanced by the establishment of an active sovereign bond market. In earlier stages of a market's development, the sovereign market contributes to the corporate market by allowing investors to hedge sovereign risks in an incomplete market. In later stages of development, the sovereign market contributes by promoting price discovery related to systematic risk. This favorable impact of new sovereign issuances on yield and bid-ask spreads of corporate bonds further establishes the liquidity service of these bonds in emerging markets.

The remainder of this paper is organized as follows. Section 2 discusses the definition of a sovereign bond and a simple theoretical framework for our empirical work. Section 3 describes the data used in our analysis. Section 4 presents our empirical approaches and results for the analysis of the hypotheses. Section 5 concludes.

1 Sovereign Bonds as Benchmark Securities

1.1 Defining a Sovereign Bond

In this section, we briefly discuss the characteristics and definition of a sovereign bond. In referring to sovereign bonds, we mean bonds issued by governments or government agencies in international markets, whose payments are guaranteed by these governments. These bonds are different than those issued by governments in their domestic markets. The majority of these bonds are issued as straightforward coupon-bearing debentures; put and call features found in other bond markets are rare. Most sovereign bonds are denominated in foreign currencies; only a few countries (essentially the G-8) are able to issue bonds in international markets denominated in local currency; Eichenbaum, Hausmann, and Panizza (2004) note that of the $434 billion of developing country debt issued in international markets between 1999 and 2001, less than $12 billion was denominated in local currency. This decision is motivated by issues of monetary and fiscal policy credibility, inflation, and default risk. Over the period 1980-2002, approximately 55%

of sovereign debt was issued in U.S. dollars, 26% in Euros or Euro-area currencies, and 14% in Japanese Yen (Chamon, Borensztein, Jeanne, Mauro, and Zettelmeyer (2004)). The most liquid issues are denominated in U.S. dollars; JP Morgan constructs its EMBI index from dollar-denominated sovereign bonds because these issues have historically been the most liquid issues.

A distinguishing feature of a sovereign bond is that it bears only macroeconomic risks for a given country rather than macroeconomic and firm-specific risks in the sense discussed in Shiller (1993). That is, the set of factors that impact other bonds, specifically corporate bonds, in the country of interest are common to both the sovereign bond and the corporate bonds, but additional risks exist that impact the prices of corporate bonds. As an example, U.S. Treasury bonds are affected only by macroeconomic risk, whereas U.S. corporate bonds are also affected by firm-specific default risk. Emerging market sovereign bonds are affected by these same macroeconomic risks, with the addition of country-specific macroeconomic (default risk). These country-specific risks affect the corporate bonds in the market as well. Consequently, emerging market sovereigns may serve as benchmarks for these emerging market corporate bonds, as they embody the same macroeconomic risks. Indeed, the most common benchmark for emerging market bonds are the EMBI indices composed by JPMorgan-Chase, which, as discussed above, are constructed only from U.S. dollar-denominated sovereign bonds.

Although, as we note above, sovereign bonds may serve as benchmark securities, our focus in this paper is not on defining benchmark status. Rather, we simply wish to analyze the impact of bonds that *may* serve as benchmarks due to the fact that their payoffs are subject only to common systematic risks in a country's bond markets, following the theoretical work in Yuan (2005). Defining benchmark status is an interesting issue in and of itself, and is extensively explored in Dunne, Moore, and Portes (2003). Our concern instead is on the impact of the introduction of a "macro" security in the sense of Shiller (1993) on the pricing of other bonds in the economy.

1.2 Theoretical Background

Given the definition of the characteristics of a sovereign bond, we summarize a simple theoretical framework to motivate our empirical investigation of the impact of sovereign bonds on a country's bond market. We assume a standard factor structure for (log) bond prices, as is common in the fixed income literature. More specifically, assume that corporate bond prices can be expressed as an exponential affine function:

$$\ln P_{ct} = \Lambda_{c0} + \Lambda_c' X_t + v_t \tag{1}$$

where X_t is a vector of common state variables, and v_t is a bond-specific risk. A continuous time version of this specification is expressed in the context of sovereign bonds in Duffie, Pedersen, and Singleton (2003). We assume that the price of a sovereign instrument is affected only by the common state variables present in the pricing of all bonds in a country:

$$\ln P_{st} = \Lambda_{s0} + \Lambda_s' X_t \tag{2}$$

We further assume that the state variables, X_t evolve according to a vector autoregression (VAR):

$$\Gamma(L) X_t = \mu + \epsilon_t \tag{3}$$

where $\Gamma(L)$ denotes a polynomial in the lag operator.

In the absence of asymmetric information, sovereign securities play a role in potentially enhancing spanning in the domestic bond market, as discussed in Shiller (1993).

We express the bond pricing equations in return form as

$$\Delta \ln P_{ct} = \alpha_c + \beta_c' \Delta X_t + \xi_{ct} \quad (4)$$

$$\Delta \ln P_{st} = \alpha_s + \beta_s' \Delta X_t \quad (5)$$

Standard arbitrage arguments suggest that with a sufficient number of corporate securities with linearly independent factor loadings, we can form portfolios of the corporate bonds that mimic the factors, thereby spanning systematic risk. In this case, the introduction of a sovereign security, which is subject only to common factor risk, would not produce a spanning enhancement since its payoff could be replicated by the corporate securities. If, however, mimicking portfolios cannot be formed with the corporate bonds, the sovereign securities represent assets free of unsystematic risk, and their inclusion in the market generates a spanning enhancement. Whether the sovereign bonds enhance the spanning ability of the corporate bonds alone is an empirical question that we address subsequently in the paper.[9]

The presence of asymmetric information offers alternative channels by which sovereign securities may be beneficial to a market. Yuan (2005) presents such a model, in which agents can choose to become informed about the asset specific innovations in asset payoffs, v_{ct} in our notation above, or innovations to the systematic factors, ϵ_t. A market maker sets prices to clear the market in a standard Kyle (1985) framework, with losses to informed traders offset by gains from liquidity traders. She shows that prices become more informative in this setting if benchmark securities are present. Further, liquidity improves in the market as well. Intuitively, the presence of benchmark securities allow investors to more precisely infer factor risk, which leads to greater factor information acquisition. In turn, investors informed in asset-specific risk can now more easily separate factor and systematic risks, enabling them to gather more asset-specific information. We address this issue empirically below by examining the effect of sovereign securities on bid-ask spreads and price discovery in emerging markets.

2 Emerging Market Bond Data

The initial sample period considered is January 3, 1996 through November 20, 2000. The primary data source is JPMorgan-Chase, a major market maker for emerging market bonds. We focus on fixed income securities with a specified maturity, face value, and coupon.[10] We limit our study to bonds issued by emerging market borrowers placed on international markets. As discussed above, the vast majority of sovereign bonds are denominated in U.S. dollar terms, and these bonds are the most liquid. Our raw sample includes only dollar-denominated bonds.

Although most of this market consists of bonds placed in the Eurodollar market, our sample includes bonds floated on the U.S. public market (the Yankee market) and the U.S. private placement market (under provisions of Rule 144A). We further limit our study to countries with a corporate bond market where corporate bond issues are traded (that is, price and yield information are available). This leaves us 98 sovereign bonds and 239 corporate bonds from eight countries: Argentina, Brazil, Chile, Korea, Mexico, the Philippines, Thailand, and Venezuela (Table 1).[11] Table 1 shows that 54 sovereign bonds are issued between May 1, 1996 to July 24, 2000.[12] As shown in the table, the stage of bond market development differs widely across countries. During the sample period, countries such as the Philippines, Thailand, and Venezuela have relatively small numbers of sovereign and corporate bonds outstanding, whereas countries such as Mexico, Argentina, and Brazil have significant numbers of sovereign and corporate bonds trading.

For each bond in our sample, we have the following pricing information at daily frequency: 1) relative bid-ask spread quoted in percentage points; and 2) stripped spread over the relevant U.S. treasury quoted in basis points: calculated by subtracting the yield on the relevant U.S. treasury security from the bond's yield (implied by either offer or bid prices) after stripping off its collateral value. Since most emerging market bonds are collateralized, stripped spread is a more appropriate measure for price. The summary statistics for these pricing data appear in Table 2. These sample statistics show that average daily spreads over the U.S. treasury are, on average, higher for corporate bonds than for sovereign bonds in Chile, Korea, Mexico, the Philippines, and Thailand, and are lower for corporate bonds in Argentina, Brazil, and Venezuela.[13] However, with the exception of Venezuela, in those countries with sovereign spreads higher than corporate spreads, the volatility of the sovereign spread is much lower than that of the corporate spread. Table 2 also shows that the market for emerging-market securities is extremely illiquid, as evidenced by the large average bid-ask spreads on these securities. Corporate securities are much less liquid than sovereign ones (except Venezuela). This potentially reflects the benchmark status of sovereign securities.

Time series plots of the average stripped yield spread for the corporate and sovereign bonds in each country are depicted in Figure 1. The effects of the Asian currency crisis can be seen clearly in the behavior of the stripped spreads in Korea and the Phillipines; the Thai Bhat was devalued in July, 1997, and we date the end of the crisis with the U.S. Federal Reserve's third rate cut in October, 1998. The effects of the crisis are also evident, although not as pronounced, in the plots for Argentina, Brazil, Mexico, and Venezuela.

In the next section, we will discuss how we use these data to investigate the hypotheses discussed in the previous section. In particular, we will use the stripped yield spreads and returns on these bonds to investigate the question of whether sovereign bonds enhance spanning in these markets. We will also use these raw spreads in the analysis of price discovery. The residuals from these regressions will be used in the final analysis, to ascertain whether there is an independent liquidity effect from the introduction of sovereign bonds into a market.

