The Pricing Impacts of Sovereign Bonds

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Abstract

In this paper, we analyze the pricing impact of emerging market sovereign bonds on corresponding corporate bonds by examining the spanning enhancement, price discovery, and issuance effects of sovereign bonds. Our evidence suggests that, (1) the effect of spanning enhancement is positive and large, (2) over one-fifth of the information in corporate bond yield spread scan be traced to innovations in the sovereign bonds market, and (3) most of these effects are due to discovery and spanning of systematic risks. In addition, we find that issuance of new sovereign bonds, controlling for the endogeneity of market timing decisions, lowers yield spreads and bid-ask spreads of existing corporate bonds. Our results indicate the benchmark status of sovereign securities and suggest they are essential for developing a vibrant corporate bond markets for emerging economies.

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1 Introduction

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

[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, Chinese government issued a $1.7 billion euro ten-year global bond, the biggest and longest maturity of euro-denominated bonds sold by an Asian country. The purpose, quoted by a Chinese officer in charge 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)

[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.

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)). This result occurs when markets are extremely incomplete and the additional security is marginally desirable.

In this paper, we attempt to empirically distinguish whether the effect of sovereign issuance is beneficial or harmful to emerging bond markets.[6] 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.

[4] This set of factors may include globally systematic factors.

[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] 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.

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.[7]

[7]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

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

a benchmark security eliminates all trading in the individual securities when traders have homogenous preferences and endowment distributions.

transaction costs. Thus, the evidence suggests a favorable impact of the issuance of a new sovereign 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 II discusses the definition of a sovereign bond and a simple theoretical framework for our empirical work. Section III describes the data used in our analysis. Section IV presents our empirical approaches and results for the analysis of the hypotheses. Section V concludes.

2 Sovereign Bonds as Benchmark Securities

2.1 Defining a Sovereign Bond

In this section, we briefly discuss the characteristics and definition of a sovereign bond. Sovereign bonds are issued by a government or government development agency that is guaranteed by the government. The majority of these bonds are issued as straightforward coupon-bearing debentures; put and call features found in other bond markets are rare. The majority of these bonds are denominated in foreign currencies; only a few countries (essentially the G-8) are able to issue sovereign bonds 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 sovereign bond is a benchmark security. By a benchmark security, we refer to a security that has only macroeconomic risk, rather than both macroeconomic and idiosyncratic risk, in the sense discussed in Shiller (1993). As an example, a U.S. Treasury bond is a sovereign instrument, and is used as a benchmark for U.S. corporate bonds, as its price is affected only by U.S. macroeconomic risk. In addition to the risks affecting U.S. Treasuries, emerging market sovereign bonds are affected by country-specific macroeconomic (default) risk, which impacts the corporate securities 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 JP Morgan, which, as discussed above, are constructed only from U.S. dollar-denominated sovereign bonds.

2.2 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

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

$$\Delta \ln P_{st} = \alpha_s + \beta_s' \Delta X_t \tag{5}$$

Standard arbitrage arguments suggest that if we have a sufficient number of sovereign securities to span the state variables, X_t, that we can construct portfolios of the sovereign securities that have the same expected return as the corporate securities; that is, we can replicate $\alpha_c + \beta_c' E\left[\Delta X_t\right]$. Since this portfolio is free of factor risk, its variance will be lower than the corporate securities, generating a spanning enhancement. However, it is possible that there are a sufficient number of corporate securities such that portfolios free of systematic risk can be formed. In this case, introducing sovereign securities would not yield 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.

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.

3 Data

3.1 Emerging Market Bond Data

The initial sample period considered is January 3, 1996 through November 20, 2000. The primary data source is J.P. Morgan-Chase, a major market maker for emerging market bonds. We focus on fixed income securities with a specified maturity, face value, and coupon.[8] 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).[9] Table 1 shows that 54

[8] 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.

[9] 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.

sovereign bonds are issued between May 1, 1996 to July 24, 2000.[10] 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.[11] 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.

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

[10] 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.

[11] 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.

evident, although not as pronounced, in the plots for Argentina, Brazil, Mexico, and Venezuela.

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 reflects the benchmark status of sovereign securities.

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.

4 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.

4.1 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 (2003), 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.[12] 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.

[12] We present minus one times the factor loading on the level factor, consistent with past literature.

