Local Currency Sovereign Risk*

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Abstract

Most emerging market sovereign borrowing is now denominated in local currencies. We introduce a new measure of sovereign risk, the local currency credit spread, defined as the synthetic dollar spread on a local currency bond after using cross currency swaps to hedge the currency risk of promised cash flows. Compared with traditional sovereign risk measures based on foreign currency denominated debt, we find that local currency credit spreads have lower means, lower cross-country correlations, and are less sensitive to global risk factors. We rationalize these findings with a model allowing for different degrees of integration between domestic and external debt markets.

Keywords: local currency, sovereign debt, currency swaps
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1 Introduction

In the aftermath of the Global Financial Crisis, sovereign debt crises are concentrated in the developed world. This itself is a remarkable development. It is even more remarkable when one considers that following the Lehman bankruptcy, some emerging market currencies lost more than half their value against the dollar. Yet even as their currencies plummeted, these countries were able to continue their debt payments. This represents a major break from past crises. In the 1980's and 1990's the developing world borrowed in currencies that they did not have the right to print, and currency mismatch was the center of past emerging market sovereign crises.[1] After a decade of rapid development of local currency (LC) sovereign bond markets in the wake of the Asian Financial Crisis, major emerging markets entered the most recent period of global financial turmoil with an increasing fraction of their debt in their own currencies and have weathered the shocks without triggering major sovereign debt crises.[2]

Yet, despite the increasingly important role of local currency debt in emerging market government finance, LC debt markets are little understood and LC sovereign risk measures are absent from the academic literature. Our paper fills this gap by introducing a new measure of LC sovereign risk, the LC credit spread, defined as the difference between the nominal yield on an LC bond and the LC risk-free rate implied from the cross currency swap (CCS) market. While government bond yields are often used directly as the risk-free rate for developed country currencies, they cannot be used as the risk-free rate in emerging markets where the risk of sovereign default and capital controls are non-negligible.[3] Instead, we use the dollar risk-free rate combined with the long-term forward rate implied from the currency swap markets as the risk-free benchmark in each LC. From a dollar investor's perspective, the LC credit spread is equivalent to the synthetic dollar spread on an LC bond over the U.S.

[1]Prominent examples are Mexico (1994), the Asian Financial Crises (1997-98), Russia (1998), Brazil (1998, 2002), Turkey (2000-01) and Argentina (2001-02).

[2]Sovereign defaults have occurred in four developing countries since 2008: Ecuador, Seychelles, Jamaica and Belize. Except for Jamaica, the other three countries do not have local currency debt markets. Ecuador is a fully dollarized economy and Seychelles and Belize are island economies.

[3]A similar point applies to many euro area countries.

Treasury rate with the currency risk of promised cash flows fully hedged using cross currency swaps. By holding an LC bond and a currency swap with the same tenor and promised cash flows, the dollar investor can lock in the LC credit spread even if the value of the currency plummets as long as explicit default is avoided. From the sovereign issuer's perspective, the LC credit spread measures the synthetic dollar borrowing cost in the LC debt market.

The bulk of the literature on emerging market LC debt has focused on why these emerging markets *cannot* borrow abroad in their own currency, the question of "original sin" surveyed in Eichengreen and Hausmann (2005). While it is true that emerging market sovereigns rarely issue LC bonds in global markets, this no longer means that foreigners do not lend to them in their own currencies. Instead foreigners are increasingly willing to purchase LC debt issued under domestic law. Figure 1 shows that the share of LC debt owned by foreigners increased from 9 percent in 2005 to 23 percent in 2011 in the sample emerging markets, now higher than the share in Japan, comparable to the share in the US and the UK, albeit lower than the share in the euro area. Furthermore, foreign participation in emerging market LC debt markets has outpaced participation in foreign currency (FC) debt. According to volume surveys conducted by the Emerging Market Trading Association, the share of LC debt in total offshore emerging market debt trading volume has increased from 35 percent in 2000 to 71 percent in 2011, reaching 4.64 trillion U.S. dollars (Figure 2). Emerging Market Portfolio Research reports that even among offshore mutual funds which had historically invested overwhelmingly in FC denominated Eurobonds[4] and Brady bonds, the cumulative fund flow into LC emerging market debt securities has outpaced the flow into debt securities in hard currencies (Figure 3).

The growing importance of LC debt markets is in stark contrast to the declining role of FC sovereign financing. This shift is rendering conventional measures of sovereign risk increasingly obsolete. In many emerging markets, government policy is to retire outstanding

[4]Throughout this paper we use eurobonds to mean foreign currency bonds issued offshore, but not necessarily in euros.

FC debt and end new FC issuance.[5] The popular country-level JP Morgan Emerging Market Bond Index (EMBI), commonly used in academic research to measure sovereign risk, is today forced to track a dwindling number of outstanding FC eurobonds with declining liquidity and trading volume. In countries such as Egypt, Thailand, Malaysia, Morocco, South Korea and Qatar, FC debt has shrunk to the point that EMBI+ has been forced to discontinue these countries' indices. In addition to FC credit spreads, sovereign CDS spreads are used as an alternative measure of sovereign risk. However, defaults on local currency bonds governed under domestic law do not constitute credit events that trigger CDS contracts in emerging markets.[6] As a result, sovereign CDS also offers an incomplete characterization of emerging market sovereign risk.

Using new data and a new measure, we document a new set of stylized facts about LC sovereign risk. To construct LC and FC sovereign credit spreads, we build a new dataset of zero-coupon LC and FC yield curves and swap rates for 10 major emerging markets at the daily frequency for a common sample period from 2005 to 2011. Using the 5-year zero-coupon benchmark, we find that LC credit spreads are significantly above zero, robust to taking into account the bid-ask spread on the swap rates. This result demonstrates the failure of long-term covered interest rate parity between government bond yields in emerging markets and the United States. Removing the currency risk highlights an important credit component in LC yields, as shown by the positive correlation between the LC credit spread and the conventional sovereign risk measure, the FC credit spread.

Despite a positive correlation, LC and FC credit spreads are different along three important dimensions. First, while LC credit spreads are large and economically significant, they are generally lower than FC credit spreads. The gap between LC and FC credit spreads significantly widened during the peak of the crisis following the Lehman bankruptcy. Second,

[5] For example in Mexico, the 2008 guidelines for public debt management is to "Continue emphasis on the use of domestic debt to finance the entire federal government deficit and the stock of external debt" (SHCP, 2008)

[6] This is different from the case of developed country sovereign CDS for which a default on local bonds would trigger CDS contracts (ISDA, 2012).

FC credit spreads are much more correlated across countries than LC credit spreads. Over 80% of the variation in FC spreads is explained by the first principal component. In contrast, only 53% of the variation in LC credit spreads is explained by the first principal component, pointing to the relative importance of country-specific factors in driving LC spreads. Third, FC credit spreads are much more correlated with global risk factors than are LC credit spreads. These ex-ante results in the yield spread space are mirrored ex-post in the excess return space, as excess holding period returns on FC bonds over U.S. Treasuries load heavily on global equity market returns while swapped LC excess holding period returns load heavily on local equity market returns. In other words, despite the common perception of emerging market LC debt as extremely risky, we find that swapped LC debt is actually safer than FC bonds for global investors measured in terms of global equity betas. The removal of currency risk is central to this finding, as the currency unhedged LC excess returns have larger betas with global equity returns than FC excess returns.

After documenting the differences between LC and FC credit spreads, we turn to examining the sources of these credit spread differentials. We build a parsimonious model that attributes the credit spread differential to the differential cash flow risks between LC and FC debt and differential investor bases between the two debt markets. FC bonds may have higher cash flow risk than LC for several reasons. These include a government's option to print money to service LC debt, the danger that a sudden exchange rate depreciation may increase the real burden of servicing FC debt, and the political economy costs of defaulting on your own citizens relative to defaulting on foreign investors. On the other hand, foreign holders of LC debt face several risks not present in FC eurobonds, including convertibility risk, as well as the risks of changing taxation and regulation and more uncertain debt restructuring process under the domestic law. In addition, LC and FC credit spreads can be different due to unhedged covariance between the exchange rate and the default process. From a dollar investor's perspective, swapped LC debt can have lower cash flow risk if investors expect to gain profits from unwinding the swap position in the event of an LC bond default.

In addition to differential cash flow risk, LC and FC debt markets have different investor bases. While an increasing fraction of LC debt is being purchased by foreign investors, the majority is still owned by domestic residents, commercial banks, and pension funds. These investors have few investment opportunities outside of domestic government bonds because of domestic financial underdevelopment or legal restrictions on their overseas investments. This can give rise to a distinct local demand factor in pricing LC debt that is absent from FC debt, which is issued in major international capital markets and purchased by diversified global investors. The existence of local clientele potentially dampens the sensitivity of LC credit spreads to fundamentals and global investor risk aversion shocks.

We study a model that allows for both differential cash flow risk and local clientele demand effects by introducing credit risk in the style of of Duffie and Singleton (1999) into a preferred habitat model that builds on Greenwood and Vayanos (2010) and Vayanos and Vila (2009). While allowing the arrival rate of credit events for FC and LC to respond differently to a local and global risk factor, we study a market structure where diversified global investors are the primary clientele for FC debt, domestic investors are the primarily clientele for LC debt, and risk-averse arbitrageurs partially integrate the two markets. In this framework, the equilibrium LC credit spread is an endogenous outcome of arbitrageurs' optimal portfolio demand and local clientele demand, with the equilibrium impact of LC clientele demand depending on on the size of the position the arbitrageur is willing to take. This, in turn, depends on the arbitrageur's risk aversion, the asset return correlation, and the size and elasticity of local clientele demand.

Guided by the model's predictions and comparative statics, we highlight the importance of differential risk premia arising from the differential investor bases in pricing swapped LC and FC bonds. The key mechanism we highlight is how changes in global risk aversion directly affect FC spreads but are only partially transmitted into LC spreads by risk-averse arbitrageurs. Consistent with the model's predictions, we first show that global risk aversion, as proxied by VIX, has a larger contemporaneous impact on FC credit spreads than on LC credit spreads, robust to a large set of determinants of sovereign risk identified by the existing literature. Differential sensitivity to VIX alone accounts for 25.6 percent of the within-country variation in the credit spread differentials and 60 percent of total explained variation after controlling for a host of economic fundamentals. Furthermore, differential contemporaneous impacts of VIX on LC and FC credit spreads generate differential predictability of excess returns through the risk premium channel. We show that high levels of VIX significantly forecast negative swapped LC over FC excess returns. As predicted by the theory, we also find that LC credit spreads are more sensitive to global risk aversion in countries with more correlated swapped LC and FC bond returns.

The paper is structured as follows. We begin by explaining this paper's place in the existing literature. Section 2 explains the mechanics of cross currency swaps and formally introduces the LC credit spread measure. Section 3 presents new stylized facts on LC sovereign risk. Section 4 lays out a no-arbitrage model of partially segmented markets with risky credit arbitrage. Section 5 performs regression analysis to test several key predictions of the model and Section 6 concludes.

1.1 Relation to the Literature

Our work is related to several distinct strands of literature: the enormous sovereign debt literature in international macroeconomics, the empirical sovereign and currency risk premia literature, the literature on currency-specific corporate credit spreads, and the segmented market asset pricing literature.

Recent work by Carmen Reinhart and Kenneth Rogoff demonstrates (Reinhart and Rogoff 2008, 2011) that LC sovereign borrowing and default are not new phenomena. Building on their work, which focuses primarily on quantities, we focus on prices and jointly examine LC and FC credit spreads. Prior to our work, the pricing of LC debt was rarely examined with exception of Burger and Warnock (2007) and Burger, Warnock, and Warnock (2012), who studied ex-post returns on LC bonds using the J.P. Morgan Emerging Market Government Bond Index (EM-GBI) index.

Using our dataset of daily yield curves and currency swaps, we document a series of new stylized facts that we believe are important to integrate into the quantitative sovereign debt literature that builds on Aguiar and Gopinath (2006) and Arellano (2008). Given that an increasing fraction of sovereign borrowing is in LC, our findings on how LC credit spreads behave differently than FC credit spreads highlight the importance of moving away from the standard assumption in this literature that governments borrow solely from foreign lenders using real debt.

Our paper is also closely related to the literature on FC sovereign risk premia and currency risk premia. Borri and Verdelhan (2011) demonstrate that FC spreads can be explained by modeling a risk-averse investor who demands risk premia for holding sovereign debt because default generally occurs during bad times for the global investors. Using data on credit default swaps (CDS) denominated in dollars, Longstaff, Pan, Pedersen, and Singleton (2011) show that global risk factors explain more of the variation in CDS spreads than do local factors. Our analysis confirms these findings. In addition, we find support for the results of Lustig and Verdelhan (2007) and Lustig, Roussanov, and Verdelhan (2012) that there is a common global factor in currency returns. This motivates our use of cross currency swaps to separate this currency risk from the credit risk on LC sovereign debt.

Cross currency swaps have previously been used to test long-term covered interest parity among government bond yields in developed countries. Popper (1993) and Fletcher and Taylor (1994, 1996) document some deviations from covered parity, but they are an order of magnitude smaller and much less persistent than those we document in our dataset of emerging markets. Currency-dependent credit spreads implied from cross currency swaps have also received attention in the empirical corporate finance literature. McBrady and Schill (2007) demonstrate that firms gauge credit spread differentials across different currencies when choosing the currency denomination of their debt. Jankowitsch and Stefan (2005) highlight the role of the correlation between FX and default risk in affecting currency-specific credit spreads.

Finally, our theoretical model builds on the asset pricing literature on investors' preferred habitats and the limits to arbitrage. Greenwood and Vayanos (2010), building on Vayanos and Vila (2009), examine the effect of increases in bond supply across the yield curve for U.S. Treasuries. The framework assumes that different maturities have different clienteles and each type of investor invests only in a certain range of maturities (their "preferred habitat"). We study an environment where preferred habitats correspond to currencies and markets rather than maturities, building on the cross-asset arbitrage theory presented by Gromb and Vayanos (2010), and solving analytically for the endogenous LC bond price.

2 Cross Currency Swaps and Sovereign Credit Spreads

2.1 Cross Currency Swaps

For short-term instruments, FX forward contracts allow investors to purchase foreign exchange at pre-determined forward rates. Beyond one year, liquidity is scarce in the forward markets and long-term currency hedging via forwards is very costly. CCS contracts, on the other hand, allow investors to conveniently hedge long-term currency risk. A CCS is an interest rate derivative contract that allows two parties to exchange interest payments and principal denominated in two currencies. A real-world example of hedging currency risk of an LC bond using CCS is given in Appendix A. For emerging markets, CCS counterparties are usually large offshore financial institutions. To mitigate the counterparty risk embedded in CCS contracts, the common market practice is to follow the Credit Support Annex of the International Swap and Derivative Association Master Agreement, which requires bilateral collateralization of CCS positions, and thus counterparty risk is fairly negligible. For countries with non-deliverable FX forwards, CCS contracts are cash settled in dollars based on LC notional amount and are free from currency convertibility risk.

For our cross-country study, it is cumbersome to deal with coupon bearing bonds and par swap rates due to the mismatch in coupon rates and payment dates between bonds and swaps. We can extract the long-term FX forward premium (the zero-coupon swap rate) implicit in the term structure of par swaps. Intuitively, a fixed for fixed LC/dollar CCS package can always be considered as the sum of two interest rate swaps. First, the investor swaps the fixed LC cash flow into a floating U.S. Libor cash flow[7] and then swaps the floating U.S. Libor cash flow into a fixed dollar cash flow. We can exploit the fact that the receiver of U.S. Libor must be indifferent between offering a fixed LC or a fixed dollar cash flow. The difference in the two swap rates thus implies the long-term currency view of the financial market. After performing this transformation, a CCS is completely analogous to a standard forward contract. The specifics are given in the following proposition.

Proposition 1. *Given implied log spot rates* $\tilde{r}^{LC}_{\tau,t}$ *from the fixed LC for U.S. Libor CCS and* $\tilde{r}^{USD}_{\tau,t}$ *from the fixed dollar for Libor interest rate swap, the implicit long-term forward premium is equal to*

$$\rho_{nt} \equiv \frac{1}{\tau}(\tilde{f}_{nt} - s_t) = \tilde{r}^{LC}_{nt} - \tilde{r}^{USD}_{nt},$$

where $\tilde{f}_n$ *is the pre-determined log forward exchange rate at which a transaction between LC and dollars takes place* n *years ahead.*

2.2 LC and FC Credit Spreads

The core of our dataset is daily zero-coupon yield curves and swap curves for LC and FC sovereign bonds issued by 10 different emerging market governments from January, 2005 to December, 2011. We use a benchmark tenor of 5 years. The choice of countries is mainly

[7] For Mexico, Hungary, Israel and Poland in our sample, this step itself combines two interest rate swaps: an onshore plain vanilla LC fixed for LC floating interest rate swap and a cross-currency LC floating for U.S. Libor basis swap.

constrained by the lack of sufficient numbers of FC bonds outstanding. Furthermore, all 10 sample countries belong to the J.P. Morgan EM-GBI index, an investable index for emerging market LC bonds. The length of the sample period is constrained by the availability of long-term currency swap data. All data on cross currency swaps are collected from Bloomberg.[8] Zero coupon yield curves are collected or estimated from various data sources. The details on the yield curve construction are given in Appendix B.