3 The Information Content of Sovereign Bond Markets

In this section, we examine three issues: (1) whether the presence of sovereign bonds in a market indeed represents an improvement in investors' opportunity sets; (2) whether price discovery takes place in the sovereign or the corporate bond market; and (3) whether the introduction of new sovereign bonds have price and liquidity impacts on existing bonds. We utilize spanning tests (Huberman and Kandel (1987), Bekaert and Urias (1996)) to investigate the first issue, and a vector autoregression (VAR) approach to address the second (Hasbrouck (1995, 2003)). We investigate the third question by employing a standard event study methodology. More detail on the methods used and evidence on these questions are provided below.

3.1 The Default Free Term Structure

Our study is primarily concerned with the ability of sovereign bonds to enhance spanning and improve price discovery and liquidity of corporate bonds. As discussed above, the framework we consider suggests that bond prices respond to innovations in default-free term structure factors, country-specific factors, and asset specific shocks. We assume that the U.S. Treasury bond market represents the default-free term structure, and that investors can trade in Treasury securities in addition to emerging market sovereign and corporate instruments. We assume that there are sufficient Treasuries to span the default free term structure factors, and consequently investors extract information about this term structure from Treasuries. As a result, in our investigations, we wish to control for innovations that are orthogonal to innovations in the U.S. term structure.

The general consensus in the literature modeling yields of U.S. Treasury securities is that three factors govern the term structure; this assumption follows principal component analysis in Litterman and Scheinkman (1991). We follow Brandt and Kavajecz (2004), among others, and extract the first three orthogonal principal components from a set of Treasury securities, performed on the covariance matrix of the yields. These components are ordered by the percentage of variation explained. We use the bid yields on the on-the-run Treasury securities closest to 90 days, one year, two years, five years, seven years, and ten years. The data are obtained from CRSP. In Table 3, we present the percentage of variation explained by each principal component, and the slope of the regression of bond yields on the components. As discussed, three principal components appear to be related to the term structure of yields. Further, these components are consistent with earlier interpretations; the first component has a positive and loading for the yields, increasing in maturity, suggesting that it represents a "level" factor in the term structure. The second component affects short-term yields positively and long-term yields negatively, consistent with the interpretation of a "slope" factor. Finally, the third component affects short-term and long-term yields positively, while affecting medium-term yields negatively, consistent with the interpretation of a "curvature" factor.

3.2 Spanning Enhancement

In order to examine whether the presence of sovereign bonds in a market serves to help complete the market, we examine tests of spanning from de Santis (1993) and Bekaert and Urias (1996). Denote the gross returns on the set of corporate bonds at time t as $\mathbf{R}_t^c$ and the gross returns on the set of sovereign bonds as $\mathbf{R}_t^s$. We estimate the parameters $\{\beta_1^c, \beta_1^s, \beta_2^c, \beta_2^s\}$ of two pricing kernels

$$\begin{aligned} M_{1t} &= \alpha_1 + \beta_1^c \left(\mathbf{R}_t^c - E\left[\mathbf{R}_t^c\right]\right) + \beta_1^s \left(\mathbf{R}_t^s - E\left[\mathbf{R}_t^s\right]\right) && (6) \\ M_{2t} &= \alpha_2 + \beta_2^c \left(\mathbf{R}_t^c - E\left[\mathbf{R}_t^c\right]\right) + \beta_2^s \left(\mathbf{R}_t^s - E\left[\mathbf{R}_t^s\right]\right) && (7) \end{aligned}$$

At first glance, the two pricing kernels appear nearly identical, as they are both linear functions of the de-meaned returns on the corporate and sovereign bonds. However, the means of the pricing kernels, α_1 and α_2, are constrained to differ, which affects the parameter estimates. We discuss this issue in more detail below. The parameters of the pricing kernel are estimated via GMM using the moment restrictions

$$\begin{aligned} \frac{1}{T}\sum_{t=1}^{T} M_{1t}\{\mathbf{R}_t^c; \mathbf{R}_t^s\} - \iota &= 0 && (8) \\ \frac{1}{T}\sum_{t=1}^{T} M_{2t}\{\mathbf{R}_t^c; \mathbf{R}_t^s\} - \iota &= 0, && (9) \end{aligned}$$

where ι represents a conforming vector of ones. That is, the parameters are estimated so that the pricing kernels M_{1t} and M_{2t} satisfy the sample analog of the standard Euler equation.

As discussed in Bekaert and Urias (1996), under the null hypothesis that the corporate bonds span the sovereign bonds, the information in the sovereign bonds will not be important for pricing the corporate bonds. That is, following Hansen and Jagannathan (1991), given the mean of the pricing kernel, α, we can construct a minimum variance pricing kernel that is in the linear span of the asset payoffs. If this pricing kernel prices both the corporate and sovereign bonds, but depends only on the payoffs of the corporate bonds, the bounds *intersect*. If this result holds for pricing kernels with different means, the corporate bonds *span* the sovereign bonds. That is, since any minimum variance pricing kernel is a linear combination of two other minimum variance pricing kernels, in an analogue to the mean-variance frontier, any two minimum variance pricing kernels with arbitrary (and different) means and different variances describe the frontier. We set these means to $\alpha_1 = 0.99$ and $\alpha_2 = 1.01$; results are not sensitive to alternate specifications of these means. We test the null hypothesis

$$H_0: \ \beta_1^s = \beta_2^s = 0 \tag{10}$$

by imposing the null hypothesis as a restriction on the pricing kernels. As discussed in Bekaert and Urias, the test of GMM overidentifying restrictions is a likelihood ratio test of the null hypothesis of spanning.

One further data issue affects our investigation of the spanning restrictions above. In our data, due to lack of trade, issuance during the sample period, or maturity during the sample period, several bonds do not have common sample lengths. We restrict the bonds included in the analysis to mature later than September 30, 2000. This restriction ensures that we have a full time series for each bond, and eliminates the possibility that the bond is in its last month of trading, when microstructure and liquidity concerns are greatest for bond returns. This restriction reduces the number of corporate (sovereign) bonds in Argentina to 31 (12), Brazil to 22 (11), Korea to 16 (13), Mexico to 52 (17), and Venezuela to 10 (4). Further, many bonds were issued after the Asian currency crisis. Restricting ourselves to bonds issued before the crisis further reduces the number of corporate (sovereign) bonds in Argentina to 23 (5), in Brazil to 21 (5), in Korea to 12 (11), in Mexico to 35 (12), in the Philippines to 11 (2), in Thailand to 5 (2), and in Venezuela to 6 (4). We further reduce the number of bonds if they do not have a complete history of trades. We present the number of corporate and sovereign bonds in each country satisfying these criteria, as well as the number of time series observations in Table 4, which presents the results of the spanning tests.

Results of these spanning tests are provided in Table 4. As shown in the table, the evidence suggests that the incorporation of sovereign bonds into the set of assets yields spanning enhancement for the majority of countries.[14] Specifically, the results indicate that the investment opportunity sets of investors in Chile, Korea, Mexico, and the Philippines, Thailand, and Venezuela are enhanced by the inclusion of sovereign bonds. The spanning tests suggest rejection of the null of spanning at the 5% critical level in Chile, Korea, Mexico, and Thailand, and at the 10% critical level in the Philippines and Venezuela. The results do not suggest statistically significant improvement in Argentina or Brazil.

We also present the maximum Sharpe ratio achievable with the assets, calculated as the annualized Sharpe ratio of the pricing kernel with mean equal to the U.S. risk-free rate and minimum variance. As shown in the Table, the results suggest relatively substantial improvements in the Sharpe ratio in all countries except Chile. The improvement in Argentina is 6.7% relative to the Sharpe ratio implied by corporate securities alone; the results indicate improvement for the remaining countries between 21.7% in Korea and 159.4% in Venezuela, with the overall average improvement as 54%. This evidence is confirmed graphically in Figure 2, which presents Hansen and Jagannathan (1991) bounds for the sets of securities in the different countries. As shown, shifts in the bounds appear substantial for all countries except Chile.

We investigate one additional spanning test. In this test, we investigate whether the sovereign bonds are spanned by a set of U.S. Treasury securities and the emerging market corporate bonds. In the tests above, it is possible that some of the spanning enhancement in sovereign bonds relative to corporate bonds occurs because the sovereign bonds permit investors to better span risks in the default-free term structure. If investors are able to invest in U.S. Treasury securities, these securities provide a natural way of extracting these risks rather than sovereign securities.[15]

Results of these tests are presented in Table 5. We utilize the six U.S. Treasury security returns discussed in the previous section to represent the set of default-free assets available to investors. As shown in the table, the inclusion of the Treasury securities suggests that the corporate and treasury securities span the sovereign securities in the Philippines and Venezuela, in addition to Brazil as discussed above. The null hypothesis of spanning is rejected at the 5% level in Chile, Korea, and Mexico, and at the 10% level in Thailand. Curiously, the spanning tests suggest that the set of corporate plus treasury securities do not span the sovereign bonds in Argentina, rejecting the null at the 5% level, while the earlier evidence suggests that corporate bonds alone span the sovereign securities. We conjecture that these results are due to the statistical properties of the test; in particular, Bekaert and Urias (1996) show that increasing the number of securities in the spanning test can affect the size and power of the test. The increase in Sharpe ratio in Argentina is only 1.5%; indeed, the average increase in Sharpe ratio is considerably smaller, at 5.1%. Nonetheless, the results suggest that for half of the countries the inclusion of sovereign bonds in addition to corporate and U.S. Treasury bonds enhances investors' opportunity set. In these four countries, Chile, Korea, Mexico, and Thailand, the average Sharpe ratio improvement from the inclusion of sovereign securities is 7.9%.

In summary, the evidence presented in this section suggests that the presence of sovereign bonds in a market contributes to an improvement in investors' opportunity sets. The evidence points to a statistically significant shift in the opportunity set in six of the eight countries, and an economically significant shift in seven of the eight countries. These results suggest that sovereign bonds systematically improve investors' opportunities and information sets in emerging markets. In the next section, we more formally consider the information content of these bonds, and examine whether pricing information is conveyed through the sovereign or the corporate bond channel.

