Do Dollar-Denominated Emerging Market Corporate Bonds Insure Foreign Exchange Risk?[*]

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Abstract

Dollar-denominated emerging market bonds are marketed to investors as a vehicle for gaining exposure to emerging fixed income markets while avoiding exposure to currency risk. However, the development literature suggests that dollarization of debt leads to increased probability of financial distress, which would indirectly expose these securities to exchange rate risk. We empirically examine the exposure of dollar-denominated corporate bonds to exchange rate risk in 14 emerging markets. We find that nearly three-fourths of bonds have yield spreads with statistically significant exposure to innovations in exchange rates, exchange rate volatility, or both. In a reduced-form bond pricing model with default risk, we find economically significant exposures of credit spreads to exchange rates and exchange rate volatility.

1   Introduction

Dollar-denominated emerging market bonds are marketed to investors as a vehicle for gaining exposure to emerging fixed income markets while avoiding exposure to currency risk. For example, in an article from Reuters Money, the author suggests that dollar-denominated emerging market bonds are immune from currency exposure:

> Those interested in emerging market bonds can choose from a growing roster of mutual funds that mine this space in different ways. Some skirt currency risk by investing exclusively in U.S. dollar-denominated bonds, while others seek to profit from a weakening dollar through bonds denominated in local currencies.[1]

A similar sentiment is echoed in this research memorandum from Morgan Stanley Smith Barney:

> For U.S. based investors, the key difference is foreign currency risk where local currency debt (if unhedged) exposes investors to currency fluctuations.[2]

Taking these quotes at face value, an investor would draw the conclusion that an investment in dollar-denominated emerging market bonds was free of currency risk.

In this paper we ask whether this conclusion is warranted by examining whether the yield spreads of bonds issued by emerging market corporations denominated in U.S. dollars exhibit sensitivity to risks in currency exchange rates. Our question is motivated by a large literature on development and finance suggesting that issuing dollar debt exposes emerging market firms to increased risk of financial distress. Dollarization potentially generates distress when the local currency is devalued, increasing the local currency value of the dollar debt and the debt burden of the issuer.[3] Krugman (1999) suggests that these balance sheet effects can be exacerbated by a reduction in domestic currency revenue and increase in interest rates during a currency crisis. These ideas are summarized in Caballero and Krishnamurthy (2003),

> Although observers still debate the causes underlying recent emerging markets' crises, one factor they agree on is that domestic firms' contracting of external debt in dollars as opposed to domestic currency creates balance sheet mismatches that lead to bankruptcies and dislocations.

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[1] "Investors warm up to emerging market bonds," *Reuters Money Online*, July 14, 2011

[2] 'Emerging Markets Debt: An Evolving Opportunity Set," by Steve Lee, CFA, Morgan Stanley Smith Barney Consulting Group Investment Advisor Research.

[3] A related idea is the increased default risk caused by deflation for nominally-denominated corporate bonds. Fisher (1933) suggests that deflation led to defaults and thus prolonged the Great Depression. In more recent work, Kang and Pflueger (2011) explore the extent to which fears about deflation are reflected in corporate bond prices.

That is, dollar debt can contribute to the default risk of emerging market firms. If currency risk generates default risk, which impacts dollar-denominated bond yields, it is difficult to argue that these bonds are immune from currency risk.

We examine a set of dollar bonds issued by large firms in eleven emerging markets: Brazil, Chile, Colombia, the Czech Republic, India, Indonesia, Mexico, Peru, South Africa, South Korea, and Thailand. Most of the firms issuing these bonds hedge currency risk, and many have operational hedges, such as sales in U.S. dollars, that should ameliorate the effects of issuing debt in U.S. dollars. Nonetheless, approximately one-half of the bonds in our sample have yield spreads that are significantly exposed to innovations in the local currency per dollar exchange rate and approximately one-quarter have yield spreads significantly exposed to innovations in the volatility of exchange rates. Altogether, 74% of the bonds in our sample have yield spreads with statistically significant exposures to exchange rate innovations, exchange rate volatility innovations, or both. These effects are broadly distributed across bonds from all countries in the sample, excepting the Philippines, in which no bonds have statistically significant coefficients. Our initial conclusion from these results is that despite dollarization, these bonds are exposed to risks in innovations in both the level and volatility of exchange rates.

Exchange rate risks are highly correlated with other sources of country-specific and global risk; thus some of the sensitivity to exchange rates and exchange rate volatility may be indirectly capturing other sources of risk. We examine the explanatory power of a number of additional variables for variation in dollar denominated emerging market corporate bond spreads. Our covariates are motivated by Carr and Wu (2007), who show that implied volatility in exchange rate options is correlated with credit default swap spreads, and Longstaff, Pan, Pedersen, and Singleton (2011), who investigate sources of sovereign credit risk. We find that the covariates, especially sovereign CDS spreads, absorb a significant amount of the explanatory power of exchange rates and their volatility for variation in corporate bond spreads. However, 42% of the bonds in our sample remain statistically significantly exposed to the marginal portion of exchange rate risks, and we conclude that the prices of dollar-denominated emerging market bonds are exposed to exchange rate risk, whether that risk is exchange rate-specific or reflective of broader global or sovereign exposure.

Finally, we model bond prices as sensitive to exchange rate and exchange rate volatility using a reduced form approach as in Duffie and Singleton (1997, 1999). We estimate model parameters using the extended Kalman filter, and find pricing errors that are similar in magnitude to those reported in Duffee (1999). Our results indicate that innovations in exchange rates appear to have a relatively minor impact on emerging market corporate spreads as reflected in our parameter estimates. A one standard deviation increase in exchange rates has a 1.5 basis point impact on credit spreads of the median bond in Brazil, the country with the most volatile exchange rates in our sample. However, spreads are much more sensitive to innovations in volatility. A one standard

deviation increase in volatility would result in an increase in median spreads ranging from 501 basis points in Chile to 999 basis points in Peru. Thus, our estimation results again suggest that exposure to exchange rate risk, captured in exchange rate volatility, is economically important despite the dollarization of these bonds.

International debt issuances represent a significant source of capital for corporations, as shown in Henderson, Jegadeesh, and Weisbach (2006). In emerging markets, the degree to which debt is issued in dollars is viewed as "excessive" (Caballero and Krishnamurthy (2003)). Our work complements this literature, which seeks to explain the fact that these corporations borrow more in dollars than would otherwise seem optimal relative to the risk that dollar debt can exacerbate a currency crisis. For example, Caballero and Krishnamurthy (2003) and Korinek (2011) examine the equilibrium composition of a company's domestic and foreign currency debt given the fact that investors demand dollar-denominated debt. That is, these authors take demand for dollar-denominated debt as given and derive optimal supply of this debt. Our investigation differs from this literature in that it takes the supply of debt as given, and asks empirically whether investors price foreign exchange risks that may be generated by the default risk externality modeled in these papers. Our results suggest that investors do, and that taking these risks into account improves upon pricing of dollar-denominated emerging market corporate bonds.

While the development literature explicitly links currency exposure to increased default risk, our results do not speak directly to the question of whether emerging market companies suffer from increased default risk due to the dollarization of debt. We do not provide a formal estimate of the magnitude or indeed whether the probability of default rises upon an innovation to exchange rates or exchange rate volatility. Rather, our results are merely suggestive. To the extent that variation in credit spreads that are unrelated to sovereign and global sources of risk reflects variation in default risk, our regressions results indicate that a substantial fraction of bonds experience variation in default risk related to currency-specific risks. Further, the sensitivity of bonds' spreads to exchange rates exhibits cross-sectional variation related to determinants of default risk documented in Campbell, Hilscher, and Szilagyi (2008). However, concerns about endogeneity and direct measurement of probability of default render this evidence only suggestive. What we can say more conclusively is that prices of dollar-denominated bonds vary with innovations to exchange rate levels and volatility, and are thus not insured from exchange rate risk.

The remainder of this paper is organized as follows. In Section 2, we discuss the data used in the paper and empirically examine the sensitivity of dollar-denominated emerging market bonds to risks in currency exchange rates. We derive a reduced-form model of dollar-denominated corporate bond pricing and estimate model parameters in Section 3. Concluding remarks and some directions for future research are discussed in Section 4.

2   Determinants of Emerging Market Bond Yield Spreads

In this section, we undertake an empirical investigation into the sensitivity of emerging market dollar-denominated bonds to risks in exchange rates. We pursue our analysis in three steps. First, we ask whether there is indeed variation in bond spreads that can be explained by innovations in the level and volatility of exchange rates. We then inquire into the source of the explanatory power, specifically how much of the explanatory power can be linked to other potential drivers of yield spread variation. Finally, we investigate how cross-sectional characteristics of firms affect their bonds' exposure to the exchange rate innovations.

Importantly, the tests in this section do not address the mechanism by which exchange rate risk affects the prices of emerging market dollar-denominated bonds. That is, we cannot say that bond prices move because an adverse movement in the exchange rate results in increased default risk. However, we can address the central question of the paper, which is to ask whether dollar-denominated bond prices are insulated from variation in exchange rates.

2.1   Emerging Market Bond Data

We obtain data for yields on emerging market corporate bonds from Datastream. Our starting sample includes all bond issues denominated in U.S. dollars by corporations domiciled in the set of MSCI emerging markets over the period January, 2001 through August, 2014. We eliminate all bonds that are not standard semiannual fixed coupon debentures, since these bonds have contractual features that are not captured well in standard models of bond pricing as in Merton (1974) or Duffie and Singleton (1999). This initial sample consists of 497 bonds in 26 countries. We further eliminate bonds issued by corporations in countries where exchange rates are pegged or quasi-pegged to other currencies, such as El Salvador, Qatar, and the United Arab Emirates, reducing our sample to 457 bonds in 23 countries.

Liquidity is a significant issue in corporate bond markets, and liquidity problems are even more salient in bond issues by emerging market firms. Many of the bonds in our sample trade infrequently and we have price, but not volume or trade information. We use the liquidity measure proposed in Lesmond, Ogden, and Trzcinka (1999), the fraction of non-zero price change days, to screen bonds for liquidity. In order to balance between liquidity and the number of bonds in the sample, we somewhat arbitrarily choose bonds with at least 75% of days with non-zero price changes.[4] We also eliminate bonds with prices that imply negative yields, and bonds with fewer than 36 months of time series observations. Finally, because we are interested in the sensitivity of yields to volatility of exchange rates, we eliminate bonds issued by corporations headquartered in Kazakhstan since

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[4]Our results are not materially changed by setting this threshold to 60% or 90%.

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we are unable to fit a volatility model (discussed below) to the Kazakh Tenge. Our final sample consists of 85 bonds in 14 countries: Argentina, Brazil, Chile, Colombia, the Czech Republic, India, Indonesia, Malaysia, Mexico, Peru, the Philippines, South Africa, South Korea, and Thailand.[5]

Descriptive information for these issues is presented in Table 1. We present the number of bonds by country, minima, medians, and maxima of coupons and maturity by country, and the minima, medians, and maxima of average spreads on bonds by country. Our sample is dominated by bonds from six countries; Argentina, Brazil, Chile, Mexico, Peru, and South Korea, with 20 bonds issued by Mexican corporations and 17 by South Korean corporations. Coupons on the bonds range from a low of 2.375% for a Mexican corporation to 11.250%, also for a Mexican corporation. The most common median bond maturity at issue is 10 years. Bond maturities at issue vary greatly across countries; the shortest issue in our sample has a 5 year life at issue and the longest 30 years. Average spreads vary widely across countries as well. Spreads are highest in Argentina, where the median average spread is over 5%, while the lowest median average spread is just under 161 basis points for a Thai bond. The maximum average spread is extremely high, 34.67% for a bond issued by a Argentinian corporation.

In Figure 1, we depict the time series of median month-end yield spreads within each country across bonds in our sample. Spreads are calculated relative to the constant maturity yield on a Treasury security with maturity closest to the maturity of the bond in question, obtained from the FRED database at the Federal Reserve. Because the number of bonds vary across the sample, and because bonds enter and exit our data set over the sample period, the plots are not representative of the spread on a fixed set of instruments over time. Nonetheless, the plots exhibit noteworthy patterns. First, in all countries, spreads exhibit a marked increase corresponding to the financial crisis of 2008 and its aftermath. Spreads remain high after the crisis in most countries, but experience further episodes of widening in several countries after the crisis. These episodes are particularly pronounced in Mexico, Chile, and Argentina, with spreads reaching crisis levels by the end of 2011. The plots also evince signs of political and economic crises in several of the sample countries, including the Thai political crisis and the Argentine default crisis.

2.2 Emerging Market Corporate Bond Spreads and Exchange Rate Risk

We speculate that foreign exchange dynamics may affect the magnitude of dollar-denominated corporate bond spreads in two ways. First, as alluded to in the introduction, unhedged level variation in exchange rates may affect default risk and, hence, dollar-denominated corporate bond spreads. Specifically, a depreciation in local currency results in an increase in dollar-denominated debt ser-

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[5]When we require only 24 months rather than 36 months, we have an additional 64 bonds in the sample. The results throughout the paper are similar using the 24 rather than 36 month cutoff.

vice from the perspective of a firm with local currency revenues. Moreover, since depreciations tend to occur in states of the world in which local currency revenues are depressed, a depreciation may have an accelerated impact on default risk. The second mechanism is volatility of foreign exchange rates. An increase in exchange rate volatility implies increased volatility in cash flows from a U.S. Dollar perspective. Since the value of a firm's assets depends on the value of its cash flows, increased volatility in dollar cash flows results in increased volatility of dollar asset value. In the context of Merton (1974), this increased asset volatility increases the probability of default and, as a consequence, the corporate bond spread.