We work with log yields throughout the paper. To fix notations, we let y^*_{nt} denote the n-year zero-coupon U.S. Treasury bond yield, the long-term risk-free rate used throughout the paper. Nominal LC and FC yields are denoted by y^{LC}_{nt} and y^{FC}_{nt}, respectively. We let ρ_{nt} denote the zero-coupon swap rate, the implicit forward premium as defined in Proposition 1. All yields and swap rates are for the n-year zero-coupon benchmark at date t. The conventional measure of sovereign risk, the FC credit spread, measures the difference between the yield on FC debt and the U.S. Treasury yield:

$$s^{FC/US}_{nt} = y^{FC}_{nt} - y^*_{nt}.$$

Our new measure for LC sovereign risk, the LC credit spread, is defined as the nominal LC spread over the the U.S. Treasury yield, minus the zero-coupon swap rate:

$$s^{SLC/US}_{nt} = y^{LC}_{nt} - y^*_{nt} - \rho_{nt},$$

or the deviation from long-term covered interest rate parity between the government bond yields. There are two ways to interpret this measure. First, the dollar investor can create a swapped LC bond by combining an LC bond with a CCS with the same promised cash

[8]Extremely illiquid trading days with bid-ask spreads over 400 basis points on CCS are excluded from the analysis (mainly for Indonesia during the 2008 crisis). All main results are not affected by including these extreme values. We compare the difference in 1-year forward premia implied by the swap and the forward markets in Table A1. The mean correlation is 99 percent. Using annualized bid-ask spreads as a proxy for liquidity,swap contracts are, on average, more liquid than short-term forward contracts (Table A2) .

flows. The synthetic dollar yield on the swapped LC bond is given by

$$y_{nt}^{SLC} = y_{nt}^{LC} - \rho_{nt}.$$

The LC credit spread is therefore equal to the dollar spread on this synthetic asset:

$$s_{nt}^{SLC/US} = (y_{nt}^{LC} - \rho_{nt}) - y_{nt}^{*} = y_{nt}^{SLC} - y_{nt}^{*}.$$

Hence, by holding the swapped LC bond to maturity, the LC credit spread gives the promised dollar spread on the LC bond to dollar investors even if the LC depreciates, provided that explicit default is avoided. In the event of default, the dollar investor can choose to unwind the swap with an unmatched LC bond payment, which could result in additional FX profits or losses from the swap. Second, investors valuing their returns in LC can combine a U.S. Treasury bond with a fixed for fixed CCS to create an LC risk-free bond. The sum of the dollar risk-free and the CCS rate gives the LC risk free rate

$$y_{nt}^{*LC} = y_{nt}^{*} + \rho_{nt},$$

and thus the LC credit spread measures the yield spread of the LC bond over the LC risk-free rate:

$$s_{nt}^{SLC/US} = y_{nt}^{LC} - (y_{nt}^{*} + \rho_{nt}) = y_{nt}^{LC} - y_{nt}^{*LC},$$

and is a pure credit spread measure for local currency. Finally, the LC over FC credit spread differential measures the spread between the yield on the synthetic dollar asset combining an LC bond and CCS over the FC bond yield:

$$s_{nt}^{SLC/FC} = y_{nt}^{LC} - \rho_{nt} - y_{nt}^{FC} = s_{nt}^{SLC/US} - s_{nt}^{FC/US}.$$

From the issuer's perspective, it gives the the difference between the synthetic dollar borrowing cost in the local market and the actual dollar borrowing cost in the external market.

3 New Stylized Facts on LC Sovereign Risk

3.1 Deviations from Long-Term CIP

If long-term covered interest parity holds for government bond yields, LC credit spreads should equal zero in the absence of transaction costs. As a starting point, Figure 4 plots the 5-year swapped UK Treasury yield in dollars and the U.S. Treasury yield from 2000 to 2011. The difference between the two curves, the UK LC credit spread, averages 10 basis points for the full sample and 6 basis points excluding 2008-2009. Long-term CIP holds quite well between the U.S. and the UK Treasury yields excluding 2008-2009. At the peak of the Global Financial Crisis around the Lehman bankruptcy, the UK credit spread temporarily increased to 100 basis points but returned to normal in a few months.

LC credit spreads in emerging markets offer a very different picture. As can be seen in Figure 5, where the 5-year zero-coupon yield spreads are plotted for our sample countries, large persistent deviations from long-term covered interest parity are the norm rather than the exception. Column 1 in Table 1 presents summary statistics for 5-year LC spreads for the sample period 2005-2011 at daily frequency. LC credit spreads, $s^{SLC/US}$, have a cross-country mean of 128 basis points, calculated using the mid-rates on the swaps. Brazil records the highest mean LC spreads equal to 313 basis points and Mexico and Peru have the lowest means about 60 basis points. All mean LC credit spreads are positive and statistically significantly different from zero using Newey-West standard errors allowing for heteroskedasticity and serial correlation.[9] Positive mean LC spreads are robust to taking into account the transaction costs of carrying out the swaps. Column 4 provides summary statistics for

[9]Following Datta and Du (2012), missing data are treated as non-serially correlated for Newey-West implementations throughout the paper.

liquidity of the cross currency swaps, $ba^{CCS/2}$, defined as half of the bid-ask spread of cross currency swap rates, with the sample average equal to 19 basis points. We perform statistical tests and find that LC credit spreads remain significantly positive for every country after subtracting one half of the bid-ask spread on the CCS in order to incorporate the transaction costs. Positive LC credit spreads suggest that emerging market nominal LC sovereign bonds are not free from credit risk from the investor's perspective. Although the government has the option to print the domestic currency, inflation is not costless and explicit repudiation of LC debt has happened in the past, such as Russia's default on its Treasury bills in 1998.

3.2 Mean Levels of Credit Spreads

To compare the sovereign's dollar borrowing costs using FC debt with the synthetic dollar borrowing costs using LC debt, we perform an ex-ante credit spread comparison. FC credit spreads, $s^{FC/US}$, reported in Column 2 in Table 1 have a mean of 195 basis points, 67 basis points higher than LC credit spreads based on the mid-rates for CCS. The difference increases to 86 basis points after taking into account the transaction cost of carrying out the swaps. In Column 3, we compute the difference between LC and FC credit spreads by country. The swapped LC over FC spread, $s^{SLC/FC}$, is significantly negative for all of our sample countries except Brazil. Although all our sample countries have LC bond markets open to foreign investors, foreigners may still need to incur transaction costs to buy in into LC markets. For 9 out of 10 countries with negative LC swapped over FC spreads, the promised dollar spread on LC bonds is unambiguously lower than that on FC bonds, since swapped LC over FC spreads would become more negative after taking into account positive taxes on LC bonds.

Brazil offers an important exception. As a country offering one of the highest nominal interest rates in the world, Brazil has implemented various measures to curb portfolio investment flows and cross-border derivative trading as macro-prudential and exchange rate policy. The *Imposto sobre Operaçoes Financieras* (IOF), or tax on financial transactions, is currently set at 6 percent upfront for all fixed income capital inflows into the country. Fortunately for our analysis, Brazil conducted four large issuances of eurobonds denominated in reals traded at the Luxembourg Stock Exchange. These bonds give offshore investors direct access to real-denominated sovereign rates without paying the onshore taxes. In addition, these bonds are payable in dollars and thus foreign investors are free from currency convertibility risk. Figure 6 shows that two long-term offshore real-denominated bonds are traded at significantly lower spreads than 10-year onshore bonds. Applying the CCS to the offshore LC yield generally gives a negative LC over FC spread. Besides Brazil, Colombia and the Philippines, more recently, have also issued several LC eurobonds payable in dollars. All the offshore LC bonds are currently traded at least 100 basis points tighter than onshore bonds, which suggests that taxes and convertibility risk are important components of the LC credit spread from the offshore investors' perspective.

Despite the level difference in credit spreads, one might expect LC and FC credit risks to be correlated within countries, as in downturns a country could find it more tempting to explicitly default on both types of debt. Column 5 confirms this conjecture. The within-country correlation between LC and FC credit spreads is positive for every country with a mean of 54 percent. However, there is significant cross-country heterogeneity. The correlation is highest for Hungary at 91% and lowest for Indonesia at 18%. This cross-country heterogeneity is a source of variation that we will later use to argue for the importance of incomplete market integration in the relative pricing of the two types of debt.

3.3 Widening Credit Spread Differentials During the Crisis

Despite the relatively short sample period, the years 2005-2011 cover dynamic world economic events: the end of the great moderation, the Global Financial Crisis and the subsequent recovery. Figure 7 plots the difference in LC and FC credit spreads, $s^{SLC/FC}$, across 10 countries over the sample period. While swapped LC over FC spreads largely remain in negative territory (with the exception of Brazil), the spreads significantly widened during the peak of the crisis following the Lehman bankruptcy. The maximum difference between

LC and FC credit spreads for any country during the crisis was negative 10 percentage points for Indonesia.

Table 2 quantitatively documents the behavior of the credit spreads during the crisis peak (defined approximately as the year following the Lehman bankruptcy from September 2008 to September 2009), measured as the increase in spreads relative to their pre-crisis means. FC credit spreads significantly increase in all countries and LC credit spreads increase significantly in 8 out of the 10 sample countries, with the exceptions of Indonesia and Peru. However, the increase in swapped LC spreads are generally less than the increase in FC spreads, as LC over FC credit spread differentials are reduced for all countries except Brazil. The divergent behavior of these credit spreads during the crisis peak highlights significant differences between LC and FC bonds, and offers a key stylized fact to be examined in Sections 4 and 5.

3.4 Cross-Country Correlations of Credit Spreads

In Table 3, we conduct a principal component (PC) analysis to determine the extent to which fluctuations in the LC and FC credit spreads are driven by common components or by idiosyncratic country shocks. In the first column, we see that the first principal component explains less than 54% of the variation in LC credit spreads across countries. This is in sharp contrast to the FC spreads (Column 2) where over 81% of total variation is explained by the first PC. The first three principal components explain slightly less than 80% of the total variation for LC credit spreads whereas for FC credit spreads they explain about 97%. In addition, we find that the average pairwise correlation of LC credit spreads between countries is only 42%, in contrast to 78% for FC credit spreads. These findings point to country-specific idiosyncratic components as important drivers of LC credit spreads, in contrast to the FC market where global factors are by far the most important.[10]

To link these results to the literature using CDS spreads as a measure of sovereign risk, we perform the same principal component analysis for 5-year sovereign CDS spreads. The results, in Column 3, are very similar to the FC results in Column 2: the first principal component explains 80 percent of total variation of CDS spreads and the pairwise correlation averages 77 percent. Our result that an overwhelming amount of the variation in CDS spreads is explained by the first PC supports the finding of Longstaff, Pan, Pedersen, and Singleton (2011), which shows that 64% of CDS spreads are explained by the first principal component of 26 developed and emerging markets. The sample period for their study is 2000-2010, but the authors find in the crisis subsample of 2007-2010 that the first principal component accounts for 75% of the variation.

3.5 Correlation of Sovereign Risk with Global Risk Factors

3.5.1 Credit Spreads

After identifying an important global component in both LC and FC credit spreads, we now try to understand what exactly this first principal component is capturing. In Table 4, we first examine the correlation of the first PC's of credit spreads with each other and with global risk factors. The global risk factors include the Merrill Lynch U.S. BBB corporate bond spread over the Treasuries, *BBB/T*, the implied volatility on S&P options, *VIX*, and the Chicago Fed National Activity Index, *CFNAI*, which is the first PC of 85 monthly real economic indicators. Panel (A) indicates that the first PC of FC credit spreads has remarkably high correlations with these three global risk factors, 93% with VIX, 88% with

[10]To assess how measurement errors in LC credit spreads relative to FC affect these results, we start with the null hypothesis that LC and FC credit spreads are the same and then introduce i.i.d. Gaussian shocks to FC credit spreads using simulations. We show that the variance of shocks to FC credit spreads need to be at least 90 basis points to match the observed cross-country correlation in LC credit spreads, which corresponds to 6 times of the standard deviation of observed one-way transaction costs (half of the observed bid-ask spread on cross currency swaps). These simulation results are available upon request.

BBB/T and 76% with global macro fundamentals (or, more precisely, US fundamentals) proxied by the CFNAI index. The correlation between the first PC of LC credit spreads and global risk factors are lower, but still substantial, with a 76% correlation with VIX, 71% with BBB/T and 57% with CFNAI.

Furthermore, since the first PC explains much more variation in FC credit spreads than in LC credit spreads, the cross-country average correlation between raw credit spreads and global risk factors is much higher for FC than for LC debt (Panel B). Notably, VIX has a mean correlation of 70 percent with FC credit spreads, but only 41 percent with LC credit spreads. This leads us to conclude that the observed global factors are more important in driving spreads on FC debt than on swapped LC debt. Unsurprisingly, the correlations between the global factors and the CDS spread are very similar to the correlations between these factors and the FC spread.

3.5.2 Excess Returns

Having examined the ex-ante promised yields in Tables 3 and 4, we next turn to ex-post realized returns. The natural measures to study are the excess returns of LC and FC bonds over U.S. Treasury bonds. In particular, we run a series of beta regressions to examine how LC and FC excess returns vary with global and local equity markets. Before turning to these results, we first define the different types of returns. Since all yields spreads are for zero-coupon benchmarks, we can quickly compute various excess returns for the holding period Δt.[11] The FC over US excess holding period return for an n-year FC bond is equal to

$$rx_{n,t+\Delta t}^{FC/US} = ns_{nt}^{FC/US} - (n - \Delta t)s_{n-\Delta t,t+\Delta t}^{FC/US},$$

which represents the change in the log price of the FC bond over a U.S. Treasury bond of the same maturity. Similarly, the *currency-specific* return differential of an LC bond over a

[11] For quarterly returns, Δt is a quarter and we approximate $s_{n-\Delta t,t+\Delta t}$ with $s_{n,t+\Delta t}$.

U.S. Treasury bond is given by

$$rx_{n,t+\Delta t}^{LC/US} = ns_{nt}^{LC/US} - (n - \Delta t)s_{n-\Delta t,t+\Delta t}^{LC/US}.$$

Depending on the specific FX hedging strategies, we can translate $rx_{n,t+\Delta t}^{LC/US}$ into three types of *dollar* excess returns on LC bonds. First, the unhedged LC over US excess return, $uhrx_{n,t+\Delta t}^{LC/US}$, is equal to the currency-specific return differential minus the ex-post LC depreciation:

$$uhrx_{n,t+\Delta t}^{LC/US} = rx_{n,t+\Delta t}^{LC/US} - (s_{t+\Delta t} - s_t),$$

where s_t denotes the log spot exchange rate. Second, the holding-period hedged LC over US excess return, $hrx_{n,t+\Delta t}^{LC/US}$, is equal to the currency-specific return differential minus the ex-ante holding period forward premium:

$$hrx_{n,t+\Delta t}^{LC/US} = rx_{n,t+\Delta t}^{LC/US} - (f_{t,t+\Delta t} - s_t),$$

where $f_{t,t+\Delta t}$ denotes the log forward rate at t for carrying out FX forward transaction Δt ahead. Third, swapped LC over US excess returns, $srx_{n,t+\Delta t}^{LC/US}$, is equal to the currency-specific return differential minus the return on the currency swap:

$$srx_{n,t+\Delta t}^{LC/US} = rx_{n,t+\Delta t}^{LC/US} - [n\rho_{nt} - (n - \Delta t)\rho_{n-\Delta t,t+\Delta t}].$$

All three LC excess returns share the same component measuring the LC and US currency-specific return differential. Depending on the specific FX hedging strategy, the ex-post LC depreciation, ex-ante holding period forward premium and ex-post return on the currency swap affect unhedged, hedged and swapped excess returns, respectively.[12]

Table 5 presents panel regression results for excess bond returns over local and global equity excess returns. Global equity excess returns are defined as the quarterly return on the S&P 500 index over 3 month U.S. Treasury bills. We define two measures of LC equity excess returns (holding-period hedged and long-term swapped) so that a foreign investor hedging her currency risk in the local equity market has the same degree of hedging on her bond position. We find that FC excess returns have significantly positive betas on both global and hedged LC equity returns, with the loading on S&P being greater. Hedged and swapped LC excess returns do not load on the S&P, but have a significantly positive beta on local equity returns. In contrast, FX unhedged LC excess returns have positive betas on both the S&P and local equity returns.

We therefore conclude that, for foreign investors, the main risk of LC bonds is that emerging market currencies depreciate when returns on global equities are low. This supports the results of Lustig, Roussanov, and Verdelhan (2011) that common factors are important drivers of currency returns. Our new result, however, is that once currency risk is removed, LC debt appears to be much less risky than FC debt in the sense that it has significantly lower loadings on global equity returns than FC debt.

3.6 Summary of Stylized Facts

We briefly summarize the results of Section 3. We first establish that emerging markets are paying positive spreads over the risk-free rate on their LC sovereign borrowing. This result indicates the failure of long-term covered interest parity for government bond yields between

[12]The hedged excess return is a first-order approximation of the mark-to-market (MTM) dollar return on money market hedging strategy by combining the LC bond with a long position in the domestic risk-free rate and a short position in the dollar risk-free rate over the U.S. Treasury bond. The swapped excess return is the first order approximation of the MTM dollar return on the bond and the CCS over the U.S. Treasury bond. The hedging notional is equal to the initial market value of the LC bond and is dynamically rebalanced. All the empirical results of the paper are robust to using the exact MTM accounting for the quarterly holding period.

our ten emerging markets and the United States. With the mean LC credit spread equal to 128 basis points, the failure is so large as to make clear the importance of credit risk on LC debt, rather than only pointing to a temporary deviation from an arbitrage relationship as documented in developed markets. Positive within-country correlations between LC credit spreads and the conventional measure of sovereign risk, FC credit spreads, also highlight the role of sovereign risk on LC debt.

