



# Essays in International Finance and Macroeconomics

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# Essays in International Finance and Macroeconomics

A dissertation presented by

Jesse Matthew Schreger

to

The Committee on Higher Degrees in Political Economy and Government

in partial fulfillment of the requirements

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Dissertation Advisors:  
Professor Gita Gopinath  
Professor Kenneth Rogoff

Author:  
Jesse Matthew Schreger

## Essays in International Finance and Macroeconomics

### Abstract

The way in which governments borrow has changed dramatically over the last decade. The first two chapters of this dissertation study the implications of the rise of local currency sovereign borrowing in emerging markets. Chapter 1 presents a method to measure the credit risk on local currency sovereign debt. Chapter 2 argues that private sector balance sheet mismatch explains why nominal sovereign debt risk is not free from default risk. Chapter 3 studies the costs of sovereign default by exploiting the timing of legal rulings in the case of *Republic of Argentina v. NML Capital* to identify the causal effect of increases in sovereign default risk on firm performance.

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Finally, I want to dedicate this dissertation to my parents, my wife, Rachael, and my sister, Molly. Graduate school was a stressful time, and their support is the main reason it was a success. I promise I'll be more fun now that it is over.

# Preface

In Chapter 1 (based on work co-authored with Wenxin Du), we introduce a new measure of emerging market sovereign credit risk: the local currency credit spread, defined as the spread of local currency bonds over the synthetic local currency risk-free rate constructed using cross-currency swaps. We find that local currency credit spreads are positive and sizable. Compared with credit spreads on foreign currency-denominated debt, local currency credit spreads have lower means, lower cross-country correlations, and are less sensitive to global risk factors. We discuss several major sources of credit spread differentials, including selective default, capital controls, covariance between currency and credit risk, and various financial market frictions.

In Chapter 2 (based on work co-authored with Wenxin Du), we examine the question of why a government would default on debt denominated in its own currency. Using a newly constructed dataset of 14 emerging markets, we document that the private sector continues to borrow from abroad in foreign currency while sovereigns increasingly borrow from foreigners in local currency. Because depreciation can be very costly for a corporate sector with a currency mismatch due to foreign currency liabilities, emerging market sovereigns may still prefer to default on local currency sovereign debt rather than inflate the debt away. Using our cross-country dataset, we show that a higher reliance on external foreign currency corporate financing is associated with a higher default risk on sovereign debt. We quantify the effects of corporate balance sheet mismatch on sovereign credit risk by introducing local currency sovereign debt and private currency mismatch into a standard sovereign debt model. The model demonstrates how the currency composition of corporate borrowing affects the sovereign's incentive to inflate or default in times of fiscal stress. Reductions in the share of private external debt in foreign currency can lead to significant reductions in sovereign default risk. A calibration of the model generates the empirical patterns of currency and credit risk in local currency sovereign debt documented in Chapter 1.

In Chapter 3 (based on work co-authored with Ben Hebert), we estimate the causal effect of sovereign default on the equity returns of Argentine firms. We identify this effect by exploiting changes in the probability of Argentine sovereign default induced by legal rulings in the case of *Republic of Argentina v. NML Capital*. Because the legal rulings affected the probability of Argentina defaulting on its debt, independent of underlying economic conditions, these rulings allow us to study the effect of default on firm performance. Using both standard event study methods and a heteroskedasticity-based identification strategy, we find that an increase in the probability of sovereign default causes a significant decline in the Argentine equity market. A 1 percent increase in the risk-neutral probability of default causes a 0.55 percent fall in the US dollar value of index of Argentine American Depository Receipts (ADRs). Extrapolating from these estimates, we conclude that the recent Argentine sovereign default episode caused a cumulative 33 percent drop in the ADR index from 2011 to 2014. We find suggestive evidence that banks, exporters, and foreign-owned firms are particularly affected.

# 1 Local Currency Sovereign Risk

## 1.1 Introduction

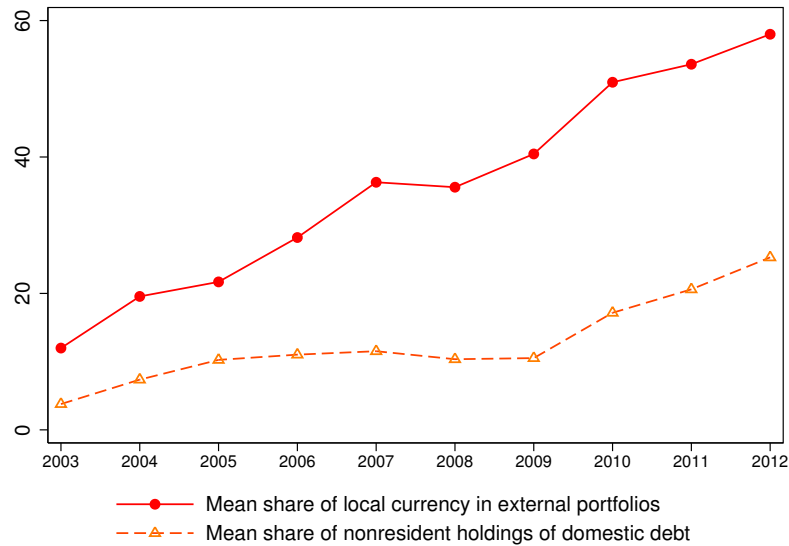
When a sovereign borrows in its own currency, the spread it pays over the U.S. Treasury risk-free benchmark potentially contains two major types of risk: currency risk and credit risk. The primary contribution of this paper is to use a model-free empirical approach to disentangle the risk that the currency depreciates (currency risk) from the risk of outright default and capital controls (credit risk). We define a new sovereign risk measure, the *local currency credit spread*, to measure the credit risk component of the LC-denominated debt. We find that the LC credit spread is positive and sizable for emerging market sovereigns, despite their ability to print their own currency to repay the debt. Furthermore, we document and explain significant differences between the LC credit spread and the conventional measure of emerging market sovereign risk based on foreign currency (FC)-denominated external debt.