4.2 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). These tests can be interpreted as examining whether the addition of a set of assets to a basis causes a shift in the Hansen and Jagannathan (1991) volatility bounds on the pricing kernel or, equivalently, a shift in the investment opportunity set. Specifically, denote the returns on the set of corporate bonds portfolio at time t as R_t^c and the returns on the sovereign bonds at time t as R_t^s. The test is based on the Euler equation restriction

$$E\left[M_t \mathbf{R}_t\right] = \iota \tag{6}$$

where $\mathbf{R}_t$ is the gross return on the set of sovereign and corporate assets, ι is a conforming unit vector, and M_t is a pricing kernel in the linear span of $\mathbf{R}_t$:

$$M_t = \alpha + \left(\mathbf{R}_t - E\left[\mathbf{R}_t\right]\right)' \beta \tag{7}$$

with α, β representing coefficients.

The spanning test relies on the notion that in a complete market, the same pricing kernel prices both sets of assets. That is, consider two potential pricing kernels:

$$\begin{aligned} M_t^c &= \alpha_c + \beta^c \left(R_t^c - E\left[R_t^c\right]\right) \\ M_t^s &= \alpha_s + \beta^s \left(R_t^s - E\left[R_t^s\right]\right) \end{aligned}$$

Under the null that the corporate bond portfolio spans the sovereign portfolio, only M_t^c should be necessary to price the assets. That is, in testing the Euler equation restrictions

$$E\left[\mathbf{R}_t \begin{pmatrix} M_t^c \\ M_t^s \end{pmatrix} - \iota\right] = 0 \tag{8}$$

we should find that $\beta_s = 0$. The coefficients can be estimated in a straightforward manner via GMM and the null hypothesis of spanning is tested via a Wald test on β_s.[13]

[13] Alternatively, as in de Santis (1993), one may perform a likelihood-ratio test.

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 yields 23 (5) corporate (sovereign) bonds in Argentina, 21 (5) in Brazil, 12 (11) in Korea 35 (12) in Mexico, 11 (2) in the Philippines 5 (2) in Thailand, and 6 (4) in Venezuela. 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. Specifically, the results indicate that the investment opportunity sets of investors in Chile, Korea, Mexico, the Philippines, Thailand, and Venezuela are enhanced by the inclusion of sovereign bonds. 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.[14]

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. Curiously, the spanning tests suggest that the set of corporate plus treasury securities do not span the sovereign bonds in Argentina, 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 that 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

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

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.

4.3 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.

4.3.1 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:

$$ys^{\perp}_{\{c,s\},t} = ys_{\{c,s\},t} - (\delta_0 + \delta_1 I_{crisis,t} + \delta_2 I_{post-crisis,t} + \beta' X_t) \tag{9}$$

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.[15] These orthogonalized yield series 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

$$\Phi(L) ys^{\top}_{\{c,s\},t} = \mathbf{e}_t \tag{10}$$

[15]Our data span the pre-crisis, crisis, and post-crisis data only in Korea. In Argentina, Brazil, Mexico, and Venezuela, 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.

where $\Phi(L)$ is a polynomial in the lag operator, $ys^{\top}_{\{c,s\},t}$ is the corporate or sovereign portfolio orthogonalized yield spread, and $\mathbf{e}_t$ is an i.i.d. error term. Stationarity implies a companion moving average representation:

$$ys^{\top}_{\{c,s\},t} = \Psi(L)\mathbf{e}_t \tag{11}$$

We are interested in the implications of this expression for orthogonalized yield spreads. Expression (11) provides us insight into the impact of a shock in sovereign yield spreads, $e_{s,t}$ on corporate yield spreads, $ys^{\top}_{c,t}$, and vice versa. As in Hasbrouck (1995, 2003), we refer to the portion of variance in the corporate yield spread explained by innovations in the sovereign yield spread as the "information share" of the sovereign market.

Again, following Hamilton (1994), we proceed as follows. Denote the second moment matrix of the innovations, $\mathbf{e}_t$, as Σ. As Σ is positive definite, we can always find a unique lower triangular matrix A, where

$$\Sigma = \mathbf{ADA}' \tag{12}$$

where $\mathbf{D}$ is a diagonal matrix with the elements of the diagonal of Σ. Under the vector moving average representation, the unconditional variance of the orthogonalized yield spread, Γ_0, can be expressed as

$$MSE\left(ys^{\top}_{\{c,s\},t+s|t}\right) = \sum_{j=s,c}\left\{Var(u_{jt})\left[\sum_{k=0}^{\infty}\Psi_k\mathbf{a}_j\mathbf{a}_j'\Psi_k\right]\right\} = \Gamma_0 \tag{13}$$

where $\mathbf{a}_j$ represents the j^{th} column of the matrix $\mathbf{A}$, and $\mathbf{u}_t = \mathbf{A}^{-1}\mathbf{e}_t$. Thus, the information share of the sovereign market in the corporate yield spread is given by letting $s \rightarrow \infty$.