Despite the positive correlation, LC and FC credit spreads differ along three important dimensions. First, while LC credit spreads are large and economically significant, they are generally lower than FC credit spreads. The difference between LC and FC credit spreads significantly widened during the peak of the crisis following the Lehman bankruptcy. Second, FC credit spreads are much more correlated across countries than LC credit spreads. Over 80% of the variation in FC spreads is explained by the first principal component. In contrast, only 53% of the variation in LC credit spreads is explained by the first principal component, pointing to the relative importance of country-specific factors in driving LC spreads. Third, FC credit spreads are much more correlated with global risk factors than LC credit spreads. We find that FC spreads are very strongly correlated with global risk factors, including a remarkable 93% correlation between the first PC of FC credit spreads and VIX. These results are mirrored in the return space, as excess holding period returns on FC debt load heavily on global equity returns while excess returns on swapped LC debt do not load on global equity returns once local equity returns are controlled.

The differences between LC and FC credit spreads have important implications. Given the fact that the bulk of emerging market sovereign borrowing takes the form of LC debt, conventional measures of sovereign risk based on FC credit spreads and CDS spreads no longer fully characterize the costs of sovereign borrowing, the cross-country dependence of sovereign risk, and sensitivities of sovereign spreads to global risk factors. Understanding why LC and FC credit spreads differ is the main focus of the next two sections.

4 A No-Arbitrage Model with Risky Credit Arbitrage

4.1 Differential Cash Flow Risk and Investor Bases

Having documented a series of new stylized facts on the differential behavior of LC and FC credit spreads, we now turn to explaining them. One natural explanation for the credit spread differential is that swapped LC and FC bonds have differential cash flow risks. First, the sovereign may have differential incentives to repay the debt. Since FC debt is mainly held by global investors whereas LC bonds are mainly held by local pension funds and commercial banks, the government may be more inclined default on FC obligations. On the other hand, if the sovereign cares more about reputational costs among international creditors and the access to global capital markets, they may have more incentive to default on local creditors.

Second, in terms of capacity to repay, sovereigns can print local currency and collect most of their revenue in local currency. During periods of sharp exchange rate depreciation, it is easier for the sovereigns to service LC debt than FC debt. However, given that LC debt now represents the bulk of sovereign borrowing, defaulting on LC debt can be a more effective way to reduce debt burden.

Third, since nearly all LC debt is issued under domestic law, LC debt is subject to the risk of changing taxation, regulation, and custody risk, as well as a more uncertain bankruptcy procedure. Offshore investors also face convertibility risk whereby a government prevents the repatriation of funds by introducing capital controls while avoiding technical default. FC bonds, on the other hand, are predominantly governed under international law and are therefore free from withholding taxes and from local government regulations.

Finally, even if the two types of debt always have the same recovery of face value upon default, there could potentially exist a wedge between credit spreads depending on FX depreciation upon default. From a dollar investor's perspective, when default on LC debt occurs, the investor holding the swapped LC debt can unwind the swap contract with an unmatched LC principal payment. This might result in additional profits in the swap position if the spot exchange rate depreciates relative to the ex-ante forward exchange rate upon default. On the other hand, if the spot exchange rate depreciates upon default less than the ex-ante forward exchange rate, there would be additional loss on the swap position. The covariance between default and FX risk is referred to as the quanto adjustment.[13]

In addition to differential cash flow risk, the differential investor bases in domestic and external debt markets can also matter for the relative pricing of the two types of debt. FC bonds are issued offshore,mainly targeting global investors. Although there has been increasing foreign ownership in LC debt markets, the bulk of the LC debt is still held by local investors, such as local pension funds, insurance companies, commercial banks and other government agencies. In emerging markets, these domestic entires are often required by law to hold a large fraction of their portfolios in LC treasury bonds, which gives rise a distinct local clientele demand that is absent from the external debt market.[14] This local clientele demand can have equilibrium impacts in the presence of frictions that create limits to arbitrage.

4.2 Environment

We formalize a parsimonious model allowing for different degrees of market integration via risky credit arbitrage. The model builds on the preferred habitat framework presented in Vayanos and Vila (2009), Greenwood and Vayanos (2010) and Hamilton and Wu (2012), and surveyed in Gromb and Vayanos (2010). Following Duffie and Singleton (1999), we take a reduced form approach to model arrival rates of credit events and allow them to depend on a local and a global factor. We introduce partial market segmentation through three main building blocks. First, we assume that FC bonds are priced by risk-averse diversified global investors with a complete-market stochastic discount factor (SDF) that only depends on

[13]To remove the covariance term, the investor would need to enter a currency swap contract with a floating notional linked to the LC bond payment (or a quanto swap). However, since EM LC bonds are not deliverable, LC credit linked quanto swaps are rarely quoted in the market.

[14]Kumara and Pfau (2011) document stringent caps faced by emerging market pension funds in investing in local equities and overseas assets.

the global factor. Global risk aversion shocks affect FC credit spreads directly through FC bonds' systematic exposure to the global shock. Second, we allow for the existence of local clientele demand, modeled as downward sloping outside demand with respect to the price of swapped LC bonds. Third, we assume that a risk-averse credit arbitrageur integrates LC and FC markets by equalizing the price of risk across the two markets adjusting for the onshore and offshore pricing wedge. As a result, the equilibrium LC credit spread is an endogenous outcome of the arbitrageurs' optimal portfolio demand and local clientele demand. The equilibrium impact of the risky arbitrage depends the size of the position the arbitrageur is willing to take, which in turn depends on the arbitrageur's risk aversion, the asset return correlation, and the size and elasticity of local clientele demand.

We begin by specifying a reduced form default process for the bonds. We define ν_i as the time when bonds of type $j = LC, FC$ issued by country i default, and the conditional survival intensity, $I^{i,j}_{t+1}$ as the probability that the bond does not default in period $t+1$ conditional on the fact that it has not yet defaulted by period t. We let the survival intensity for bond j in country i depend on local (z^i_t) and global (z^w_t) factors:

$$I^{i,j}_{t+1} = P(\nu^j_i > t+1 | \nu^j_i > t) = \exp[-(\lambda^{i,j}_0 + \lambda^j_c z^i_t + \lambda^j_w z^w_t + \sigma^j_{\lambda c}\xi^i_{t+1} + \sigma^j_{\lambda w}\xi^w_{t+1})].$$

For simplicity, we assume zero-recovery upon default. The local and global factors follow two AR(1) processes:

$$\begin{aligned} z^i_{t+1} &= \varsigma^c + \phi^c z^i_t + \xi^i_{t+1} \\ z^w_{t+1} &= \varsigma^w + \phi^w z^w_t + \xi^w_{t+1}, \end{aligned}$$

where ξ^w_{t+1} and ξ^i_{t+1} are independent standard normal innovations, ς^c and ς^w are AR(1) drifts, and ϕ^c and ϕ^w are the autoregressive coefficients. We interpret an increase in the factors as worsening macroeconomic fundamentals that make default more likely. The global SDF is given by

$$-\log M_{t+1} = -m^*_{t+1} = \psi_0 - \psi z^w_t - \gamma \xi^w_{t+1},$$

where γ indicates the risk aversion of global investors. The one-period risk-free rate is therefore

$$y^*_{1t} = -\log E_t(M_{t+1}) = \psi_0 - \psi z^w_t - \gamma^2/2.$$

4.3 Pricing FC and LC Bonds

In the case of one period bonds when defaulted bonds have zero recovery rates, the survival process fully determines the bond returns. The variance of one-period log returns for bond j is equal to $(\sigma^j_1)^2 \equiv (\sigma^j_{\lambda c})^2 + (\sigma^j_{\lambda w})^2$. Given the global SDF and the one-period survival rate, the one-period log FC spread over the risk-free rate is given by

$$s^{FC}_{1t} \;\; = \;\; -\log E_t(M_{t+1} I^{i,FC}_{t+1}) - y^*_{1t} = \lambda^{FC}_0 + \lambda^{FC}_w z^w_t + \lambda^{FC}_c z^i_t - (\sigma^{FC}_1)^2/2 + \gamma \sigma^{FC}_{\lambda w}.$$

The first set of terms $\lambda^{FC}_0 + \lambda^{FC}_c z^i_t + \lambda^{FC}_w z^w_t$ is the expected default loss of the bond conditional on the factors. The term $(\sigma^{FC}_1)^2/2$ is the Jensen's inequality correction from working with log yields. The third term is the risk premium on the FC bond. When $\sigma_{\lambda w} > 0$, defaults are more likely in the bad states of the world for the global investor, leading the FC bond to carry a positive risk premium due to its systematic exposure to global shocks. This is the empirically relevant case as demonstrated in Borri and Verdelhan (2011).

Now suppose that the local bond market has an outside clientele demand, i.e., local pension funds, and there are risk-averse arbitrageurs who arbitrage between LC and FC markets. The arbitrageurs take the FC spread priced by the global investor as given. The LC credit spread is an equilibrium outcome of arbitrageurs' portfolio demand and local clientele demand. Assume that the arbitrageurs have power utility over next-period wealth with constant relative risk aversion γ_a. As demonstrated in Campbell and Viceira (2002), the first-order condition of an arbitrageur's optimal portfolio decision is given by

$$E_t r_{1t+1} - y_{1t}^* + \frac{1}{2}\sigma_t^2 = \gamma_a V \alpha_t$$

where r_{1t+1} is a column vector of one-period log returns of the swapped LC and FC bonds, σ_t^2 is the variance of log excess returns, V is the variance-covariance matrix of log excess returns, and α_t is a column vector with the arbitrageur's portfolio weights in LC and FC debt.

We conjecture that the LC credit spread $s_{1t}^{SLC/US}$ is affine in the local and global factors z_t^i and z_t^w and is given by

$$s_{1t}^{SLC/US} = (b_{10} + \lambda_0^{SLC} - \sigma_{SLC}^2/2) + (b_{1c} + \lambda_c^{SLC})z_t^i + (b_{1w} + \lambda_w^{SLC})z_t^w$$

where the spread parameters b_{10}, b_{1c}, and b_{1w} will be solved for in the equilibrium. The expected dollar return on swapped LC bonds is then equal to

$$E_t r_{1t+1}^{SLC} - y_{1t}^* + \sigma_{SLC}^2/2 = (b_{10} + b_{1c}z_t^i + b_{1w}z_t^w) - (\tau_{10} - q_{10}),$$

where τ_{10} is the transaction cost (e.g. taxes on capital inflows) for offshore investors and q_{10} is the quanto adjustment due to covariance between the exchange rate and the default process that cannot be hedged away. We refer $\tau_{10} - q_{10}$ as the offshore pricing wedge because this valuation adjustment only applies to offshore dollar investors. By inverting the variance-covariance matrix V, we can calculate the arbitrageur's optimal portfolio weights in local and foreign currency bonds, α_t^{SLC} and α_t^{FC} from the first-order condition:

$$\begin{bmatrix} \alpha_{1t}^{SLC} \\ \alpha_{1t}^{FC} \end{bmatrix} = \frac{1}{\gamma_a(1-\rho_{r1}^2)(\sigma_1^{SLC})^2(\sigma_1^{FC})^2} \begin{bmatrix} (\sigma_1^{FC})^2 & -\rho_{r1}\sigma_1^{SLC}\sigma_1^{FC} \\ -\rho_{r1}\sigma_1^{SLC}\sigma_1^{FC} & (\sigma_1^{SLC})^2 \end{bmatrix} \begin{bmatrix} (b_{10} + b_{1c}z_t^i + b_{1w}z_t^w) - (\tau_{10} - q_{10}) \\ \gamma\sigma_{\lambda w}^{FC} \end{bmatrix},$$

where $\rho_{r1} \equiv (\sigma_{\lambda w}^{SLC}\sigma_{\lambda w}^{FC} + \sigma_{\lambda c}^{SLC}\sigma_{\lambda c}^{FC})/(\sigma_1^{SLC}\sigma_1^{FC})$ is the correlation in log returns. When log returns are positively correlated, $\rho_{r1} > 0$, the arbitrageur takes offsetting positions in LC and FC bonds to hedge risk.

Following Greenwood and Vayanos (2010), we close the model by positing a downward sloping excess clientele demand for LC bonds d_t^{SLC} (normalizing the supply of LC bonds to zero), which is decreasing in the price of the swapped LC bond, p_{1t}^{SLC},

$$d_{1t}^{SLC}/W = \kappa_1(-p_{1t}^{SLC} - \beta_1),$$

with $\kappa_1 > 0$. Local investors care about the price of the swapped LC bond because it can be translated into how much the LC bond yields relative to the LC risk-free rate. Following Hamilton and Wu (2012), we normalize the clientele demand by the level of arbitrageur's wealth, W. Furthermore, we assume that β_1 is affine in factors and takes the form:

$$\beta_1 = \left[\theta_{10} + \lambda_0^{SLC} - (\sigma_1^{SLC})^2/2\right] + (\theta_{1c} + \lambda_c^{SLC})z_t^i + (\theta_{1w} + \lambda_w^{SLC})z_t^w + y_{1t}^*.$$

In the absence of arbitrage, the market clearing condition requires that excess demand is zero, and thus $y_t^{SLC} = \beta_1$ and the expected excess return on swapped LC bonds is then equal to $\theta_{10} + \theta_{1c}z_t^i + \theta_{1w}^w z_t^w$. This parametrization of β_1 allows us to conveniently summarize local demand as the deviation from zero expected excess returns on swapped LC bonds that would occur in the absence of arbitrage. Negative values of θ_{1c} and θ_{1w} dampen the sensitivity of the LC credit spread to local and global shocks.

Equilibrium requires that asset markets clear, or the arbitrageur's optimal portfolio demand exactly offsets local clientele demand:

$$\alpha_{1t}^{SLC} + d_{1t}^{SLC}/W = 0.$$

Using the above equilibrium condition, we can solve for the equilibrium spread parameters b_{10}, b_{1c} and b_{1w} in closed forms as follows:

$$b_{10} = \omega_1 \theta_{10} + (1-\omega_1)(\tau_{10} - q_{10}) + \delta_1^{SLC}\gamma, \quad b_{1c} = \omega_1 \theta_{1c} \quad \text{and} \quad b_{1w} = \omega_1 \theta_{1w}, \tag{1}$$

where

$$\omega_1 = \frac{\kappa_1}{\kappa_1 + \frac{1}{\gamma_a(1-\rho_{r1}^2)(\sigma_1^{SLC})^2}}, \quad \text{and} \quad \delta_1^{SLC} \equiv \frac{\rho_{r1}\sigma_1^{SLC}/\sigma_1^{FC}}{\kappa_1\gamma_a(1-\rho_{r1}^2)(\sigma_1^{SLC})^2 + 1}\sigma_{\lambda w}^{FC}.$$

Therefore, the equilibrium LC credit spread depends on the local demand shifters θ_{10}, θ_{1c} and θ_{1w}, the offshore pricing wedge $\tau_{10} - q_{10}$, and the global investor's risk aversion γ. The exact magnitude of these equilibrium effects depend on the arbitrageur's risk aversion, the return correlation and the elasticity of local demand. These will be examined in the next subsection.

4.4 Comparative Statics

To gain intuition, we perform several comparative statics. First, we study the pass-through of global risk aversion into the LC credit spread. The pass-through of global risk aversion into the LC spread is the derivative of the spread $s_{1t}^{SLC/US}$ with respect to risk aversion γ:

$$\delta_1^{SLC} \equiv \frac{\partial s_{1t}^{SLC/US}}{\partial \gamma} = \frac{\rho_{r1}\sigma_1^{SLC}/\sigma_1^{FC}}{\kappa_1\gamma_a(1-\rho_{r1}^2)(\sigma_1^{SLC})^2 + 1}\sigma_{\lambda w}^{FC}, \tag{2}$$

where we refer to δ^{SLC} as the pass-though parameter for swapped LC debt. Similarly, for FC debt, we have that the pass-through of risk aversion γ into FC spreads s_{1t}^{FC} is given by:

$$\delta_1^{FC} \equiv \frac{\partial s_{1t}^{FC/US}}{\partial \gamma} = \sigma_{\lambda w}^{FC}.$$

It is straightforward to establish the following proposition using Equation 2:

Proposition 2. *(Pass-through of Global Risk Aversion) If the asset return correlation times the standard deviation of swapped LC returns is less than the standard deviation of FC returns* $\left(\rho_{r1}\sigma_1^{SLC} < \sigma_1^{FC}\right)$*, the pass-through of global risk aversion shocks into the swapped LC spread is less than into FC spreads,* $\delta_1^{SLC} < \delta_1^{FC}$*. Furthermore, the pass-through into LC spreads is increasing in the return correlation* $\left(\partial\delta_1^{SLC}/\partial\rho_{r1} > 0\right)$*, decreasing in the arbitrageur's risk aversion* $\left(\partial\delta_1^{SLC}/\partial\gamma^a < 0\right)$*, and decreasing in the elasticity of local demand* $\left(\partial\delta_1^{SLC}/\partial\kappa_1 < 0\right)$*.*

Although the price of risk is equalized across the two markets by the arbitrageur, the quantity of risk can still be different. Under the condition that $\rho_{r1}\sigma_1^{SLC} < \sigma_1^{FC}$, swapped LC bonds have a lower quantity of risk. We can re-express this condition as $\beta_{SLC/FC} = Cov(rx_{t+1}^{SLC}, rx_{t+1}^{FC})/Var(rx_{t+1}^{FC}) < 1$ in the beta regression of running swapped LC excess returns on FC excess returns:

$$rx_{t+1}^{SLC} = \beta_0 + \beta_{SLC/FC} rx_{t+1}^{FC} + \epsilon_{t+1}.$$

Due to the lower quantity of risk, swapped LC bonds carry a lower risk premium. In the one-period model, both ρ_{r1} and $\sigma_{\lambda w}$ are given exogenously by the default processes and do not depend on the local demands θ_{1c} and θ_{1w}. In Section C of Appendix, we relax this feature of the model in a multi-period specification in which the price of the bond next period is also uncertain even in the absence of default and the price sensitivity depends on the local demand parameters. The mechanism of pass-through of global risk aversion into the LC credit spread is as follows. An increase in global risk aversion γ increases the FC spread and the expected excess returns on the FC bond. Holding the arbitrageur's risk aversion constant, the arbitrageur takes advantage of this opportunity by going long in FC bonds and hedges her position by shorting swapped LC bonds, which drives up the swapped LC spread. The pass-through of global risk aversion is lower into the LC bond if the quantity of risk in LC bonds is lower.