An understanding of the credit risk on LC sovereign debt is important because LC debt has become the primary form of financing for many emerging market sovereigns, as well as a growing global asset class. While there is an important literature examining why emerging markets could not borrow in their own currency from foreigners in the past (Eichengreen and Hausmann, 1999, 2005), the situation has changed dramatically over the last decade. As we show in Du and Schreger (2014c), the mean share of LC debt in total external sovereign debt held by nonresidents increased from 10 percent to around 60 percent over the past decade for a sample of 14 emerging markets (Figure 1). According to volume surveys conducted by the Emerging Market Trading Association (EMTA), the share of LC debt in total offshore emerging market debt trading volume has increased from 35 percent in 2000 to 66 percent in 2013, reaching \$3.5 trillion (Figure 2). The growing importance of LC debt markets stands in stark contrast to the declining role of FC sovereign financing. 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.<sup>1</sup>

Figure 1: Evolution of the Emerging Market Sovereign Debt Portfolio

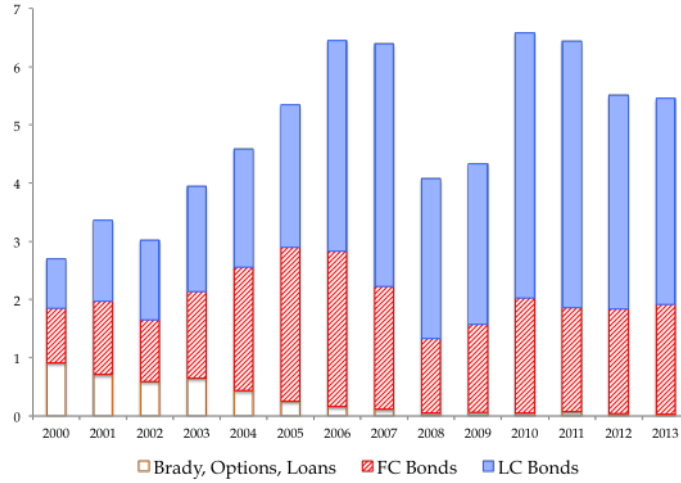


*Notes:* This figure displays the mean share of LC debt held by foreigners in total LC government debt (dotted) and the mean share of LC debt in total external debt held by foreigners (solid). The 14 sample countries are: Brazil, Colombia, Hungary, Indonesia, Israel, South Korea, Mexico, Malaysia, Peru, Poland, Russia, Thailand, Turkey and South Africa. See Du and Schreger (2014c) for details on the dataset construction.

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<sup>1</sup>Furthermore, defaults on LC bonds governed under domestic law do not constitute credit events that trigger credit default swap (CDS) contracts in emerging markets (ISDA, 2012). As a result, sovereign CDS spreads cannot directly characterize LC sovereign credit risk.

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



*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.  
*Source:* Annual Debt Trading Volume Survey (2000-2013) by Emerging Market Trading Association (EMTA)

Taking a frictionless financial market as a benchmark, we construct the LC risk-free rate by swapping the dollar cash flows from a default-free U.S. Treasury bond into the LC using a cross currency swap (CCS) with negligible counterparty risk. We then define the LC credit spread as the difference between the nominal yield on an LC bond and this LC risk-free rate, or the deviation from covered interest parity between government bond yields in emerging markets and the United States. In the absence of financial market frictions, the LC credit spread can be positive only if there is explicit default risk associated with the LC debt. Formally speaking, the LC credit spread is exactly equal to the risk-neutral expected default loss of the LC bond under the LC risk-neutral measure.

From a dollar investor’s perspective, the LC credit spread is equivalent to the synthetic dollar spread on a swapped LC bond over the U.S. Treasury yield. By swapping all the promised cash flows of LC debt into the U.S. dollar, a dollar investor can lock in the LC credit spread even if the value of the currency plummets as long as explicit default is avoided. However, if an LC default does occur, in addition to the default loss measured in dollars, the dollar investor will have over-hedged currency risk, as the CCS notional exceeds the

realized LC bond cash flows due to the loss caused by default. The valuation impact of this currency hedging error depends on the covariance between currency risk and default risk, which we refer to as the “quanto adjustment”. Formally speaking, under the dollar risk-neutral measure, the LC credit spread is equal to the risk-neutral expected default loss of the LC bond, plus the quanto adjustment. In the case of positively correlated credit and currency risk, the quanto adjustment is negative, and thus the LC credit spread will understate the risk-neutral expected default losses under the dollar measure.

Using a new dataset of daily zero-coupon LC and FC yield curves and swap rates for 10 major emerging market countries with sizable LC and FC sovereign debt markets from 2005 to 2014, we present the first set of broad stylized facts about LC sovereign risk and its relationship to FC sovereign risk. We find that LC credit spreads are significantly above zero. For 5-year zero-coupon bonds, the mean LC credit spread is equal to 145 basis points, which accounts for more than one quarter of the LC nominal spread over U.S. Treasuries. The LC credit spread is lower than the average credit spread of 201 basis points on FC sovereign debt during the same period.

LC and FC credit spreads are different along three important dimensions. First, LC credit spreads are persistently lower than FC credit spreads in 9 out of 10 sample countries, with the exception of Brazil. The mean LC-over-FC credit spread differential is equal to negative 56 basis points. The gap between LC and FC credit spreads significantly widened during the peak of the crisis following the Lehman Brothers bankruptcy. Second, FC credit spreads are much more correlated across countries than LC credit spreads are. The first principal component can explain 77 percent of variations in FC credit spreads, but only 54 percent of variations in LC credit spreads, 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 are, in both the ex-ante yield space and the ex-post return space. Despite the common perception that emerging market LC debt is very

risky, we find that after the currency risk is hedged, swapped LC debt has lower loadings on global risk factors than FC debt does.

The comparison between LC and FC credit spreads not only sheds light on differential cash flow risks between the two types of debt, but it also illustrates various financial market frictions. After presenting the stylized facts, we discuss three potential sources of the credit spread differentials: (1) selective default and capital control risk; (2) covariance between currency and credit risk, or the quanto adjustment; and (3) several important financial market frictions.