3.3 Price Discovery

The second impact that sovereign securities may have on a market is price discovery. As discussed above, and detailed in Yuan (2005), the presence of a benchmark security can enhance price discovery, since agents are better able to gather information about systematic factors. This improvement allows more agents to gather information on firm-specific innovations, improving price discovery in these securities as well. In this section, we address the question of where price discovery occurs in emerging bond markets; in the sovereign or the corporate issues. The information transmission story suggested in Yuan (2005) suggests that common information is discovered in the sovereign market, leading to a transmission of information from the sovereign instruments to the corporate instruments.

3.3.1 Empirical Methodology

As in Hasbrouck (1995, 2003), we utilize variance decompositions from a vector autoregression representation of the yield spreads on corporate and sovereign securities to assess the contribution of each asset to price discovery. In contrast to the spanning tests above, we utilize daily data on the stripped yield spread over treasuries. Further, since we are interested in analyzing an average impact on price informativeness in a market, we simply create equal-weighted portfolios of the corporate and the sovereign instruments in the market. We confine our attention to the set of instruments and time frame represented by the time-homogeneous set of securities considered in the analysis on spanning.

One issue that is apparent in the series is the effect of the Russian default and Asian currency crisis. The data for Argentina, Brazil, Mexico, Korea, and Venezuela span the currency crisis, which we define as beginning July 2, 1997 with the devaluation of the Thai Baht, and ending October 17, 1998 with the U.S. Federal Reserve's third interest rate cut. The crisis appears to generate three distinct periods in the series: the pre-crisis period, with relatively low yield spreads, the crisis period, with quite high spreads, and a post-crisis period, in which spreads are higher than pre-crisis, but lower than during the crisis period.

We elect to deal with the crisis in a straightforward manner; as discussed above, we wish to explore the impact on price discovery beyond the impact of the U.S. Treasury market. Therefore, we examine orthogonalized yield spreads as the residual in a regression:

$$ys_{\{c,s\},t} = \delta_0 + \delta_1 I_{crisis,t} + \delta_2 I_{post-crisis,t} + \beta' X_t + ys^{\perp}_{\{c,s\},t} \tag{11}$$

where $I_{crisis,t}$ is an indicator variable that takes on value 1 during the crisis period and zero otherwise, $I_{post-crisis,t}$ takes on a value 1 after the crisis, and zero otherwise, and X_t represents the vector of three principal components retrieved from the U.S. term structure discussed above.[16] The residuals, $ys^{\perp}_{\{c,s\},t}$, represent the orthogonalized yield spreads and are presented in Figure 3. As shown, although volatility is higher during the crisis period, the yield spreads look quite stationary. Indeed, as shown in Table 6, we reject the null hypothesis of a unit root at the 5% significance level in all eight countries' sovereign and corporate bond portfolios.

The intuition for assessing price discovery follows Hasbrouck (1995, 2003), and is based on variance decompositions for VARs discussed in Hamilton (1994). As discussed in Section 2, we have assumed an autoregressive process for the state variables underlying the log bond prices. Since yield spreads are simply an affine transformation of these state variables, we can write

$$\Phi(L)\mathbf{ys}_t^{\perp} = \mathbf{e}_t \tag{12}$$

where $\Phi(L)$ is a polynomial in the lag operator, $\mathbf{ys}_t^{\perp}$ is a vector of the orthogonalized corporate and sovereign portfolio yield spread from the regression (11), and $\mathbf{e}_t$ is an i.i.d. error term. The first step of our procedure is to estimate the parameters Φ of this vector autoregression and retrieve the residuals. We discuss the lag length in the VAR in greater detail below.

Given the residuals, $\mathbf{e}_t$, of the VAR, we construct their sample covariance matrix $\hat{\Sigma}$. As discussed in Hamilton (1994), since this matrix is positive definite, we can decompose the covariance matrix into a unique lower triangular matrix $\mathbf{A}$ and diagonal matrix $\mathbf{D}$ such that

$$\hat{\Sigma} = \mathbf{ADA}' \tag{13}$$

The elements of $\mathbf{D}$ are the diagonal elements of $\hat{\Sigma}$. We then construct a set of orthogonal residuals using $\mathbf{A}$:

$$\mathbf{u}_t = \mathbf{A}^{-1}\mathbf{e}_t \tag{14}$$

Again, these residuals represent orthogonalized shocks to corporate and sovereign bond yield spreads in the VAR.

The orthogonalized residuals, $\mathbf{u}_t$ are used in conjunction with the vector moving average (VMA) representation of the VAR to decompose the variance of yield spreads into components attributable to shocks in corporate yield spreads, $e_{c,t}$, and sovereign yield spreads, $e_{s,t}$. The propagation of these shocks through the yield spread system is characterized by this companion moving average representation:

$$\mathbf{ys}_t^{\perp} = \Psi(L)\mathbf{e}_t \tag{15}$$

The VMA representation allows us to express the mean-squared error of a τ-period forecast of the yield spread as

$$MSE\left(\hat{\mathbf{ys}}_{t+\tau|t}^{\perp}\right) = \sum_{k=0}^{\tau-1} \Psi_k \hat{\Sigma} \Psi_k' \tag{16}$$

with $\Psi_0 = \mathbf{I}$. The orthogonalized residuals allow us to separate the components of this MSE into components attributable solely to innovations in the corporate yield spreads and to innovations in the sovereign yield spreads. Noting that $\hat{\Sigma} = \mathbf{A}E\left[\mathbf{u}_t\mathbf{u}_t'\right]\mathbf{A}'$, we can re-express the forecast mean-squared error as

$$MSE\left(\hat{\mathbf{ys}}_{t+\tau|t}^{\perp}\right) = \sum_{j=c,s} \sum_{k=0}^{\tau-1} \Psi_k \mathbf{a}_j \mathbf{a}_j' \Psi_k' Var\left(u_{jt}\right) \tag{17}$$

where $\mathbf{a}_c$ and $\mathbf{a}_s$ are the columns of the matrix $\mathbf{A}$ corresponding to the corporate and sovereign bonds, respectively.

As discussed above, construction of the forecast mean-squared error as above allows us to separate the forecast error into components related solely to innovations in corporate bond yield spreads and to innovations in sovereign bond yield spreads. In the limiting case $\tau \to \infty$, the forecast mean-squared error converges to the unconditional covariance matrix of the yield spreads. Hasbrouck (1995, 2003) refers to the portion of the unconditional variance attributable to an element of the VAR as the "information share" of the market, since innovations in the series represent unanticipated news. We report the fraction of the unconditional variance in corporate yield spreads that can be attributed to orthogonalized variations in sovereign yield spreads and, following Hasbrouck, interpret this quantity as a measure of how much of corporate market-relevant information is discovered in the sovereign market.

If the matrix $\mathbf{A}$ is diagonal, the orthogonalization will be exact, and we will have a perfect representation of the proportion of variation coming from innovations in each market. Unfortunately, in general $\mathbf{A}$ will not be diagonal. However, we can place bounds on the variance contribution by simply reordering the spreads in the VAR. If the sovereign spread is the first variable in the VAR, we will obtain an upper bound on the proportion of volatility in the corporate market attributable to the sovereign market. Estimating the VAR with the corporate spread as the first variable provides the complementary lower bound.

In addition to the variance decompositions, we also examine the impact of innovations in the corporate and sovereign yield spreads on future realizations of the yield spreads. We do so by examining the impulse response function for the VAR system in each country. Specifically, we consider the orthogonalized impact of a unit shock to each equation in the system on the future realization of the system. That is, we can calculate the impact of a shock to the system at horizon τ as

$$\Delta \hat{\mathbf{y}}\mathbf{s}^{\perp}_{t+\tau} = \Psi_{\tau}\mathbf{a}_j \tag{18}$$

where $\mathbf{a}_j$ again represents the j^{th} column of the matrix $\mathbf{A}$ above, with $j = \{c, s\}$. Of particular interest in our case is the cumulative impulse response function,

$$\hat{\mathbf{y}}\mathbf{s}^{\perp}_{t+\tau} = \sum_{\tau} \Psi_{\tau}\mathbf{a}_j \tag{19}$$

This quantity informs us of the long-run impact of a shock in the system on the yield spread.

3.3.2 Empirical Results

We estimate VARs for the sovereign and corporate bond portfolios of eight countries. The lag length in the VAR is determined via a recursive likelihood ratio test with the null hypothesis that a VAR with lag l is preferred to a VAR with lag $l + 1$.[17] We set the maximum lag length to 20 lags, corresponding to a time frame of approximately one month. This procedure produces VARs of 18 lags in all countries; the results are not materially impacted by reducing the number of lags. For brevity, we do not provide the VAR results.[18]

The bounds on the information share in each market are presented in Table 7. As shown, the maximum information shares in all markets suggest a substantial role for the sovereign securities. In five of the eight markets (Argentina, Brazil, Korea, the Philippines, and Venezuela), the maximum information share in the sovereign market exceeds 50%. The minimum information share exceeds 20% in all markets with the exception of Chile. Thus, the variance decomposition results suggest that a substantial portion of the price discovery in these markets is attributable to the sovereign market. Although these bounds are fairly wide, the results suggest that over one-fifth of the information in corporate bond yield spreads can be traced to innovations in the sovereign bond market.

To further assess the impact of sovereign bonds on price discovery, we examine the cumulative impulse response functions for the vector autoregressions. These response functions represent the *long-run* impact of a shock in the sovereign market on pricing in the corporate market. The quantities depicted are not the impact of an instantaneous shock in the sovereign market on the yield spread on the yield spread in the corporate market. Rather, the impulse response functions indicate the eventual impact of a shock in sovereign market on the yield spread in the corporate market if there are no shocks to the corporate market, and no new information arrives in the market. That is, the impulse response functions indicate the eventual impact of discovery of information in the sovereign market on pricing in the corporate market.