The extent of the trade and its subsequent impact on the LC credit spread depends on three key parameters. First, the differential pass-through depends on the return correlation ρ_{r1}. Higher correlations increase LC pass-through by allowing the arbitrageur to better hedge her risk and hence take a larger position. When returns are uncorrelated ($\rho_{r1} = 0$), the pass-through is zero, and when returns are perfectly correlated ($\rho_{r1} = 1$), pass-through achieves its maximum at $\frac{\sigma_1^{SLC}}{\sigma_1^{FC}} \sigma_{\lambda w}^{FC}$. Second, the differential pass-through depends on the arbitrageur's risk aversion γ_a : an increase in arbitrageur risk aversion decreases pass-through. When γ_a is infinite, pass-through is zero because the arbitrageur is too risk-averse to make any trades. When γ_a is zero, meaning that the arbitrageur is risk-neutral, pass-through is maximized for a given return correlation, ρ_{r1}. Third, the differential pass-through depends on the elasticity of local clientele demand κ_1 : An increase in the elasticity of local clientele demand decreases pass-though. A more elastic local demand increases the ability of the LC credit spread to absorb larger positions taken by arbitrageurs. When κ_1 is infinite, local clientele demand is perfectly elastic and therefore the LC credit spread is completely determined by local conditions, leaving no room for arbitrageurs to play a role. On the other hand, when $\kappa_1 = 0$, local clientele demand is zero and thus pass-through is maximized.

In addition to capturing the default intensity and the risk premium, the equilibrium LC credit spread is a weighted average of the onshore local clientele effects and the offshore pricing wedge. The pass-through of local clientele effects into the LC credit spread in terms of level (θ_{10}) and sensitivities (θ_{1c}, θ_{1w}) to shocks is equal to

$$\frac{\partial b_{10}}{\partial \theta_{10}} = \frac{\partial b_{1c}}{\partial \theta_{1c}} = \frac{\partial b_{1w}}{\partial \theta_{1w}} = \omega_1 = \frac{\kappa_1}{\kappa_1 + \frac{1}{\gamma^a (1-\rho_{r1}^2)(\sigma_1^{SLC})^2}}$$

Interestingly, the pass-through of the offshore pricing wedge is equal to $1 - \omega_1$.

$$\frac{\partial b_{10}}{\partial \tau_{10}} = -\frac{\partial b_{10}}{\partial q_{10}} = 1 - \omega_1.$$

The parameter ω_1 governs the relative importance of onshore and offshore investors in determining the equilibrium LC credit spread. Under complete segmentation ($\omega_1 = 1$), only the local clientele matters, leaving no scope for offshore transaction costs or the covariance between the exchange rate and defaults. On the other hand, under perfect integration ($\omega_1 = 0$), local clientele effects are completely arbitraged away and the credit spread is entirely determined by offshore credit valuation.

4.5 Empirical Decomposition of Credit Spread Differentials

Using the model, we can decompose the difference in LC and FC credit spreads into three components:

$$\begin{aligned} s_{1t}^{SLC/FC} &= \underbrace{(\tilde{\lambda}_0 + \tilde{\lambda}_i z_t^i + \tilde{\lambda}_w z_t^w - \tilde{\sigma^2}/2)}_{\text{differential recovery (convexity)}} + \underbrace{w_n(\theta_{10} + \theta_{1c} z_t^i + \theta_{1w} z_t^w) + (1-\omega_1)(\tau_{10} - q_{10})}_{\text{weighted pricing wedge}} \\ &\quad + \underbrace{[\delta_1^{SLC}(\omega_1) - \delta_1^{FC}]\gamma}_{\text{risk premium}} \end{aligned}$$

where $\tilde{x} \equiv x^{SLC} - x^{FC}$. The first term in the curly bracket measures the difference in default intensity between LC and FC bonds adjusting for convexity in log yields. The second term measures the weighted onshore and offshore pricing wedges. Finally, the third term measures the difference in risk premia, arising from risky arbitrage between the two markets.

To give an example of perfect market integration, Figure 8 shows LC (euro) and FC (dollar) sovereign credit spreads for Italy. Prior to 2008, the two credit spreads were indistinguishable. Starting in 2008, the euro credit spread became slightly lower than the dollar credit spread, reflecting either expected higher recovery on euro debt or depreciation of euro upon Italian default. Despite the level difference, the within country correlation between the two credit spreads is 99 percent. On the other extreme, Russia displays extreme market segmentation between LC and FC debt market during the 2008-09 crisis (Figure 9), as the LC credit spread reached negative 10 percentage points during the crisis. While the nominal government bond yield differential was around 10 percentage points, the ruble/dollar CCS rate increased to 20 percentage points as offshore investors were concerned that Russia would abandon the euro/dollar peg and devalue. Local investors continued to hold LC debt despite extremely unattractive yields.

Our sample emerging markets are in between the two extreme cases of perfect integration and complete segmentation. In the next section, we demonstrate that consistent with theory's predictions, differential sensitivities to global risk aversion shocks can explain large cross-sectional and time series variations in credit spread differentials.

5 Differential Risk Premia

5.1 Benchmark Regressions

To test the model's predictions on the differential pass-through of global risk aversion (γ_t) summarized in Proposition 2, we perform a panel regression with country fixed effects:

$$s_{i,t}^j = \alpha_i^j + \delta^j \gamma_t + \lambda_c z_t^i + \lambda_w z_t^w + \epsilon_{it}^j,$$

where i denotes country and j denote three different spreads, the LC credit spread (SLC), the FC credit spread (FC), and the swapped LC over FC spread (SLC/FC). We first assume that δ^j, the pass-through coefficient of global risk aversion, is the same across all countries, which will be relaxed in the next subsection. Sensitivity to global and local risk factors is also assumed to be the same across countries and to be time-invariant. We include a country fixed effect in the regression to allow each country to have a different intercept for credit spreads. The theory predicts that the pass-through coefficient of global risk aversion should be lower for LC credit spreads than for FC credit spreads: $\delta^{SLC} < \delta^{FC}$, and as a result, $\delta^{SLC/FC} < 0$. We use VIX as a proxy for the global risk aversion γ_t,[15] and a host of

[15]We divide the conventional quote of VIX by $\sqrt{12}$ to measure unannualized implied volatility over the next 30 days.

global and local macroeconomic variables as proxies for z_t^i and z_t^w. Table 6 reports regression results for (1) the LC credit spread (2) the FC credit spread and (3) the swapped LC over FC spread, the difference between (1) and (2). By construction, the LC credit spread is equal to the difference between the nominal LC over US spread and the swap rate. We thus also report the regression results for the nominal LC over US spread in Column (4) and the swap rate in Column (5) to better understand the determinants of the LC credit spread. Following Driscoll and Kraay (1998), all regressions are run at monthly frequency with country fixed effects using the Newey-West type standard errors with 12-month lags to account for within-country serial correlation and clustering by month to correct for spatial correlation across countries for the same month.

As our primary measure of global economic fundamentals, we use the Chicago Fed National Activity Index (CFNAI), which is the first principal component 85 monthly economic indicators of the U.S. economy. The next variable ba^{CCS} is equal to one half of the bid-ask spread on 5-year par cross currency swaps, measured in basis points. Although it is specifically a measure of the liquidity on swaps, we use it as a proxy for the overall liquidity conditions in emerging market fixed income markets, especially in the offshore markets. For local controls, we first include $LC\,Equity\,Vol.$ the realized standard deviation of local equity returns, measured using the daily local MSCI equity returns for 30-day rolling windows. We expect this measure to reflect omitted local fundamentals and local risk aversion. In addition, we include a set of country-specific macroeconomic controls that previous literature has emphasized as potentially important in explaining sovereign spreads. These include the FC debt/GDP ratio, the LC debt/GDP ratio, the level and volatility of monthly inflation and changes in the terms of trade, as well as monthly changes in foreign exchange reserves.[16]

[16] Debt to GDP ratios are computed by aggregating the entire universe of individual sovereign bond issuance in Bloomberg. Using this index, rather than the aggregated data from the Bank for International Settlements (BIS), we obtain a higher frequency measure of the debt outstanding than the quarterly measure produced by the BIS. The correlation between our debt/GDP ratios with the BIS official statistics is 96 percent for FC debt and 80 percent for LC debt. More details on construction of macroeconomic controls are given in the Appendix Table A3.

As predicted by the theory, VIX has a smaller impact on the LC credit spread than on the FC credit spread conditional on macroeconomic fundamentals. The coefficient on VIX for the FC credit spread is three times as large as the coefficient for the LC credit spread. The coefficient on VIX in the LC over FC credit spread differential regression (Column 3) is negative and statistically significant. The magnitude of the coefficient suggests that an expected one percentage point increase in the volatility of the S&P 500 over the next 30 days is associated with an 8 basis point increase in the LC credit spread, a 23 basis point increase in the FC credit spread, and thus a 15 basis point reduction in the LC over FC credit spread differential. This risk aversion pass-through differential is economically significant. In our estimated sample, a one standard deviation increase in VIX over its mean decreases the credit spread differential by 45 basis points. The largest spike in VIX following the Lehman bankruptcy corresponds to a 3.5 standard deviation increase in VIX over the mean, which can generate a 157 basis point differential in LC and FC credit spreads, controlling for the worsening local and global economic fundamentals during the crisis.

The importance of VIX in explaining credit spread differentials can also be seen from the R-squared of regressions. VIX alone explains large fractions of the total variation in all credit spread regressions, particularly for the FC credit spread. The within R-squared of a panel regression with VIX as the only regressor is equal to 24.7 for the LC credit spread, 58.5 percent for the FC credit spread, and 25.6 percent for the credit spread differential. Conditional on macroeconomic fundamentals, VIX increases the R-squared of the regression from 27.1 to 30.1 percent for the LC credit spread, from 62.2 to 72.8 percent for the FC credit spread and from 36.4 percent to 42.6 percent for the differential. Therefore, VIX alone accounts for 60 percent of total explained variations in the credit spread differential. After controlling for fundamentals, VIX accounts for an increase equal to 15 percent of total explained variations in explanatory power of the benchmark regression.

Conditional on our host of controls, swap liquidity does not significantly affect the LC credit spread. Although the bid-ask spread of the swap significantly increases with the swap rate, it is also associated with a similar increase in the nominal LC over US spread. On the other hand, the FC credit spread significantly increases with the bid-ask spread, despite the fact that no swaps are used in the construction of the measure. This supports our use of the bid-ask spread on the swap as a general measure of liquidity as well as a direct measure of swap liquidity. Furthermore, we find that worsening global macroeconomic conditions, higher local equity volatility, higher FC debt/GDP and higher inflation volatility all significantly increase the FC credit spread, but have either insignificant or smaller impacts on the LC credit spread.

5.2 Cross-Country Variation

We now relax the assumption that the pass-through of global risk-aversion into FC debt, δ^{FC}, is the same across all countries. The theory predicts that the ratio of swapped LC to FC pass-thorough $\delta_i^{SLC}/\delta_i^{FC}$ increases in ρ_r^i. To test this prediction, we obtain estimates of $\hat{\delta}_i^{SLC}$ and $\hat{\delta}_i^{FC}$ from the coefficients on the interaction terms between country dummies and VIX in the regression:

$$s_{i,t}^j = \alpha_{1,i}^j + \sum_i \delta_i^j C_i \gamma_t + \lambda_c z_t^i + \lambda_w z_t^w + \epsilon_{it}^j, \tag{3}$$

where the country dummy $C_i = 1$ for country i. Columns 1 and 2 of Table 7 report the coefficient estimates for $\hat{\delta}_i^{SLC}$ and $\hat{\delta}_i^{FC}$. For our model to find empirical support, we would expect countries with a higher ratio $\hat{\delta}_i^{SLC}/\hat{\delta}_i^{FC}$ to have a higher return correlation. As demonstrated by comparing Column 3, where we compute this ratio country by country, and Column 4, where we present the return correlations, this is precisely what we find, with the correlation between the two columns at a remarkable 84 percent. Differential sensitivities to VIX explain the bulk of the cross-sectional variations in excess return correlations. We present this result visually in Figure 10, showing once again that the strong positive relationship between the pass-through of risk aversion into the LC credit spread relative to the FC credit spread and the return correlation between the two assets.

5.3 Excess Returns Predictability

We now present evidence on how differential risk premia affect the time series properties of credit spreads. Since VIX has a contemporaneous positive impact on credit spreads through the risk premium channel, high levels of VIX are associated with high risk premia, and hence high excess returns over U.S. Treasury bonds. Since VIX has a differential contemporaneous pass-through into LC and FC credit spreads, we should also expect VIX to have differential predictive power for LC and FC excess returns. Consistent with the prediction, we find that high VIX predicts higher FC excess returns than swapped LC excess returns, and thus negative swapped LC over FC excess returns. The negative predictive power of VIX for swapped LC over FC excess returns naturally gives rise to an investment strategy. When global risk aversion is high, an arbitrageur can long FC bonds and short swapped LC bonds. Since FC spreads are much more sensitive to the global risk aversion shocks than swapped LC, high risk aversion predicts positive excess returns on this strategy, which compensates for the risk that the arbitrageur takes. On the other hand, global macroeconomic fundamentals marginally forecast persistence, rather than mean reversion in swapped LC over FC excess returns once VIX is controlled. Therefore, it is unlikely that the predictive power of VIX is due to its correlation with unobserved macroeconomic fundamentals.

In the first panel of Table 8, we examine the forecasting power of these variables for annualized excess returns of swapped LC bonds over U.S. Treasury bonds for a quarterly holding period. In the first regression, we see that high levels of VIX forecast excess returns at the quarterly horizon with an R^2 of 4.2%. We next run a second univariate forecasting regression and find that CFNAI, our measure of local fundamentals, has similar forecasting power as VIX for swapped LC excess returns. When we run a bivariate forecasting regression including both VIX and CFNAI in the third row, both lose significance and the increase in forecasting power is marginal compared to including VIX alone. Including the spread on the cross currency swap rate $ba^{CCS}/2$ and the volatility on the local equity indices $LCVol$ have little effect, but including industrial production growth ΔIP leads to a significant increase in forecasting power. Higher industrial production growth forecasts lower excess returns on swapped LC bonds.

In the second panel of Table 8, we repeat this forecasting exercise for excess returns on FC bonds over U.S. Treasury bonds. In the first row, we see that VIX alone has an R^2 of 10.1% and the coefficient on VIX is more than double the coefficient on VIX in the univariate regressions for excess returns on swapped LC bonds, and the R^2 is more than doubled as well. In the second regression, we once again remove VIX to examine the forecasting power of CFNAI alone and find that, in contrast to the results in the first panel, the R^2 is only one quarter the value it is in the univariate forecast using VIX. In the third row, we see that a forecasting regression with both VIX and the CNFAI has an R^2 less than one percentage point higher than for VIX alone. The key finding is that conditional on VIX, the global fundamental does not forecast mean reversion in returns. The magnitude of the coefficient on VIX actually increases by 45 basis points after controlling for CFNAI, once again in sharp contrast to the forecasting results for swapped LC excess returns. In the fourth row, we add our liquidity measure to these two variables and find that the forecasting power of the regression is increased significantly to 15.5%. After adding the full set of local controls, the coefficient on VIX is significantly positive at 2.82.

Finally, in the third panel, we examine how these variables forecast excess returns of swapped LC bonds over FC bonds. In the first row, we see that higher levels of VIX forecast a negative excess return of swapped LC over FC debt, as would be expected since we found in the first two panels that elevated levels of VIX forecast much higher FC returns than swapped LC returns. Looking at all 6 forecasting regressions in the third panel, we see that the forecasting strength of VIX is sharpened as we add in our measures for global fundamentals, global liquidity, local market conditions, and miscellaneous controls. Because

VIX covaries strongly with global fundamentals and global fundamentals marginally forecast return persistence, the predictive power of VIX is increased when we condition on fundamentals. Conditional on fundamentals, a one standard deviation increase in VIX over its mean forecasts negative 6.3 percent annualized excess returns of swapped LC over FC bonds.

6 Conclusion

The last decade has seen a remarkable change in emerging market government finance. No longer do major emerging markets have to borrow in external markets in FC to borrow from global investors. Instead, global investors are increasingly willing to lend to emerging market governments by investing in LC debt issued in domestic markets. Despite these major changes, the academic literature on sovereign risk still remains focused on emerging market debt crises involving FC debt issued abroad. In this paper, we tried to understand the impact of these changes by jointly examining the sovereign risk on LC and FC debt. To do so, we introduce a new measure of LC sovereign risk, the LC credit spread, defined as the difference between LC bond yield and the LC risk-free rate implied from the swap market.

This new measure delivers several key findings. First, emerging market LC bonds promise to pay a significant positive spread over the risk-free rate, direct evidence for the failure of long-term covered interest rate parity for government bond yields between emerging markets and the United States. Second, LC debt has lower credit spreads than FC debt issued by the same sovereign at the same tenor. The LC over FC credit spread differential becomes even more negative during the peak of the crisis. Third, FC credit spreads are very integrated across countries and more responsive to global risk factors, but LC credit spreads are much less so. From an offshore investor's perspective, the commonly perceived systematic risk on LC debt mainly comes from the currency risk. Once the currency risk is hedged, LC bonds are safer than FC bonds in terms of the correlations between asset returns and global risk factors.