In order to investigate the impact of these two sources of risk on corporate yield spreads, we conduct a simple regression analysis. Specifically, we estimate the parameters of the following regression,

$$\Delta S_{i,k,t} = a_i + b_{fx,i,k}\Delta fx_{k,t} + b_{v,i,k}\Delta v_{fx,k,t} + \epsilon_{i,k,t}, \tag{1}$$

where $\Delta S_{i,k,t}$ is the first difference in the spread on bond i in country k at time t, i.e., the difference in the yield on bond i and a comparable Treasury, $\Delta fx_{k,t}$ is the change in the log level of the exchange rate between the home currency of the issuer of bond and the U.S. Dollar, and $\Delta v_{fx,k,t}$ is the change in the log annualized volatility of the first difference in the log exchange rate between the home currency of the issuer of bond and the U.S. Dollar. The comparable Treasury security yield used in computing the spread on bond i is the constant maturity Treasury yield on a Treasury security with time to maturity closest to that of bond i. Treasury yields for 1-, 2-, 3-, 5-, 7-, 10-, 20-, and 30-year maturities are obtained from the FRED database at the Federal reserve. The regression is estimated at the monthly frequency; we sample the data at the daily frequency but use the last observation of the calendar month to calculate first differences.

Data on exchange rates are taken from Datastream. We sample exchange rates in terms of foreign currency per U.S. Dollar at the daily frequency over the period January 3, 1994 through September 28, 2010. We use these data to construct the time series of foreign exchange volatility, $v_{fx,k,t}$, by filtering from an MA(1)-EGARCH(1,1) model. While the state of the art in modeling realized volatility is arguably using intraday data to measure the volatility, we do not have access to intraday data. Andersen and Bollerslev (1998) and Baillie and Bollerslev (1989) argue that the simple MA(1)-GARCH(1,1) model adequately captures foreign exchange dynamics. Since the principal contribution of our work is not in modeling foreign exchange volatility, we adopt their advice, but use an EGARCH(1,1) specification for volatility as this specification appears to yield more stable parameter estimates. Results of the estimation of the time series models for exchange rates are provided in the Appendix.

Results of the estimation of equation (1) are presented in Table 2. We present 25th, 50th, and 75th percentiles of parameter estimates and R^2 in Panel A. Percentiles are presented as calculated

across all bonds as well as within six countries for which there are sufficient bonds to make percentile calculations meaningful (Argentina, Brazil, Chile, Mexico, Peru, and South Korea). The table shows that the median and interquartile range for the sensitivity of bond yields to innovations in exchange rates and exchange rate volatility are positive. The median point estimate of 3.90 suggests that a 1% increase in the exchange rate leads to an approximately 4% increase in the spread on dollar-denominated corporate bonds at the median. In contrast, the median point estimate for the sensitivity of spread innovations to innovations in volatility suggests that a 1% increase in volatility results in an increase of 0.17%. Finally, for the median bond in our sample, innovations in exchange rates and exchange rate volatility explain approximately 16% of the variation in innovations in spreads. At the 75$^{\text{th}}$ percentile, this proportion of variation explained rises to approximately 27%.

There are notable differences across countries in sensitivities of innovations in spreads to innovations in exchange rates and exchange rate volatility. The median bond in Peru is the most sensitive to innovations in exchange rates, with a 1% increase in exchange rates leading to approximately a 10% increase in spreads. The median Mexican bond is also sensitive to exchange rate innovations, responding to a 1% increase in exchange rates with a 5% increase in spreads. These two countries also have the highest median explanatory power, with regression adjusted R^2 of approximately 26% and 23% for Mexico and Peru, respectively. In all countries except for Argentina and Peru, the interquartile range of sensitivities of spread innovations to exchange rate and exchange rate volatility is positive. In Argentina, the 25$^{\text{th}}$ percentile bond has spreads that are negatively exposed to exchange rates, and the entire interquartile range of Peruvian bonds exhibits negative sensitivities of spread innovations to exchange rate volatility innovations.

In order to assess the statistical significance of our results, in Table 3, we tabulate the frequency with which we observe point estimates with standard errors implying statistical significance at the 10% critical threshold. The table presents four columns: the total number of bonds in each country, the number of bonds with a significant coefficient on $\Delta fx_{k,t}$, the number of bonds with a significant coefficient on $\Delta v_{fx,k,t}$, and the number of bonds that have a significant coefficient on either $\Delta fx_{k,t}$, $\Delta v_{fx,k,t}$, or both. Across the full sample, 49 bonds, or 57.6% of the sample have statistically significant exposures to innovations in the level of foreign exchange rates, 27, or 31.8% have statistically significant exposures to innovations in the volatility of exchange rates, and 63, or 74.1% have statistically significant exposures to innovations in either the level or volatility of exchange rates or both. Thus, the evidence suggests that nearly three-quarters of the emerging market dollar-denominated bonds in our sample have prices that are exposed to risks in exchange rates.

As with the point estimates themselves, there is considerable variation across countries as to the fraction of bonds with significant exposures, and whether exposure to level or volatility innovations dominate the sensitivity of bond spreads to exchange rate risk. 100% of the bonds in Colombia,

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the Czech Republic, India, Indonesia, Malaysia, South Africa, and Thailand have exposure to one of the sources of risk. In all of these countries, excepting India and Indonesia, there is only one bond in our sample. Within each country with larger numbers of bonds, Argentina, Brazil, Chile, Mexico, Peru, and South Korea, over half of the bonds have some exposure to exchange rate risks. The percentage exposure ranges from 58% in Peru to 88% in Brazil. Only in the Philippines, where we have a single bond, is there no statistically significant exposure to exchange rate risk.

The conclusion that we draw from the results presented in this section is that the rationale for buying dollar-denominated bonds discussed in the Introduction, that dollar bonds immunize the buyer from exchange rate risk, is at least to some degree flawed. Our evidence suggests that when exchange rates, or their volatility move, so do the prices of dollar denominated bonds. Approximately three-quarters of the bonds in our sample have statistically significant exposures of spread innovations to exchange rate risks. Thus, holders of these bonds experience volatility in prices that are related to volatility in exchange rates. If an investor is concerned about the volatility of the price of his bonds, he should be concerned about volatility in exchange rates, even if the bond payments are denominated in dollars rather than foreign currency.

2.3   Sources of Exchange Rate Risk

In the previous section, we document evidence that although dollar-denominated emerging market bonds pay cash flows in dollars, their prices are affected by risks in exchange rates. However, it is not clear from this evidence whether the exchange rate risk is specific to variation in exchange rates and exchange rate volatility, or due to broader systematic risks that affect exchange rates. In particular, Carr and Wu (2007) document correlation in sovereign credit default swap (CDS) spreads and implied volatility in exchange rates and Longstaff, Pan, Pedersen, and Singleton (2011) document correlation in sovereign CDS spreads and exchange rates. In this section, we examine the degree to which these other variables subsume exchange rate risk exposure, providing insight into the reasons why dollar-denominated bonds are sensitive to exchange rate risk. Specifically, our analysis asks whether exchange rate innovations affect bond prices due to exchange rate-specific sources of risk, or whether these effects are due wholly or in part to risks common in exchange rates and other factors.

Our investigation is guided by Longstaff, Pan, Pedersen, and Singleton (2011), who examine common sources of risk in sovereign CDS spreads. As they note, there is no guidance, and no limit, regarding variables that might be related to sovereign (and therefore by extension emerging market corporate) risk. Thus, we utilize a similar set of variables, the description of which we detail below.[6]

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[6]We omit two of the variables that the authors include, the flow of investment capital to foreign equity and bond markets. The authors find only limited evidence of significance of these variables. Further, of those countries with

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Local Variables

Longstaff, Pan, Pedersen, and Singleton (2011) note that among the many variables that may determine the credit spread of a sovereign entity, perhaps the most important is the state of the local economy. We speculate that this observation holds for corporate issuers as well, and that the effects may be above and beyond those of the impact on sovereign debt. With these considerations in mind, we control for the following variables:

- Return on the local stock market $(r_{k,t})$, measured as the log return on the local country k's stock market index obtained from Datastream. The return on the local stock market index captures the overall health of the corporate sector of the country's economy.

- Sovereign CDS spread $(\Delta cds_{k,t})$, the first difference in the log 5-year CDS spread on sovereign bonds issued by the country in which the corporate issue is headquartered. Data are obtained from Bloomberg. This measure captures the fiscal health of the country in which the company resides. Further, controlling for this variable allows us to isolate impacts of foreign exchange variables above and beyond the impacts of these variables on sovereign yields.

- Log percentage changes in the country's holdings of foreign reserves $(\Delta res_{k,t})$. We obtain data on foreign reserve holdings from the International Monetary Fund.

In addition to the local stock market index return and change in reserves, Longstaff, Pan, Pedersen, and Singleton (2011) include the percentage change in the level of the local currency per dollar as a measure of local economic health. We include the percentage change in local currency as a measure of exposure to foreign exchange risk.

Global Variables

Globalization and liberalization of financial markets suggest that global factors influence the prices and returns on emerging market securities in addition to local factors. As in Longstaff, Pan, Pedersen, and Singleton (2011), we include measures from the U.S. equity and fixed income markets to capture global indicators of the state of the economy.

- The log return on the U.S. equity market $(r_{us,t})$, the return on the CRSP value-weighted index. This variable is intended to capture the state of the economy for the global corporate sector.

- First difference of the log yield on 5-year constant maturity Treasury Notes $(\Delta y_{5,t})$. The level of the term structure has important influences on the yield on default-sensitive bonds, as

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significant coefficients, only Chile overlaps their sample and our sample.

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documented in Longstaff and Schwartz (1995) and Duffee (1999). Additionally, the variable captures the state of the global risk-free sovereign market. Data are obtained from the Federal Reserve report H.15.

- First difference of the term spread on U.S. Treasuries (ΔTS_t). Litterman and Scheinkmann (1991) document the presence of three latent variables in the term structure of interest rates. Of these variables, two, linked to the level and the slope of the term structure, dominate variation in Treasury yields. Again following Collin-Dufresne, Goldstein, and Martin (2001), we include a measure of the first difference in the term spread, measured as the difference in yields on 10-year and 2-year constant maturity Treasury bonds from the Federal Reserve report H.15.

- The first difference in the spread between Moody's Baa-rated and Moody's Aaa-rated bonds (ΔDS_t). This variable is frequently referred to as the "default spread," and captures the premium required in the U.S. market for borderline investment-grade bonds over the most creditworthy corporate issues.

Global Risk Premia

As discussed above, at least some of the variation in foreign exchange rates, and foreign exchange volatility in particular, can be linked to measures of aggregate risk premia. Further, variation in credit spreads may be due to changes in the premium required for holding risky assets rather than variation in default probability *per se*. Following Longstaff, Pan, Pedersen, and Singleton (2011), we include several variables meant to capture these risk premia.

- Change in U.S. market log price-earnings ratio (Δpe_t). Longstaff, Pan, Pedersen, and Singleton (2011) suggest using the earnings-to-price ratio on a U.S. index as a coarse measure of the aggregate risk premium. We utilize the price-to-earnings ratio on the S&P 500 as a measure of the risk premium with data obtained from Robert Shiller's website.[7]

- First difference in the log variance risk premium (Δvrp_t). The variance risk premium, calculated as the difference in the implied and realized volatility on the S&P 100 index, is a measure of the premium required for bearing volatility risk. The realized volatility is calculated using the open-high-low-close estimator of Garman and Klass (1980) using a 20-day rolling window of prices on the S&P 100 index. Both the implied volatility series and the relevant prices are obtained from Yahoo! Finance. The premium is included in first differences in the estimation.

Common Information in Exchange Rate Innovations and Covariates

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[7]Data are obtained from `http://http://www.econ.yale.edu/~shiller/`.

We estimate coefficients of regressions of the first difference in log exchange rates and log exchange rate volatility on the nine variables above. Data are sampled at the monthly frequency over the time period January, 2001 through August, 2014. Because CDS spreads are not available over the full time period for all countries, the length of the time series varies by country. Additionally, reserves information for the Czech Republic was available only for a limited number of months in the sample; therefore this variable is omitted in the regressions for the Czech Republic. Finally, CDS spreads are not available for India, so the country is dropped from the sample for the purposes of this analysis. We report t-statistics and adjusted R^2 for the regressions; coefficient estimates are available from the authors upon request.

Results for regressions of exchange rate innovations on the covariates are presented in Table 4. The table shows that there is a strong positive and statistically significant relation between innovations in the sovereign CDS for the country and the exchange rate in nine of the fourteen countries in our sample. The positive coefficients indicate that an increase in sovereign default risk is associated with a depreciation in the local currency. The regressions are not indicative of causality, and so we cannot say that exchange rate innovations are driven by innovations in sovereign default risk, but the regression results suggest that the two are strongly associated with one another. Exchange rate innovations are also strongly associated with changes in reserves, returns on the U.S. equity market, and changes in the yield on 5-year Treasuries. We find the significance of the U.S. equity market return to be somewhat surprising; like the evidence for CDS spreads in Longstaff, Pan, Pedersen, and Singleton (2011), we find it intriguing that a common factor is so important in determining variation in exchange rates.

Complementary results for innovations in the volatility in exchange rates are exhibited in Table 5. The dominant covariate that appears to be important for capturing variation in the volatility of exchange rates is again the sovereign CDS spread. This variable is statistically significant and positive in nine of the fourteen countries in our sample. Interestingly, most of the countries with insignificant coefficients on the CDS spread for exchange rate innovation regressions have significant coefficients for the volatility innovation regressions, with the Czech Republic as the sole exception. These results are consistent with the evidence in Carr and Wu (2007), and in conjunction with the previous results suggest a strong association between innovations in exchange rate risks and sovereign credit risk. The tabulated results indicate that none of the other covariates have a statistically significant association with innovations in exchange rate volatility for more than half of the countries in our sample.

These results indicate that a significant portion of the effect of exchange rate innovations and innovations in the volatility of exchange rates may derive from sources of risk that these innovations share with the covariates that we examine. In particular, given the strong relation between sovereign credit risk and exchange rate and exchange rate volatility innovations, some of the explanatory

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power of the exchange rate and volatility innovations may be due to this common variation. We examine this issue in more detail by estimating regressions of innovations in dollar-denominated emerging market corporate bond spreads on innovations in exchange rates, their volatility, and the covariates.