First, selective default is the risk that the sovereign may choose to default on one type of debt but not on the others. In our sample countries, the vast majority of LC debt is issued in domestic markets under domestic law, while FC debt is issued in international markets under foreign law. Default outcomes can be quite different for bonds governed under different jurisdictions, as illustrated by the Russian default in 1998 (Duffie et al., 2003), and the recent Greek default experience (Chamon et al., 2014). It is, a priori, ambiguous whether LC or FC sovereign debt is associated with a higher probability or severity of default, as the recent historical incidence of domestic LC default and FC external default is quite comparable (Moody's, 2014; Standard & Poor's, 2014). In addition to outright default, foreign holders of LC debt also face several risks not present in FC debt, including currency convertibility risk, as well as the risks of changing taxation and regulation. From an offshore investor's perspective, we also consider these additional risks as a general form of credit risk on LC debt, even though the government may not explicitly break the bond covenants. We show that capital controls and jurisdiction risks are particularly helpful in explaining the Brazilian exception, in which the LC credit spread is higher than the FC credit spread.

Second, the covariance between currency and default risk can create a wedge between LC and FC credit spreads. Our simple calibration suggests that a 39 percent expected LC depreciation upon default relative to the counterfactual non-default state would imply an equal expected default loss on the LC and FC debt under the dollar risk-neutral measure.

Our risk-neutral calibration of depreciation upon default based on CDS spreads denominated in different currencies gives an estimate of about 37 percent. In addition, we also perform a historical calibration of depreciation upon default using ex-post realized exchange rates over the 5-year horizon and historical default classifications by Reinhart and Rogoff (2008) and Cruces and Trebesch (2013a). We show that the value of the currency in defaulting countries is 30 to 35 percent lower than in ex-ante similar countries without a default. Therefore, the magnitude of the covariance adjustment is broadly equal to the observed mean difference in credit spreads, suggesting that LC and FC bonds have similar risk-neutral expected default losses under the dollar measure.

Third, various financial market frictions can also affect the relative pricing of swapped LC and FC bonds. We discuss the impacts of differential liquidity risk, market segmentation between domestic and external markets, short-selling constraints and no-arbitrage violations in the currency markets. In particular, we show that compared to the FC debt, the swapped LC debt is more liquid, but more difficult to short, and more likely affected by market segmentation between domestic and external debt markets as well as frictions in the currency markets. We provide quantification for the plausible magnitude for these frictions. These estimates can be further refined in future work by focusing on specific frictions.

Our paper contributes to several strands of the literature. First, our primary contribution is to present a set of new stylized facts about the LC sovereign risk, contributing to work by Reinhart and Rogoff (2011) on domestic defaults and earlier work by Burger and Warnock (2007) and Burger et al. (2012) on pricing the LC debt using bond return indices. By contrasting LC sovereign risk with FC sovereign risk, our work is also closely related to the large empirical literature on FC sovereign risk and currency risk, including Longstaff et al. (2011b), Borri and Verdelhan (2011), Lustig and Verdelhan (2007), Lustig et al. (2014), and Lettau et al. (2014). Second, we contribute to the literature using currency forwards or swaps to study ex-ante yield differentials across different currencies. Popper (1993) and Fletcher and Taylor (1994, 1996) document some small and less persistent deviations from

covered parity between Treasury yields in developed markets. Yield differentials between euro and dollar denominated sovereign bonds have been examined for three emerging markets in Buraschi et al. (forthcoming) and for European sovereigns in Corradin and Rodriguez-Moreno (2014). CCS have been also used to study corporate credit spreads in different currencies and their relationship to corporate issuance decisions (McBrady and Schill, 2007). Third, our results shed light on the joint dynamics between currency and default risk and are thus related to the literature on the so-called “cousin risk” (Didier and Garcia, 2003 and Garcia and Lowenkron, 2005). The role of correlation between foreign exchange (FX) and default risk in affecting currency-specific corporate credit spreads is also studied in Jankowitsch and Stefan (2005). Fourth, we document various financial market frictions in emerging market currency and fixed income markets. The existing asset pricing literature helps us understand credit spread differentials in the presence of financial market frictions, which includes works on liquidity (i.e., Chen et al., 2007 and Bao et al., 2011), short-selling constraints (i.e., Miller, 1977 and Duffie et al., 2002), market segmentation (i.e., Gromb and Vayanos, 2002 and Greenwood and Vayanos, 2014) and slow-moving capital (i.e., Shleifer and Vishny, 1997 and Duffie, 2010). Finally, our empirical LC credit risk measure is useful for recent theoretical work on optimal LC default, including Aguiar et al. (2013) Araujo et al. (2013) and Corsetti and Dedola (2013), Da-Rocha et al. (2012).

The rest of the paper is structured as follows. Section 1.2 formally introduces the LC credit spread measure. Section 1.3 presents new stylized facts on LC sovereign risk. Section 1.4 discusses major sources of credit spread differentials. Section 1.5 concludes.

## **1.2 LC and FC Sovereign Credit Spreads**

### **1.2.1 Historical Defaults on LC Debt**

Although sovereigns have the ability to print the currency in which the LC bond is denominated, they may still choose to default on the debt for economic or political reasons. The government might find it preferable to explicitly default rather than tolerate very high in-

flation,<sup>2</sup> or it might find that the additional cost of defaulting on LC debt is small if the sovereign has already decided to default on its FC debt. Additionally, LC debt issued in domestic markets and governed under domestic law contains the risk that sovereigns can change the law. The sovereign can also suspend currency convertibility or impose capital controls on repatriation of foreign funds without explicitly breaking the bond covenants. Our model-free empirical measure, the LC credit spread, captures these credit risks embedded in LC debt.