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 s as

$$\Delta Y_{\{c,s\}t+s} = \Psi_s \mathbf{a}_j \tag{14}$$

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,

$$Y_{\{c,s\},t+s} = \sum_k \Psi_k \mathbf{a}_j \tag{15}$$

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

4.3.2 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 $l + 1$.[16] 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.[17]

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

[16]Similar results are obtained with different lag lengths, and the BIC suggests similar lag structures.
[17]These results are, however, available from the authors upon request.

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 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.

4.4 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' spreads over U.S. treasury yields 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 spreads drop relatively more than spreads on corresponding 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 spreads on the first three principal components of the default-free term structure, EMBI spread, and exchange rate; all variables are expressed in logs. We examine the impact of a sovereign issue on the residuals from this projection 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. We perform a similar procedure for the bid-ask spreads.

Our specific framework is as follows. Let the spread and bid-ask residuals for bond i in country j at time t be denoted $u^s_{i,j,t}$ and $u^b_{i,j,t}$, respectively, and define an indicator variable, I^s_t, where $I^s_t = 1$ after a new sovereign issue is traded and 0 otherwise. Specifically, for each of 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:[18]

$$u^s_{i,j} = \alpha_s + \beta_s I^s_t + \sum_k \kappa_k Iss_k + \sum_l \kappa_l New_l + \sum_t \kappa_t t + \epsilon^s_{i,j} \quad (16)$$

$$u^b_{i,j} = \alpha_b + \beta_b I^s_t + \sum_k \kappa_k Iss_k + \sum_l \kappa_l New_l + \sum_t \kappa_t t + \epsilon^b_{i,j} \quad (17)$$

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 spread and bid-ask residuals, $u^s_{i,j,t}$ and $u^b_{i,j,t}$, 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.[19] We confine our attention to bond issues in excess of $200 million face value at issuance, as smaller issues are very thinly traded.

[18]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 including all corporate bonds in the estimation.

[19]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.

Results of estimation using stripped 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 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 spread of bonds in these countries, consistent with the hypothesis advanced above. That is, the evidence suggest 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 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.

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.[20] In

[20]We have also checked for the extent of stable price quotes among corporate bonds in our database by computing the percentage of zero returns using bid price quotes. The percentage of zero returns has been used as a liquidity proxy in a host of empirical studies (Lesmond, Schill, and Zhou (2004), Bekaert, Harvey, and Lundblad (2005), Chen, Lesmond, and Wei (2005)). However, in our database, the percentage of stable quotes, or the percentage of zero returns, is very small (ranging from 0.005% of quotes to 0.265% of quotes.) For comparison, the average percentage of zero returns in the database for U.S. corporate bonds used by Chen, Lesmond, and Wei (2005) ranges from 3.88% (lowest) to 41% (highest). Therefore, stale price quotes are less a concern in our study. These results are available from

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]

5 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 gener-

the authors upon request.

[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.

ating 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. 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.

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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 collateralized 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 portfolio returns span the corporate and sovereign bond portfolio returns. The tests are performed via GMM using moment conditions

$$E\left[\mathbf{R}_t \begin{pmatrix} M_t^c \\ M_t^s \end{pmatrix} - \iota\right] = 0$$

where the superscript c denotes the returns on the corporate portfolio and s denotes the returns on the sovereign portfolio. Standard errors are corrected using the Newey and West (1987) procedure, and p-values for the test statistics 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 set of U.S. Treasury bond and emerging corporate bond returns span the sovereign bond returns. The tests are performed via GMM using moment conditions

$$E\left[\mathbf{R}_t\begin{pmatrix} M_t^{u+c} \\ M_t^s \end{pmatrix} - \iota\right] = 0$$

where the superscript c denotes the returns on the corporate bonds, u denotes the returns on the U.S. Treasury securities, and s denotes the returns on the sovereign portfolio. Standard errors are corrected using the Newey and West (1987) procedure, and p-values for the test statistics are presented in parentheses. We also present the annualized Sharpe ratios of portfolios of corporate and U.S. Treasury bonds (λ_{U+C}) and Treasury plus corporate 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)
$\lambda_{U+C}/\lambda_{U+C+S}$	0.355/0.361	$\lambda_{U+C}/\lambda_{U+C+S}$	0.336/0.339	$\lambda_{U+C}/\lambda_{U+C+S}$	0.793/0.812	$\lambda_{U+C}/\lambda_{U+C+S}$	0.295/0.304