These response functions are plotted in Figure 4 and represent the cumulative impact of a one standard deviation change in the logged, de-meaned and de-trended yield spread on sovereign bond issues on the logged, de-meaned, and de-trended yield spread on corporate bond issues. As shown in the figure, for most of the countries (Argentina, Brazil, Chile, Mexico, the Philippines, and Venezuela), shocks propagate relatively slowly through the system and then plateau after a period of about 50 to 100 days. In each of these six markets, the standard deviation of a de-meaned and de-trended shock is just over one basis point. The long-run impact of this shock on the corporate yield spread is approximately 5.7 basis points in Argentina, 4.9 basis points in Brazil, 1.1 basis points in Chile, 6.2 basis points in Korea, 0.9 basis points in Mexico, 1.8 basis points in the Philippines, and 12.8 basis points in Venezuela. Given the small size of a one standard deviation shock, the economic magnitude of these shocks is quite large.

Thailand presents a somewhat different picture than the remaining countries. Like Mexico and, to a lesser extent Argentina, Brazil, the Philippines, and Venezuela, the impact of the shock reverts at some point over the function. As stated, this effect is most pronounced in Mexico, where the cumulative impulse response function peaks at approximately 5 basis points, but reverts to a bit less than 1 basis point in the long run. Thailand represents more oscillatory behavior: the cumulative impulse response function peaks in excess of 1.5 basis points, drops below -1 basis point, and stabilizes around -0.5 basis points. Our suspicion is that, as the Thai series is the shortest of those examined, that we are unable to accurately capture the dynamics of price discovery in this market. However, with the exception of the Thai market, we conclude that an innovation in the sovereign market has a large impact for most markets on future yield spreads.

3.4 Price Impact of Sovereign Bond Issuance on Existing Bonds

To test the liquidity effect of new benchmark sovereign issues on corporate bonds, we employ a standard event study methodology. We construct a time window around each benchmark sovereign issue date and estimate the liquidity effect as the change in corporate bonds' stripped yield spreads and bid-ask spreads in response to a new sovereign issue within the time window for each country. If the introduction of a sovereign benchmark lowers the liquidity premium on corporate bonds as suggested by Subrahmanyam (1991), Gorton and Pennacchi (1993), and Yuan (2005), we should observe that corporate yield and bid-ask spreads drop relatively more than the corresponding spreads on sovereign bonds. The reason is that corporate bonds are exposed to both systematic and idiosyncratic risk factors while sovereign bonds are only exposed to the systematic risk factor. Upon the introduction of a benchmark, adverse selection is lower in the trading of both systematic and idiosyncratic risk factors. This in turn promotes information production and lowers liquidity premia associated with the trading of both risk factors.

As in most event studies, the issue decision may be endogenous. That is, the government may time sovereign issuances and choose to issue when yields are low and liquidity is high. Endogeneity may result in upward-biased estimates of the mean liquidity effect of sovereign bonds. To address these concerns, we project stripped yield spreads on the first three principal components of the default-free term structure, EMBI spread, and exchange rate, similar to our analysis in the preceding section:

$$ys_{\{c,s\},t} = \delta_{10} + \beta_1' X_t + \gamma_{11} ex_t + \gamma_{12} embi_t + u^{ys}_{\{c,s\},t} \tag{20}$$

$$bs_{\{c,s\},t} = \delta_{20} + \beta_2' X_t + \gamma_{21} ex_t + \gamma_{22} embi_t + u^{bs}_{\{c,s\},t} \tag{21}$$

where $ys_{\{c,s\},t}$ represents the stripped yield spread on corporate (c) and sovereign (s)

instruments and $bs_{\{c,s\},t}$ represents the bid-ask spread on corporate and sovereign instruments. The variables X_t are the principal components in the U.S. term structure discussed above, ex_t is the local currency-U.S. dollar exchange rate, and $embi_t$ is the stripped yield spread on the country EMBI index. All variables are expressed in logs.

The objects of interest in our analysis are the residuals in the above expression, $u^{ys}_{\{c,s\},t}$ and $u^{bs}_{\{c,s\},t}$, which represent the innovation in the yield and bid-ask spread, respectively, independent of information in the default-free term structure, exchange rates, or average yield movements in the country. We examine the impact of a sovereign issue on these residuals for existing corporate and sovereign bonds. Our motivation for using these controls is to remove as much of the effects of the default-free term structure and timing concerns as possible. In particular, the EMBI spread represents an instrument for the government market timing decision. This spread is the spread on an average existing sovereign bond. Consequently, if market liquidity or yield conditions are favorable, independent of the new bond issuance, these conditions should be reflected in the existing sovereign bonds and, hence, the EMBI spread. In this case, we expect to see no reduction in the spread differential between corporate and corresponding sovereign bonds after the sovereign benchmark issuance.

Our specific framework is as follows. Define an indicator variable, I^s_t, where $I^s_t = 1$ after a new sovereign issue is traded and 0 otherwise. We omit Thailand and Chile because there is no EMBI available. For each of the remaining six countries, Argentina, Brazil, Korean, Mexico, the Philippines, and Venezuela, we estimate the coefficients of the following regression using fixed effects on each sovereign issue window for corresponding corporate bonds:[19]

$$u^{ys}_{i,j} = \alpha_s + \beta_s I^s_t + \sum_k \kappa_k Iss_k + \sum_l \kappa_l New_l + \sum_t \kappa_t t + \epsilon^{ys}_{i,j} \quad (22)$$

$$u^{bs}_{i,j} = \alpha_b + \beta_b I^s_t + \sum_k \kappa_k Iss_k + \sum_l \kappa_l New_l + \sum_t \kappa_t t + \epsilon^{bs}_{i,j} \quad (23)$$

where k refers to the kth. issuer, l indicates the lth new sovereign issue, Iss_k, New_l, and t are dummy variables for each issuer, each event window, and each distinct month and year combination, respectively. The parameters (αs and βs) are constrained to be the same across issuers in the same country. Therefore, in this specification, as yield and bid-ask spread residuals, $u^{ys}_{i,j,t}$ and $u^{bs}_{i,j,t}$, are net of term structure effects and default risk factors, the coefficient on I^s_t measures only the liquidity service of a new sovereign issue: A negative coefficient indicates that sovereign bonds have a liquidity service and the magnitude of the liquidity service is measured by the absolute value of the coefficient. All estimation is conducted using fixed effects on each sovereign issue event window, where standard errors are corrected based on Newey and West (1987). The estimation is performed for six event windows, ranging from 7 weeks to 2 weeks prior and subsequent to the sovereign issue date.[20]

Results of estimation using stripped yield spreads are reported in Panel A of Table 8. As indicated in the Table, the introduction of a sovereign bond has a statistically significant impact on the stripped yield spreads of corporate bonds in Argentina, Brazil, Mexico, and Venezuela. The results suggest that the introduction of a new sovereign bond results in a reduction in the stripped yield spread of bonds in these countries, consistent with the hypothesis advanced above. That is, the evidence suggests that the introduction of a new sovereign issue results in greater ability to hedge systematic risk, which in turn lowers adverse selection costs, and improves liquidity. Results for Mexico are statistically significant only at the -2-week, +2-week window, but indicate a reduction in the yield spread out to the -5-week, +5-week window. Results in Korea and the Philippines are not statistically significant.

In order to interpret these results, consider the Venezuelan corporate market. In this market, the average reduction in spread upon the introduction of a new sovereign bond is 5.9% or, evaluated at the average daily corporate spread, approximately 26 basis points. This 26 basis points quantity is approximately four times the average bid-ask spread in the Venezuelan corporate bond market. Thus, the reduction in spread is economically significant and far exceeds transaction costs. Again, the result is indicative of a price impact of new sovereign issues on the pricing of corporate bonds. We note, however, that without further decomposition of the yield spread, we cannot conclusively tie the improvement in the yield spread to liquidity. The reason is that the yield spread contains both a credit and a liquidity component. While we argue that using yield spreads orthogonalized relative to the EMBI should control for much of this credit component, we acknowledge that some of the improvement in the yield spread may be due to credit risk impacts.

Results for bid-ask spreads are presented in Panel B. As shown in the table, the introduction of a new sovereign issue leads to a reduction in the bid-ask spread at all windows in Argentina, Korea, Mexico, and Venezuela. These reductions are all statistically significant, with the exception of the shortest (-2-week, +2-week) window in Argentina. These results support the conclusion that sovereign bonds' price impact is related to the liquidity service of these bonds. The average reduction in spreads is in excess of 17% in Argentina, 26% in Korea, 9% in Mexico, and 8% in Venezuela. In summary, the results suggest that the issuance of sovereign bonds has an impact on the pricing of corporate bonds in the secondary market after controlling for potential sources of systematic risk, indicating that the price impact comes from liquidity improvement. The liquidity service of sovereign bonds appears both economically and statistically significant across most of the bond markets in our study.[21]

Since our data are quote data, a natural concern is whether these quotes reflect information or stale prices. Several studies, including Bekaert, Harvey, and Lundblad (2005), Lesmond, Schill, and Zhou (2004), and Chen, Lesmond, and Wei (2005) examine the extent of stable prices by computing the percentage of zero returns. Chen, Lesmond, and Wei (2005) study the percentage of zero returns in U.S. corporate bonds and find the percentage ranges from 3.88% to 41%. As a robustness check, we also calculate the percentage of zero returns, returns less than 5 bp in absolute value, and less than 10 bp in absolute value.[22] The percentage of zero returns in our sample range from 0.005% to 0.265% of quotes; results are similar for the 5 bp screen and approach those in other studies only for the 10 bp screen. As a 5 bp spread exceeds the bid-ask spread, we suggest that stale quotes are not responsible for the low percentage of zero returns; market makers would be providing arbitrage opportunities by moving quotes in this magnitude without information. However, we acknowledge that, due to the fact that we only have quote data available, stale quotes are a potential concern.