One famous example of domestic sovereign default is the Russian default in 1998. Prior to the default, Russia had successfully brought down chronically high inflation from three digits to around 10 percent by early 1998. When the fiscal crisis began, rather than financing the sovereign debt entirely via money printing and exposing the country again to very high inflation, the government instead chose to first selectively default on 3-month LC Treasury bills (GKO) and a dollar-denominated bond under domestic jurisdiction (MINFIN 3), before carrying out more comprehensive debt restructuring. Duffie et al. (2003) provide a detailed discussion of the yield differentials across different Russian sovereign bonds around the default, suggesting that the market expected different default scenarios for different types of bonds issued by the same sovereign. Another example of an LC sovereign default is given by Turkey in 1999, soon after the Asian and Russian crises and the Kocaeli earthquake. While inflation in Turkey was around 70 percent, the government defaulted by retroactively imposing high withholding taxes on all outstanding LC government securities. Fixed-rate LC bonds were taxed at 20 percent while FC debt was untouched. Given the uncertainty in LC default and recovery, an empirical measure is needed to assess credit risk on LC debt.

### 1.2.2 Definition of the LC Credit Spread

As a start, we begin defining and interpreting the LC credit spread under a frictionless financial market by maintaining three key assumptions:

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<sup>2</sup>In Du and Schreger (2014c), we present a model where private FC debt discourages the government from inflating away LC sovereign debt and generates equilibrium default risk.

**Assumption 1.** *The financial market does not allow risk-free arbitrage. In particular, we assume that (1) all bonds have perfect liquidity; (2) all bonds can be accessed by unconstrained arbitrageurs; (3) there are no short-selling constraints; and (4) there is a perfectly elastic supply of long-term capital denominated in both the U.S. dollar and emerging market local currencies.*<sup>3</sup>

**Assumption 2.** *FX forward and swap contracts are free from counterparty risk.*

**Assumption 3.** *U.S. Treasuries denominated in dollars are default-free.*

Before proceeding to the definition of the LC credit spread, we first explain how to derive the long-term FX forward premium implicit in the zero-coupon fixed-for-fixed CCS. A fixed-for-fixed LC/dollar CCS can be constructed in two steps. The investor first swaps fixed LC cash flows into floating U.S. London Interbank Offer Rate (LIBOR) cash flows,<sup>4</sup> and then swaps floating U.S. LIBOR cash flows into fixed dollar cash flows. We show in the following lemma that the difference in the two swap rates, or the zero-coupon fixed-for-fixed LC/dollar CCS rate, must be equal to the long-term forward premium by no arbitrage.<sup>5</sup>

**Lemma 1.** *We let  $F_{t,t+n} \equiv \exp(f_{t,t+n})$  denote the outright forward exchange rate and  $\mathcal{E}_t \equiv \exp(e_t)$  denote the spot exchange rate, measured as LC units per dollar. Given the log zero-coupon swap rate  $\tilde{r}_{nt}^{LC}$  from the fixed LC for U.S. LIBOR CCS and  $\tilde{r}_{nt}^{\$}$  from the fixed dollar for U.S. LIBOR interest rate swap, the zero-coupon fixed-for-fixed LC/dollar CCS rate ( $\rho_{nt} \equiv \tilde{r}_{nt}^{LC} - \tilde{r}_{nt}^{\$}$ ) is equal to the long-term forward premium:*

$$\rho_{nt} = \frac{1}{n}(f_{t,t+n} - e_t). \quad (1)$$

*Proof.* The net cash flows of a fixed-for-fixed LC/dollar CCS are as follows: Party A gives 1 dollar to Party B and receives  $\mathcal{E}_t$  units of LC at the inception of the swap at time  $t$ . At the maturity of the swap, Party A pays  $\exp(n\tilde{r}_{nt}^{LC})\mathcal{E}_t$  units of LC to Party B and receives  $\exp(n\tilde{r}_{nt}^{\$})$  dollars. There are no net exchanges of floating payments, as both parties are paying and receiving the same LIBOR cash flow at each coupon period. At time  $t$ , since the

<sup>3</sup>These assumptions for frictionless financial markets follow Buraschi et al. (forthcoming).

<sup>4</sup>For Mexico, Hungary, Israel and Poland in our sample, this step itself combines two interest rate swaps: a plain vanilla LC fixed for LC floating interest rate swap and a cross-currency LC floating for U.S. LIBOR basis swap.

<sup>5</sup> In the case that long-dated forward contracts are directly traded, such as the euro/dollar pair, the difference between the CCS and long-term forward is indeed very small (Buraschi et al., forthcoming).



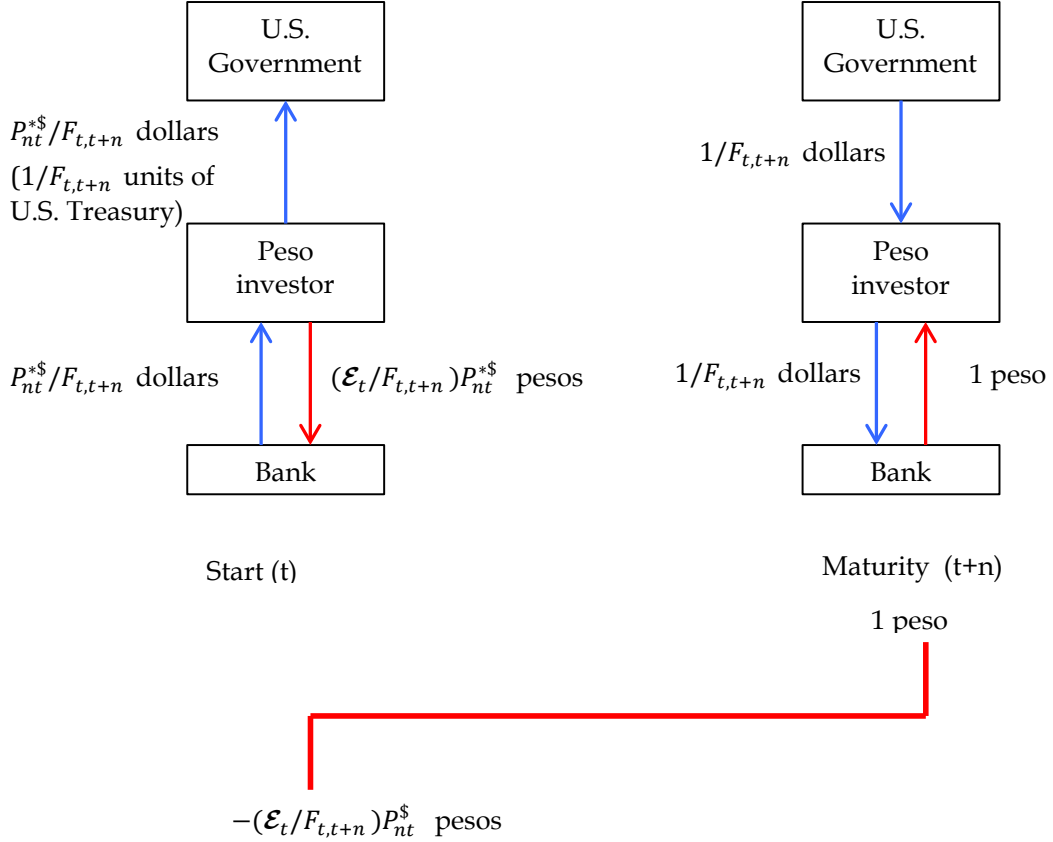
LC can be exchanged forward at time  $t + n$  at the outright forward rate  $F_{t,t+n}$ , and both parties must be ex-ante indifferent between  $\exp(n\tilde{r}_{nt}^{LC})\mathcal{E}_t$  units of LC and  $\exp(n\tilde{r}_{nt}^{\$})$  dollars at time  $t + n$ , we must have