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)
$\lambda_{U+C}/\lambda_{U+C+S}$	0.402/0.494	$\lambda_{U+C}/\lambda_{U+C+S}$	0.405/0.429	$\lambda_{U+C}/\lambda_{U+C+S}$	0.677/0.699	$\lambda_{U+C}/\lambda_{U+C+S}$	0.297/0.300

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

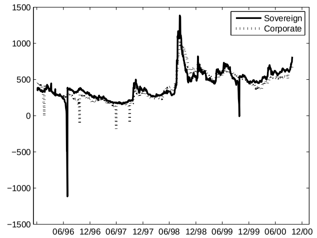
Table 8 reports the estimated effect of issuing a new sovereign bond on stripped spreads(in Panel A) and bid-ask spreads (in Panel B) of corresponding country's existing corporate bonds. The estimation is done for six event windows, each ranging from 7- to 2-week before the sovereign issue date to 7- 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

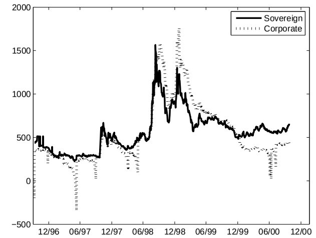
Window	ARG	BRA	KOR	MEX	PHL	VEN
(-7-week, + 7-week)	-0.0189	-0.0181	0.0060	0.0010	0.0200	-0.0480
	(0.0031)	(0.0038)	(0.0060)	(0.0030)	(0.0370)	(0.0120)
(-6-week, + 6-week)	-0.0134	-0.0189	0.0050	0.0020	0.0640	-0.0590
	(0.0033)	(0.0042)	(0.0070)	(0.0030)	(0.0330)	(0.0100)
(-5-week, + 5-week)	-0.0088	-0.0159	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

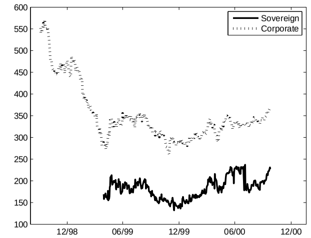
Window	ARG	BRA	KOR	MEX	PHL	VEN
(-7-week, + 7-week)	-0.2580	-0.0030	-0.2510	-0.0570	0.0200	-0.0970
	(0.0430)	(0.0140)	(0.0390)	(0.0200)	(0.0370)	(0.0200)
(-6-week, + 6-week)	-0.2470	0.0010	-0.2690	-0.0600	0.0640	-0.0790
	(0.0470)	(0.0150)	(0.0410)	(0.0210)	(0.0330)	(0.0120)
(-5-week, + 5-week)	-0.2210	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)