3.5 Interpreting the Results Across Countries

Thus far, we have found that for many countries, the presence of a sovereign bond market leads to spanning enhancement, improved price discovery through the sovereign market, and improvement in liquidity as measured by the bid-ask spread. However, these gains are not universal across countries in our sample. A natural question to ask is whether there are any differences among these countries that can help us understand why some of these countries improve in certain regards and others do not.

Our ability to investigate this issue is limited by the fact that we have only eight countries in our sample, significantly impacting any statistical power in tests that we may conduct. We confine our discussion in this section to largely qualitative discussions of the correlations between the measures of improvement that we discuss in the paper and cross-sectional variables measuring differences among the countries. In particular, we examine: (1) the Sharpe ratio improvement of corporates, sovereigns, and U.S. treasuries relative to corporates and U.S. treasuries; (2) The minimum corporate information share attributable to sovereigns; and (3) the (-7,+7) week bid-ask spread change. We compare these variables to the Index of Economic Freedom variables from the Heritage Foundation.[23] We examine these economic freedom variables in 2000, at the end of the time series for the countries in our sample.

We present the correlations between the measures of improvement conferred by sovereign instruments and the index of economic freedom variables in Table 9. Correlations that are statistically different than zero at the 10% level are presented in boldface type; again, caution must be exercised in interpreting these coefficients as there are 8 or fewer observations for each correlation. The index of economic freedom ranks variables on a scale of 1 (most conducive to economic freedom) to 5 (least conducive to economic freedom). Therefore, a high correlation between the improvement measure and a variable indicates that the benefit is greater for less free countries. We express the bid-ask spread in terms of bid-ask improvement (minus one times the bid-ask reduction) in order to provide a consistent interpretation across these measures.

The first point to note from the table is that the improvement in bid-ask spread and the information share of sovereign bonds are strongly related to overall economic freedom. Interestingly, the signs on these variables are reversed. That is, the correlations suggest that the less economically free the country, the greater the benefit of sovereign bonds through information transmission; in contrast, the more economically free the country, the greater the benefit of sovereign bonds through liquidity improvement. Further insight into these patterns are gained by examining the components of the index that are significantly related to these improvement measures. The same variables seem to impact both the bid-ask spread improvement and price discovery: monetary policy, foreign investment, personal property rights regulation, and informal markets. All of these variables capture financial market development and openness. Thus, the results suggest that liquidity benefits of sovereign bonds are relatively higher for more developed and open capital markets, whereas price discovery benefits are relatively higher for less developed and open markets. These results seem sensible; for liquidity to be a dominating concern for investors, capital markets must be relatively free, open, and well-functioning. In contrast, in financial markets in which governments frequently intervene and regulation is poor, informational benefits are likely to dominate other benefits for investors.

The Sharpe ratio improvement is not significantly related to overall economic freedom, but does show strong correlation with the freedom of the banking center and government regulation. Our interpretation of spanning enhancement is that sovereign bonds permit investors to isolate systematic risk components of asset payoffs from firm-specific components. In an economy where the government tightly regulates and restricts entry into business and interferes in the banking and financial markets, the transparency of corporate fundamentals will be quite low; it will be difficult to disentangle these fundamentals from government interference. With the addition of sovereign bonds, with prices that are less subject to these concerns, investors can isolate the firm-specific components of asset payoffs from systematic components, allowing a spanning enhancement.

In general, these results suggest that the less economically free the country, the greater the improvements conferred by sovereign bonds in terms of enhancing the investment opportunity set and conveying information. In contrast, the more free the country, the greater the benefits from liquidity improvement. Again, we caution against an overly strong interpretation of these results due to the small sample size, but suggest that these measures of economic development seem to provide further insight into why different countries benefit differently from the presence of sovereign bonds.

4 Conclusion

In this paper, we ask the question of whether sovereign bonds represent an improvement or a drain on emerging corporate bond markets. Our evidence suggests that the answer is that these bonds improve the corporate bond market. We investigate the benchmark role of sovereign bonds in three ways: examining improvements in investors' opportunity sets derived from the inclusion of sovereign bonds in a market, investigating whether the existence of sovereign bonds contributes to price discovery in a market, and determining whether these bonds have an effect on pricing of corporate securities above and beyond that represented by improved spanning of systematic market factors. The answer to all of these questions, based on our evidence, is yes.

The source of the gains from the presence of sovereign bonds in a market appear to be spanning, price discovery, and liquidity enhancement. The evidence suggests that introducing sovereign bonds improves investors' abilities to span the systematic risks of the market, which in turn allows traders in corporate markets to better understand systematic pricing risks. Through their improved ability to hedge these risks and price bonds, we observe greater information production due to lower adverse selection costs. Consequently, we see a large impact of price discovery in sovereign markets on corporate markets, and witness a reduction in yield and bid-ask spreads in the corporate markets. In other words, sovereign bonds enhance corporate bond markets in emerging economies by providing more information, stimulating information production, and thereby generating reduced adverse selection costs and improved liquidity.

As we note, several east Asian countries are preparing to launch, or have recently launched sovereign bonds, most notably China. Our results suggest that the issuance of these bonds will represent an improvement for the Chinese bond market.[24] As the sovereign market grows in these countries, we expect to see overall information revelation and the liquidity of corporate bond markets in these countries improve. In summary, our evidence suggests that sovereign bond issuances are essential for developing vibrant corporate bond markets in emerging economies.

Figure Legends

Figure 1: Corporate and Sovereign Portfolio Stripped Yield Spreads. This figure presents the time series stripped yield spreads for sovereign (in solid lines) and corporate (in dotted lines) portfolios during the sample period of the following countries: Argentina, Brazil, Chile, Korea, Mexico, the Philippines, Thailand, and Venezuela.

Figure 2: Hansen-Jagannathan Bounds. This figure presents Hansen-Jagannathan (1991) bounds on admissible pricing kernels for two asset sets; corporate bonds alone in solid lines and corporate bonds plus sovereign bonds in dotted lines. The bounds are constructed using weekly returns on value-weighted portfolios of sovereign and corporate bonds. All plots are bounded by [0.97,1.01] in x-axis.

Figure 3: Corporate and Sovereign Portfolio Stripped Yield Spreads. This figure presents the time series stripped yield spreads for sovereign (in solid lines) and corporate (in dotted lines) portfolios during the sample period of the following countries: Argentina, Brazil, Chile, Korea, Mexico, the Philippines, Thailand, and Venezuela. Spreads are orthogonalized relative to the principal components in the U.S. term structure and effects of the Asian currency crisis on the mean spread are removed.

Figure 4: Impulse Response Functions. This figure presents impulse response functions for the effect of a one standard deviation shock in the sovereign stripped spread yield on the corporate stripped spread yield. Shocks are orthogonalized using a Cholesky decomposition, and are based on the VAR results supporting Table 7.

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Notes

[1]This objective is drawn from remarks made by the Chilean Minister of Finance, Dr. Eduardo Aninat, reported by the *Financial Times* on April 21, 1999. The Chilean government did not issue the bond to finance a budget deficit as it had a fiscal surplus of 131.2 billion Pesos in 1998 and 623.2 billion Pesos in 1997. Nor did it issue the bond to time the market, as the risk premium for emerging market securities was quite high at the time. The J.P. Morgan emerging-market bond index (EMBI) was priced at an average of 618 basis points over comparable treasuries from 1997 to 1998, but was priced at an average of 1130 basis points for the first four months of 1999.

[2]In October 2004, the Chinese government issued a $1.5 billion ten-year and $500 million five-year global bond, denominated in euros. The ten-year bond is the largest issue and has the longest maturity of euro-denominated bonds sold by an Asian country. The purpose, quoted by a Chinese officer in charge of foreign debt under the Ministry of Finance, "is to establish a benchmark bond with more liquidity instead of just raising money ... and to lower the costs of bond issuances for those Chinese enterprises who plan to finance overseas," (Bloomberg.com, October 19, 2004). Verifying this claim, Wang Zhao, a senior researcher at the State Council's Development Research Center said that, in fact, China does not need foreign currency because it has sufficient foreign exchange reserves. He pointed out that the country's foreign exchange reserves reached $514.5 billion by the end of September, 2004, an increase of US $111.2 billion from the beginning of the year (*Financial Times*, October 25, 2004).

[3]A cursory examination of the time series relationship patterns of sovereign issuances relative to the corresponding exchange rate movements in our sample suggests that the issuing decision of sovereign bonds in emerging markets is not solely motivated by favorable exchange rate conditions and could be motivated by financing budget deficits

or enhancing bond market liquidity.

[4] By benchmark securities, we refer to securities that are influenced only by systematic factors, which may include globally systematic factors. We are not attempting to define the benchmark status of the bond, which is a separate issue discussed in detail, for example, in Dunne, Moore, and Portes (2003).

[5] In addition to the standard market microstructure benefits of hedging adverse selection risks, sovereign bonds can allow emerging markets investors to hedge international trade risks. This benefit is a potential additional strength of the benchmark status of sovereign bonds. For countries in our sample, risks in international trade can be quite large. For example, the magnitude and percentage of total trade of these countries with the U.S. is quite large. We thank an anonymous referee for making this point.

[6] The recent work by Krishnamurthy and Vissing-Jorgensen (2006) shows that the size of Treasury debt in the U.S. is negatively correlated with the spread between corporate bond yields and Treasury bond yields. This result indicates Treasury securities provide a "convenience" value, which is consistent with the findings of our paper.