$$\exp(n\tilde{r}_{nt}^{\$}) = \exp(n\tilde{r}_{nt}^{LC})\mathcal{E}_t/F_{t,t+n}$$

or in logs,  $\rho_{nt} \equiv \tilde{r}_{nt}^{LC} - \tilde{r}_{nt}^{\$} = \frac{1}{n}(f_{t,t+n} - e_t)$ . □

To measure credit risk on LC debt, we first construct the LC risk-free rate. We demonstrate in the following proposition that we can construct a default-free LC instrument by swapping the U.S. Treasury bond into the LC using the CCS contract. A cash flow diagram of this synthetic LC default-free bond is given in Figure 3.

Figure 3: Cash Flow Diagram for a Synthetic LC Risk-Free Bond



*Notes:* This diagram shows cash flows for a synthetic LC risk-free bond by swapping the U.S. Treasury bond into pesos using an outright FX forward contract. At time  $t$ , consider a peso investor exchanges  $(\mathcal{E}_t/F_{t,t+n})P_{nt}^{*\$}$  pesos for  $P_{nt}^{*\$}/F_{t,t+n}$  dollars with a bank at the spot exchange rate  $\mathcal{E}_t$ , where  $P_{nt}^{*\$}$  is the price of the Treasury at time  $t$  and  $F_{t,t+n}$  is the outright forward rate. She then invests all the dollar proceeds into zero-coupon U.S. Treasuries with face value  $1/F_{t,t+n}$ . Meanwhile, at time  $t$ , she enters in an outright forward contract to sell  $1/F_{t,t+n}$  dollars forward for 1 peso at time  $t+n$ . At time  $t+n$ , the U.S. government repays full principal,  $1/F_{t,t+n}$  dollars. The peso investor gives all the dollar payment to the bank to fulfill the outright forward contract and receives 1 peso. The net cash flows of this synthetic risk-free peso bond is that the peso investor invests in  $(\mathcal{E}_t/F_{t,t+n})P_{nt}^{*\$}$  peso at time  $t$  and receives 1 peso with certainty at time  $t+n$ . Therefore, the synthetic peso risk-free rate is given by  $y_{nt}^{*LC} = -\frac{1}{n} \log[(\mathcal{E}_t/F_{t,t+n})P_{nt}^{*\$}] = y_{nt}^{*\$} + \rho_{nt}$ .

**Proposition 1.** Let  $y_{nt}^{*\$}$  denote the log zero-coupon yield on the  $n$ -year U.S. Treasury bond, and  $\rho_{nt}$  denote the  $n$ -year fixed-for-fixed log zero-coupon CCS rate from the U.S. dollar to the LC. We can obtain the following log LC risk-free rate:

$$y_{nt}^{*LC} = y_{nt}^{*\$} + \rho_{nt}. \quad (2)$$

*Proof.* Given the U.S. Treasury yield  $y_{nt}^{*\$}$ , the price of the U.S. Treasury bond at time  $t$  is equal to  $P_{nt}^{*\$} = \exp(-ny_{nt}^{*\$})$ . Suppose an LC investor has  $(\mathcal{E}_t/F_{t,t+n})P_{nt}^{*\$}$  units of the LC at

time  $t$ . She can lock in a default-free LC return by exchanging the LC in  $(P_{nt}^{*\$}/F_{t,t+n})$  in U.S. dollars and investing the dollar proceeds into  $1/F_{t,t+n}$  units of U.S. Treasury bonds at time  $t$ . Meanwhile, the investor can sell  $1/F_{t,t+n}$  dollars forward for one unit of the LC. At time  $t+n$ , the U.S. Treasury bond pays off  $1/F_{t,t+n}$  dollars with certainty. In the absence of counterparty risk in the forward contract, the investor gives  $1/F_{t,t+n}$  dollars to the bank, exactly offsetting the U.S. Treasury bond payment, and receives on net 1 unit of the LC at time  $t+n$  with certainty. By Lemma 1,  $F_{t,t+n} = \exp(n\rho_{nt}^*)\mathcal{E}_t$ . Therefore, the annualized log LC risk-free rate is equal to

$$y_{nt}^{*LC} = -\frac{1}{n} \log[(\mathcal{E}_t/F_{t,t+n})P_{nt}^{*\$}] = y_{nt}^{*\$} + \rho_{nt}.$$

□

Once we have the LC risk-free rate, we can define the LC credit spread as follows.