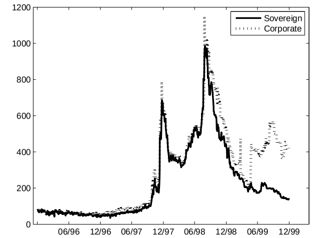
(a) Argentina



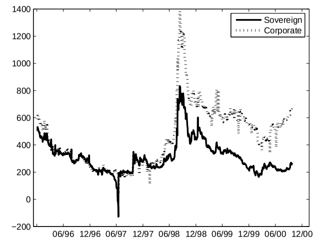
(b) Brazil



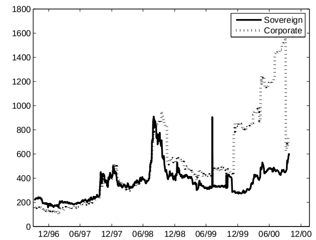
(c) Chile



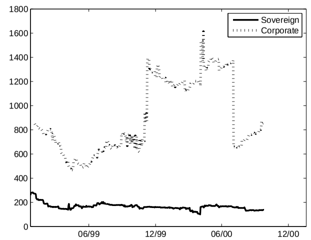
(d) Korea



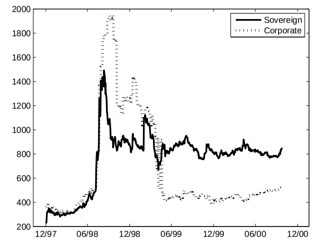
(e) Mexico



(f) Philippines



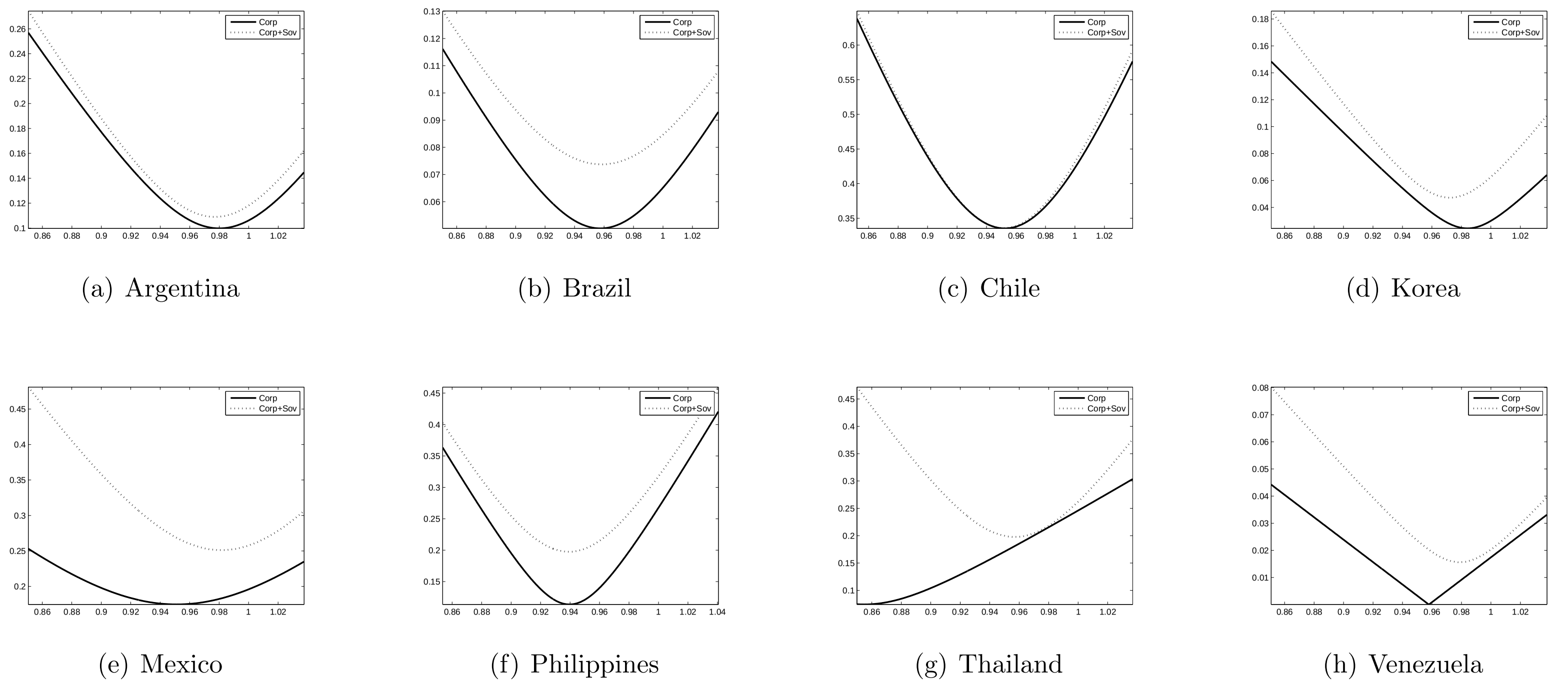
(g) Thailand



(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.