We rationalize these new empirical findings using a model allowing for partial integration between domestic and external debt markets. The model features local investors with preferred habitats in the LC debt and risky credit arbitrage between the domestic and external markets. The equilibrium LC credit spread is a weighted average of credit valuation of local clienteles and offshore investors. Consistent with the model's prediction, we find that differential exposure to global risk aversion explains a significant portion of the cross-country and time series variations in credit spread differentials, conditional on a host of macroeconomic variables. The differential sensitivities of LC and FC credit spreads to global risk aversion shocks sheds light on the degree of market integration between domestic and external debt markets.

While our reduced form model captures many of the new stylized facts that we document, we have abstracted from how the sovereign decides whether to issue LC or FC debt. Integrating our empirical findings using price data into sovereign issuance patterns using bond supply and ownership data is part of ongoing research.

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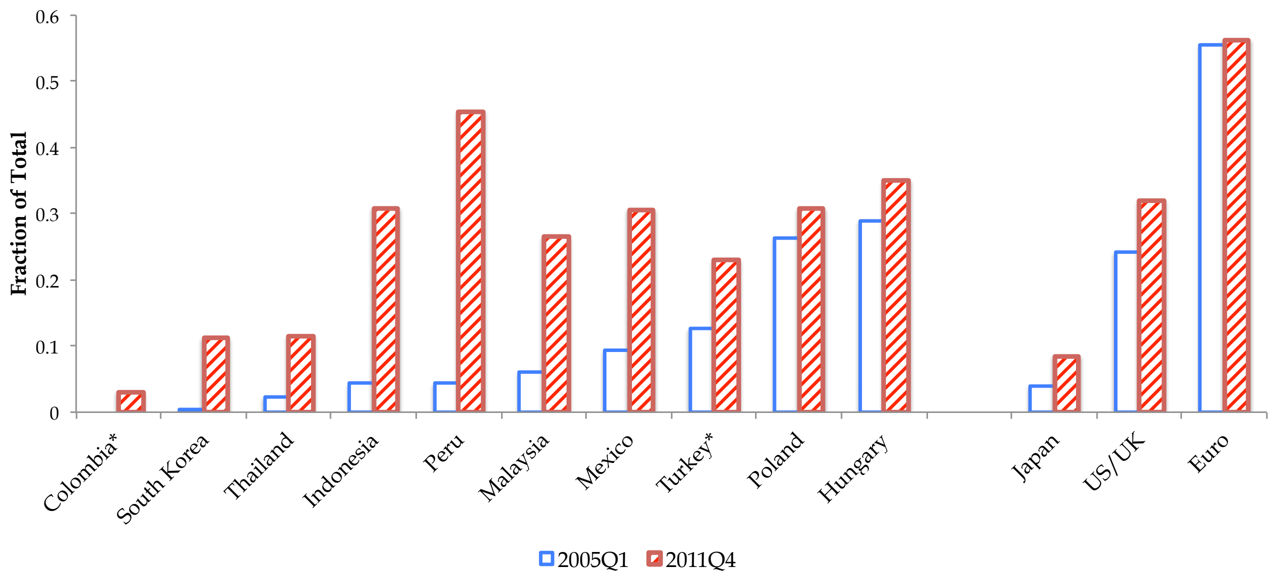
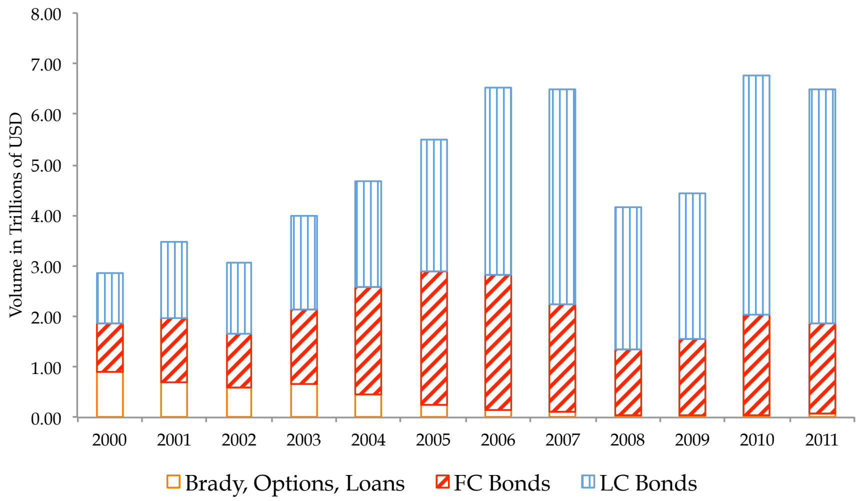
Figure 1: Foreign Ownership of Government Debt in Emerging and Developed Markets



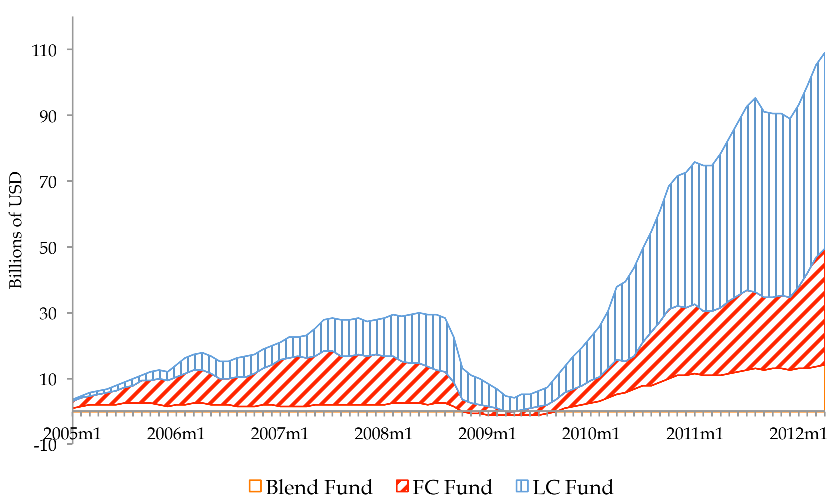
Notes: This figure displays shares of domestic government debt owned by foreigners in emerging markets and developed countries. Data for South Korea, Thailand, Japan, Indonesia and Malaysia are from the Asian Bonds Online website of the Asian Development Bank. Data for Colombia, Peru, Mexico, Turkey, Poland and Hungary are from the websites of the respective central banks and national treasuries. Ownership data for Colombia, South Korea, Thailand, Japan, Indonesia, Peru, Malaysia, Mexico, Turkey, Poland and Hungary refer to domestically issued LC debt. The symbol * indicates that no data was available for 2005Q1 and that 2006Q1 data was used instead. "UK/US" is the mean of the United States and the United Kingdom. "Euro" is the mean of the values for France, Germany, Greece, Ireland, Italy, the Netherlands, and Spain. Data for the euro area countries, US, and UK are from (Merler and Pisani-Ferry, 2012). Ownership data for the euro area countries, the US, and the UK generally covers all Central Government debt, with details found in Merler and Pisani-Ferry (2012).

Figure 2: Offshore Trading Volume by Instrument Types (Trillions of USD)



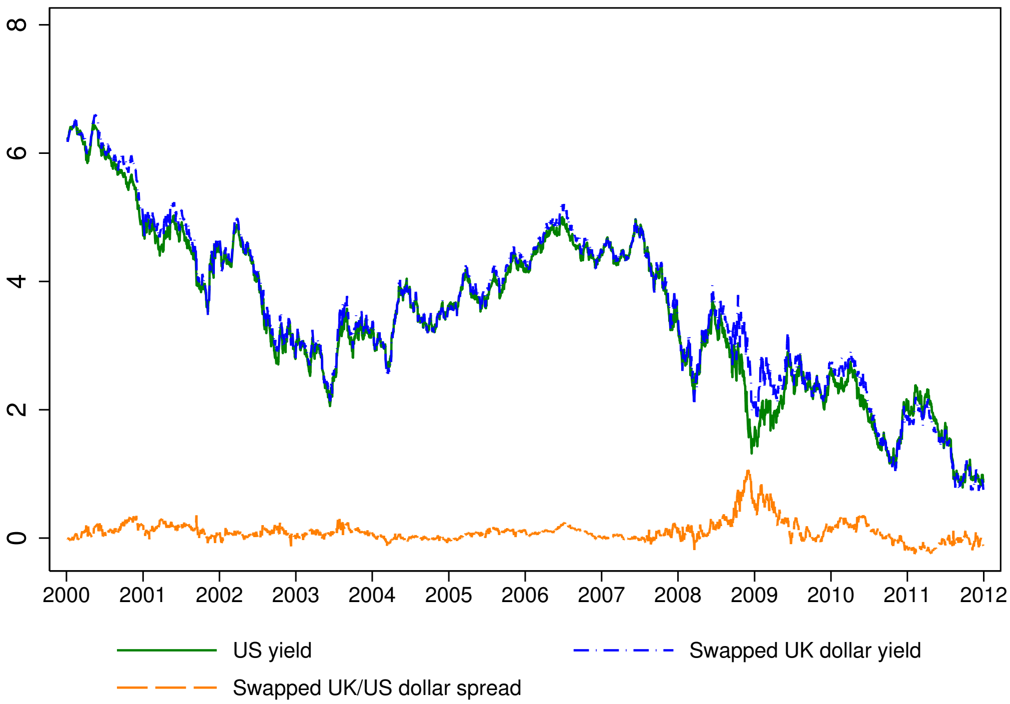
Source: Annual *Debt Trading Volume Survey* (2000-2011) by Emerging Market Trading Association (EMTA)
Notes: This figure plots total trading volumes of emerging market debt by instrument type in trillions of dollars. In addition to FC bonds, the "Brady, Option, Loans" category also refers to debt instruments denominated in foreign currencies. The survey participants consist of large offshore financial institutions.

Figure 3: Cumulative Flows of Offshore Emerging Market Funds (Billions of USD)



Source: Emerging Market Portfolio Research
Notes: This figure plots cumulative flows of offshore mutual funds designated to emerging market debt since 2005, measured in billions of USD. Monthly fund flow is measured as end-of-month assets - beginning-of-month assets - portfolio change - FX change. The total cumulative flow is broken down by currency type. LC Fund refers to funds that invest 75 percent or more in local currency debt; FC Fund refers to funds that invest 75 or more in hard currency debt; and Blend Fund refers to funds that invest in a combination of both, less than 75 percent for either of the above categories.

Figure 4: 5-Year U.S. and Swapped UK Treasury Yields in percentage points

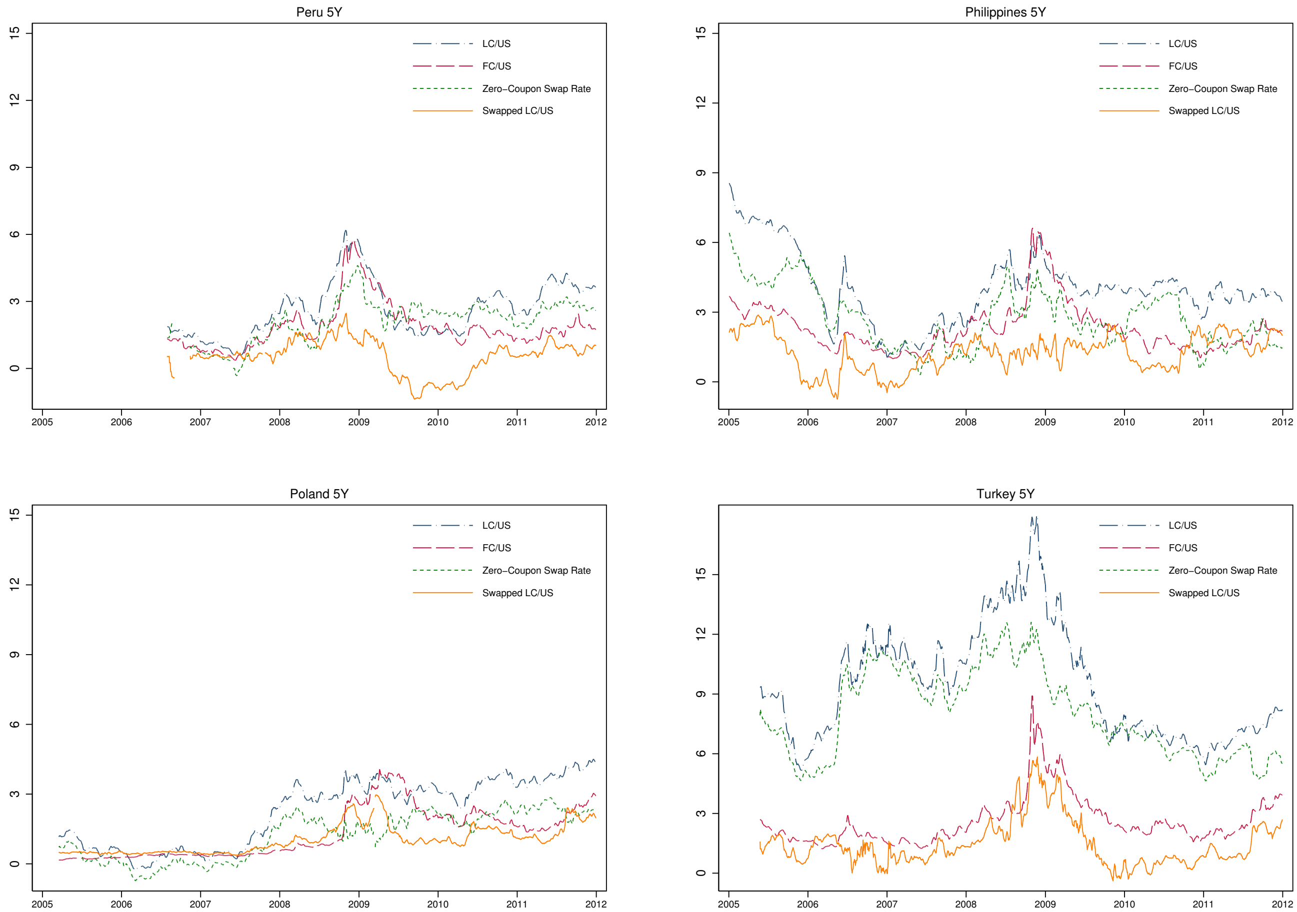


Notes: The green solid line plots the 5-Year zero-coupon U.S. Treasury yield. The blue dash-dotted line plots the 5-year zero-coupon swapped UK Treasury yield after applying a cross currency swap package consisting of two plain vanilla interest rate swaps (dollar and sterling) and the U.S. and UK Libor cross-currency basis swap. The orange dashed line plots the yield spread of the swapped UK Treasury yield over the U.S. Treasury. The mean of the yield spreads is 10 basis points with standard deviation equal to 16 basis points. The minimum spread is equal to negative 25 basis points and the maximum spread is equal to 106 basis points during the peak of the crisis. Excluding 2008-2009, the mean spread is 6 basis points with standard deviation equal to 10 basis points. The U.S. zero-coupon yield is from St. Louis Fed. The UK zero-coupon yield is from Bank of England. Swap rates are from Bloomberg.

Figure 5: 5-Year Swapped LC and FC Spreads in percentage points

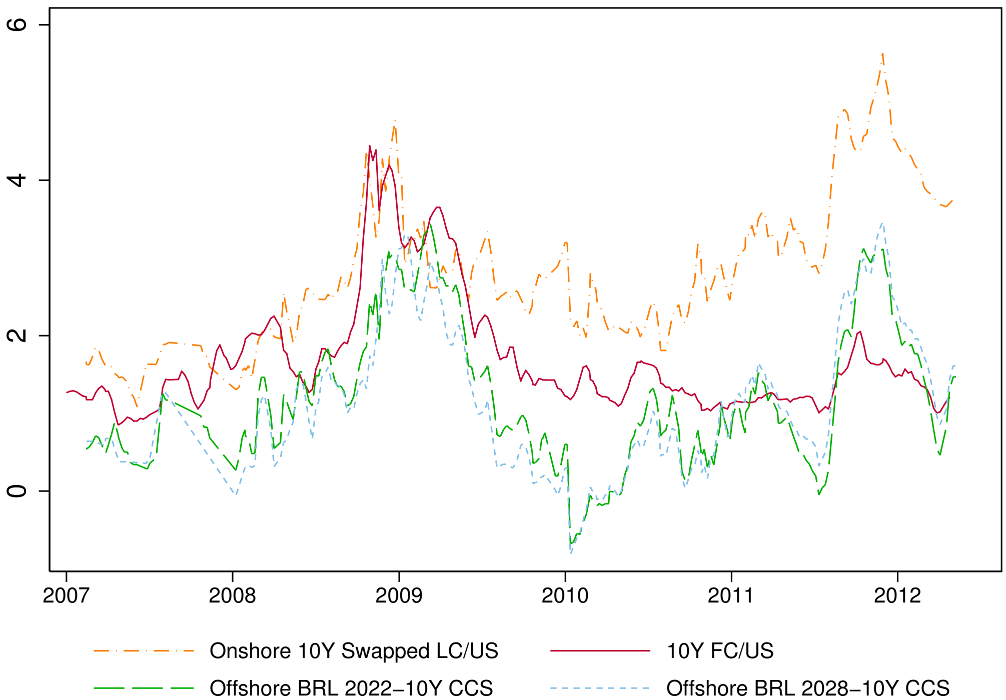
Notes: Each figure plots 10-day moving averages of zero-coupon LC and FC spreads over the U.S. Treasury at 5 years. LC/US denotes the LC yield over the U.S. Treasury yield. FC/US denotes the FC yield over the U.S. Treasury yield. Zero-coupon swap rate is the zero-coupon fixed for fixed CCS rate implied from par fixed for floating CCS and plain vanilla interest rate swap rates. Swapped LC/US denotes the swapped LC over U.S. Treasury yield spread. All yields and swap rates are for the 5-year tenor. Data sources and details on yield curve construction are given in Appendix Table A3.