Determinants of Innovations in Emerging Market Corporate Bond Spreads

Results of regressing spreads on emerging market dollar-denominated bonds on the eleven variables in our study are presented in Table 6. Results are presented for all countries and within countries. For brevity, we report only the median point estimate and adjusted R^2 in the table. Additional information on the distribution of point estimates are available from the authors upon request. As shown in the table, the median bond across all countries has a spread that responds positively to innovations in the exchange rate, its volatility, the sovereign CDS spread, the default spread, and the variance risk premium. In contrast, at the median, spreads change negatively in response to returns to the local stock market, foreign currency reserves, the return on U.S. equities, U.S. Treasury yields, the U.S. price-equity ratio, and the U.S. term spread. These coefficients seem generally sensible; when local conditions deteriorate, as implied by an increase in the sovereign CDS spread, a drop in domestic stock markets, or a decrease in foreign currency reserves, corporate bond yield spreads increase. Similarly, when global conditions deteriorate, marked by a decrease in the U.S. equity market or an increase in the U.S. default risk premium, spreads also widen. Finally, an increase in global risk premia, represented by an increase in the variance risk premium or a decrease in the price-equity ratio is also associated with an increase in emerging market corporate bond spreads.

The table also indicates that exposure of spread innovations to innovations in the exchange rate and its volatility also remain positive at the median. However, exposure of spreads to exchange rate innovations falls by an order of magnitude relative to earlier results. When not controlling for innovations in the other covariates, the median bond yield spread increases by 3.90 basis points for a one basis point innovation in yield spreads. This sensitivity falls at the median to 0.11 basis points controlling for other covariates. Sensitivity of yield spreads to volatility innovations is roughly halved. The table also shows that there is considerable cross-sectional heterogeneity in median sensitivities. In Brazil, Mexico, and Peru, the median bond has a positive exposure to exchange rate innovations, whereas in Argentina, Chile, and South Korea the median bond is negatively exposed to these innovations.

In order to get more sense of how likely different covariates are to have a significant impact on yield spreads, we tabulate the number of coefficients that are statistically significantly different than zero at the 10% critical level, analogous to Table 3, in Table 7. There are now 83 bonds in our sample, as the two bonds from India have dropped out due to the lack of CDS data from India. The

table shows that the single most important variable for determining spreads, in terms of count of statistically significant coefficients, is the CDS spread. Of 83 bonds, 39, or 47%, have statistically significant coefficients. Thus, perhaps not surprisingly, sovereign risk plays an important role in determining the pricing of emerging market bonds. Three other variables stand out as playing a significant role as well; the junk spread, the price-earnings ratio, and the variance risk premium. Between one-quarter and one-third of bonds are sensitive to these variables, which could all be viewed as reflecting measures of aggregate risk premia. Thus, our results suggest that sovereign and aggregate risk play a significant role in determining the prices of emerging market corporate bonds.

The table also shows that exchange rate innovations retain an important role in explaining innovations in corporate bond yields. Of the 83 bonds in our sample, 23, or 28% exhibit statistically significant exposure to exchange rate innovations and 22, or 27% exhibit statistically significant exposure to exchange rate volatility innovations. In the final column of the table, we tabulate bonds that have statistically significant exposure to exchange rate innovations, exchange rate volatility innovations, or both. The table shows that 35, or 42% of bonds have statistically significant exposures to some form of exchange rate risk. This represents the second highest count of exposures after the sovereign CDS spread. The main conclusion that we draw from these results is that exchange rate variation remains an important determinant of emerging market corporate bond spreads even after controlling for other, possibly related aggregate variables.

The results presented in this section complement our results from Section 2.2 in which we show that nearly three-fourths of bonds have some exposure to exchange rate risk. Here, we examine the degree to which this exposure reflects currency-specific risk, common risk across countries, and sovereign credit risk. The results in this section suggest that a substantial portion of the risk can be traced to sovereign and global systematic risk. However, a significant proportion of bonds are still exposed to risk that is specific to currency risk and independent from sovereign or global systematic risk. Moreover, these bonds' prices are exposed to risks in exchange rate and exchange rate volatility variation, whether this exposure reflects exposure specific to local currency risk or common to sovereign and global systematic risk. Thus, our earlier conclusion remains: dollar-denominated corporate bonds are not immune to currency risk.

2.4 Cross-Sectional Determinants of Foreign Exchange Sensitivity

In the preceding sections, we document that a substantial fraction of the dollar-denominated bonds in our sample have prices that are exposed to exchange rate risks. In this section, we examine factors that might drive cross-sectional differences in the exposure to these risks. As discussed in the introduction, dollarization of debt may increase the exposure of a borrower to default risk.

Hence, we investigate whether the sensitivities that we document are related to variables shown to affect risk of default as in Campbell, Hilscher, and Szilagyi (2008). Additionally, the companies in our sample are generally large international corporations. As a result, they have access to financial and operational hedges that may alter the sensitivity of their cash flows to exchange rate fluctuations. We follow Bartram, Brown, and Minton (2010) in selecting variables that may affect the exposure of firms' security prices to exchange rate risk.

We collect financial statement data for the firms in our sample from Worldscope or, for debt information, directly from company financial statements. We select financial statement data for fiscal years ending in 2011, 2012, and 2013, as this period covers most of the time series of firms in our sample. From these data, we construct the following variables in the spirit of Bartram, Brown, and Minton (2010) and Campbell, Hilscher, and Szilagyi (2008):

1. *Foreign sales percentage.* This variable, $psales_{j,t}$, is the fraction of total revenues from non-domestic sources. We expect that, all other considerations constant, firms with more foreign sales will be less vulnerable to foreign exchange risks, as these firms' foreign revenues will offset risks induced by lower cash flows due to exchange rate fluctuations.

2. *Percent of U.S. dollar debt.* The percent of U.S. dollar debt, $pdebt_{j,t}$ reflects the importance of dollar debt in the overall debt structure of the firm. The variable is calculated as the ratio of dollar-denominated long-term debt to total long-term debt. In some cases, the current portion of long-term debt was not separated from the dollar portion of short-term debt. In these cases, we utilize the ratio of total dollar debt to total long and short-term debt. We expect that for firms for which the U.S. dollar bonds are a more important fraction of their overall capital structure, that sensitivities to foreign exchange risk will be higher.[8]

3. *Profitability.* We construct a measure of profitability as the ratio of net income to market value of total assets, $nimta_{j,t}$. The ratio is constructed by dividing net income by the sum of the market value of equity and the book value of total liabilities. More profitable firms are expected to be less sensitive to default risk; if there is a positive link between exchange rate sensitivity and default risk, we expect a negative coefficient.

4. *Leverage.* Leverage is measured as the ratio of total liabilities to market value of total assets, $tltma_{j,t}$, as defined above. We expect a positive relation between leverage and exchange rate sensitivity insofar as firms with greater default risk are more exposed to currency fluctuations.

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[8]While we hypothesize that a greater fraction of U.S. debt leads to a greater sensitivity to exchange rate risk, we acknowledge that it is also possible that the reverse, or no relation may exist between the fraction of U.S. debt and exchange rate exposure. It is distinctly possible that firms with less exposure to exchange rate risk might decide to take on a greater fraction of their debt denominated in U.S. dollars. That is, the decision to issue dollar-denominated debt may be endogenous to the firm's exposure to exchange rate risk.

5. *Cash.* Cash is measured as the ratio of cash and short-term investments to the market value of total assets, $cash_{j,t}$. Since cash provides something of a buffer against adverse effects of distress on operational cash flows, we expect a negative relation between cash and default risk, and hence exchange rate sensitivity.

6. *Market-to-Book.* We measure the market-to-book ratio, $mb_{j,t}$, as the ratio of market value of equity to the book value of equity. Book value of equity is assumed to be the difference in book value of assets and book value of liabilities. Campbell, Hilscher, and Szilagyi (2008) hypothesize that firms with low market-to-book ratios are more likely to be distressed. Therefore, we expect a negative relation between this ratio and sensitivity to exchange rate movements.

7. *Volatility.* Return data are obtained from Yahoo! Finance. We calculate the standard deviation of daily returns over the calendar year, $\sigma_{j,t}$. Firms with more volatile equity returns are assumed to be riskier, reflecting higher default risk. Hence, we expect a positive relation between volatility and exchange rate sensitivity.

8. *Excess return.* The excess return is the annual return on the firm's equity in excess of the return on the S&P 500 index. Campbell, Hilscher, and Szilagyi (2008) utilize the excess return as a market perception of the overall health of the company. We expect this variable to be negatively related to exchange rate sensitivity.

Bartram, Brown, and Minton (2010) also include an indicator variable for derivative usage. All of the firms in our sample indicate that they utilize currency derivatives on their financial statements. Hence, we do not include this variable in our analysis. Additionally, foreign asset data are not available for most firms in our sample, so we do not include this variable in our regressions. We also omit two variables used in Campbell, Hilscher, and Szilagyi (2008), price and the log of market value. These two variables are generally denominated in terms of the home currency, and thus comparisons across countries are not meaningful. We include two additional variables in the regression; the coupon rate of the bond and the maturity of the bond. These variables serve a dual purpose. First, the variables are related to the bond's duration, and affect the interest rate sensitivity of the bond's price. Second, the variables are specific to the bond and thus serve as a kind of bond "fixed-effect."

Summary statistics for the variables are shown in Table 8. Since we require all data items to be non-missing, several companies and, as a result countries, fall out of our analysis. As shown in the table, many of the firms in our sample have some natural operational hedge against dollar exchange rate risk in the form of U.S sales. On average, the firms in our sample derive nearly one-third of their sales from foreign sources. U.S. debt is also an important part of their capital structure, with an average of 22.94% of long-term debt denominated in dollars. Cross-sectionally,

Peruvian firms are the most and Argentinian the least profitable. Argentinian firms are the most, and Chilean firms the least levered. The average Brazilian firm holds 12.59% of the market value of its assets in cash, compared to 4.50% for the average Peruvian firm. Stock returns are most volatile for Peruvian firms and least volatile for South Korean firms. Finally, most of the firms in our sample have negative returns compared to the S&P 500. Given the time frame of 2010-2013, this is perhaps not surprising given strong returns in the United States and weak returns in the rest of the world.

Regression results for the sensitivity of yield spreads on exchange rates and exchange rate volatility on the firm-specific variables are presented in Table 9. Most of the statistically significant coefficients exhibit the signs predicted above. Firms with a higher fraction of foreign sales, more cash, and higher excess returns have bonds with yields less sensitive to exchange rate innovations. Firms with higher return volatility have bonds with greater sensitivity to exchange rate risk, as do firms with bonds with higher coupons. The two surprising results are that firms with higher profitability have greater sensitivity of bond prices to exchange rate innovations, and that those with a higher fraction of dollar debt have less sensitivity to exchange rate innovations. As alluded to above, theses results may be due to endogeneity; it is quite likely that those firms with better natural hedges, and therefore less sensitivity to exchange rate risk, may be more likely to assume a greater fraction of their capital structure in U.S. Dollars. Similarly, more profitable firms may be better able to assume greater exchange rate risk exposure.

Results for the sensitivity of yield spreads to innovations in exchange rate volatility are presented in the second column. The results of these regressions suggest that the effect of the cross-sectional variables on exchange rate volatility innovation sensitivity is generally opposite that of exchange rate innovation sensitivity. Firms with a higher fraction of foreign sales and excess returns have bond prices which are more sensitive to exchange rate volatility, whereas firms with higher net income have bond prices that are less sensitive to exchange rate volatility. While the net income result affords with our intuition, the former two results appear to be somewhat puzzling.

The results suggest that the sensitivity of bond prices to exchange rates and exchange rate volatility are negatively correlated, as indicated by the opposing signs of the cross-sectional variables in the two regressions. We repeat our analysis, but include the complementary coefficient as a regressor in the regression in the third and fourth columns of the table. That is, we repeat the regression analysis, but for the specification with the sensitivity to exchange rate innovations (volatility innovations) as the regressand, we include the sensitivity to exchange rate volatility innovations (level innovations) on the right hand side. As shown in the table, the two variables are strongly negatively correlated, with highly statistically significant coefficients in both regression specifications.

The results suggest that the earlier conclusions for exchange rate level innovations are largely unchanged. The signs of all covariates remain the same as in Column 1, although statistical significance changes. Exchange rate sensitivity is negatively related to the fraction of foreign sales, suggesting that foreign sales may act as a natural hedge against this sensitivity. Coupon rates and profitability are positively and significantly associated with sensitivity to exchange rate innovations. The latter result remains puzzling, but is consistent with the earlier results. Results in Column 4 suggest that sensitivity to exchange rate volatility is largely absorbed by the sensitivity to exchange rate levels. Controlling for this variable, none of the cross-sectional variables have statistically significant explanatory power for cross-sectional variation in sensitivity to exchange rate volatility.

We conclude from the results in this section that the sensitivity of dollar-denominated bond prices to exchange rate innovations is related to natural hedges against exchange rate risk and, to some degree, determinants of default risk exposure. Firms with greater natural hedges seem generally to have bond prices that are less exposed to exchange rate level risk, and those with greater vulnerability to default risk are more exposed to this risk. An important caveat is profitability; more profitable firms have bonds with more exposure to exchange rate risk. Finally, exposure to exchange rate volatility risk appears to be largely orthogonal to these determinants. Controlling for the exposure to exchange rate level risk, we find that none of the cross-sectional variables have statistically significant explanatory power for explaining bond exposure to exchange rate volatility risk.

3 Modeling Dollar-Denominated Corporate Bond Prices

In Section 2, we present evidence supporting the conclusion that dollar-denominated bond prices are exposed to risk in exchange rates and exchange rate volatilities. Our evidence is gathered using reduced-form regressions of innovations in bond yield spreads on innovations in exchange rates, exchange rate volatility, and covariates. In this section, we formalize the analysis of the exchange rate risk exposure of dollar-denominated bonds by specifying and estimating a reduced-form bond pricing model in the spirit of Duffie and Singleton (1997, 1999). In contrast to their model, spreads are allowed to be affected by not only the factors in the risk free term structure, but also exchange rates and their volatility. Our model allows some of the variation in bond-specific hazard rates to be absorbed by exchange rate and volatility variation.