**Definition 1.** The LC credit spread,  $s_{nt}^{LCCS}$ , is defined as the difference between the LC nominal yield,  $y_{nt}^{LC}$ , and the LC risk-free rate,  $y_{nt}^{*LC}$ :

$$s_{nt}^{LCCS} \equiv y_{nt}^{LC} - y_{nt}^{*LC} = y_{nt}^{LC} - (y_{nt}^{*\$} + \rho_{nt}), \quad (3)$$

or the deviation in covered interest parity (CIP) between government bond yields in emerging markets and the United States.

We provide a formal interpretation of the LC credit spread under the LC and dollar risk-neutral measure, respectively, in Proposition 2. For simplicity, we consider a one-period defaultable LC bond. Intuitively, our LC credit spread gives the expected default loss as a fraction of the face value of the debt in LC, regardless of the exchange rate dynamics. However, the dollar numeraire-based LC credit risk measures the expected default loss as a fraction of the face value of the LC debt in dollars, which would be higher than the LC credit spread if the local currency is expected to be less valuable in the default state than in the repayment state.

**Proposition 2.** Let  $\mathbb{Q}_t^{LC}$  and  $\mathbb{Q}_t^{\$}$  denote the risk-neutral measures for the LC and U.S. dollar, respectively, at time  $t$ , and  $L_{t+1}^{LC}$  denote the default loss on the LC bond at time  $t+1$  measured as a fraction of the face value in the LC. Then the LC credit spread at time  $t$  is

given by

$$s_t^{LCCS} \approx \mathbb{E}_t^{\mathbb{Q}^{LC}} L_{t+1}^{LC} \quad \text{under } \mathbb{Q}^{LC} \quad (4)$$

$$\approx \mathbb{E}_t^{\mathbb{Q}^{\$}} L_{t+1}^{LC} - q_t \quad \text{under } \mathbb{Q}^{\$}, \quad (5)$$

where  $q_t = \frac{\text{Cov}_t^{\mathbb{Q}^{\$}}(1-L_{t+1}^{LC}, \mathcal{E}_t/\mathcal{E}_{t+1})}{\mathbb{E}_t^{\mathbb{Q}^{\$}}(1-L_{t+1}^{LC})\mathbb{E}_t^{\mathbb{Q}^{\$}}(\mathcal{E}_t/\mathcal{E}_{t+1})}$  measures the covariance between currency and credit risk under  $\mathbb{Q}^{\$}$ , referred to as the “quanto adjustment.”

*Proof.* Under the LC risk-neutral measure,  $\mathbb{Q}^{LC}$ , we know that the price of an LC bond is equal to the discounted expected value of future LC cash flows, with cash flows discounted at the LC risk-free rate and the expectation taken under the LC risk-neutral measure:

$$P_t^{LC} = \exp(-y_t^{*LC}) \mathbb{E}_t^{\mathbb{Q}^{LC}} (1 - L_{t+1}^{LC}),$$

which gives

$$s_t^{LCCS} = y_t^{LC} - y_t^{*LC} = -\ln \mathbb{E}_t^{\mathbb{Q}^{LC}} (1 - L_{t+1}^{LC}) \approx \mathbb{E}_t^{\mathbb{Q}^{LC}} L_{t+1}^{LC}.$$

Under the dollar risk-neutral measure  $\mathbb{Q}^{\$}$ , we know that the price of an LC bond in dollars is equal to the expected discounted value of future dollar cash flows, with cash flows discounted at the dollar risk-free rate and the expectation taken under the dollar risk-neutral measure:

$$P_t^{LC} / \mathcal{E}_t = \exp(-y_t^{*,\$}) \mathbb{E}_t^{\mathbb{Q}^{\$}} [(1 - L_{t+1}^{LC}) / \mathcal{E}_{t+1}].$$

Using the no-arbitrage condition between LC and the dollar:

$$\exp(-y_t^{*,\$}) \mathbb{E}_t^{\mathbb{Q}^{\$}} (\mathcal{E}_t / \mathcal{E}_{t+1}) = \exp(-y_t^{*LC}),$$

we can rewrite the pricing equation as

$$P_t^{LC} = \exp(-y_t^{*LC}) \mathbb{E}_t^{\mathbb{Q}^{\$}} (1 - L_{t+1}^{LC}) \left[ 1 + \frac{\text{Cov}_t^{\mathbb{Q}^{\$}}(1 - L_{t+1}^{LC}, \mathcal{E}_t / \mathcal{E}_{t+1})}{\mathbb{E}_t^{\mathbb{Q}^{\$}}(1 - L_{t+1}^{LC})\mathbb{E}_t^{\mathbb{Q}^{\$}}(\mathcal{E}_t / \mathcal{E}_{t+1})} \right].$$

Therefore, we have

$$s_t^{LCCS} = y_t^{LC} - y_t^{*LC} \approx \mathbb{E}_t^{\mathbb{Q}^{\$}} L_{t+1}^{LC} - \frac{\text{Cov}_t^{\mathbb{Q}^{\$}}(1 - L_{t+1}^{LC}, \mathcal{E}_t / \mathcal{E}_{t+1})}{\mathbb{E}_t^{\mathbb{Q}^{\$}}(1 - L_{t+1}^{LC})\mathbb{E}_t^{\mathbb{Q}^{\$}}(\mathcal{E}_t / \mathcal{E}_{t+1})} = \mathbb{E}_t^{\mathbb{Q}^{\$}} L_{t+1}^{LC} - q_t,$$

where  $q_t \equiv \frac{\text{Cov}_t^{\mathbb{Q}^{\$}}(1 - L_{t+1}^{LC}, \mathcal{E}_t / \mathcal{E}_{t+1})}{\mathbb{E}_t^{\mathbb{Q}^{\$}}(1 - L_{t+1}^{LC})\mathbb{E}_t^{\mathbb{Q}^{\$}}(\mathcal{E}_t / \mathcal{E}_{t+1})}$ . □