Figure 5: 5-Year Swapped LC and FC Spreads in percentage points (continued)



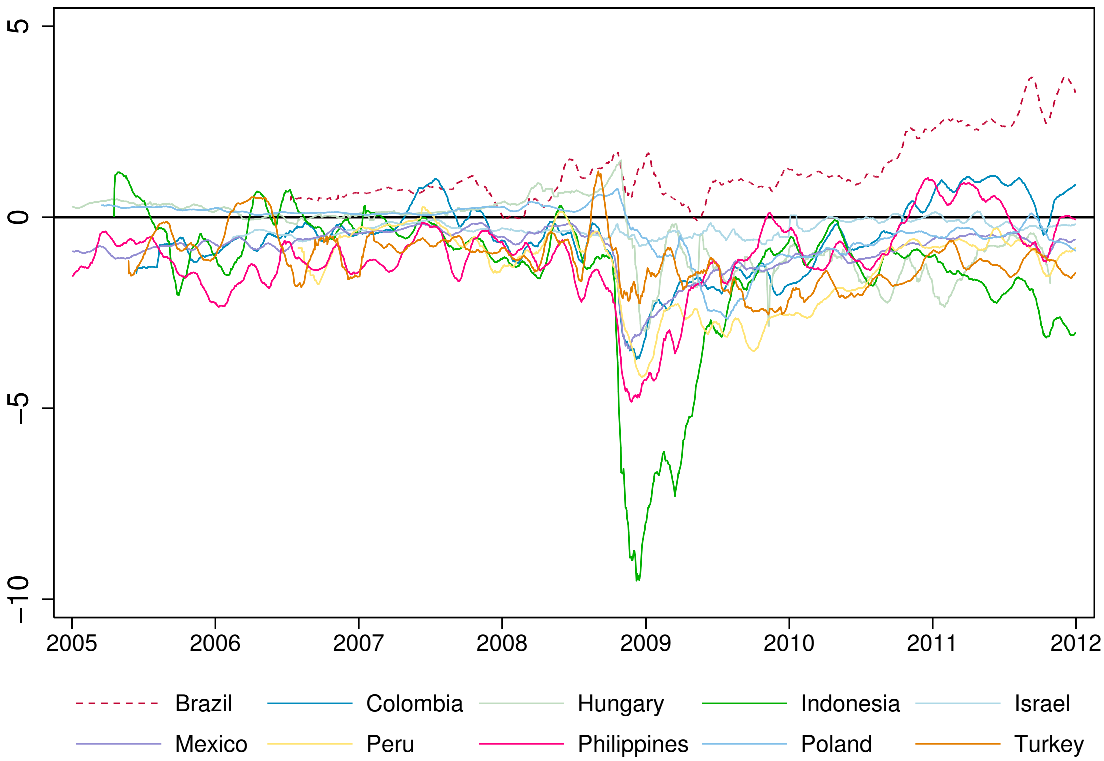
Notes: Each figure plots 10-day moving averages of zero-coupon LC and FC spreads over the U.S. Treasury at 5 years. LC/US denotes the LC yield over the U.S. Treasury yield. FC/US denotes the FC yield over the U.S. Treasury yield. Zero-coupon swap rate is the zero-coupon fixed for fixed CCS rate implied from par fixed for floating CCS and plain vanilla interest rate swap rates. Swapped LC/US denotes the swapped LC over U.S. Treasury yield spread. All yields and swap rates are for the 5-year tenor. Data sources and details on yield curve construction are given in Appendix Table A3.

Figure 6: Brazil Onshore and Offshore Yield Comparison



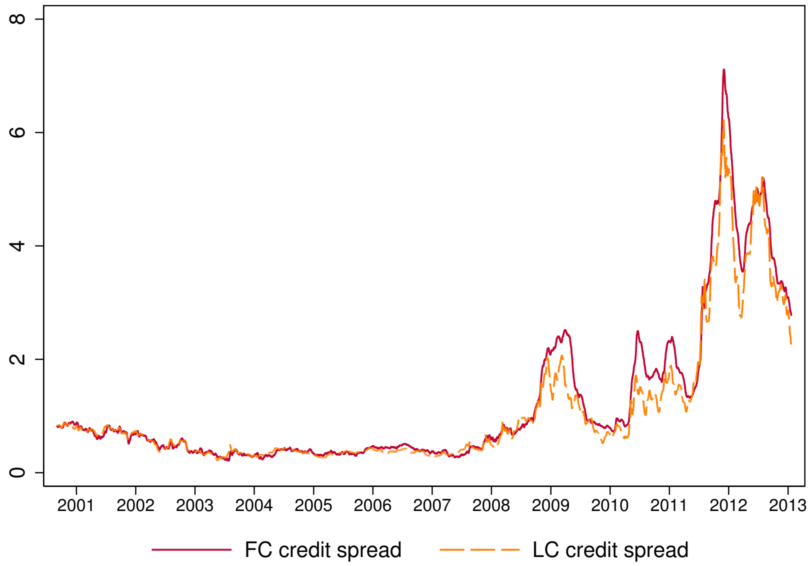
Notes: This figure plots nominal yields minus 10-year zero-coupon real/dollar swap rates on two Eurobonds denominated in Brazilian reals traded at the Luxembourg Stock Exchange with maturity years 2022 and 2028 (BRL 2022 by the green long-dashed line and BRL 2028 by the blue short-dashed line). Offshore swapped yields are compared with the 10-year zero-coupon onshore LC swapped yield plotted by the orange dash-dotted line and the offshore FC dollar yield plotted by the red solid line. The onshore LC zero-coupon yield is obtained from ANBIMA. The FC zero-coupon yield is estimated from Bloomberg BFV par yield curve. LC Eurobond yields are provided by the Luxembourg Stock Exchange.

Figure 7: Swapped LC over FC spreads



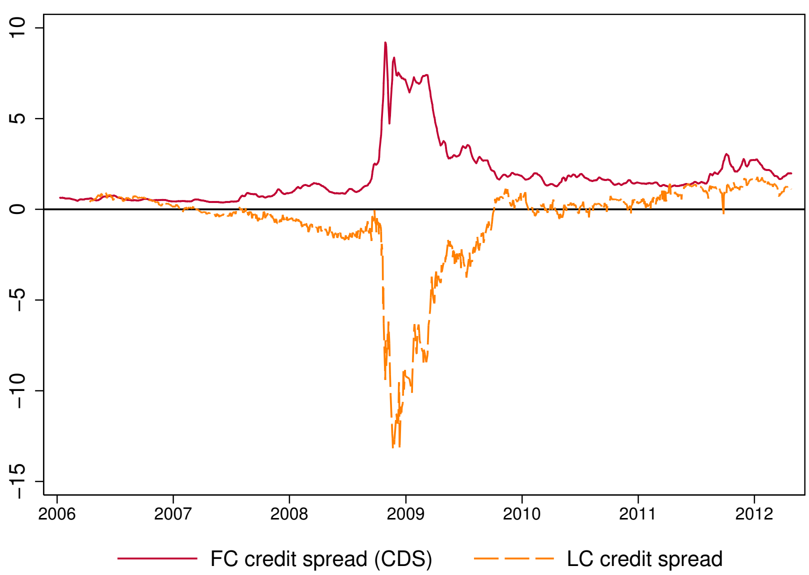
Notes: This figure plots 30-day moving averages of 5-year zero-coupon swapped LC over FC spreads (the difference between LC and FC credit spreads) using 5-year cross currency swaps for all 10 sample countries. Data sources and details on yield curve construction are given Appendix Table A3.

Figure 8: 5-Year Sovereign Credit Spreads in Italy



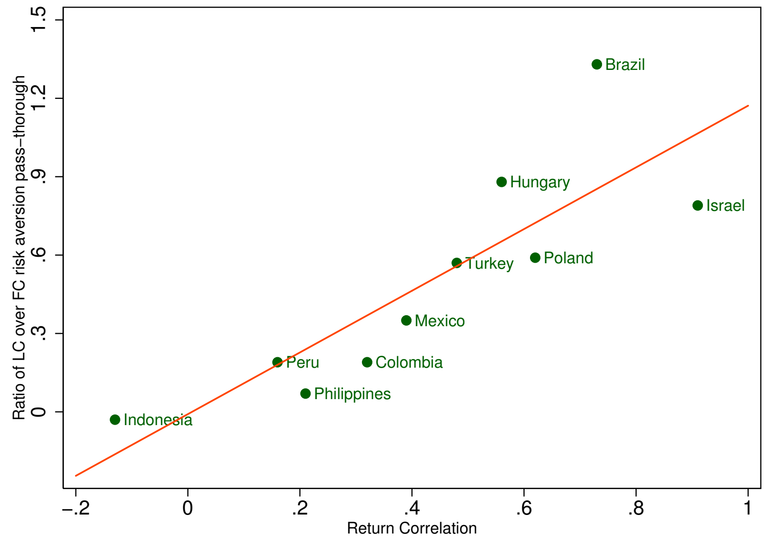
Notes: The solid line FC credit spread plots 5-year yield spreads of dollar denominated Italian sovereign bonds over U.S. Treasury bonds. The dotted line LC credit spread plots 5-year yield spreads of euro-denominated Italian sovereign bonds after swapping into dollars using the euro/dollar CCS over U.S. Treasury bonds. All data are from Bloomberg.

Figure 9: 5-Year Sovereign Credit Spreads in Russia



Notes: The solid line FC credit spread plots 5-year Russian sovereign credit spread swaps spreads denominated in dollars (Russia does not have enough dollar bonds outstanding to construct yield curves). The dotted line LC credit spread plots 5-year yield spreads of Russian ruble-denominated Russian sovereign bonds after swapping into dollars using the ruble/dollar CCS over U.S. Treasury bonds. Ruble bond yields are from the Moscow Stock Exchange. All the other data are from Bloomberg.

Figure 10: Differential Risk Aversion Pass-Though and Return Correlation



Notes: This figure plots the ratio of global risk aversion pass-through into LC credit spreads over the pass-through into FC credit spreads on the y-axis (Column 3 in Table 7) and correlation between swapped LC and FC quarterly holding period returns over U.S. Treasury bill rates on the x-axis (Column 4 in Table 7). The ratio of pass-through is computed based on Columns 1 and 2 in Table 7. The full regression specification is given by Equation 3.

Table 1: Mean LC and FC Credit Spread Comparison, 2005-2011

Country	Sample Start	(1) $s^{SLC/US}$	(2) $s^{FC/US}$	(3) $s^{SLC/FC}$	(4) $ba^{CCS}/2$	(5) *Corr(SLC,FC)*
Brazil	Jul. 2006	3.13***	1.78***	**1.35*****	0.32	0.56
		(1.13)	(0.91)	(0.94)	(0.13)	
Colombia	Jun. 2005	1.47***	2.03***	**-0.56*****	0.16	0.34
		(0.69)	(1.01)	(1.01)	(0.10)	
Hungary	Jan. 2005	1.69***	2.15***	**-0.47****	0.19	0.91
		(1.23)	(2.01)	(1.03)	(0.14)	
Indonesia	Apr. 2005	1.14***	2.52***	**-1.38*****	0.38	0.18
		(0.73)	(1.59)	(1.61)	(0.23)	
Israel	Feb. 2006	0.86***	1.12***	**-0.26*****	0.12	0.84
		(0.43)	(0.42)	(0.21)	(0.03)	
Mexico	Jan. 2005	0.60***	1.44***	**-0.83*****	0.09	0.66
		(0.40)	(0.79)	(0.60)	(0.06)	
Peru	Jul. 2006	0.55***	1.97***	**-1.42*****	0.16	0.34
		(0.80)	(1.05)	(1.09)	(0.07)	
Philippines	Mar. 2005	1.25***	2.31***	**-1.07*****	0.28	0.34
		(0.80)	(1.04)	(1.07)	(0.14)	
Poland	Mar. 2005	1.04***	1.29***	**-0.25****	0.12	0.78
		(0.60)	(1.01)	(0.62)	(0.08)	
Turkey	May 2005	1.46***	2.57***	**-1.12*****	0.11	0.78
		(1.19)	(1.20)	(0.81)	(0.08)	
Total	Jan. 2005	1.28***	1.95***	**-0.67*****	0.19	0.54
		(1.06)	(1.23)	(1.22)	(0.15)	
Observations		13151	13151	13151	13151	

Notes: This table reports sample starting date, mean and standard deviation of 5-year log yield spreads at daily frequency. The variables are (1) $s^{SLC/US}$, swapped LC over U.S. Treasury spread; (2) $s^{FC/US}$, FC over U.S. Treasury spread; (3) $s^{SLC/FC}$, swapped LC over FC spread, or column (2) - column (1). (4) $ba^{CCS}/2$, half of bid-ask spread of cross-currency swaps. Standard deviations of the variables are reported in the parentheses. We test significance of means using Newey-West standard errors with 120-day lags. Standard errors are omitted. Test results are reported for columns (1), (2) and (3), *** p<0.01, ** p<0.05, * p<0.1. Since the bid-ask spread is always nonnegative, significance tests are not performed for column 4. Two additional tests are conducted for hypotheses (1) $s^{SLC/US} - ba^{CCS}/2 = 0$ and $s^{SLC/FC} - ba^{CCS/2}/2 = 0$, both tests can be rejected at 5 percent or lower confidence levels for all countries using Newey-West standard errors with 120-day lags. Column (5) reports within-country correlations between $s^{SLC/US}$ and $s^{FC/US}$.

Table 2: Changes in Credit Spreads During Crisis Peak (09/01/08 - 09/01/09)

Country	(1) $\Delta s^{SLC/US}$	(2) $\Delta s^{FC/US}$	(3) $\Delta s^{SLC/FC}$	(4) $\Delta ba^{CCS}/2$
Brazil	1.93***	1.82***	**0.11**	0.26***
	(1.13)	(0.99)	(0.66)	(0.13)
Colombia	0.64***	2.31***	**-1.66*****	0.10***
	(0.67)	(1.21)	(0.82)	(0.18)
Hungary	2.70***	3.80***	**-1.10****	0.31***
	(1.12)	(2.17)	(1.48)	(0.22)
Indonesia	0.07	3.67***	**-3.61*****	0.45***
	(0.65)	(2.17)	(2.41)	(0.39)
Israel	0.54***	0.68***	**-0.15*****	0.05***
	(0.26)	(0.26)	(0.21)	(0.04)
Mexico	0.60***	1.97***	**-1.38*****	-0.03***
	(0.30)	(0.87)	(0.80)	(0.01)
Peru	-0.05	2.21***	**-2.26*****	0.07***
	(0.95)	(1.12)	(0.81)	(0.08)
Philippines	0.36***	1.91***	**-1.55*****	0.18***
	(0.40)	(1.28)	(1.33)	(0.22)
Poland	1.26***	2.35***	**-1.09*****	0.17***
	(0.58)	(0.92)	(1.01)	(0.09)
Turkey	1.89***	2.70***	**-0.81*****	-0.06***
	(1.44)	(1.47)	(0.86)	(0.07)
Total	0.91***	2.30***	**-1.40*****	0.14***
	(1.16)	(1.48)	(1.51)	(0.22)
Observations	2058	2058	2058	2058

Notes: This table reports the mean and standard deviation of changes in LC and FC credit spreads during the peak of the Global Financial Crisis (09/01/2008-09/01/2009) relative to their pre-crisis means. (1) $\Delta s^{SLC/US}$ is the increase in swapped LC over U.S. Treasury spreads; (2) $\Delta s^{FC/US}$ is the increase in the FC over U.S. Treasury spreads; (3) $\Delta s^{SLC/FC}$ is the increase in swapped LC over FC spreads, or column (2)-column (1); and (4) $\Delta ba^{CCS}/2$ is the increase in one half of bid-ask spreads. Standard deviations of variables are reported in the parentheses. Statistical significance of the means are tested using Newey-West standard errors with 120-day lags. Significance levels are denoted by *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Cross-Country Correlation of Credit Spreads, 2005-2011

Principal Components	(1) $s^{SLC/US}$ percentage	total	(2) $s^{FC/US}$ percentage	total	(3) *5Y CDS* percentage	total
First	53.49	53.49	81.52	81.52	80.02	80.02
Second	16.30	69.78	11.70	93.22	15.34	95.36
Third	10.17	79.95	3.68	96.90	2.06	97.41
Pairwise Corr.	0.42		0.78		0.77	

Notes: This table reports summary statistics of principal component analysis and cross-country correlation matrices of monthly 5-Year LC and FC credit spreads and sovereign credit default swap spreads. The variables are (1) $s^{SLC/US}$, swapped LC over U.S. Treasury spreads; (2) $s^{FC/US}$, FC over U.S. Treasury spreads; (3) *5Y CDS*, five-year sovereign CDS spreads. The rows "First", "Second", "Third" report percentage and cumulative percentage of total variations explained by the first, second and third principal components, respectively. The row "Pairwise Corr." reports the mean of all bilateral correlations for all country pairs. All variables are end-of-the-month observations.