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3.1 Pricing Risky Bonds

We specify a reduced-form model of bond prices following Duffie and Singleton (1999). Specifically, we assume that the price of a zero-coupon bond with default risk is given by

$$P_{0,i}(t, T - t) = E_t^Q \left[e^{-\int_t^T R_i(s)ds} \right],$$
(2)

with $R_i(s)$ representing the instantaneous default-adjusted discount rate,

$$R_i(t) = r(t) + (1 - \delta_i) \lambda_i(t),$$
(3)

where $r(t)$ is the instantaneous risk free rate, i indexes bonds, δ_i is the rate of recovery on the debt, and $\lambda_i(t)(1 - \delta_i)$ is the spread in excess of the risk-free rate.

We specify the risk free term structure following Duffee (1999) as a two-factor term structure model in the affine class of models derived by Duffie and Kan (1996). We assume that the risk free rate can be expressed as an affine function of two state variables,

$$r(t) = a_f + x_1(t) + x_2(t),$$
(4)

where the state variables $x_1(t)$ and $x_2(t)$ follow square root dynamic processes under the risk-neutral probability measure Q as in Cox, Ingersoll, and Ross (1985),

$$dx_1(t) = \left[\kappa_{x_1} \theta_{x_1} - (\kappa_{x_1} + \eta_{x_1}) x_1(t) \right] dt + \sigma_{x_1} \sqrt{x_1(t)} dW_{x_1}^Q(t)$$
(5)

$$dx_2(t) = \left[\kappa_{x_2} \theta_{x_2} - (\kappa_{x_2} + \eta_{x_2}) x_2(t) \right] dt + \sigma_{x_2} \sqrt{x_2(t)} dW_{x_2}^Q(t).$$
(6)

The parameters η_{x_1} and η_{x_2} represent prices of risk and $dW_{x_1}^Q(t)$ and $dW_{x_2}^Q(t)$ are independent Brownian motions under the risk neutral probability measure Q.

The credit spread, $(1 - \delta_i)\lambda_i(t)$, is modeled using the special case of Duffie and Singleton (1999) employed in Duffee (1999). The spread is assumed to be a function of the risk-free term structure state variables, the exchange rate and its volatility, and a default risk variable,

$$(1 - \delta_i) \lambda_i(t) = a_i + h_i(t) + \beta'_{i,\mathbf{x}} (\mathbf{x}(t) - \bar{\mathbf{x}}) + \beta_{i,fx} fx(t) + \beta_{i,v} v_{fx}(t).$$
(7)

The vector $\bar{\mathbf{x}}$ denotes the unconditional sample average of the risk-free state variables $\mathbf{x}(t)$. The parameter vector $\beta_{i,\mathbf{x}}$ allows for correlation between the default-free term structure and the spread on corporate bonds; as referenced above, Longstaff and Schwartz (1995) argue that structural models in the line of Merton (1974) result in a negative relation between the credit spread and the risk-free rate. The variables $fx(t)$ and $v_{fx}(t)$ are the levels of the exchange rate and its variance,

respectively.

The default risk factor, $h_i(t)$, is referred to as the hazard rate and follows a stochastic process under the risk-neutral probability measure Q defined as

$$dh_i(t) = [\kappa_{h_i}\theta_{h_i} - (\kappa_{h_i} + \eta_{h_i})\, h_i(t)]\, dt + \sigma_{h_i}\sqrt{h_i(t)}dW_{h_i}^Q(t). \tag{8}$$

We assume that the Brownian motion driving the evolution of the hazard rate is independent of the Brownian motions governing the riskless rate.[9] Duffie and Singleton (1999) note that one can view the hazard rate as the arrival intensity of a jump that first occurs as default. Thus, although default is a discrete event, the intensity follows a diffusion.

In a fully specified international bond pricing model, the drift of the exchange rate under the risk-neutral probability measure is equal to the difference in interest rate levels between the two countries. Rather than model the term structures of the countries in our sample, we simplify the risk neutral drift to

$$r^l(t) - r(t) = \mu_{fx} - \eta_{fx}v_{fx}(t),$$

where $r^l(t)$ is the interest rate in the foreign country, the constant μ_{fx} is the drift term for the exchange rate under the physical measure, $v_{fx}(t)$ is the exchange rate variance and η_{fx} is the price of exchange rate risk. The exchange rate is assumed to follow an arithmetic Brownian motion with stochastic volatility,

$$dfx(t) = (\mu_{fx} - \eta_{fx}v_{fx}(t))\, dt + \sqrt{v_{fx}(t)}dW_{fx}^Q(t) \tag{9}$$

$$dv_{fx}(t) = [\kappa_v\theta_v - (\kappa_v + \eta_v)\, v_{fx}(t)]\, dt + \sigma_v\sqrt{v_{fx}(t)}dW_v^Q(t), \tag{10}$$

where the variance of the exchange rate follows a square root process. The parameters κ_v, θ_v are positive, as is the sum $\kappa_v + \eta_v$.

Using Ito's Lemma, bond price dynamics satisfy

$$\begin{aligned}
dP_{0,i}(t, T-t) &= \left[P_{0,i}(t, T-t) + \mathbf{P}'_{0,i,\mathbf{z}}\, \boldsymbol{\mu}\,(\mathbf{z}(t), t) + \frac{1}{2}trace\left(\boldsymbol{\sigma}\,(\mathbf{z}(t), t)'\, \mathbf{P}_{0,i,\mathbf{zz}}\, \boldsymbol{\sigma}\,(\mathbf{z}(t), t)\right)\right] dt \\
&+ \mathbf{P}'_{0,i,\mathbf{z}}\, \boldsymbol{\sigma}\,(\mathbf{z}(t), t)\; d\mathbf{W}^Q(t),
\end{aligned} \tag{11}$$

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[9]An alternative approach is to use a three-factor model in which the correlation among the state variables is explicit. Dai and Singleton (2000) provide conditions for which affine term structure models are identified. The principal cost of doing so, as the authors note, is that the correlation structure and the stochastic volatility in the hazard rate process are constrained. In order to allow negative correlation between the hazard rate process and the risk-free term structure, one would have to model the hazard process as a Gaussian state variable. This would allow the spread to potentially take on negative values, which is undesirable in the context of a positive premium for default risk.

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where $\mathbf{z}(t) = \{x_1^*(t), x_2^*(t), fx^*(t), v_{fx}^*(t), h_i(t)\}$, $x_n^*(t) = (1 + \beta_{i,x_n})x_n(t)$ for $n = 1, 2$, $fx^*(t) = \beta_{i,fx}fx(t)$, and $v_{fx}^*(t) = \beta_{i,v}v_{fx}(t)$. $\mathbf{P}_{0,i,\mathbf{z}}$ and $\mathbf{P}_{0,i,\mathbf{zz}}$ are the gradient and hessian of the bond price, $\boldsymbol{\sigma}(\mathbf{z}(t), t)$ is the diagonal matrix of volatilities, and $d\mathbf{W}^Q(t)$ is the vector of Brownian shocks. Letting $\tau = T - t$, we postulate that yields are affine in the state variables of the model:

$$\ln P_{0,i}(t, \tau) = A_i(\tau) + \mathbf{B}_{i,\mathbf{x}^*}'(\tau)\mathbf{x}^*(t) + B_{h_i}(\tau) h_i(t) + B_{i,fx^*}(\tau) fx^*(t) + B_{i,v^*}(\tau) v_{fx}^*(t). \quad (12)$$

Using the fact that under the risk-neutral measure the discounted bond price is a martingale, we obtain a partial differential equation that can be represented as a system of ordinary differential equations. The exact forms of the coefficients are provided in the Appendix. These solutions are for zero-coupon bond prices, whereas the bonds in our sample are coupon bonds. We treat these coupon bonds as a portfolio of zero coupon bonds with face value c plus a zero coupon bond with face value of 1. Mathematically, the price of the coupon bond with time to maturity τ is given by

$$P_i(t, \tau, c) = E_t^Q \left[c \sum_{m=1}^{\tau} e^{-\int_t^{t+m} R_i(s)ds} + e^{-\int_t^{\tau+t} R_i(s)ds} \right], \quad (13)$$

where m indexes the periodic coupon payments.

3.2 Estimation Procedure

The state variables of the default-free term structure, x_1 and x_2, as well as the hazard rate h_i, are unobservable. We estimate model parameters and identify the latent variables using the extended Kalman filter. Our Kalman filtering process first estimates parameters of the risk-free term structure using the measurement equation

$$\mathbf{y}(t, \boldsymbol{\tau}) = a_f \boldsymbol{\iota} - \frac{1}{\tau} \left(\mathbf{A}(\boldsymbol{\tau}) + \mathbf{B}'(\boldsymbol{\tau}) \mathbf{x}_t \right) + \mathbf{u}_t \quad (14)$$

where $\mathbf{y}(t, \boldsymbol{\tau})$ is a vector of risk-free zero coupon Treasury yields observed at time t with maturities $\boldsymbol{\tau}$, $\mathbf{A}(\boldsymbol{\tau})$ is a vector of parameters that depend on the time to maturity, and $\mathbf{B}(\boldsymbol{\tau})$ is the vector of coefficients for the discrete-time term-structure state variables $x_{1,t}$ and $x_{2,t}$.[10] The vector of pricing errors $\mathbf{u}_t$ is assumed to be i.i.d. $\mathcal{N}(\mathbf{0}, \boldsymbol{\Sigma}_u)$, where $\boldsymbol{\Sigma}_u$ is a diagonal covariance matrix.

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[10]The exact form of these vectors are similar to the ones described in the Appendix for the risky corporate bonds. Because we estimate the risk-free term structure using constant maturity bonds, the vector of time to maturities $\boldsymbol{\tau}$ does not change in the time-series.

Transition equations for the state variables are given by:

$$\begin{pmatrix} x_{1,t} \\ x_{2,t} \end{pmatrix} = \begin{pmatrix} \theta_{x_1} \left(1 - e^{-\kappa_{x_1}}\right) \\ \theta_{x_2} \left(1 - e^{-\kappa_{x_2}}\right) \end{pmatrix} + \begin{pmatrix} e^{-\kappa_{x_1}} & 0 \\ 0 & e^{-\kappa_{x_2}} \end{pmatrix} \begin{pmatrix} x_{1,t-1} \\ x_{2,t-1} \end{pmatrix} + \begin{pmatrix} w_{x_1,t} \\ w_{x_2,t} \end{pmatrix}, \tag{15}$$

where

$$\mathbf{w}_t \sim \mathcal{N} \left(\mathbf{0}, \begin{bmatrix} Q_{x_1,t} & 0 \\ 0 & Q_{x_2,t} \end{bmatrix} \right) \tag{16}$$

$$Q_{x_n,t} = x_{n,t} \frac{\sigma_{x_n}^2}{\kappa_{x_n}} \left(e^{-\kappa_{x_n}} - e^{-2\kappa_{x_n}}\right) + \theta_{x_n} \frac{\sigma_{x_n}^2}{2\kappa_{x_n}} \left(1 - e^{-\kappa_{x_n}}\right)^2, \quad n = 1, 2. \tag{17}$$

These transition dynamics represent the conditional means and volatilities of the state variables of square root processes as shown in Cox, Ingersoll, and Ross (1985), where the innovation terms are assumed Gaussian. We use the measurement and transition errors to find parameter estimates and filter state variables by maximizing the log likelihood function of the measurement errors.

Given the estimates of the risk-free term structure parameters and the state variables, we estimate the parameters of the risky term structure and filter hazard rates. Our measurement equation is a discretized version of the risky coupon bond price from equation (13), measured with error:

$$P_i(t, \tau, c) = c \sum_{m=1}^{\tau} P_{0,i}(t, m) + P_{0,i}(t, \tau) + u_{i,t}, \tag{18}$$

Since we take the latent risk-free variables as given from the estimation of the risk-free term structure, our transition equation applies to the hazard rate:

$$h_{i,t} = \frac{\theta_{h_i} \kappa_{h_i}}{\kappa_{h_i} + \eta_{h_i}} \left(1 - e^{-\kappa_{h_i}}\right) + e^{-\kappa_{h_i}} h_{i,t-1} + w_{h_i,t}, \tag{19}$$

where

$$w_{h_i,t} \sim \mathcal{N}\left(0, Q_{h_i,t}\right), \tag{20}$$

$$Q_{h_i,t} = h_{i,t-1} \frac{\sigma_{h_i}^2}{\kappa_{h_i}} \left(e^{-\kappa_{h_i}} - e^{-2\kappa_{h_i}}\right) + \theta_{h_i} \frac{\sigma_{h_i}^2}{2\kappa_{h_i}} \left(1 - e^{-\kappa_{h_i}}\right)^2. \tag{21}$$

As with the risk-free estimation, we estimate parameters and filter hazard rates by maximizing the log likelihood function of the measurement errors for each bond in our sample.

The standard errors of parameter estimates are constructed according to the quasi-maximum likelihood error approach. The approach uses both the Hessian of the log likelihood function and the outer product estimate for the information matrix. The conditional normality assumption for the log likelihood function is an approximation to the true data generating process which, under

the assumption of a square-root process for the state variables, is a non-central χ^2 distribution. In tabulating our results, we do not report the standard errors for the point estimates of the hazard rate process; instead, we report quantiles of the estimates.

Our estimation approach mirrors Duffee (1999). As in his investigation, we estimate parameters of the risk free term structure separately from estimation for individual bonds. Doing so ensures that that common risk free term structure factors and parameters are common to all bonds. In principle, it would be desirable to jointly estimate the parameters of the risky and risk free term structures. However, the technical complications of a joint estimation over a large cross-section of assets renders joint estimation infeasible.