[7] This study investigates the spill-over effect of sovereign bonds on corporate bonds, rather than the primary reasons why sovereign entities issue bonds. Governments issue bonds for a number of reasons. For example, they may issue bonds to finance fiscal deficits or to refinance existing debt at better terms.

[8] More precisely, in Subrahmanyam (1991), the benchmark security is the basket of existing securities. He finds that the introduction of a basket security may lower the price informativeness for securities that have lower weights in the benchmark. Gorton and Pennacchi (1993) find that the introduction of a benchmark security eliminates all trading in the individual securities when traders have homogenous preferences and

endowment distributions.

[9]We note that a special feature of sovereign bonds is that they are subject to sovereign default risk. This risk is generally political, rather than economic in nature. If the payoffs on the corporate assets are independent of this political risk, it will be impossible for corporate bonds to span sovereign bonds. However, sovereign defaults do generally impact the prices of corporate bonds in the country, as observed in the Russian default in 1998. Thus, the corporate bonds' payoff is most likely not independent of this political risk factor.

[10]We exclude convertible and floating rates bond issues on the grounds that the risks and relationships to fundamentals are different and warrant a separate analysis.

[11]Our sample also includes Russian bonds (nine sovereign and five corporate bonds). Since our sample period covers the Russian default and observations for most Russian bonds during the crisis period are missing, it is infeasible for us to conduct the price impact analysis for Russian bonds. We therefore choose to omit reporting summary statistics on Russian bonds, but they are available upon request.

[12]The event study is conducted for the period between May 1, 1996 and July 24, 2000 so that appropriate event window length can be constructed.

[13]Normally, spreads on sovereign bonds establish a sovereign ceiling and have a lower spread than corresponding corporate bonds. Occasionally (although very rarely), some corporations may be regarded by investors as better investments than sovereign securities because these firms either do not have much exchange rate risk exposure or have a better revenue outlook. In the case of Argentina, Bco Credito, Perex, and the City of Buenos Aries break this ceiling and have bonds traded below the average sovereign spread. In the case of Brazil, Petrobras, Telebras, Bco Safra, Unibanco, and Bamerindus have bonds

traded below the average sovereign spread.

[14]Throughout, we use a 10% critical value to establish statistical significance. This choice is motivated by the low power of the spanning tests, documented in Bekaert and Urias (1996). We clarify, however, whether null hypotheses are rejected at the 10% or 5% critical level in the text.

[15]We thank a referee for suggesting that we investigate this issue.

[16]Our data span the pre-crisis, crisis, and post-crisis data only in Korea. In Argentina, Brazil, Mexico, and Venzuela, since the data occur only during and after the crisis, we restrict $\delta_1 = 0$. In Chile, the Philippines, and Thailand, all data are after the crisis; consequently, we restrict $\delta_1 = \delta_2 = 0$ for these countries.

[17]Similar results are obtained with different lag lengths, and the BIC suggests similar lag structures.

[18]These results are, however, available from the authors upon request.

[19]We report the estimation results for corporate issues in excess of $200 million face value at issuance, as smaller issues are very thinly traded. The results are similar when we include all corporate bonds in the estimation.

[20]We have examined windows as long as 12 months before and after a sovereign new issue date. The results are qualitatively similar, but exhibit weaker statistical significance.

[21]As a robustness check, we have also estimated equations (16) and (17) excluding the crisis period (from July 2, 1997 to October 17, 1998). The results are similar with a slight improvement in the level of statistical significance.

[22]These results are available from the authors upon request.

[23]Data are obtained from the website http://www.heritage.org/research/features/index/.

[24]The 10-year and 5-year benchmark bonds issued by the Chinese government in October, 2004 were heavily oversubscribed. The 10-year tranche saw demand of approximately 4.2 times the allocation, while the 5-year tranche received orders three times the allocation. The issuance was hailed as a "landmark achievement" by practitioners. According to Cristian Jonsson, the head of Asia debt syndicate at UBS, China has "established the first major euro benchmark and set an example to the Asian sovereign and corporate issues in the euro market," (*South China Morning Post*, October 22, 2004).

Table 1: Summary Statistics (Issues and Issuers)

This table reports total numbers of sovereign and corporate bonds for each country over the sample period. The sample period starts on January 3, 1996 and ends on November 20, 2000. It also reports the number of new sovereign bonds issued between May 1, 1996 and September 30, 2000.

Country	Sovereign Bonds	Corporate Bonds	New Sovereign Bonds
Argentina	22	47	11
Brazil	11	34	10
Chile	1	22	1
Korea	18	17	10
Mexico	30	82	12
Philippines	7	16	6
Thailand	2	8	1
Venezuela	7	13	3

Table 2: Summary Statistics (Daily Prices)

This table reports numbers of observations, means and standard deviations (in parentheses) of daily strip spread over treasury, bid-ask spread, and J.P. Morgan-Chase emerging-market bond spread index (EMBI) for each country in the sample. The sample period starts on January 3, 1996 and ends on November 20, 2000. Daily strip spreads over treasury are calculated using offer prices after the collaterialized components (principal and/or interest) are stripped off and are in basis points. Daily bid-ask spreads are relative bid-ask spreads in percentage points.

Country	Observations		Strip Spread		Bid Ask Spread		EMBI
	Sovereign	Corporate	Sovereign	Corporate	Sovereign	Corporate	
Argentina	11001	30624	436.219	427.691	0.671	1.441	646.867
			(211.933)	(345.655)	(0.975)	(1.919)	(144.159)
Brazil	4339	22399	601.540	581.647	0.949	1.582	732.813
			(255.062)	(484.955)	(0.885)	(1.933)	(232.875)
Chile	354	7709	182.720	332.742	0.830	1.165	187.017
			(24.104)	(286.715)	(0.357)	(1.494)	(9.650)
Korea	12558	4689	247.239	377.095	0.716	1.674	205.366
			(211.963)	(435.182)	(0.675)	(3.213)	(176.415)
Mexico	21308	51594	293.414	541.322	0.860	1.416	540.283
			(144.878)	(4999.890)	(0.843)	(4.691)	(165.450)
Philippines	2724	7006	402.222	535.968	0.809	2.138	450.453
			(165.006)	(981.728)	(0.602)	(1.544)	(152.777)
Thailand	1430	2206	240.589	1039.290	1.314	2.595	114.707
			(152.792)	(1145.100)	(1.242)	(1.268)	(29.974)
Venezuela	2949	5051	658.015	440.694	1.771	1.470	811.973
			(401.027)	(234.762)	(1.827)	(1.799)	(548.290)

Table 3: Principal Components Analysis

This table presents the loadings of orthogonal principal components extracted from the covariance matrix of yields on representative Treasury securities. Securities are on-the-run securities with maturities closest to three months, one year, two years, five years, seven years, and 10 years. Yield data are obtained from CRSP and cover the period January, 1996 through November, 2000 at the daily frequency. Principal components are ordered in terms of the percentage of variation explained; only the first four principal component loadings are presented.

3-Month	0.233	0.732	0.612	-0.182
1-Year	0.366	0.427	-0.477	0.556
2-Year	0.440	0.135	-0.405	-0.289
5-Year	0.455	-0.179	-0.083	-0.227
7-Year	0.459	-0.288	0.084	-0.421
10-Year	0.447	-0.386	0.469	0.588
Pct. Explained	85.450	12.553	1.712	0.175

Table 4: Spanning Tests

This table presents tests of spanning following Bekaert and Urias (1996). The table presents tests of the null hypothesis that the corporate bond returns span the sovereign bond returns. The tests are performed via GMM using moment conditions

$$\begin{aligned} \frac{1}{T}\sum_{t=1}^{T} M_{1t}\{\mathbf{R}_t^c;\mathbf{R}_t^s\} - \iota &= 0 \\ \frac{1}{T}\sum_{t=1}^{T} M_{2t}\{\mathbf{R}_t^c;\mathbf{R}_t^s\} - \iota &= 0 \end{aligned}$$

where

$$\begin{aligned} M_{1t} &= \alpha_1 + \beta_1^c\left(\mathbf{R}_t^c - \bar{\mathbf{R}}^c\right) \\ M_{1t} &= \alpha_2 + \beta_2^c\left(\mathbf{R}_t^c - \bar{\mathbf{R}}^c\right) \end{aligned}$$

The variables $\mathbf{R}_t^c$ and $\mathbf{R}_t^s$ are the gross returns on the corporate and sovereign bonds, respectively. Standard errors are corrected using the Newey and West (1987) procedure, and p-values for the test of overidentifying restrictions are presented in parentheses. We also present the number of corporate (N_C) and sovereign (N_S) bonds in each country, the number of weekly observations (T), and the annualized Sharpe ratios of portfolios of corporate bonds alone (λ_C) and corporate plus sovereign bonds (λ_{C+S}).