Table 4: Correlation among Credit Spreads and Global Risk Factors. 2005-2011

	(A) First PC of Credit Spreads			*(B) Raw Credit Spreads*			*(C) Global Risk Factors*		
	$s^{SLC/US}$	$s^{FC/US}$	*5Y CDS*	$s^{SLC/US}$	$s^{FC/US}$	*5Y CDS*	*BBB/T*	*-CFNAI*	*VIX*
$s^{SLC/US}$	1.00			1.00					
$s^{FC/US}$	0.81	1.00		0.49	1.00				
5Y CDS	0.80	0.94	1.00	0.48	0.91	1.00			
BBB/T	0.71	0.88	0.89	0.38	0.66	0.62	1.00		
-CFNAI	0.57	0.76	0.75	0.33	0.58	0.52	0.87	1.00	
VIX	0.76	0.93	0.87	0.41	0.70	0.61	0.80	0.68	1.00

Notes: This table reports correlations among credit spreads and global risk factors. Panel (A) reports correlations between the first principal component of credit spreads and global risk factors. Panel (B) reports average correlations between raw credit spreads in 10 sample countries and global risk factors. Panel (C) reports correlations between global risk factors only. The three credit spreads are (1) $s^{SLC/US}$, 5-year swapped LC over U.S. Treasury spread; (2) $s^{FC/US}$, 5-year FC over U.S. Treasury spread; and (3) *5Y CDS*, 5-year sovereign credit default swap spread. The three global risk factors are (1) *BBB/T,* Merrill Lynch BBB over 10-year Treasury spread; (2) *-CFNAI,* negative of the real-time Chicago Fed National Activity Index, or the first principal component of 85 monthly economic indicators (positive CFNAI indicates improvement in macroeconomic fundamentals), and (3) *VIX*, implied volatility on the S&P index options. All variables use end-of-the-month observations.

Table 5: Regressions of Bond Excess Returns on Equity Returns, 2005-2011

	(1) $rx^{FC/US}$	(2) $hrx^{LC/US}$	(3) $uhrx^{LC/US}$	(4) $rx^{FC/US}$	(5) $srx^{LC/US}$	(6) $uhrx^{LC/US}$
S&P $rx	0.17***	-0.023	0.26***	0.22***	0.0011	0.42***
	(0.060)	(0.057)	(0.081)	(0.055)	(0.025)	(0.086)
LC equity hedged $rx	0.11***	0.21***	0.33***			
	(0.036)	(0.036)	(0.049)			
LC equity swapped $rx				0.066***	0.099***	0.19***
				(0.022)	(0.021)	(0.047)
Observations	12,122	12,122	12,122	12,122	12,122	12,122
R-squared	0.485	0.314	0.498	0.438	0.159	0.416

Notes: This table reports contemporaneous betas of bond quarterly excess returns on global and local equity excess returns. The dependent variables are (1) and (4) $rx^{FC/US}$, FC over U.S. Treasury bond excess returns; (2) $hrx^{LC/US}$, hedged LC over U.S. Treasury bond excess return using 3-month forward contracts; (3) and (6) $uhrx^{LC/US}$, unhedged LC over U.S. Treasury bond excess returns; and (5) $srx^{LC/US}$, swapped LC over U.S. Treasury bond excess returns All excess returns are computed based on the quarterly holding period returns on 5-year zero-coupon benchmarks (annualized). The independent variables are *S&P $rx*, quarterly return on the S&P 500 index over 3-month U.S. T-bills; *LC equity hedged $rx*, quarterly return on local MSCI index hedged using 3-month FX forward over 3-month U.S. T-bills; and *LC equity swapped $rx*, quarterly return on local MSCI index combined with a 5-year CCS over 3-month U.S. T-bills; All regressions are run at daily frequency with country fixed effects using Newey-West standard errors with 120-day lags and clustering by date following Driscoll and Kraay (1998). Significance levels are denoted by *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Regression of 5-Year Credit Spreads on VIX, 2005m1-2011m12

	(1) $s^{SLC/US}$	(2) $s^{FC/US}$	(3) $s^{SLC/FC}$	(4) $s^{LC/US}$	(5) ccs
VIX	**0.088*****	**0.23*****	**-0.15*****	0.16***	0.070**
	(0.029)	(0.019)	(0.025)	(0.043)	(0.031)
CFNAI	-0.017	-0.16***	0.15	-0.15	-0.13
	(0.082)	(0.040)	(0.094)	(0.14)	(0.13)
ba^{CCS}	0.0037	0.025***	-0.021***	0.024***	0.020***
	(0.0049)	(0.0025)	(0.0056)	(0.0092)	(0.0058)
LC Equity Vol.	0.12	0.19**	-0.065	0.19	0.071
	(0.075)	(0.082)	(0.054)	(0.17)	(0.12)
ΔIP	-0.10	-0.076*	-0.027	0.084	0.19*
	(0.066)	(0.040)	(0.073)	(0.11)	(0.096)
Other Controls					
FC Debt/GDP	-0.026	0.12***	-0.15***	0.0096	0.035
LC Debt/GDP	-0.024	0.011	-0.035***	-0.052***	-0.028***
ΔCPI	0.10*	0.033	0.068*	0.32***	0.21***
Std(ΔCPI)	0.39**	0.50***	-0.10	1.09***	0.69***
ΔToT	-0.0086	0.0077	-0.016**	0.011	0.019***
Std(ΔToT)	0.024	0.021	0.0032	0.27***	0.25***
Δ*Reserve*	-0.0013	-0.011	0.010	-0.029**	-0.028**
Observations	762	762	762	762	762
Within R-Squared					
Full model	0.301	0.728	0.426	0.442	0.308
Without VIX	0.271	0.622	0.364	0.415	0.299
With VIX only	0.247	0.585	0.256	0.266	0.111

Notes: This table reports fixed-effect panel regression results of yield spreads and the swap rate on VIX and controls. The dependent variables are as follows: (1) $s^{SLC/US}$, swapped LC over U.S. Treasury spread; (2) $s^{FC/US}$, FC over U.S. Treasury spread; (3) $s^{SLC/FC}$, swapped LC over FC spread; (4) $s^{LC/US}$, unhedged LC over US Treasury spread; (5) *CCS*, 5-year zero-coupon cross-currency swap rate. The independent variables are: *VIX,* monthly standard deviation of implied volatility on S&P index options (conventional quote/$\sqrt{12}$); *CFNAI*, Chicago Fed National Activity Index, or the first principal component of 85 monthly economic indicators; ba^{CCS}/s, one half of bid-ask spread on 5-year par CCS in basis points; *LC Equity Vol.*, realized standard deviation of daily local MSCI equity returns computed using a moving window of 30 days; ΔIP, monthly percentage change in country-specific industrial production index; *FC Debt/GDP* and *LC Debt/GDP*, monthly LC and FC debt to GDP ratios aggregating from the entire universe of Bloomberg sovereign bonds outstanding; ΔCPI, monthly percentage change in consumer price index; *Std*(ΔCPI), standard deviation of ΔCPI for the past 12 months; ΔToT, monthly percentage change in terms of trade; *Std*(ΔToT), standard deviation of ΔToT for the past 12 months; and Δ*Reserve*, monthly percentage change in FX reserves. All regressions are run at monthly frequency with country fixed effects using Newey-West standard errors with 12-month lags clustered by month following Driscoll and Kraay (1998) *** p<0.01, ** p<0.05, * p<0.1. Within R-squared is reported for the panel regressions.

Table 7: Impact of VIX on Credit Spreads by Country

	(1) δ^{SLC}	(2) δ^{FC}	(3) δ^{SLC}/δ^{FC}	(4) ρ_r^i
Brazil	0.19***	0.14***	1.33	0.73
	(0.044)	(0.025)		
Colombia	0.046	0.24***	0.19	0.32
	(0.028)	(0.020)		
Hungary	0.31***	0.35***	0.88	0.56
	(0.055)	(0.059)		
Indonesia	-0.010	0.39***	-0.03	-0.13
	(0.045)	(0.076)		
Israel	0.051	0.064*	0.79	0.91
	(0.045)	(0.034)		
Mexico	0.066*	0.19***	0.35	0.39
	(0.039)	(0.022)		
Peru	0.043	0.23***	0.19	0.16
	(0.035)	(0.037)		
Philippines	0.016	0.24***	0.07	0.21
	(0.045)	(0.043)		
Poland	0.11***	0.19***	0.59	0.62
	(0.031)	(0.036)		
Turkey	0.21***	0.36***	0.57	0.48
	(0.055)	(0.033)		
All Macro Controls	Yes	Yes	Correlation (3) and (4)	
Observations	762	762		**0.84**
R-squared	0.404	0.782		

Notes: The table reports results of cross-country variations in the impact of VIX on credit spreads. Columns (1) and (2) report coefficients on VIX interacting with country dummies in credit spread regressions with macroeconomic controls, as specified by Equation 3. Column (1) reports the pass-through of VIX into LC credit spreads and Column (2) reports the pass-through of VIX into FC credit spreads. All controls are the same as in regression Table 6. All regressions are run at monthly frequency with country fixed effects using Newey-West standard errors with 12-month lags clustered by month following Driscoll and Kraay (1998) *** p<0.01, ** p<0.05, * p<0.1. Column (3) computes the ratios of coefficients in Column (1) over Column (2) and Column (4) reports the correlation between swapped LC and FC quarterly excess returns over the U.S. T-bill rates. A scatter plot of columns (3) against (4) is shown in Figure 10.

Table 8: Forecasting Quarterly Holding-Period Excess Returns, 2005m1-2011m12

		VIX	*CFNAI*	$ba^{CCS}/2$	*LC Vol*	ΔIP	*Other Controls*	R^2
	(1)	0.92**					No	0.042
		(0.41)						
	(2)		-2.95**				No	0.037
			(1.24)					
	(3)	0.620	-1.460				No	0.047
		(0.43)	(1.53)					
$srx_{t+3}^{LC/US}$	(4)	0.600	-1.370	0.0320			No	0.048
		(0.45)	(1.52)	(0.046)				
	(5)	0.440	0.210	0.0180	1.010	-3.77***	No	0.078
		(0.48)	(1.25)	(0.047)	(0.98)	(1.24)		
	(6)	0.710	-0.0770	-0.0210	0.300	-3.45**	Yes	0.106
		(0.54)	(0.98)	(0.045)	(1.08)	(1.50)		
	(1)	1.95***					No	0.101
		(0.66)						
	(2)		-3.330				No	0.025
			(2.26)					
	(3)	2.49**	2.620				No	0.109
		(1.07)	(3.60)					
$rx_{t+3}^{FC/US}$	(4)	2.21**	3.550	0.33***			No	0.155
		(1.01)	(3.78)	(0.098)				
	(5)	2.08*	5.100	0.32***	0.820	-3.69**	No	0.170
		(1.11)	(3.80)	(0.090)	(1.32)	(1.53)		
	(6)	2.82**	4.790	0.28***	0.0240	-2.530	Yes	0.212
		(1.36)	(3.44)	(0.065)	(1.43)	(1.69)		
	(1)	-1.03***					No	0.028
		(0.29)						
	(2)		0.380				No	0.000
			(1.32)					
	(3)	-1.87***	-4.09*				No	0.047
		(0.66)	(2.35)					
$srx_{t+3}^{LC/FC}$	(4)	-1.61***	-4.93*	-0.30***			No	0.085
		(0.60)	(2.60)	(0.11)				
	(5)	-1.64**	-4.89*	-0.30***	0.190	-0.0790	No	0.085
		(0.67)	(2.75)	(0.11)	(1.05)	(0.99)		
	(6)	-2.12**	-4.87*	-0.30***	0.270	-0.910	Yes	0.111
		(0.86)	(2.68)	(0.089)	(1.05)	(0.80)		

Notes: This table reports annualized quarterly return forecasting results for $srx_{t+3}^{LC/US}$, swapped LC over U.S. excess returns, $rx_{t+3}^{FC/US}$, FC over US excess returns, and $srx_{t+3}^{LC/FC}$, swapped LC over FC excess returns. See Table 6 for definition of predictive variables. *Other Controls* refer to all other macroeconomic controls used in Table 6. All regressions are run at monthly frequency with country fixed effects using Newey-West standard errors with 12-month lags clustered by month following Driscoll and Kraay (1998) *** p<0.01, ** p<0.05, * p<0.1.

Appendix

A A Real-World Example

Figure A1 illustrates a concrete example of swapping an LC yield into a dollar yield using CCS. Let S denote the spot peso/dollar exchange rate. Suppose a dollar-based investor lends to the Mexican government by purchasing LC bonds traded at par with notional amount equal to S pesos. If the government does not default, she will receive y percent coupons at each coupon date and the principal of S pesos at maturity. Without any currency hedging, even if the bond does not default, the dollar payoff is uncertain since both the coupons and the principal are subject to exchange rate risk. If the dollar investor does not wish to bear the currency risk, she can enter into a CCS package with a swapmaker (e.g., a bank) to lock in a dollar yield. The details are as follows. At the inception of the swap, the dollar investor gives 1 dollar to the bank. In exchange, she receives S pesos from the bank to lend to the Mexican government. At each coupon date, the dollar investor passes the y percent fixed coupons she receives in pesos from the Mexican government to the bank and receives $y - \rho$ percent fixed coupon in dollars, where ρ is the fixed peso for dollar swap rate. At the maturity of the swap, the investor gives the S pesos in principal repaid by the government to the bank and gets 1 dollar back. Therefore, the net cash flow of the investor is entirely in dollars. The CCS swap package transforms the LC bond into a synthetic dollar bond that promises to yield $y - \rho$ percent.

B Yield Curve Construction

Zero-coupon LC and FC yield curves for our sample countries are obtained or constructed from three main sources.[17] First, our preference is to use zero-coupon LC curves constructed by the central bank of government agencies when they are available. Second, when national data are unavailable, we use the Bloomberg Fair Value (BFV) curve. The BFV curves are par yield curves estimated by Bloomberg on actively traded bonds using piecewise linear zero-coupon curves (Lee, 2007). These curves often serve as the benchmark reference rate in respective currencies. Traders using the Bloomberg trading platform can easily select these BFV curves for asset swap analysis. We use the standard Nelson-Siegel methodology to convert the par yield curves into zero curves with the scaling parameter for the curvature factor fixed using the value in Diebold and Li (2006).

Finally, for countries without national data or BFV curves, and to ensure reliability of the existing BFV curves, we estimate zero coupon yield curves using the individual bond data. We collected these data from Bloomberg by performing an exhaustive search for all available yields on active and matured bonds under <Govt TK> for our sample countries. We supplement Bloomberg FC bond yield data with additional data from Cbonds. We use nominal, fixed-coupon, bullet bonds without embedded options. LC curve estimation follows the Diebold and Li (2006) formulation of Nelson and Siegel (1987) and FC curve estimation follows Arellano and Ramanarayanan (2012) by fitting level, slope and curvature factors to

[17]Full details on LC and FC yield curve construction are given in the data appendix Table A3.

the spread of zero-coupon FC curves over the corresponding dollar, Euro (Bundesbank), Yen and Sterling zero-coupon Treasury yields, depending on the currency denomination of the FC bonds. As in Arellano and Ramanarayanan (2012), we perform yield curve estimation when there are at least four bond yields observed on one day. We calculate yields using estimated parameters only up to the maximum tenor of the observed yields to avoid problems from extrapolation. When the Bloomberg BFV curves exists, our estimated yield curves track them very closely (details available upon request). However, since Bloomberg has partially removed historical yields for matured bonds from the system, the BFV curves offer more continuous series than our estimates. Therefore, we use BFV curves when they are available. For countries without BFV curves or earlier samples when BFV curves are not available, our estimated zero-coupon curves are used instead.