3.3   Model Performance

We present the 25th, median, and 75th percentile of parameter estimates and root mean pricing errors for all countries, and within countries for which there are sufficient observations, in Table 10. For brevity, we focus only on the parameters determining the risk neutral dynamics of the hazard rate process, as well as the sensitivity of bond yields to the risk free term structure, exchange rates, and exchange rate volatility.

Parameters of the hazard rate and the price of risk are presented in the first five columns of the table. Our median point estimates for these parameters are similar to those documented in Duffee (1999) in examining 161 corporate bond yields. The median estimate of the mean reversion parameter, κ_{h_i}, is 0.143, compared to a median point estimate of 0.238 in Duffee (1999). It is not clear whether the slower mean reversion is a function of the timing of our sample or a reflection of greater persistence in the hazard rate for emerging market dollar-denominated bonds. The long-run mean of the hazard rate, θ_{h_i} is approximately twice as large as reported in Duffee (1999), with a point estimate of 0.0102 compared to 0.0056 in his study, perhaps reflecting greater average default risk in these securities. Finally, the price of default risk, η_{h_i} is also roughly twice as large, with a median point estimate of -0.454, compared to Duffee's estimate of -0.235. The interquartile range of the mean reversion parameter and long-run mean parameter remain positive, while the interquartile range of the price of risk is negative.

Across countries, we observe that the median mean reversion parameter is lowest in Brazil, with a point estimate of 0.026 and highest in Argentina, with a median point estimate of 0.609, indicating that the median bond's hazard rate has much greater persistence in Brazil than in Argentina. The median long-run mean parameter is lowest in South Korea, with a point estimate of 0.0035, compared to 0.0200 in Peru, suggesting the highest (median) long-run mean default risk in Peru. Finally the largest magnitude price of default risk is observed in Argentina, while the lowest is observed in Chile, with point estimates of -0.840 and -0.272, respectively. In all six

countries, the interquartile range of the prices of default risk are negative, consistent with a positive price of default risk.

At the median, the sensitivity of yields to the default free-term structure factors is negative. Again, these results are consistent with those in Duffee (1999) for U.S. corporate bonds. The first term structure factor is related to the level of risk-free bond yields and the second is related to the slope. Longstaff and Schwartz (1995) suggest that bond yield spreads will be negatively related to the level of interest rates because an increase in interest rates results in an increase in the risk neutral drift of firm value. This in turn reduces the probability of default, lowering the credit spread. The effect is similar in magnitude to that reported in Duffee (1999); our median point estimate is -0.110 as compared to his of -0.096. The impact of the second state variable is considerably smaller than the first, with a coefficient approximately one order of magnitude smaller at -0.008, again comparable to Duffee's median point estimate of -0.009. As he notes, this coefficient suggests an economically negligible impact of the second state variable on yield spreads.

Most pertinent to our analysis are the coefficients β_{fx} and β_v, which capture sensitivity of spreads to exchange rate levels and volatility, respectively. The median point estimate of β_{fx} is positive, but is quite small with a point estimate of 0.0015. To place this in some context, the point estimate suggests that if recovery rates are 40%, a 100 basis point increase in exchange rates would result in a less than 1 basis point increase in spreads. The annualized standard deviation of log exchange rate innovations over our sample period range from 4.8% (Peru) to 17.6% (Brazil). Applying the median coefficient to these standard deviations produces a range of impact on spreads from 0.72 basis points to 2.64 basis points. Thus, for the median firm, it appears that the sensitivity of spreads to exchange rates is likely to be relatively negligible. However, for firms in some countries, the effects are more substantial. A one standard deviation annual positive shock to exchange rates in Brazil, applied to the 75th percentile firm coefficient of 0.0325 implies an increase in spreads of 57 basis points. The same calculation for the 75th percentile Peruvian firm implies an increase in spreads of approximately 13 basis points.

The magnitude of the median coefficient on exchange rate volatility, β_v, is considerably larger with a point estimate of 0.7102. Again, this coefficient has little meaning without some economic interpretation. A 100 basis point innovation in the volatility of exchange rates would result in a 71 basis point increase in the spread for the median firm, assuming a 40% recovery rate. One annualized standard deviation in the innovation of the volatility of exchange rates ranges from 5.9% (Chile) to 11.8% (Peru). A one standard deviation increase in volatility of exchange rates would result in a 420 basis point increase in the spread of the median Chilean firm, while a one standard deviation increase in the volatility of exchange rates would result in a 840 basis point increase in the spread of the median Peruvian firm. These quantities are clearly economically significant.

In the final column of the table, we present the root mean square pricing error of the model, expressed in basis points. Again, the results are quite comparable to those presented in Duffee (1999). At the median, the model prices bonds with a root mean square error of 9.90 basis points, compared to 9.83 reported by Duffee. The interquartile range is also similar, ranging from 7.55 basis points (7.39 reported by Duffee) to 13.42 basis points (11.05 reported by Duffee). As shown in the table, however, there is considerable cross-sectional variation in root mean square errors. Bonds are priced most accurately in South Korea, with a median pricing error of 6.92 basis points, and most poorly in Argentina with a median pricing error of 27.39 basis points. The interquartile range is quite large in Mexico as well, ranging from 7.50 basis points at the 25th percentile to 20.21 basis points at the 75th percentile. In general, however, the results suggest that the model prices dollar-denominated emerging market corporate bonds about as well as U.S. corporate bonds.

To summarize, in this section we present a model of emerging market bond prices in which yield spreads are exposed to exchange rates and their volatility. We find that the model prices bonds about as well as a comparable model without exchange rates and volatility investigated in Duffee (1999). Our evidence suggests that there are measurable impacts of both exchange rate level innovations and volatility innovations on the spreads of emerging market corporate bonds. The impact of volatility on spreads is particularly large. Thus, the results of our model estimation, in tandem with the reduced form regressions earlier in the paper, suggest that emerging market dollar denominated corporate bonds have prices that are strongly exposed to risks in exchange rates. As such, they cannot be deemed as insulated from exchange rate risk.

4 Conclusion

Dollar denominated emerging market bonds are marketed to investors as free of exchange rate risk. In this paper, we present evidence to suggest that in the case of a sample of corporate bonds that this claim is not strictly true. When we simply ask whether innovations in bond yields are sensitive to innovations in exchange rates and exchange rate volatility, we find that a substantial fraction of the bonds in our sample are exposed to these innovations. Approximately 58% of the bonds in our sample have statistically significant exposures to foreign exchange rate innovations, and 32% have significant exposure to exchange rate volatility innovations. Nearly three quarters of the bonds in our sample, 74%, have spreads with statistically significant exposure to exchange rates, exchange rate volatility, or both. These risks account for a median 16% of the variation in bond yield innovations in our sample, and over 20% of the median variation in yield innovations in Mexico and Peru.

Exchange rates and their volatility are related to a number of other factors, including the U.S.

term structure, sovereign risk, and other global factors. Controlling for these factors, we find that some of the channels through which yields are influenced by exchange rate risk are correlated with these covariates. In particular, sovereign credit risk and exchange rates are strongly related, and sovereign credit risk, as captured by sovereign CDS spreads, emerges as the most frequently significant determinant of yield spreads on dollar-denominated bonds. Nonetheless, 35 of the 83 bonds in our sample, or approximately 42%, have statistically significant exposure to exchange rate or exchange rate volatility risk after controlling for these covariates. Thus our results further confirm the sensitivity of dollar-denominated emerging market bonds to exchange rate risk, whether directly related to the risks themselves, or indirectly through covariates.

We formalize our regression findings in a model of reduced-form defaultable bond pricing as in Duffie and Singleton (1997, 1999), augmented to allow for sensitivity of bond yields to exchange rates and exchange rate volatility. Bonds in our sample exhibits relatively little economic sensitivity to exchange rate level risk; for the median Brazilian bond, a one standard deviation increase in exchange rates would result in a 1.55 basis point increase in spreads. However, bonds are much more exposed to exchange rate volatility. A one standard deviation increase in the volatility of exchange rates implies an increase in spreads of 999 basis points for the median Chilean firm. Thus, our model suggests that dollar-denominated bonds are significantly economically exposed to risks in exchange rates.

As discussed above, a large literature in development economics predicts that emerging market companies that issue dollar-denominated debt will suffer increased default risk when the local currency loses value. Our results support this prediction, insofar as the price of risky bonds varies due to default risk. Unfortunately, we cannot directly assess whether the dollar debt burden of these firms results in a higher probability of default. However, our results raise an additional question. Whether it is due to increased default risk or another mechanism, dollar-denominated bonds are exposed to risks in exchange rates. To the extent that the rationale for dollarization is to protect investors from emerging market currency devaluations, our evidence suggests that this rationale is flawed. Rather, both firms and investors might be better served by issuing debt in local currency, and letting investors hedge these risks in derivative markets. We believe an intriguing question for future research is whether such an alternative security design could benefit both bondholders and bond issuers.

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A   Appendix

In this appendix, we present the explicit form of bond pricing coefficients for the models estimated in the paper. In our fully specified model with default and foreign exchange risk, a system of four variables follows risk neutral dynamics

$$
\begin{pmatrix} dx_1(t) \\ dx_2(t) \\ dv_{fx}(t) \\ dfx(t) \\ dh_i(t) \end{pmatrix} = \begin{pmatrix} \kappa_{x_1} & 0 & 0 & 0 & 0 \\ 0 & \kappa_{x_2} & 0 & 0 & 0 \\ 0 & 0 & \kappa_v & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & \kappa_{h_i} \end{pmatrix} \begin{pmatrix} \theta_{x_1} \\ \theta_{x_2} \\ \theta_v \\ \mu_{fx} \\ \theta_{h_i} \end{pmatrix} dt
$$

$$
- \begin{pmatrix} \kappa_{x_1} + \eta_{x_1} & 0 & 0 & 0 & 0 \\ 0 & \kappa_{x_2} + \eta_{x_2} & 0 & 0 & 0 \\ 0 & 0 & \kappa_v + \eta_v & 0 & 0 \\ 0 & 0 & 0 & \eta_{fx} & 0 \\ 0 & 0 & 0 & 0 & \kappa_{h_i} + \eta_{h_i} \end{pmatrix} \begin{pmatrix} x_1(t) \\ x_2(t) \\ v_{fx}(t) \\ v_{fx}(t) \\ h_i(t) \end{pmatrix} dt
$$

$$
+ \begin{pmatrix} \sigma_{x_1} & 0 & 0 & 0 & 0 \\ 0 & \sigma_{x_2} & 0 & 0 & 0 \\ 0 & 0 & \sigma_v & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & \sigma_{h_i} \end{pmatrix} \begin{pmatrix} \sqrt{x_1(t)} & 0 & 0 & 0 & 0 \\ 0 & \sqrt{x_2(t)} & 0 & 0 & 0 \\ 0 & 0 & \sqrt{v_{fx}(t)} & 0 & 0 \\ 0 & 0 & 0 & \sqrt{v_{fx}(t)} & 0 \\ 0 & 0 & 0 & 0 & \sqrt{h_i(t)} \end{pmatrix} \begin{pmatrix} dW_{x_1}^Q(t) \\ dW_{x_2}^Q(t) \\ dW_v^Q(t) \\ dW_{fx}^Q(t) \\ dW_{h_i}^Q(t) \end{pmatrix},
$$

where $x_1(t)$ and $x_2(t)$ are state variables governing the default-free term structure, $v_{fx}(t)$ is the foreign exchange variance, $fx(t)$ is the exchange rate, and $h_i(t)$ is the default intensity for bond i. The instantaneous risk-free rate is a linear function of the state variables,

$$
r(t) = a_f + x_1(t) + x_2(t),
$$

and the credit spread is given by

$$
R_i(t) - r(t) = (1 - \delta_i)\lambda_i(t) = a_i + \beta_{i,x_1}(x_1(t) - \bar{x}_1) + \beta_{i,x_2}(x_2(t) - \bar{x}_2) + \beta_{i,fx}fx(t) + \beta_{i,v}v_{fx}(t) + h_i(t),
$$

where $R_i(t)$ is the instantaneous zero-coupon yield on a risky bond.

Log risky zero-coupon bond prices are affine in the state variables

$$
\ln P_{0,i}(t,\tau) = A(\tau) + B_{i,x_1^*}(\tau)x_1^*(t) + B_{i,x_2^*}(\tau)x_2^*(t) + B_{i,v^*}(\tau)v_{fx}^*(t) + B_{i,fx^*}(\tau)fx^*(t) + B_{h_i}(\tau)h_i(t),
$$

where τ is the time to maturity in years, $x_n^*(t) = (1 + \beta_{i,x_n})x_n(t)$ for $n = 1, 2$, $fx^*(t) = \beta_{i,fx}fx(t)$,

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and $v_{fx}^*(t) = \beta_{i,v} v_{fx}(t)$.