Country	$J(p)$	Country	$J(p)$	Country	$J(p)$	Country	$J(p)$
AR	13.593 (0.192)	BR	4.843 (0.564)	CL	15.866 (0.009)	KR	35.227 (0.009)
T	151	T	151	T	72	T	151
N_C/N_S	13/5	N_C/N_S	11/3	N_C/N_S	21/1	N_C/N_S	3/9
λ_C/λ_{C+S}	0.116/0.124	λ_C/λ_{C+S}	0.059/0.082	λ_C/λ_{C+S}	0.353/0.354	λ_C/λ_{C+S}	0.054/0.065

Country	$J(p)$	Country	$J(p)$	Country	$J(p)$	Country	$J(p)$
MX	97.572 (0.000)	PH	11.415 (0.076)	TH	35.339 (0.000)	VE	8.612 (0.072)
T	160	T	81	T	87	T	137
N_C/N_S	18/11	N_C/N_S	6/3	N_C/N_S	2/2	N_C/N_S	1/2
λ_C/λ_{C+S}	0.186/0.263	λ_C/λ_{C+S}	0.122/0.211	λ_C/λ_{C+S}	0.111/0.210	λ_C/λ_{C+S}	0.013/0.035

Table 5: Spanning Tests: US and Corporate vs. Sovereign

This table presents tests of spanning following Bekaert and Urias (1996). The table presents tests of the null hypothesis that the U.S. Treasury and corporate bond returns span the sovereign bond returns. The tests are performed via GMM using moment conditions

$$\begin{aligned}\frac{1}{T}\sum_{t=1}^{T} M_{1t}\{\mathbf{R}_t^c;\mathbf{R}_t^u;\mathbf{R}_t^s\} - \iota &= 0\\ \frac{1}{T}\sum_{t=1}^{T} M_{2t}\{\mathbf{R}_t^c;\mathbf{R}_t^u;\mathbf{R}_t^s\} - \iota &= 0\end{aligned}$$

where

$$\begin{aligned}M_{1t} &= \alpha_1 + \beta_1^c\left(\mathbf{R}_t^c - \bar{R}^c\right) + \beta_1^u\left(\mathbf{R}_t^u - \bar{R}^u\right)\\ M_{1t} &= \alpha_2 + \beta_2^c\left(\mathbf{R}_t^c - \bar{R}^c\right) + \beta_2^u\left(\mathbf{R}_t^u - \bar{R}^u\right)\end{aligned}$$

The variables $\mathbf{R}_t^c$, $\mathbf{R}_t^u$, and $\mathbf{R}_t^s$ are the gross returns on the corporate, U.S. Treasury, and sovereign bonds, respectively. The means of the pricing kernels are set to $\alpha_1 = 0.99$ and $\alpha_2 = 1.01$. Standard errors are corrected using the Newey and West (1987) procedure, and p-values for the test of overidentifying restrictions are presented in parentheses. We also present the annualized Sharpe ratios of portfolios of corporate and U.S. Treasury bonds (λ_{U+C}) and corporate and U.S. Treasury plus sovereign bonds (λ_{U+C+S}).

Country	$J(p)$	Country	$J(p)$	Country	$J(p)$	Country	$J(p)$
AR	21.384 (0.019)	BR	2.187 (0.902)	CL	9.467 (0.009)	KR	39.862 (0.002)
λ_{U+C}	0.355	λ_{U+C}	0.336	λ_{U+C}	0.793	λ_{U+C}	0.295
λ_{U+C+S}	0.361	λ_{U+C+S}	0.339	λ_{U+C+S}	0.812	λ_{U+C+S}	0.304

Country	$J(p)$	Country	$J(p)$	Country	$J(p)$	Country	$J(p)$
MX	99.337 (0.000)	PH	8.956 (0.176)	TH	9.227 (0.056)	VE	4.540 (0.338)
λ_{U+C}	0.402	λ_{U+C}	0.405	λ_{U+C}	0.677	λ_{U+C}	0.297
λ_{U+C+S}	0.494	λ_{U+C+S}	0.429	λ_{U+C+S}	0.699	λ_{U+C+S}	0.300

Table 6: ADF Tests: Corporate and Sovereign Portfolio Spreads

Table 6 presents augmented Dickey-Fuller (ADF) tests for the stationarity of the orthogonalized spreads on corporate and sovereign portfolios. Spreads are orthogonalized using the regression

$$ys^{\perp}_{\{c,s\},t} = ys_{\{c,s\},t} - \left(\delta_0 + \delta_1 I_{crisis,t} + \delta_2 I_{post-crisis,t} + \beta' X_t\right)$$

where $I_{crisis,t}$ is an indicator variable that takes on value 1 during the Asian currency crisis period and zero otherwise, $I_{post-crisis,t}$ takes on a value 1 after the crisis, and zero otherwise, and X_t represents the vector of three principal components retrieved from the U.S. term structure. The ADF lags are determined using the recursive procedure suggested in Campbell and Perron (1991). We present the ADF test statistic and the 5% critical value for the null hypothesis of a unit root.

	Corporate		Sovereign	
	ADF	Crit.	ADF	Crit.
Argentina	-2.787	-1.957	-2.932	-1.957
Brazil	-3.339	-1.957	-3.468	-1.957
Chile	-3.662	-1.964	-4.227	-1.964
Korea	-4.046	-1.957	-3.096	-1.957
Mexico	-3.943	-1.957	-7.841	-1.957
Philippines	-2.598	-1.939	-2.610	-1.939
Thailand	-3.158	-1.968	-3.689	-1.991
Venezuela	-3.795	-1.957	-2.231	-1.957

Table 7: Variance Decompositions

Table 7 presents variance decompositions of the orthogonalized corporate yield spreads. Decompositions are performed using the vector moving average representation of the sovereign and corporate bond yield system:

$$ys_t^{\top} = \Psi(L)e_t$$

where $\Psi(L)$ is a lag polynomial. Decompositions are performed using the diagonalized form of the innovation covariance matrix, Σ:

$$\Sigma = \mathbf{ADA}'$$

where $\mathbf{D}$ is a diagonal matrix with the elements of the diagonal of Σ. The column labeled 'Max' represents the variance decomposition with the sovereign spread ordered first in the system; the column labeled 'Min' represents the decomposition with the corporate spread ordered first in the system.

Country	Max	Min
Argentina	0.803	0.284
Brazil	0.864	0.468
Chile	0.207	0.042
Korea	0.786	0.206
Mexico	0.341	0.219
Philippines	0.699	0.212
Thailand	0.422	0.343
Venezuela	0.793	0.729

Table 8: The Liquidity Service of Sovereign Bonds on Corporate Bonds

Table 8 reports the estimated effect of issuing a new sovereign bond on stripped spreads(in Panel A) and bid-ask spreads (in Panel B) of corresponding country's existing corporate bonds. The estimation is done for six event windows, each ranging from 7- to 2-week before the sovereign issue date to 7- to 2-week after the sovereign issue date. Regressions control for time, issue, and issuer fixed effects, and are performed by regressing the residual stripped yield spread or bid-ask spread on an indicator variable for the issue window. The bid-ask and yield spread residuals are obtained from a first stage projection of the bid-ask and yield spreads on U.S. Treasury principal components, the EMBI for the country, and the exchange rate. The estimations are pooled regressions for each of the following countries: Argentina, Brazil, Korea, Mexico, Philippines, and Venezuela, adjusted for event window, issuer, year fixed effects. Standard errors of the estimates are in parentheses, corrected based on Newey and West (1987).

Panel A: Yield Spreads

Window	ARG	BRA	KOR	MEX	PHL	VEN
(-7-week, + 7-week)	-0.0189	-0.0181	0.0060	0.0010	0.0200	-0.0480
	(0.0031)	(0.0038)	(0.0060)	(0.0030)	(0.0370)	(0.0120)
(-6-week, + 6-week)	-0.0134	-0.0189	0.0050	0.0020	0.0640	-0.0590
	(0.0033)	(0.0042)	(0.0070)	(0.0030)	(0.0330)	(0.0100)
(-5-week, + 5-week)	-0.0088	-0.0159	0.0080	-0.0010	0.0610	-0.0520
	(0.0035)	(0.0048)	(0.0080)	(0.0040)	(0.0350)	(0.0110)
(-4-week, + 4-week)	-0.0069	-0.0172	0.0130	-0.0040	0.0680	-0.0570
	(0.0039)	(0.0057)	(0.0090)	(0.0040)	(0.0380)	(0.0130)
(-3-week, + 3-week)	-0.0069	-0.0215	0.0190	-0.0050	0.0700	-0.0590
	(0.0045)	(0.0066)	(0.0100)	(0.0050)	(0.0390)	(0.0160)
(-2-week, + 2-week)	-0.0118	-0.0228	0.0210	-0.0120	0.0300	-0.0530
	(0.0058)	(0.0065)	(0.0120)	(0.0040)	(0.0630)	(0.0200)