Throughout out the paper, we refer  $\mathbb{E}_t^{\mathbb{Q}^{LC}} L_{t+1}^{LC}$  as the credit risk of the LC debt measured using the LC numeraire and  $\mathbb{E}_t^{\mathbb{Q}^{\$}} L_{t+1}^{LC}$  as the credit risk of the LC debt measured using the

dollar numeraire. For simplicity of exposition, we assume two future states: a repayment state in which  $L_{t+1}^{LC} = 0$ , and a default state in which  $L_{t+1}^{LC} = \delta_{t+1}$ . First, Equation 4 shows that the LC credit spread captures the risk-neutral expected default loss of the LC debt measured in terms of the LC risk-free bond. By going long one unit of the LC sovereign bond at  $y_t^{LC} = y_t^{*LC} + s_t^{LCCS}$  and going short one unit of the LC risk-free bond at  $y_t^{*LC}$ , the LC investor receives the LC credit spread,  $s_t^{LCCS}$ , in units of LC at time  $t$ . At time  $t + 1$ , the investor receives zero net cash flows if the sovereign repays and loses  $\delta_{t+1}$  units of LC if the sovereign defaults.<sup>6</sup> By no arbitrage, at time  $t$ , the risk-neutral expected default loss of the LC debt at  $t + 1$  must be equal to  $s_t^{LCCS}$  percent of one unit of the risk-free LC. This LC measure-based perspective captures the credit component of the LC debt, independent of the joint dynamics between currency and default risk.

Second, Equation 5 shows that the LC credit spread also captures the risk-neutral expected default loss of LC debt measured in terms of risk-free dollar bonds, plus an adjustment for the covariance between currency risk and default risk. To see this, in Figure 4, we consider a dollar investor who uses the CCS to hedge the promised cash flows of the LC bond. We refer to the LC bond and CCS package as a swapped LC bond with the promised yield equal to  $y_t^{SLC} = y_t^{LC} - \rho_t$ . The LC credit spread is also equal to the dollar spread on the swapped LC bond,  $s_t^{LCCS} = (y_t^{LC} - \rho_t) - y_t^{*\$} = s_t^{SLC} - y_t^{*\$}$ . To collect the LC credit spread from the dollar investor's perspective, we consider the strategy going long one unit of the swapped LC bond at  $y_t^{SLC}$  and shorting one unit of the U.S. Treasury bond at  $y_t^{*\$}$ .<sup>7</sup> The dollar investor receives the LC credit spread,  $s_t^{LCCS}$ , in dollars at time  $t$ . If the sovereign repays, the strategy yields zero net cash flows at time  $t + 1$ . The dollar investor can lock in  $s_t^{LCCS}$  dollars even if the LC depreciates, provided that an explicit default is avoided. However, if the sovereign defaults, the currency hedging becomes imperfect, and the dollar investor loses  $\delta_{t+1}$  dollars and still needs to unwind the swap position with unmatched LC cash flows. In the case of

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<sup>6</sup>We draw these net cash flows of going long in the LC sovereign and short in the LC risk-free bond in Appendix Figure 27a.

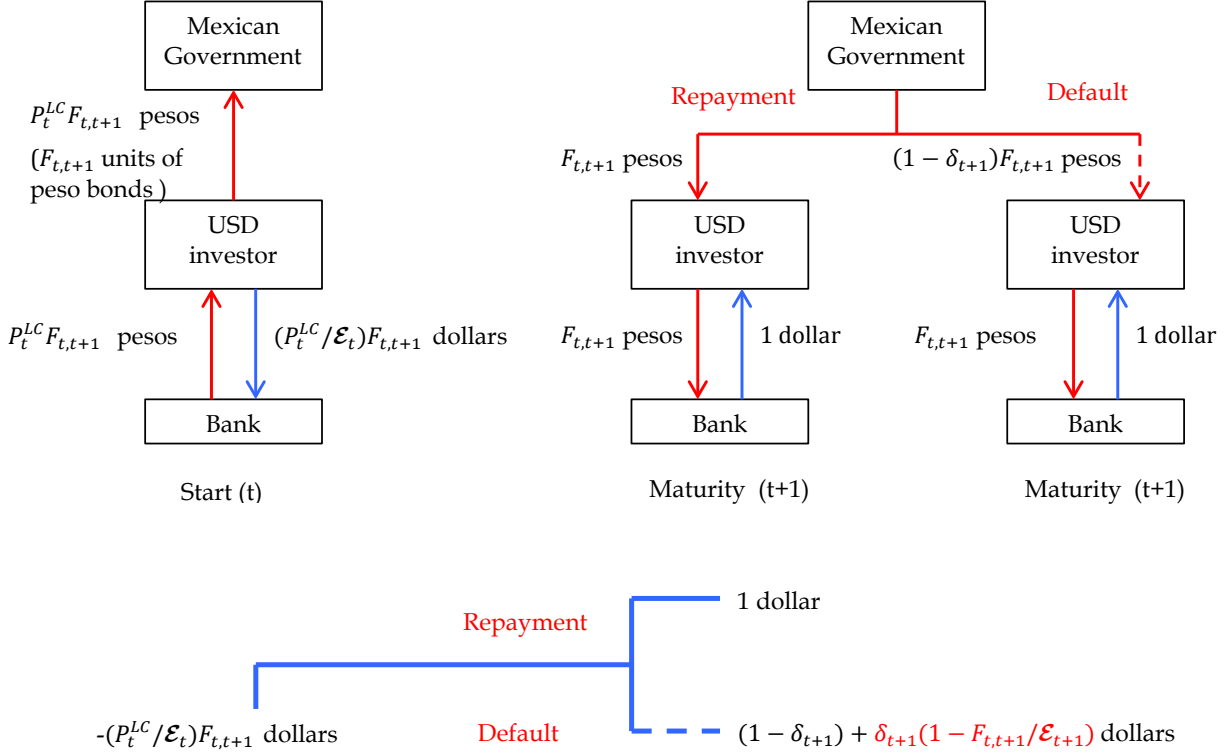
<sup>7</sup>We draw these net cash flows of this strategy in Appendix Figure 27b.

positively correlated credit and currency risk, the LC depreciates more upon default relative to the non-default state. The dollar investor holding the swapped LC bond has a net long position in dollars in the event of an LC default, which corresponds to additional currency gains.<sup>8</sup> These profits would be passed into an ex-ante negative spread adjustment. As shown in Appendix 5.1.1, the valuation impact of this hedging error is exactly equal to the quanto adjustment,  $q_t$ .