Using the fact that under the risk-neutral measure the discounted bond price is a martingale, we obtain a partial differential equation that can be represented as a system of ordinary differential equations,

$$1 = \frac{1}{2} B_{i,x_1^*}^2(\tau) \sigma_{i,x_1^*}^2 - B_{i,x_1^*}(\tau)(\kappa_{x_1} + \eta_{x_1}) - \partial B_{i,x_1^*}(\tau)/\partial \tau \tag{A.1}$$

$$1 = \frac{1}{2} B_{i,x_2^*}^2(\tau) \sigma_{i,x_2^*}^2 - B_{i,x_2^*}(\tau)(\kappa_{x_2} + \eta_{x_2}) - \partial B_{i,x_2^*}(\tau)/\partial \tau \tag{A.2}$$

$$1 = \frac{1}{2} B_{h_i}^2(\tau) \sigma_{h_i}^2 - B_{h_i}(\tau)(\kappa_{h_i} + \eta_{h_i}) - \partial B_{h_i}(\tau)/\partial \tau \tag{A.3}$$

$$1 = \frac{1}{2} B_{i,v^*}^2(\tau) \sigma_{i,v^*}^2 - B_{i,v^*}(\tau)(\kappa_v + \eta_v) - \partial B_{i,v^*}(\tau)/\partial \tau + \frac{1}{2} B_{i,fx^*}^2(\tau) \frac{\beta_{i,fx}^2}{\beta_{i,v}} - B_{i,fx}(\tau) \frac{\eta_{fx}\beta_{i,fx}}{\beta_{i,v}} \tag{A.4}$$

$$1 = -\partial B_{i,fx^*}(\tau)/\partial \tau \tag{A.5}$$

$$0 = \partial A_i(\tau)/\partial \tau - a_h - a_f + \beta_{i,x_1}\bar{x}_1 + \beta_{i,x_2}\bar{x}_2 + \sum_{z \in \{x_1^*, x_2^*, h_i, v_{fx}^*\}} B_{i,z}(\tau)\kappa_z \theta_{i,z} + B_{i,fx^*}(\tau)\mu_{i,fx^*}, \tag{A.6}$$

where $\sigma_{x_n^*}^2 = \sigma_{i,x_n}^2 \sqrt{1 + \beta_{i,x_n}}$, $\theta_{i,x_n^*} = \theta_{i,x_n}(1 + \beta_{i,x_n})$, $\kappa_{x_n^*} = \kappa_{x_n}$ for $n = 1, 2$, $\sigma_{i,v^*}^2 = \sigma_v^2 \sqrt{\beta_{i,v}}$, $\theta_{i,v^*} = \theta_v \beta_{i,v}$, $\kappa_{v^*} = \kappa_v$, and $\mu_{i,fx^*} = \mu_{fx}\beta_{i,fx}$.

Collecting the variables into a five-dimensional vector $\mathbf{z}_t = \{x_1^*(t), x_2^*(t), v^*(t), fx^*(t), h_i(t)\}$, the solutions to the above system of ODE's are given by

$$B_{x_n^*}(\tau) = -\frac{2(e^{\gamma_{x_n^*}\tau} - 1)}{2\gamma_{x_n^*} + (\kappa_{x_n} + \eta_{x_n} + \gamma_{x_n^*})(e^{\gamma_{x_n^*}\tau} - 1)} \quad \text{for } n \in \{1, 2\}$$

$$B_{h_i}(\tau) = -\frac{2(e^{\gamma_{h_i}\tau} - 1)}{2\gamma_{h_i} + (\kappa_{h_i} + \eta_{h_i} + \gamma_{h_i})(e^{\gamma_{h_i}\tau} - 1)}$$

$$B_{fx^*}(\tau) = -\tau$$

$$A(\tau) = -a_d\tau - a_f\tau + \beta_{i,x_1}\bar{x}_1\tau + \beta_{i,x_2}\bar{x}_2\tau - \frac{1}{2}\mu_{fx}^*\tau^2$$

$$+ \sum_{z \in \{x_1^*, x_2^*, h_i\}} \frac{2\kappa_z\theta_z}{\sigma_z^2} \log\left[\frac{2\gamma_z e^{\frac{1}{2}(\kappa_z + \eta_z + \gamma_z)\tau}}{2\gamma_z + (\kappa_z + \eta_z + \gamma_z)(e^{\gamma_z\tau} - 1)}\right] + H_{v^*}(\tau).$$

with $\gamma_z = \sqrt{(\kappa_z + \eta_z)^2 + 2\sigma_z^2}$ for $z \in \{x_1^*, x_2^*, h_i\}$. The coefficient $B_{v^*}(\tau)$ is the numerical solution to the ODE in equation (A.4), and $H_{v^*}(\tau)$ is the anti-derivative of $B_{v^*}(\tau)$, which is also calculated numerically.

Table 1: Summary Statistics for Emerging Market Dollar-Denominated Bonds

Table 1 presents summary statistics for emerging market dollar-denominated bonds in our sample. Bonds are sampled from Datastream and represent fixed coupon semi-annual debentures issued by corporations with no call provisions and fixed maturity. All bonds have payments denominated in U.S. Dollars and are issued by companies in countries considered emerging markets as of January, 2001. Bonds must have at least 36 months of price information and 75% of daily price changes non-zero. The table presents, by country, number of bonds in the sample, median, minimum, and maximum coupon rates, years to maturity of the bonds, and spreads over comparable maturity treasury securities. Data are sampled over the period January 1, 2001 through August 14, 2014.

Country	N	Coupon			Life at Issue			Mean Spread		
		Min	Median	Max	Min	Median	Max	Min	Median	Max
Argentina	6	5.875	8.188	10.000	6.0	10.0	11.0	1.363	5.251	34.655
Brazil	8	6.250	7.000	9.750	6.0	10.0	30.0	2.834	3.237	6.982
Chile	12	2.875	5.813	8.250	5.0	10.0	23.0	0.949	2.343	5.448
Colombia	1	7.625	7.625	7.625	10.0	10.0	10.0	3.509	3.509	3.509
Czech Rep	1	4.500	4.500	4.500	5.0	5.0	5.0	2.396	2.396	2.396
India	2	5.625	8.000	10.375	10.0	15.0	20.0	2.753	4.411	6.069
Indonesia	2	5.250	5.875	6.500	10.0	20.0	30.0	2.381	2.411	2.440
Malaysia	1	7.875	7.875	7.875	30.0	30.0	30.0	3.059	3.059	3.059
Mexico	20	2.375	7.063	11.250	5.0	10.0	20.0	0.980	4.081	26.131
Peru	12	4.656	6.563	9.000	5.0	7.5	20.0	1.555	3.674	6.047
Philippines	1	6.500	6.500	6.500	10.0	10.0	10.0	3.365	3.365	3.365
South Africa	1	4.500	4.500	4.500	5.0	5.0	5.0	2.161	2.161	2.161
South Korea	17	3.125	4.875	7.700	5.0	10.0	30.0	0.025	1.689	2.480
Thailand	1	5.875	5.875	5.875	30.0	30.0	30.0	1.609	1.609	1.609

Table 2: Sensitivity of Spreads to Foreign Exchange Innovations and Volatility

Table 2 presents results regressing innovations in yield spreads on emerging market dollar-denominated bonds on innovations in exchange rates and exchange rate volatility,

$$\Delta S_{i,k,t} = a_{i,k} + b_{fx,i,k}\Delta fx_{k,t} + b_{v,i,k}\Delta v_{fx,k,t} + \epsilon_{i,k,t},$$

where $\Delta S_{i,k,t}$ is the change in the spread over comparable Treasury security of bond i in country k at time t, $\Delta fx_{k,t}$ is the change in the log exchange rate in country k at time t, and $\Delta v_{fx,k,t}$ is the change in the log volatility of the exchange rate in country k at time t. Exchange rate volatility is modeled via an MA(1), EGARCH (1,1) time series specification. Data on emerging market corporate bonds and exchange rates are obtained from Datastream; the bond data represent 85 issues from fourteen countries. Treasury yield data are constant maturity yields obtained from the FRED database at the Federal Reserve. Data are sampled at the monthly frequency over various horizons with the first observation in January, 2001 and the final observation in August, 2014. The table presents the 25th, 50th, and 75th percentiles of point estimates and adjusted R^2.

All Countries	P25	P50	P75
b_{fx}	2.07	3.90	6.69
b_v	0.00	0.17	0.32
$\bar{R}^2$	8.94	16.18	26.51

Argentina	P25	P50	P75
b_{fx}	-5.15	1.63	4.81
b_v	0.07	0.18	0.38
$\bar{R}^2$	0.74	7.91	12.15

Brazil	P25	P50	P75
b_{fx}	1.21	2.82	3.14
b_v	0.06	0.33	0.55
$\bar{R}^2$	12.67	17.50	32.35

Chile	P25	P50	P75
b_{fx}	0.77	2.13	4.83
b_v	0.11	0.26	0.32
$\bar{R}^2$	8.27	9.37	17.35

Mexico	P25	P50	P75
b_{fx}	3.61	5.41	8.14
b_v	0.14	0.24	0.30
$\bar{R}^2$	17.35	25.55	33.09

Peru	P25	P50	P75
b_{fx}	3.96	10.45	12.27
b_v	-0.11	-0.09	-0.02
$\bar{R}^2$	3.93	22.66	24.00

South Korea	P25	P50	P75
b_{fx}	1.35	2.47	4.10
b_v	0.05	0.16	0.35
$\bar{R}^2$	11.47	14.93	17.83

Table 3: Count of Statistically Significant Coefficients

Table 3 presents a count of statistically significant coefficients in regressions

$$\Delta S_{i,k,t} = a_{i,k} + b_{fx,i,k}\Delta fx_{k,t} + b_{v,i,k}\Delta v_{fx,k,t} + \epsilon_{i,k,t},$$

where $\Delta S_{i,k,t}$ is the change in the spread over comparable Treasury security of bond i in country k at time t, $\Delta fx_{k,t}$ is the change in the log exchange rate in country k at time t, and $\Delta v_{fx,k,t}$ is the change in the log volatility of the exchange rate in country k at time t. Exchange rate volatility is modeled via an MA(1), EGARCH (1,1) time series specification. Data on emerging market corporate bonds and exchange rates are obtained from Datastream; the bond data represent 85 issues across fourteen countries. Treasury yield data are constant maturity yields obtained from the FRED database at the Federal Reserve. Cutoff level for significance is the 10% critical level. Column b_{fx} represents the number of significant coefficients on the exchange rate innovation, b_v represents the number of significant coefficients on the exchange rate volatility innovation, and b_{fx}/b_v represents the number of times that with the exchange rate volatility or exchange rate innovation coefficient are statistically significantly different than zero. Data are sampled at the monthly frequency over various horizons with the first observation in January, 2001 and the final observation in August, 2014.

Country	N	b_{fx}	b_v	b_{fx}/b_v
Argentina	6	1	2	3
Brazil	8	6	4	7
Chile	12	4	5	8
Colombia	1	1	1	1
Czech Rep	1	1	0	1
India	2	2	0	2
Indonesia	2	2	2	2
Malaysia	1	0	1	1
Mexico	20	14	4	16
Peru	12	7	2	7
Philippines	1	0	0	0
S Africa	1	1	0	1
S Korea	17	10	5	13
Thailand	1	0	1	1
Total	85	49	27	63

Table 4: Relation of Exchange Rate Innovations to Common Covariates

Table 4 reports t-statistics for regressions of innovations of exchange rate innovations on a set of covariates,

$$\Delta fx_{k,t} = a + b_{k,cds}\Delta cds_t + b_{k,r_k}r_{k,t} + b_{k,res}\Delta res_{k,t} + b_{k,r_{us}}r_{us,t} + b_{k,y_5}\Delta y_{5,t} + b_{k,\Delta ds}\Delta ds_t$$
$$+ b_{k,\Delta pe}\Delta pe_t + b_{k,\Delta vrp}\Delta vrp_t + b_{k,\Delta ts}\Delta ts_t + e_{k,t},$$

where $\Delta fx_{k,t}$ is the first difference in the log exchange rate between the domestic currency of country k and the U.S. dollar, $r_{k,t}$ is the return on the local country's equity market, $\Delta res_{k,t}$ is the first difference in log foreign currency reserves in country k, $r_{us,t}$ is the log return on the CRSP value-weighted index, $\Delta y_{5,t}$ is the first difference in the log yield on 5-year constant maturity Treasury Notes, Δds_t is the first difference in the spread between yields on Moody's Baa-rated and Moody's Aaa-rated bonds, Δpe_t is the first difference in the log price-earnings ratio on the S&P 500, Δvrp_t is the first difference in the log variance risk premium, and Δts_t is the first difference in the term spread, measured as the difference in yields on 10-year and 2-year constant maturity Treasury Notes. Data are sampled at the monthly frequency and cover various time periods from January, 2001 through August, 2014.

Country	$\Delta cds_{k,t}$	$r_{k,t}$	$\Delta res_{k,t}$	$r_{us,t}$	$\Delta y_{5,t}$	Δds_t	Δpe_t	Δvrp_t	Δts_t	$\bar{R}^2$
Argentina	2.414	-3.404	-3.778	1.064	-0.370	-1.707	0.960	-0.897	0.555	0.269
Brazil	4.727	-1.222	-1.829	-2.753	-0.348	-0.564	-1.374	1.588	-0.507	0.455
Chile	1.199	-1.561	-0.924	-3.122	3.246	1.804	-1.242	-0.212	-0.994	0.294
Colombia	2.497	-1.343	-1.032	-3.098	1.728	-0.802	-0.750	1.005	-1.069	0.313
Czech Republic	-0.121	-0.870		-3.101	1.770	0.592	0.376	0.773	-0.840	0.227
Indonesia	1.456	-4.293	-1.979	-1.075	-0.382	-0.784	0.010	0.518	0.094	0.466
Malaysia	2.403	-1.282	-1.813	-3.028	3.113	-1.364	0.205	0.926	0.431	0.379
Mexico	2.436	0.176	7.969	-4.828	3.130	0.877	0.862	1.416	0.145	0.673
Peru	3.448	0.594	-1.556	-1.236	2.637	-0.238	-0.066	0.268	-0.734	0.212
Philippines	3.215	-0.340	-1.399	-0.964	2.424	-0.283	-0.034	0.292	-0.749	0.210
South Africa	2.895	0.096	16.195	-1.575	1.327	1.492	0.713	0.281	1.115	0.751
South Korea	3.117	0.351	-3.946	-3.566	1.635	-2.102	0.169	-1.167	0.017	0.418
Thailand	0.988	-2.658	-4.531	-0.977	0.444	0.184	0.090	-0.070	-1.204	0.285

Table 5: Relation of Exchange Rate Volatility Innovations to Common Covariates

Table 5 reports t-statistics for regressions of innovations of exchange rate volatility innovations on a set of covariates,

$$\Delta v_{fx,k,t} = a + b_{k,cds}\Delta cds_t + b_{k,r_k}r_{k,t} + b_{k,res}\Delta res_{k,t} + b_{k,r_{us}}r_{us,t} + b_{k,y_5}\Delta y_{5,t} + b_{k,\Delta ds}\Delta ds_t$$
$$+ b_{k,\Delta pe}\Delta pe_t + b_{k,\Delta vrp}\Delta vrp_t + b_{k,\Delta ts}\Delta ts_t + e_{k,t},$$

where $\Delta v_{fx,k,t}$ is the first difference in the log exchange rate volatility between the domestic currency of country k and the U.S. dollar, $r_{k,t}$ is the return on the local country's equity market, $\Delta res_{k,t}$ is the first difference in log foreign currency reserves in country k, $r_{us,t}$ is the log return on the CRSP value-weighted index, $\Delta y_{5,t}$ is the first difference in the log yield on 5-year constant maturity Treasury Notes, Δds_t is the first difference in the spread between yields on Moody's Baa-rated and Moody's Aaa-rated bonds, Δpe_t is the first difference in the log price-earnings ratio on the S&P 500, Δvrp_t is the first difference in the log variance risk premium, and Δts_t is the first difference in the term spread, measured as the difference in yields on 10-year and 2-year constant maturity Treasury Notes. Exchange rate volatility is filtered from an MA(1), EGARCH(1,1) model. Data are sampled at the monthly frequency and cover various time periods from January, 2001 through August, 2014.