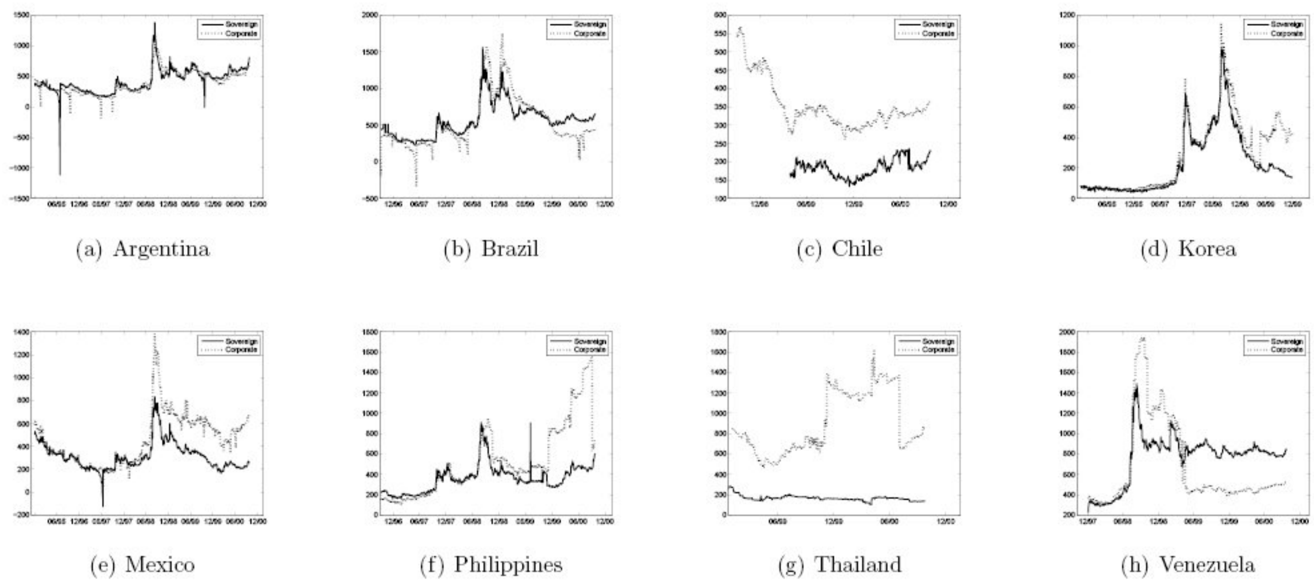
Panel B: Bid-Ask Spreads

Window	ARG	BRA	KOR	MEX	PHL	VEN
(-7-week, + 7-week)	-0.2580	-0.0030	-0.2510	-0.0570	0.0200	-0.0970
	(0.0430)	(0.0140)	(0.0390)	(0.0200)	(0.0370)	(0.0200)
(-6-week, + 6-week)	-0.2470	0.0010	-0.2690	-0.0600	0.0640	-0.0790
	(0.0470)	(0.0150)	(0.0410)	(0.0210)	(0.0330)	(0.0120)
(-5-week, + 5-week)	-0.2210	0.0170	-0.2850	-0.0880	0.0610	-0.0800
	(0.0520)	(0.0160)	(0.0439)	(0.0210)	(0.0350)	(0.0140)
(-4-week, + 4-week)	-0.1810	0.0060	-0.2710	-0.1290	0.0680	-0.0850
	(0.0600)	(0.0170)	(0.0490)	(0.0210)	(0.0380)	(0.0150)
(-3-week, + 3-week)	-0.1220	-0.0170	-0.2570	-0.1270	0.0700	-0.0870
	(0.0720)	(0.0190)	(0.0550)	(0.0230)	(0.0390)	(0.0170)
(-2-week, + 2-week)	-0.0320	-0.0260	-0.2530	-0.1050	0.0300	-0.0790
	(0.0940)	(0.0220)	(0.0690)	(0.0280)	(0.0630)	(0.0180)

Table 9: Improvements from Sovereign Bonds and IEF Variables

Country	2000 Score	Trade	Fiscal	Gov Int	Mon Pol	For Inv	Banking	Wages	PPR	Reg	Inf Mkts
Sharpe	0.10	-0.22	0.03	-0.18	0.10	-0.34	**0.78**	-0.20	0.28	**0.58**	-0.09
Min Info Shr	**0.73**	0.24	-0.13	**0.71**	**0.68**	**0.62**	-0.08	**0.66**	**0.70**	0.10	**0.73**
Bid-Ask	**-0.82**	-0.11	0.43	-0.38	**-0.63**	**-0.73**	-0.53	-0.04	**-0.63**	**-0.72**	**-0.75**

Table 9 presents correlations between measures of market improvement conferred by the presence of sovereign bonds and measures of economic freedom published in the Index of Economic Freedom from the Heritage Society. The measures of improvement are the improvement in maximum Sharpe ratio from the set of sovereign plus corporate plus U.S. treasuries relative to the set of corporate and U.S. treasury bonds, the minimum information share in corporate bond yield spread innovations attributable to sovereign bonds, and the improvement in the bid-ask spread upon the introduction of a sovereign issue. The economic freedom variables are the overall score for 2000, trade policy, fiscal burden, government intervention, monetary policy, foreign investment, banking sector, wages, prices and property rights, regulation, and informal markets. Correlations significant at the 10% level are presented in boldface type.

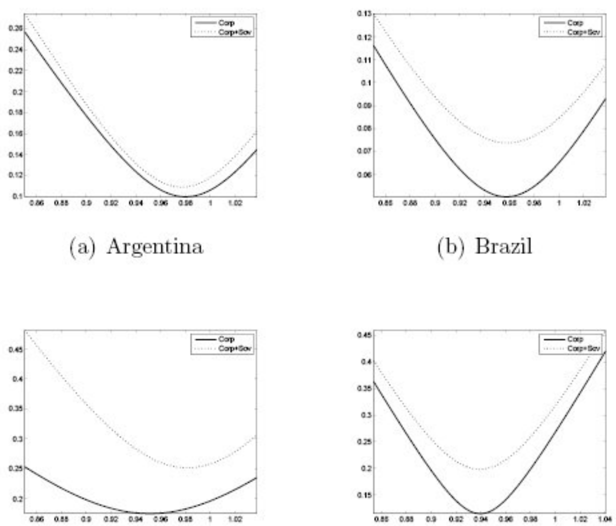


(a) Argentina (b) Brazil (c) Chile (d) Korea

(e) Mexico (f) Philippines (g) Thailand (h) Venezuela

Figure 1: Corporate and Sovereign Portfolio Stripped Yield Spreads

This figure presents the time series stripped yield spreads for sovereign (in solid lines) and corporate (in dotted lines) portfolios during the sample period of the following countries: Argentina, Brazil, Chile, Korea, Mexico, the Philippines, Thailand, and Venezuela.

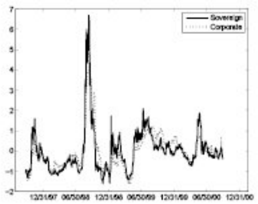


(a) Argentina (b) Brazil (c) Chile (d) Korea

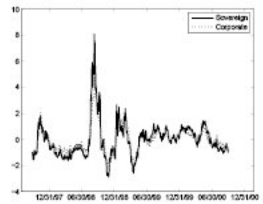
(e) Mexico (f) Philippines (g) Thailand (h) Venezuela

Figure 2: Hansen-Jagannathan Bounds

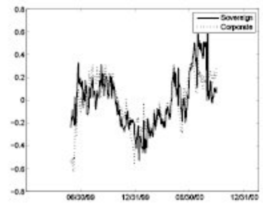
This figure presents Hansen-Jagannathan (1991) bounds on admissible pricing kernels for two asset sets; corporate bonds alone in solid lines and corporate bonds plus sovereign bonds in dotted lines. The bounds are constructed using weekly returns on value-weighted portfolios of sovereign and corporate bonds. All plots are bounded by [0.97,1.01] in x-axis.



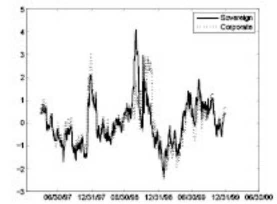
(a) Argentina



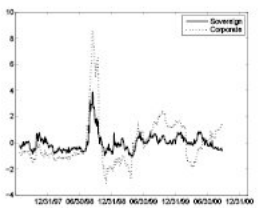
(b) Brazil



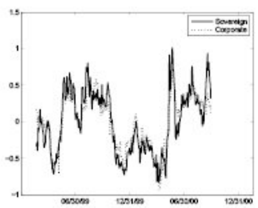
(c) Chile



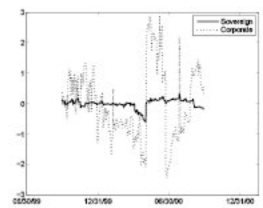
(d) Korea



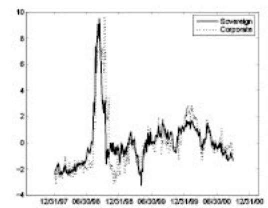
(e) Mexico



(f) Philippines



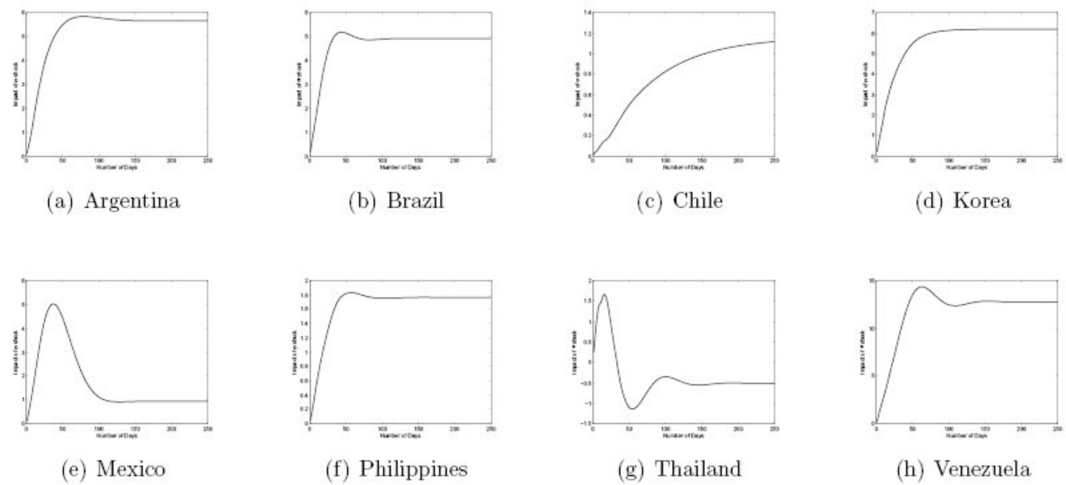
(g) Thailand



(h) Venezuela

Figure 3: Corporate and Sovereign Portfolio Stripped Yield Spreads

This figure presents the time series stripped yield spreads for sovereign (in solid lines) and corporate (in dotted lines) portfolios during the sample period of the following countries: Argentina, Brazil, Chile, Korea, Mexico, the Philippines, Thailand, and Venezuela. Spreads are orthogonalized relative to the principal components in the U.S. term structure and effects of the Asian currency crisis on the mean spread are removed.



(a) Argentina (b) Brazil (c) Chile (d) Korea

(e) Mexico (f) Philippines (g) Thailand (h) Venezuela

Figure 4: Impulse Response Functions

This figure presents impulse response functions for the effect of a one standard deviation shock in the sovereign stripped spread yield on the corporate stripped spread yield. Shocks are orthogonalized using a Cholesky decomposition, and are based on the VAR results supporting Table 7.