C N-Period Extension

C.1 Risk-Free Rates

Given the global SDF $-\log M_{t+1} = -m^*_{t+1} = \psi_0 - \psi z^w_t - \gamma \xi^w_{t+1}$. The log price of an n-period risk-free bond is given by:

$$-p_{nt} = A_n + B_n z^w_t,$$

where

$$B_n = \phi^w B_{n-1} - \psi = -\psi[1-(\phi^w)^n]/(1-\phi^w)$$
$$A_n - A_{n-1} = \psi_0 + B_{n-1}c^w - (\gamma - B_{n-1})^2/2.$$

C.2 FC Bonds

We conjecture the price of a n-period FC bond is given by

$$-p^{FC}_{nt} = A^{FC}_n + B^{FC}_n z^w_t + C^{FC}_n z^i_t.$$

Since $p^{FC}_{nt} = E_t(m_{t+1} + i^{FC}_{t+1} + p^{FC}_{n-1,t+1}) + Var_t(m_{t+1} + i^{FC}_{t+1} + p^{FC}_{n-1,t+1})/2$, where $i^{FC}_{t+1} \equiv \log(I^{FC}_{t+1})$, we can solve for the price of a n-period FC bond as the

$$B^{FC}_n = \phi^w B^{FC}_{n-1} + \lambda^{FC}_w - \psi = (\lambda^{FC}_w - \psi)[1-(\phi^w)^n]/(1-\phi^w)$$
$$C^{FC}_n = \phi^C C^{FC}_{n-1} + \lambda^{FC}_i = \lambda^{FC}_i[1-(\phi^w)^n]/(1-\phi^w)$$
$$A^{FC}_n - A^{FC}_{n-1} = \psi_0 + \lambda^{FC}_0 + B^{FC}_{n-1}c^w + C^{FC}_{n-1}c^i - (B^{FC}_{n-1} + \sigma^{FC}_{\lambda w} - \gamma)^2/2 - (C^{FC}_{n-1} + \sigma^{FC}_{\lambda c})^2/2$$

The expected excess returns on FC bonds is given by

$$\begin{aligned} E_t(r^{FC}_{n,t+1}) - y^*_{1t} + Var_t(r^{FC}_{n,t+1})/2 &= -Cov_t(m_{t+1}, r^{FC}_{n,t+1}) = \gamma(B_{n-1} + \sigma^{FC}_{\lambda w}) \\ &= \gamma\left[(\lambda^{FC}_w - \psi)\frac{1-(\phi^w)^{n-1}}{1-\phi^w} + \sigma^{FC}_{\lambda w}\right] \equiv \gamma\delta^{FC}_n \end{aligned}$$

We can then compute the FC spread as

$$s_{nt}^{FC/US} = \frac{1}{n}\left[\alpha_{n0}^{FC} + \lambda_w^{FC}\frac{1-(\phi^w)^{n-1}}{1-\phi^w}z_t^w + \lambda_i^{FC}\frac{1-(\phi^i)^{n-1}}{1-\phi^i}z_t^i\right]. \tag{A4}$$

C.3 LC Bonds

Again, we assume a downward sloping clientele demand for the n-period LC

$$d_{nt}^{SLC}/W = \kappa_n(-p_{nt}^{SLC} - \beta_{nt})$$

for $\kappa_n > 0$. We assume that β_{nt} is also affine in factors. For analytical convenience, we parametrize β_n as

$$\beta_{nt} = -\tilde{p}_{nt}^{SLC} + \theta_{n0} + \theta_{nc}z_t^i + \theta_{nw}z_t^w,$$

where $-\tilde{p}_{nt}^{SLC} = \tilde{\lambda}_{n0} + \tilde{\lambda}_{nc}z_t^i + \tilde{\lambda}_{nw}z_t^w$ is the swapped LC price that implies zero expected simple excess returns on swapped LC bonds as follows:

$$-\tilde{p}_{nt}^{SLC} = -E_t(i_{t+1}^{SLC} + p_{n-1,t+1}^{SLC}) - Var_t(i_{t+1}^{SLC} + p_{n-1,t+1}^{SLC})/2 + y_{1t}^*$$

Thus, θ_{n0}, θ_{nc} and θ_{nw} measure deviations from zero expected returns in the absence of arbitrage. We conjecture the equilibrium swapped LC price takes the form

$$-p_{nt}^{SLC} = -\tilde{p}_{nt}^{SLC} + b_{n0} + b_{nc}z_t^i + b_{nw}z_t^w = (\tilde{\lambda}_{n0} + b_{n0}) + (\tilde{\lambda}_{nc} + b_{nc})z_t^i + (\tilde{\lambda}_{nw} + b_{nw})z_t^w$$

Therefore, the expected simple excess returns on swapped LC is simply

$$E_t r_{t+1}^{SLC} - y_{1t}^* + Var_t(r_{t+1}^{SLC})/2 = (b_{n0} + b_{nc}z_t^i + b_{nw}z_t^w) - (\tau_{n0} - q_{n0}).$$

Solving the arbitrage's portfolio problem gives[18]

$$\begin{aligned} b_{n0} &= \frac{\kappa_n\theta_{n0}}{\kappa_n + \frac{1}{\gamma_a(1-\rho_{rn}^2)(\sigma_n^{SLC})^2}} + \frac{q_{n0}}{\kappa_n\gamma_a(1-\rho_{rn}^2)(\sigma_n^{SLC})^2+1} \\ &\quad + \frac{\rho_{rn}\frac{\sigma_n^{SLC}}{\sigma_n^{FC}}\left[(\lambda_w^{FC}-\psi)\frac{1-(\phi^w)^{n-1}}{1-\phi^w} + \sigma_{\lambda w}^{FC}\right]}{\kappa_n\gamma_a(1-\rho_{rn}^2)(\sigma_n^{SLC})^2+1}\gamma \equiv \omega_n\theta_{n0} + (1-\omega_n)(\tau_{n0}-q_{n0}) + \delta_n^{SLC}\gamma \quad \text{(A5)} \\ b_{nc} &= \frac{\kappa_n\theta_{nc}}{\kappa_n + \frac{1}{\gamma_a(1-\rho_{rn}^2)(\sigma_n^{SLC})^2}} \equiv \omega_n\theta_{nc} \\ b_{nw} &= \frac{\kappa_n\theta_{nw}}{\kappa_n + \frac{1}{\gamma_a(1-\rho_{rn}^2)(\sigma_n^{SLC})^2}} \equiv \omega_n\theta_{nw}, \quad \text{(A6)} \end{aligned}$$

where volatility and correlation of asset returns are given by

$$(\sigma_n^{SLC})^2 = [(\tilde{\lambda}_{n-1,w} + b_{n-1,w}) + \sigma_{\lambda w}^{SLC}]^2 + [(\tilde{\lambda}_{n-1,c} + b_{n-1,c}) + \sigma_{\lambda c}^{SLC}]^2 \tag{A7}$$

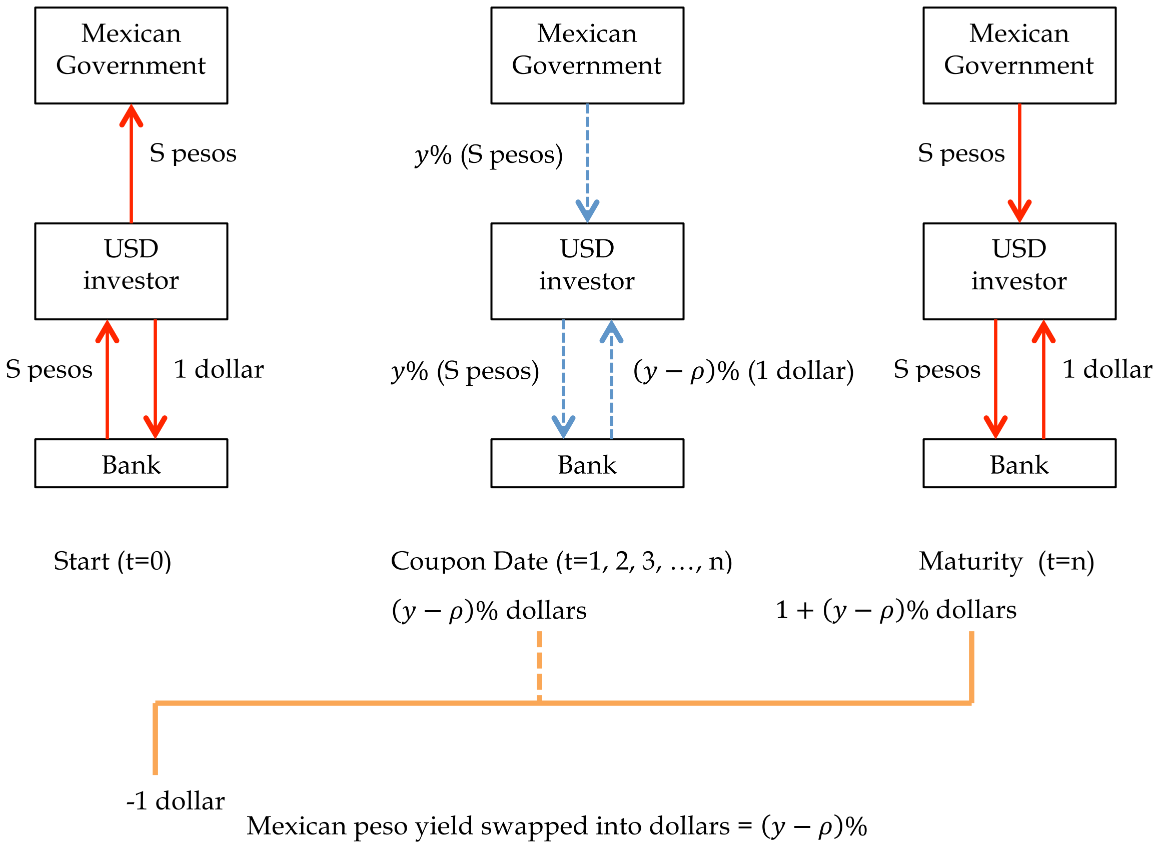
[18]For simplicity, we assume the arbitrageur arbitrages between swapped LC and FC bonds of the same maturity. Allowing additional cross-maturity arbitrage for swapped LC bonds does not add more insights given FC bonds are already integrated across different maturities.

$$(\sigma_n^{FC})^2 = \left[(\lambda_w^{FC} - \psi)\frac{1-(\phi^w)^{n-1}}{1-\phi^w} + \sigma_{\lambda w}^{FC}\right]^2 + \left[\lambda_c^{FC}\frac{1-(\phi^c)^{n-1}}{1-\phi^w} + \sigma_{\lambda c}^{FC}\right]^2$$

$$\begin{aligned}\rho_{rn} &= [(\tilde{\lambda}_{n-1,w} + b_{n-1,w}) + \sigma_{\lambda w}^{SLC}]\left[(\lambda_w^{FC} - \psi)\frac{1-(\phi^w)^{n-1}}{1-\phi^w} + \sigma_{\lambda w}^{FC}\right] \\ &\quad + [(\tilde{\lambda}_{n-1,c} + b_{n-1,c}) + \sigma_{\lambda c}^{SLC}]\left[\lambda_c^{FC}\frac{1-(\phi^c)^{n-1}}{1-\phi^w} + \sigma_{\lambda c}^{FC}\right]. \end{aligned} \tag{A8}$$

Since σ_n^{SLC} and ρ_{rn} also depend on $b_{n-1,w}$, local clientele demand $\theta_{m-1,w}$ and $\theta_{m-1,c}$ for $m \leq n$ also affects volatility of swapped LC bond excess returns and correlation between swapped LC and FC excess returns. The n-period equilibrium solution in A6 is exactly analogous to the one-period solution in Equation 1, and thus we can generalize Propositions 2 a to the n-period case.

Figure A1: An Illustration of Swap Covered Local Currency Investment



Notes: This figure illustrates how a dollar based investor can use a fixed peso for fixed dollar cross-currency swap package to fully hedge currency risk for all coupons and the principal of a Mexican peso denominated LC bond and receive fixed dollar cash flows. We let S denote the spot peso/dollar exchange rate at the inception of the swap, y denote the yield on the peso bond, and ρ denote the fixed peso for fixed dollar swap rate. By purchasing the peso bond while entering the asset swap, the LC bond is transformed into a dollar bond with a dollar yield equal to $y - \rho$.

Table A1: Cross-Currency Swaps and Currency Forward Comparison, 2005-2011

Country	NDS	*Floating Leg*	*Corr(CCS,Fwd)*	*CCS*		*Fwd*		*CCS-Fwd*	
Brazil	Yes	N/A	97.16	7.19	(1.28)	7.45	(1.28)	-0.27	(0.30)
Colombia	Yes	N/A	99.19	3.52	(2.25)	3.57	(2.24)	-0.05	(0.26)
Hungary	No	Bubor	99.16	3.75	(1.35)	3.80	(1.41)	-0.04	(0.27)
Indonesia	Yes	N/A	97.79	5.67	(3.48)	5.61	(3.82)	-0.06	(0.83)
Israel	Yes	Telbor	98.10	0.52	(0.74)	0.48	(0.74)	0.05	(0.13)
Mexico	No	TIIE	99.58	3.68	(1.24)	4.05	(1.32)	-0.37	(0.14)
Peru	Yes	N/A	98.76	0.98	(1.38)	0.96	(1.42)	0.02	(0.22)
Philippines	Yes	N/A	97.25	1.96	(2.00)	1.83	(2.02)	-0.13	(0.47)
Poland	No	Wibor	98.96	1.69	(1.62)	1.47	(1.51)	0.23	(0.25)
Turkey	No	N/A	98.69	9.36	(2.90)	9.51	(2.93)	-0.15	(0.15)
Total			98.68	3.95	(3.42)	3.99	(3.54)	-0.04	(0.40)

Notes: This table reports summary statistics for 1-year fixed for fixed cross currency swap (*CCS*) rates and 1-year offshore forward premium (*Fwd*) implied by outright forward contracts. Column 1 lists whether the currency swap is non-deliverable. Column 2 lists the name of the local floating leg against U.S. Libor if the currency swap consists of a plain-vanilla interest rate swap and a cross-currency basis swap. *Corr(CCS,Fwd)* reports correlation between swap rates and forward rates. The difference between the two variables are reported in the last column (*CCS-Fwd*). Forward rates are from Datastream and fixed for fixed CCS rates are computed by authors based on CCS and interest rate swap data from Bloomberg. Data are at daily frequency for the sample periods 2005-2011.

Table A2: Half of Bid-ask Spreads on FX Spots, Forwards and Swaps, 2005-2011

	(1)	(2)	(3)	(4)	(5)
Country	1M Fwd	3M Fwd	6M Fwd	1Y Fwd	5Y CCS
Brazil	98.34	53.80	30.99	22.41	32.13
	(17.1)	(18.3)	(15.0)	(14.0)	(13.5)
Colombia	123.37	68.71	42.23	30.19	16.24
	(14.7)	(12.3)	(9.43)	(10.8)	(10.7)
Hungary	112.04	52.88	37.88	28.08	18.54
	(10.8)	(11.2)	(14.5)	(23.1)	(14.2)
Indonesia	315.96	139.57	90.30	52.87	37.49
	(69.8)	(51.3)	(47.3)	(37.9)	(23.1)
Israel	88.03	36.52	23.86	16.62	11.39
	(12.9)	(8.50)	(6.78)	(7.45)	(4.31)
Mexico	31.20	12.88	8.58	6.12	8.59
	(7.76)	(5.65)	(4.94)	(6.12)	(6.17)
Peru	100.25	47.61	29.39	23.87	16.00
	(13.7)	(10.0)	(6.97)	(6.92)	(7.15)
Philippines	126.57	46.34	37.24	27.05	28.00
	(7.69)	(4.53)	(5.72)	(5.79)	(14.7)
Poland	72.40	27.38	17.67	11.98	11.50
	(8.56)	(5.80)	(6.86)	(6.30)	(8.33)
Turkey	126.76	59.79	41.72	25.85	11.00
	(25.8)	(19.4)	(18.9)	(15.2)	(8.14)
Total	117.55	53.75	35.41	23.96	19.07
	(33.3)	(25.6)	(23.5)	(20.1)	(15.7)

Notes: This table reports mean and standard deviations of half of the bid-ask spreads of FX forward and CCS contracts in basis points for 10 sample countries at daily frequency from 2005 to 2011. Columns 1 to 4 report half of annualized bid-ask spreads for FX forward contracts at 1, 3, 6, and 12 months. Column 5 reports the half of the bid-ask for the spread for the 5-year swap contracts. Annualized standard deviations are reported in the parentheses. Spot and Forward data use closing quotes from WM/Reuter (access via Datastream) with the exceptions of Indonesia and Philippines for which the offshore forward rates use closing quotes of non-deliverable forwards from Tullet Prebon (access via Datastream). Swap rates are from Bloomberg.

Table A3: Data Sources and Variable Construction

(A) Yield Curve Construction

Country	*Curve Currency*	*Zero-Coupon Curve Type*	*Data Source*
Brazil	LC	Svensson	Brazilian Financial and Capital Market Associations (ANBIMA)
	FC	Nelson-Siegel	Bloomberg Fair Value par to zero
Colombia	LC	Nelson-Siegel	Bloomberg Fair Value par to zero
	FC	Nelson-Siegel	Bloomberg Fair Value par to zero
Hungary	LC	Svensson	Hungary Government Debt Management Office (AKK)
	FC	Nelson-Siegel	Authors' estimation based on individual bond prices Bloomberg and CBonds
Indonesia	LC	Nelson-Siegel	Bloomberg Fair Value par to zero
	FC	Nelson-Siegel	Authors' estimation based on individual bond prices Bloomberg and CBonds
Israel	LC	Svensson	Bank of Israel
	FC	Nelson-Siegel	Authors' estimation based on individual bond prices Bloomberg and CBonds
Mexico	LC	Nelson-Siegel	Bloomberg Fair Value par to zero
	FC	Nelson-Siegel	Bloomberg Fair Value par to zero
Peru	LC	Nelson-Siegel	Bloomberg Fair Value par to zero
	FC	Nelson-Siegel	BFV and authors' estimation based on Bloomberg individual bond prices
Philippines	LC	Nelson-Siegel	Authors' estimation based on constant maturity yield curves provided by Philippines Dealing and Exchange Corp (PDEx) and average coupon rates from individual bonds from Bloomberg
	FC	Nelson-Siegel	Bloomberg Fair Value par to zero
Poland	LC	Nelson-Siegel	Bloomberg Fair Value par to zero
	FC	Nelson-Siegel	Authors' estimation based on individual bond prices Bloomberg and CBonds
Turkey	LC	Svensson	Central Bank of Turkey
	FC	Nelson-Siegel	Bloomberg Fair Value par to zero

(B) Other Variables

Variable	*Data Source*	*Description*
CDS	Bloomberg	Sovereign credit default swaps at various tenors denominated in dollars.
lc eq vol	Datastream	Local equity volatility: volatility of daily equity returns measured in local currency computed using backward-looking rolling windows equal to 30 days.
BBB/T	Datastream	Merrill-Lynch BBB U.S. corporate bond spread over the 10-year U.S. Treasury yield
CFNAI	Chicago Fed	Chicago Fed National Activity Index
VIX	WRDS	Implied volatility on S&P index options.
ΔIP	Global Financial Data	Monthly log change in the industrial production index
FC Debt/GDP	Authors' calculations	FC debt to GDP ratio, aggregated from face value of all FC bonds in Bloomberg.
LC Debt/GDP	Authors' calculations	LC debt to GDP ratio, aggregated from face value of all LC bonds in Bloomberg.
ΔCPI, $Std(\Delta CPI)$	International Financial Statistics	Monthly log change in the consumer priceand standard deviations of ΔCPI in last 12 months.
ΔToT, $Std(\Delta ToT)$	Bank of International Settlement	Monthly log change in terms of trade and standard deviations of ΔToT in last 12 months.
$\Delta Reserve$	International Financial Statistics	Monthly log change in foreign exchange reserves.