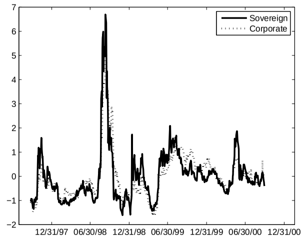


(a) Argentina (b) Brazil (c) Chile (d) Korea

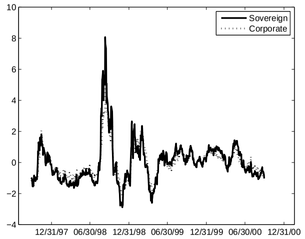
(e) Mexico (f) Philippines (g) Thailand (h) Venezuela

Figure 2: Hansen-Jagannathan Bounds

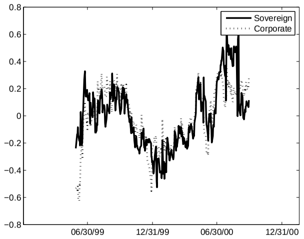
This figure presents Hansen-Jagannathan (1991) bounds on admissible pricing kernels for two asset sets; corporate bonds alone in solid lines and corporate bonds plus sovereign bonds in dotted lines. The bounds are constructed using weekly returns on value-weighted portfolios of sovereign and corporate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



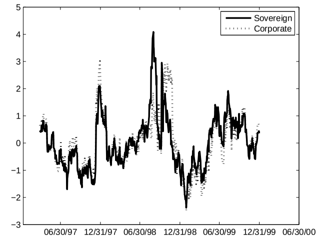
(a) Argentina



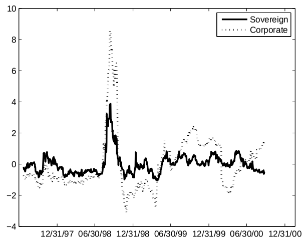
(b) Brazil



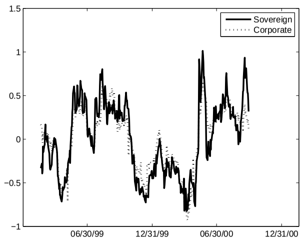
(c) Chile



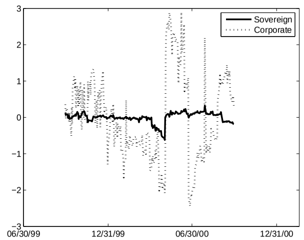
(d) Korea



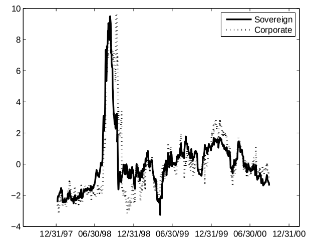
(e) Mexico



(f) Philippines



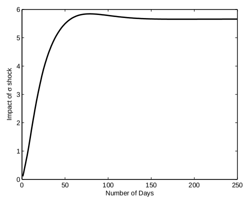
(g) Thailand



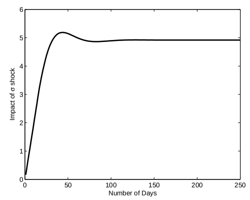
(h) Venezuela

Figure 3: Corporate and Sovereign Portfolio Stripped Yield Spreads

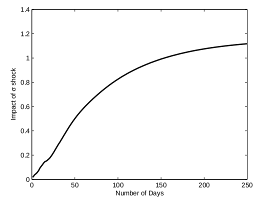
This figure presents the time series stripped yield spreads for sovereign (in solid lines) and corporate (in dotted lines) portfolios during the sample period of the following countries: Argentina, Brazil, Chile, Korea, Mexico, the Philippines, Thailand, and Venezuela. Spreads are orthogonalized relative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



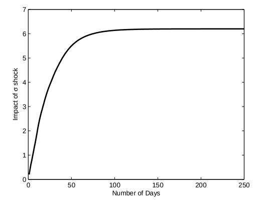
(a) Argentina



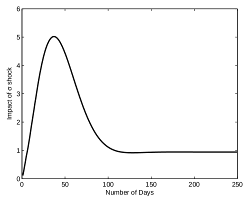
(b) Brazil



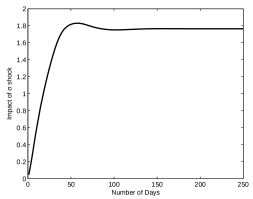
(c) Chile



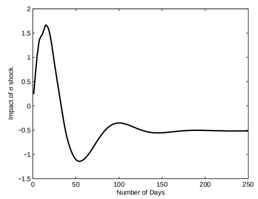
(d) Korea



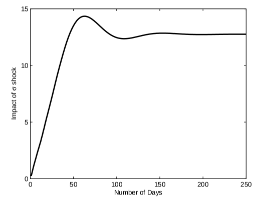
(e) Mexico



(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.