Country	$\Delta cds_{k,t}$	$r_{k,t}$	$\Delta res_{k,t}$	$r_{us,t}$	$\Delta y_{5,t}$	Δds_t	Δpe_t	Δvrp_t	Δts_t	$\overline{R}^2$
Argentina	2.503	-0.913	-0.903	0.228	1.288	-0.678	-1.074	-0.265	1.106	0.096
Brazil	3.448	-1.823	1.087	0.197	-0.324	-1.421	0.387	2.129	-0.914	0.228
Chile	2.550	-0.665	-0.269	-1.081	-0.591	-1.732	-0.848	1.141	-0.521	0.143
Colombia	3.902	-0.090	0.447	0.854	1.055	-1.231	1.956	0.011	-0.395	0.119
Czech Republic	-0.657	-1.691		-1.283	-0.168	2.534	-1.298	2.701	-1.373	0.236
Indonesia	2.203	-2.395	-1.562	0.495	-0.710	0.253	0.186	1.024	-1.044	0.257
Malaysia	0.764	-0.158	-0.794	0.336	0.934	0.367	0.778	0.751	0.216	-0.045
Mexico	3.110	0.493	1.962	-0.793	0.302	0.670	0.232	2.207	-0.902	0.236
Peru	1.751	1.440	-0.635	0.080	-0.271	0.240	0.255	-0.530	-0.201	-0.028
Philippines	0.545	0.188	-0.985	-1.521	1.252	-0.742	0.495	1.458	-0.492	0.015
South Africa	1.340	-0.918	-0.279	0.974	-0.554	0.110	0.336	-0.474	-0.238	-0.039
South Korea	5.176	-2.600	1.395	0.559	0.521	0.163	-1.021	0.558	-0.310	0.266
Thailand	2.577	-0.224	0.035	1.106	-0.726	0.424	-0.377	0.794	-0.895	0.020

Table 6: Sensitivity of Spreads to Exchange Rates and Covariates

Table 6 presents results of regressions of innovations in emerging market corporate bond spreads on exchange rate, $\Delta fx_{k,t}$, and exchange rate volatility, $\Delta v_{fx,k,t}$ innovations, as well as additional covariates. Exchange rate volatility is modeled via an MA(1), EGARCH (1,1) time series specification. Covariates are $\Delta cds_{k,t}$, the first difference in sovereign CDS spreads in country k, $r_{k,t}$, the return on the local country's equity market, $\Delta res_{k,t}$, the first difference in log foreign currency reserves in country k, $r_{us,t}$, the log return on the CRSP value-weighted index, $\Delta y_{5,t}$, the first difference in the log yield on 5-year constant maturity Treasury Notes, Δds_t, the first difference in the spread between yields on Moody's Baa-rated and Moody's Aaa-rated bonds, Δpe_t, the first difference in the log price-earnings ratio on the S&P 500, Δvrp_t, the first difference in the log variance risk premium, and Δts_t, the first difference in the term spread, measured as the difference in yields on 10-year and 2-year constant maturity Treasury Notes. Reported estimates are the median estimate across all countries and within each country. Data on emerging market corporate bonds and exchange rates are obtained from Datastream; the bond data represent 83 issues across 13 countries. Data are sampled at the monthly frequency over various horizons with the first observation in January, 2001 and the final observation in August, 2014.

	b_{fx}	b_v	b_{cds}	b_{r_k}	b_{res}	$b_{r_{us}}$	b_{y5}	b_{ds}	b_{pe}	b_{vrp}	b_{ts}	R^2
All Countries	0.105	0.069	0.689	-0.547	-0.415	-0.715	-0.360	0.366	-0.252	0.003	-0.004	0.542
Argentina	-1.029	0.088	0.108	-3.445	0.776	3.686	0.716	2.365	-1.632	0.022	-1.236	0.476
Brazil	0.922	0.195	0.333	-1.166	-2.170	0.452	-0.088	-0.228	0.153	-0.022	-0.737	0.599
Chile	-1.052	0.180	0.512	-0.442	0.535	-0.994	-0.371	0.143	-0.176	0.001	-0.038	0.385
Colombia	-0.660	0.143	1.287	-0.634	0.785	-2.089	-0.783	-0.221	0.245	-0.003	0.764	0.545
Czech Rep	0.406	-0.008	0.416	-0.780		0.597	0.096	-0.155	-1.868	0.075	-0.199	0.445
Indonesia	5.048	0.182	0.843	-1.900	-1.502	-7.055	-0.845	-0.268	3.312	-0.074	0.725	0.867
Malaysia	0.580	0.149	0.260	-1.069	-0.885	-0.223	-0.014	1.064	-0.439	0.003	-0.023	0.423
Mexico	1.354	0.109	0.788	-0.686	-0.613	0.538	-0.376	0.360	-0.435	0.003	-0.224	0.526
Peru	4.930	-0.105	0.867	0.363	0.290	-1.619	-0.677	0.353	1.494	0.002	0.897	0.565
Philippines	-1.453	-0.068	0.730	0.947	-4.479	0.286	-0.571	0.114	-5.515	0.099	-0.813	0.711
S Africa	-0.691	0.692	3.489	5.328	-7.005	-6.415	-0.600	0.779	-0.779	-0.136	1.006	0.723
S Korea	-1.237	0.064	0.596	0.207	-4.672	-0.360	-0.084	0.607	-0.682	0.006	0.010	0.549
Thailand	-1.290	0.099	0.103	-1.488	0.365	0.031	0.207	1.626	-0.226	0.001	0.011	0.347

Table 7: Count of Statistically Significant Coefficients in Regressions with Covariates

Table 7 presents a count of statistically significant coefficients in regressions of innovations in corporate bond spreads on innovations in exchange rates, $\Delta fx_{k,t}$, and exchange rate volatility, $\Delta v_{fx,k,t}$ in country k, as well as a set of covariates. Covariates are $\Delta cds_{k,t}$, the first difference in sovereign CDS spreads in country k, $r_{k,t}$, the return on the local country's equity market, $\Delta res_{k,t}$, the first difference in log foreign currency reserves in country k, $r_{us,t}$, the log return on the CRSP value-weighted index, $\Delta y_{5,t}$, the first difference in the log yield on 5-year constant maturity Treasury Notes, Δds_t, the first difference in the spread between yields on Moody's Baa-rated and Moody's Aaa-rated bonds, Δpe_t, the first difference in the log price-earnings ratio on the S&P 500, Δvrp_t, the first difference in the log variance risk premium, and Δts_t, the first difference in the term spread, measured as the difference in yields on 10-year and 2-year constant maturity Treasury Notes. Exchange rate volatility is modeled via an MA(1), EGARCH (1,1) time series specification. Cutoff level for significance is the 10% critical level. The final column, b_{fx}/b_v, represents the number of times that with the exchange rate volatility or exchange rate innovation coefficient are statistically significantly different than zero. Data are sampled at the monthly frequency over various horizons with the first observation in January, 2001 and the final observation in August, 2014.

	b_{fx}	b_v	b_{cds}	b_{r_j}	b_{res}	$b_{r_{us}}$	b_{y_5}	b_{ds}	b_{pe}	b_{vrp}	b_{ts}	b_{fx}/b_v
Argentina	0	0	0	3	0	1	0	2	3	2	2	0
Brazil	1	3	2	3	1	0	2	1	1	0	2	4
Chile	2	4	4	3	1	2	2	5	2	5	3	5
Colombia	0	0	1	0	0	0	0	0	0	0	0	0
Czech Rep	0	0	1	0	0	0	0	0	0	1	0	0
Indonesia	2	0	2	0	0	2	1	0	1	1	0	2
Malaysia	0	1	1	0	0	0	0	1	1	0	1	1
Mexico	5	4	9	5	4	3	2	5	3	4	1	7
Peru	7	5	9	1	1	3	5	0	6	5	4	8
Philippines	0	0	0	0	1	0	0	0	1	1	0	0
S Africa	0	1	1	1	1	1	0	0	0	1	0	1
S Korea	6	4	9	0	7	1	3	7	4	8	1	7
Thailand	0	0	0	0	0	0	0	1	0	0	0	0
Total	23	22	39	16	16	13	15	22	22	28	14	35

Table 8: Summary Statistics of Firm-Level Variables

In Table 8, we present summary statistics for financial statement and equity return variables for the firms in our sample. The variables reported are $psales_{j,t}$, the proportion of firm j's sales derived in non-domestic markets, $pdebt_{j,t}$, the proportion of firm j's total long term debt composed of U.S. dollar debt, $nimta_{j,t}$, net income to market value of total assets, $tlmta_{j,t}$, total liabilities to market value of total assets, $cash_{j,t}$, cash and equivalents to market value of total assets, $mb_{j,t}$, the market-to-book ratio, $\sigma_{j,t}$, the volatility of firm j's equity return, and $exret_{j,t}$, the return on the firm's equity in excess of the S&P 500. We report means of the variables across all countries and within countries for which data are available. Firm data are taken from Worldscope, company financial statements, and Yahoo! Finance over calendar years ending in 2011, 2012, and 2013.

	$psales$	$pdebt$	$nimta$	$tlmta$	$cash$	mb	σ	$exret$
All	31.27	22.94	3.24	49.44	8.51	1.77	35.59	-17.74
Argentina	1.39	86.17	0.38	62.63	5.01	1.50	44.42	-28.10
Brazil	0.15	33.97	2.01	53.68	12.59	1.19	28.63	-18.84
Chile	58.16	15.82	3.55	36.10	5.98	1.98	30.08	-33.19
Malaysia	8.84	17.65	3.48	40.98	12.21	2.82	13.58	10.91
Mexico	41.80	16.26	2.86	50.59	7.35	2.31	45.33	-8.08
Peru	0.00	89.02	4.77	42.44	4.50	1.90	55.72	-20.11
South Korea	17.88	8.78	4.60	57.63	12.10	0.87	26.97	-17.34

Table 9: Cross-Sectional Determinants of Foreign Exchange Sensitivity

In Table 9, we present estimates of coefficients in the regressions

$$\hat{b}_{x,i} = d_1 + d_2 pdebt_{j,t} + d_3 psales_{j,t} + d_4 nimta_{j,t} + d_5 tlmta_{j,t} + d_6 cash_{j,t} + d_7 mb_{j,t} + d_8 \sigma_{j,t}$$
$$+ d_9 exret_{j,t} + d_{10} coupon_i + d_{11} maturity_i + d_{12} \hat{b}_{y,i} + u_{2i},$$

where $\hat{b}_{z,i}$, $z \in \{fx, v_{fx}\}$, is the point estimate of the sensitivity of bond i's credit spread to innovations in the level or volatility of exchange rates as reported in Table 6. The variable $psales_{j,t}$ is the proportion of firm j's sales derived in non-domestic markets, $pdebt_{j,t}$ is the proportion of firm j's total long term debt composed of U.S. dollar debt, $nimta_{j,t}$ is net income to market value of total assets, $tlmta_{j,t}$ is total liabilities to market value of total assets, $cash_{j,t}$ is cash and equivalents to market value of total assets, $mb_{j,t}$ is the market-to-book ratio, $\sigma_{j,t}$ is the volatility of firm j's equity return, $exret_{j,t}$ is the return on the firm's equity in excess of the S&P 500, $coupon_i$ is the coupon rate on bond i, $maturity_i$ is the years to maturity of bond i, and $\hat{b}_{y,i}$ is the point estimate of the sensitivity of bond i's spread to innovations in the exchange rate or exchange rate volatility. Firm data are taken from Worldscope, company financial statements, and Yahoo! Finance over calendar years ending in 2011, 2012, and 2013. t-statistics are shown in brackets.

Dependent Var:	b_{fx}	b_v	b_{fx}	b_v
Intercept	-33.85	1.28	-21.36	-1.19
	-[2.57]	[1.12]	[-2.98]	[-1.86]
pdebt	-0.19	1.27	-0.07	-0.13
	[-2.26]	[1.74]	[-1.45]	[-0.31]
psales	-0.27	1.66	-0.11	-0.32
	[-4.12]	[2.91]	[-2.94]	[-0.95]
nimta	3.36	-19.61	1.45	4.99
	[5.28]	[-3.55]	[3.94]	[1.45]
tlmta	0.11	0.08	0.12	0.88
	[0.69]	[0.06]	[1.37]	[1.18]
cash	-0.42	2.83	-0.15	-0.27
	[-1.65]	[1.27]	[-1.06]	[-0.22]
mb	3.11	-0.05	2.65	0.18
	[1.36]	[-0.24]	[2.14]	[1.66]
σ	0.19	-1.26	0.06	0.11
	[2.43]	[-1.89]	[1.52]	[0.29]
exret	-0.15	1.10	-0.05	-0.02
	[-3.16]	[2.61]	[-1.70]	[-0.09]
coupon	4.00	-22.69	1.79	6.59
	[3.16]	[-2.07]	[2.56]	[1.05]
maturity	-0.59	6.13	0.00	1.79
	[-0.95]	[1.14]	[0.01]	[0.61]
b_v			-9.72	
			[-14.32]	
b_{fx}				-7.32
				[-14.32]
$\bar{R}^2$	25.83	10.74	78.36	73.96

Table 10: Parameter Estimates and Pricing Errors

Table 10 presents parameter estimates of a reduced-form pricing model for risky bond prices,

$$P_{i,k}(t,\tau,c) = E_t^Q \left[c \sum_{m=1}^{\tau} e^{-\int_t^{t+m} R_{i,k}(s)ds} + e^{-\int_t^{\tau+t} R_{i,k}(s)ds} \right]$$

where the risk-neutral defaultable yield, $R_{i,k}(s)$, for bond i in country k is specified as

$$R_{i,k}(t) - r(t) = a_i + h_i(t) + \boldsymbol{\beta}'_{i,\mathbf{x}}(\mathbf{x}(t) - \bar{\mathbf{x}}) + \beta_{i,k,v}v_{fx,k}(t) + \beta_{i,k,fx}fx_k(t).$$

The variables $\mathbf{x}_t = \{x_1(t), x_2(t)\}$ are the state variables implied by parameter estimates from the risk free term structure, $fx_k(t)$ is the exchange rate between country k's currency and the U.S. dollar, $v_{fx,k}(t)$ is the volatility of the exchange rate, and $h_i(t)$ is the hazard rate, which follows the stochastic differential equation

$$dh_i(t) = [\kappa_{h_i}\theta_{h_i} - (\kappa_{h_i} + \eta_{h_i})h_i(t)]dt + \sigma_{h_i}\sqrt{h_i(t)}dW_{h_i}^Q(t).$$

Parameters are estimated via the extended Kalman filter using discrete time Euler approximations to continuous time dynamics. Parameters are estimated for 85 bonds across five countries using daily observations on bond yields. We report 25th percentile, median, and 75th percentile estimates and model root mean squared error for the full sample and within each country.

Country	Pct.	a_i	κ_i	θ_i	σ_i	η_i	$\beta_{1,i}$	$\beta_{2,i}$	$\beta_{fx,i}$	$\beta_{v,i}$	RMSE
All	25	-0.1350	0.0003	0.0035	0.0351	-0.7477	-0.1823	-0.0209	-0.0091	-0.3666	7.55
	50	-0.0279	0.1434	0.0102	0.0666	-0.4540	-0.1101	-0.0083	0.0015	0.7102	9.90
	75	0.0109	0.4652	0.0239	0.1314	-0.1657	0.1062	0.0085	0.0133	1.8011	13.42
Argentina	25	-0.0431	0.3678	0.0031	0.0720	-1.5438	-0.3472	0.0107	-0.0122	-1.8512	17.95
	50	-0.0172	0.6092	0.0167	0.1441	-0.8398	-0.1947	0.0112	0.0084	-0.0061	27.39
	75	0.0344	0.9786	0.0267	0.2245	-0.3370	0.0463	0.0182	0.0182	1.1864	38.84
Brazil	25	-0.2741	0.0000	0.0072	0.0116	-0.7138	-0.1749	-0.0205	-0.0010	0.8588	6.26
	50	-0.1097	0.0264	0.0102	0.0427	-0.6940	-0.1403	-0.0093	0.0120	1.4155	11.24
	75	0.0125	0.0987	0.0205	0.1194	-0.3166	0.1205	-0.0020	0.0325	2.4930	15.26
Chile	25	-0.1106	0.0000	0.0021	0.0272	-0.6046	-0.1722	-0.0267	-0.0021	-4.8300	7.79
	50	-0.0775	0.0458	0.0180	0.0448	-0.2717	0.0828	-0.0185	0.0014	-0.4824	9.56
	75	-0.0263	0.5779	0.0496	0.1478	-0.0608	0.2749	-0.0049	0.0191	0.2634	13.05
Mexico	25	-0.1431	0.0001	0.0055	0.0296	-0.8110	-0.1823	-0.0215	-0.0185	-0.4306	7.50
	50	-0.0143	0.0572	0.0119	0.0700	-0.4495	-0.1378	-0.0163	0.0018	1.1331	9.88
	75	0.0003	0.4360	0.0223	0.1091	-0.1161	-0.0722	0.0107	0.0043	2.4864	20.21
Peru	25	-0.1495	0.0931	0.0080	0.0305	-0.7920	-0.1082	-0.0179	-0.0971	-0.2508	9.99
	50	-0.0424	0.2775	0.0200	0.1448	-0.4099	-0.0203	-0.0083	-0.0184	0.8703	11.10
	75	0.0331	0.4687	0.0281	0.2595	-0.2102	0.0617	0.0038	0.0282	1.7718	13.82
South Korea	25	-0.0577	0.0003	0.0008	0.0403	-0.7160	-0.2029	-0.0167	-0.0064	0.0353	5.53
	50	-0.0186	0.0551	0.0035	0.0501	-0.4996	-0.1408	-0.0063	-0.0013	1.0702	6.92
	75	0.0304	0.2787	0.0062	0.0808	-0.1747	0.0949	0.0062	0.0082	2.5469	10.26

Figure 1: Time Series of Average Bond Yield Spreads

Figure 1 presents the time series of average yield spreads of emerging market corporate bonds plotted for each country in our sample. Yield spreads for individual bonds are calculated as the difference in the yield to maturity on the issue and the yield on a Treasury security with the closest maturity. Yield spreads are then averaged across the bonds within each country on each date to produce a single time series observation for each country. Data on individual bond yields are obtained from DataStream and Treasury yields are constant maturity yields from the Federal Reserve Board of Governors (FRED). Data plotted cover various periods depending on data availability and are sampled at the daily frequency. Panel a) depicts average spreads for Argentine bonds, b) for Brazilian bonds, c) Chilean bonds, d) Colombian bonds, e) Czech bonds, f) Indian bonds, g) Indonesian bonds, h) Malaysian bonds, i) Mexican bonds, j) Peruvian bonds, k) Phillipine bonds, l) South African bonds, m) South Korean bonds, and n) Thai bonds.
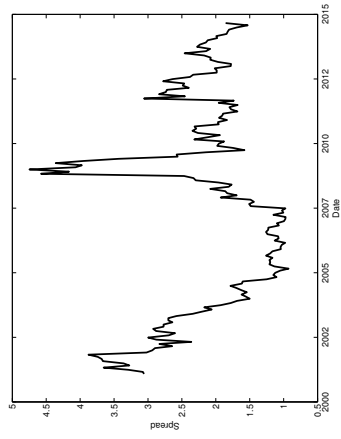

(a) Argentina

(b) Brazil

(c) Chile

(d) Colombia

(e) Czech Republic

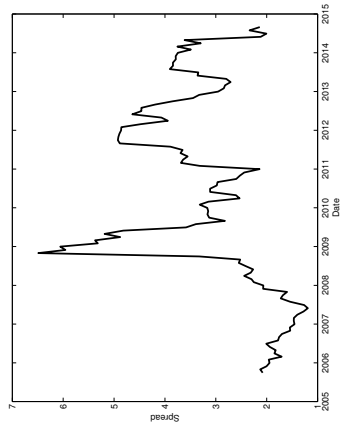(f) India

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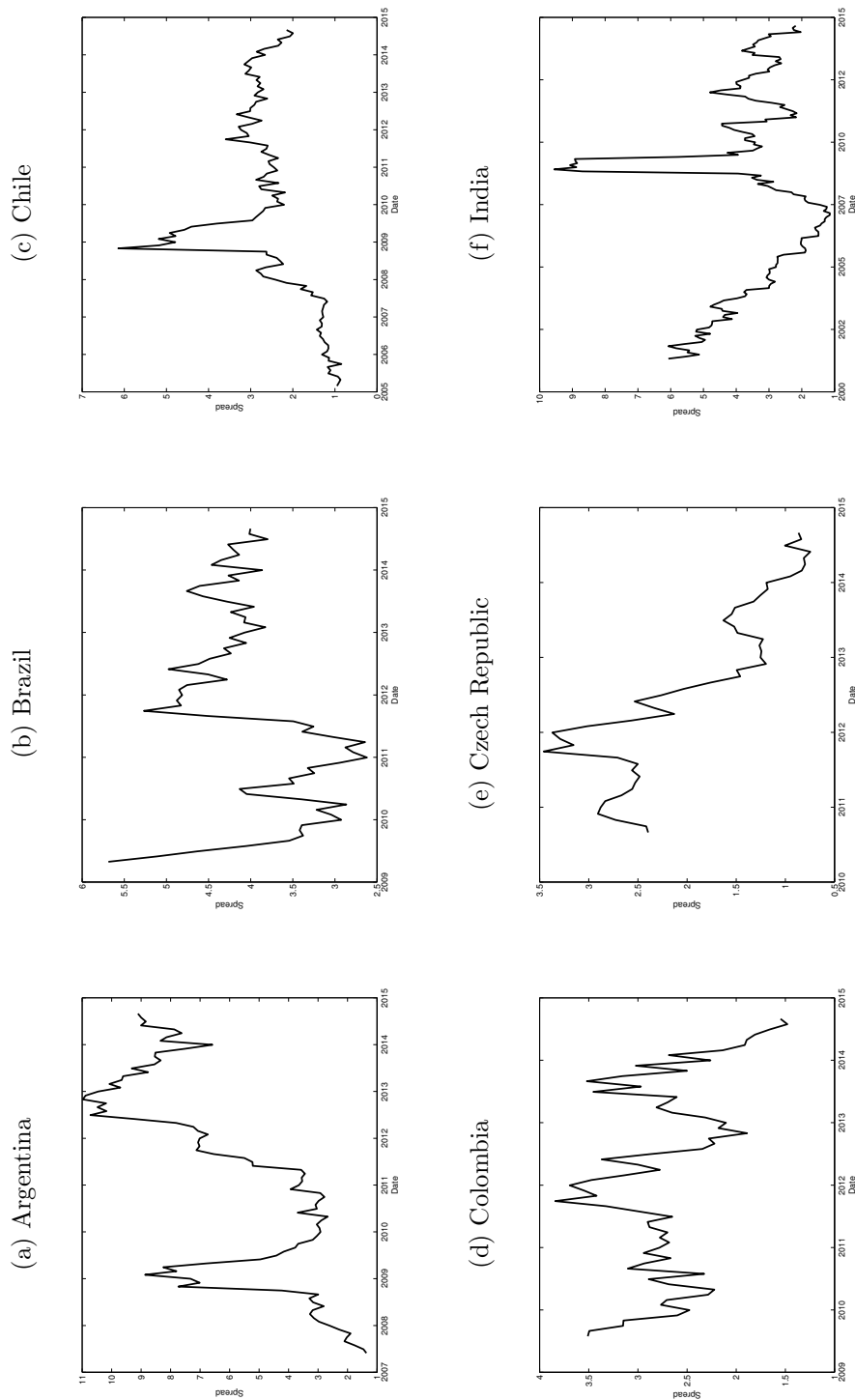
(g) Indonesia
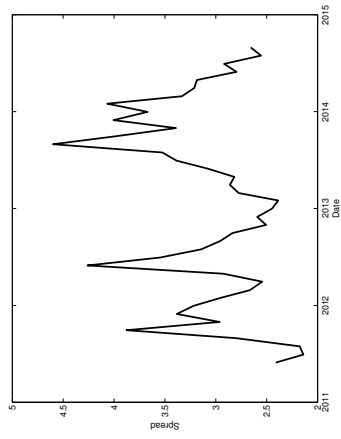
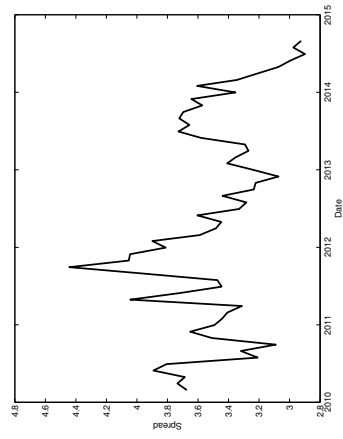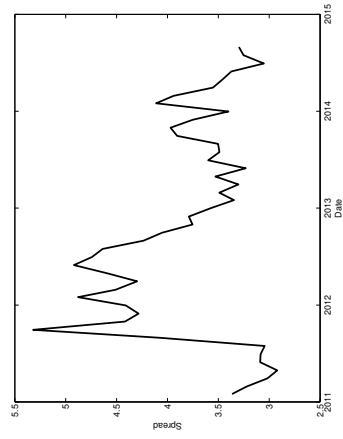
(h) Malaysia

(i) Mexico

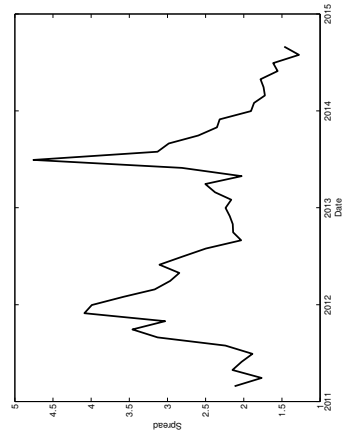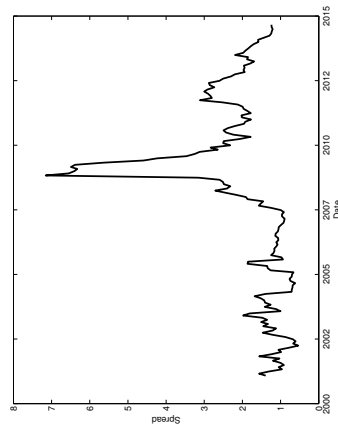
(j) Peru

(k) Philippines

(l) South Africa

Figure continued on next page.

(m) South Korea   (n) Thailand

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