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<sup>8</sup>To see this, we note that in Figure 4, the hedging error upon default is given by  $\delta_{t+1}(1 - F_{t,t+1}/\mathcal{E}_{t+1})$ , where  $\delta_{t+1}$  is loss given default. If currency depreciates upon default relative to the non-default state, we have  $\mathcal{E}_{t+1} > F_{t,t+1}$ , and thus  $\delta_{t+1}(1 - F_{t,t+1}/\mathcal{E}_{t+1}) > 0$ , which implies positive profits.

Figure 4: Cash Flow Diagram for a Swapped LC Sovereign Bond



*Notes:* This diagram shows cash flows for a synthetic dollar bond by swapping a peso bond into U.S. dollars using an outright FX forward contract. At time  $t$ , the dollar investor exchanges  $(P_t^{LC}/\mathcal{E}_t)F_{t,t+1}$  dollars for  $P_t^{LC}F_{t,t+1}$  pesos with a bank at the spot exchange rate  $\mathcal{E}_t$ , where  $P_t^{LC}$  is the price of a zero-coupon Mexican Treasury in pesos and  $F_{t,t+1}$  is the outright forward rate at time  $t$ . She then invests all the peso proceeds into the Mexican Treasuries with face value  $F_{t,t+1}$ . Meanwhile, at time  $t$ , she enters in an outright forward contract to sell  $F_{t,t+1}$  pesos forward for 1 dollar at time  $t+1$ . At time  $t+1$ , if the Mexican government repays full principal,  $F_{t,t+1}$ , the dollar investor gives all the peso payments to the bank to fulfill the outright forward contract and receives 1 dollar. However, if the Mexican government defaults, the peso payment to the dollar investor becomes  $(1 - \delta_{t+1})F_{t,t+1}$ , where  $\delta_{t+1}$  denotes the loss given default. However, the dollar investor still has to fulfill the outright forward, so the total cash flow from the bond and swap package is equal to  $[(1 - \delta_{t+1}) + \delta_{t+1}(1 - F_{t,t+1}/\mathcal{E}_{t+1})]$  upon default, where the last term  $\delta_{t+1}(1 - F_{t,t+1}/\mathcal{E}_{t+1})$  denotes the FX hedging error. As the swapped LC bond pays off 1 dollar in the non-default state, the synthetic dollar yield on the swapped LC bond is equal to  $y_t^{SLC} = -[(P_t^{LC}/\mathcal{E}_t)F_{t,t+1}] = y_t^{LC} - \rho_t$ .

Therefore, in a frictionless financial market, the LC credit spread is always equal to expected default losses under the LC risk-neutral measure. If the covariance between currency and credit risk is zero ( $q_t = 0$ ), then the LC credit spread will also equal the expected default losses under the dollar risk-neutral measure. However, if credit and currency risks are positively correlated ( $q_t > 0$ ), then the LC credit spread will understate expected default losses

under the dollar measure.<sup>9</sup> After presenting the stylized facts on LC credit spreads, we will return to a theoretical and empirical calibration of the magnitude of  $q_t$  in Section 1.4.2.

Finally, as additional evidence for the validity of the LC risk-free rate and the presence of credit risk on emerging market LC debt, we examine the yields paid by AAA-rated supranationals in various emerging market currencies. While the U.S. Treasury does not issue debt in emerging market local currencies, some supranationals, such as the World Bank and the European Investment Bank, have issued debt denominated in emerging market local currencies. We can define an alternative LC credit spread measure as the difference between LC emerging market sovereign yields and AAA-rated supranational yields in the same currency. We show the results for Brazil and Turkey using this alternative construction in Section 1.3.4, which does not rely on U.S. Treasuries or CCS rates. Due to the limited availability of supranational bond issuance in most emerging market currencies, this method cannot be generalized for all sample countries.

### 1.2.3 LC and FC Credit Spread Benchmark Comparison

In this subsection, we perform a theoretical comparison between LC and FC credit spreads in a frictionless financial market. We start with the conventional definition of the FC credit spread.

**Definition 2.** Let  $y_{nt}^{FC}$  denote the  $n$ -year zero-coupon yield on the U.S. dollar denominated debt and  $y_{nt}^{*\$}$  denote the zero-coupon yield on the  $n$ -year U.S. Treasury bond. We define the FC credit spread as

$$s_{nt}^{FCCS} \equiv y_{nt}^{FC} - y_{nt}^{*\$}. \quad (6)$$

As a corollary to Proposition 2, the difference between LC and FC credit spreads is given as follows.

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<sup>9</sup>Similarly, if the currency depreciates upon the implementation of capital control measures targeting capital outflows, the hedge also becomes imperfect and the covariance adjustment needs to be made. We thank one anonymous referee for raising this point.



**Corollary 1.** Let  $\mathbb{Q}_t^{LC}$  and  $\mathbb{Q}_t^{\$}$  denote the risk-neutral measure for the LC and U.S. dollar, respectively, at time  $t$ , and let  $L_{t+1}^{LC}$  and  $L_{t+1}^{FC}$  denote the default losses on the LC and FC bonds, respectively, at time  $t + 1$ , measured in terms of the fraction of the face value in the respective currency. Then the LC-over-FC credit spread differential,  $s_t^{LC/FCCS} \equiv s_t^{LCCS} - s_t^{FCCS}$ , is given as follows:

$$s_t^{LC/FCCS} = \mathbb{E}_t^{\mathbb{Q}^{LC}} L_{t+1}^{LC} - \mathbb{E}_t^{\mathbb{Q}^{\$}} L_{t+1}^{FC} \quad (7)$$

$$= \mathbb{E}_t^{\mathbb{Q}^{\$}} (L_{t+1}^{LC} - L_{t+1}^{FC}) - q_t, \quad (8)$$

where  $q_t \equiv \frac{\text{Cov}_t^{\mathbb{Q}^{\$}}(1-L_{t+1}^{LC}, \mathcal{E}_t/\mathcal{E}_{t+1})}{\mathbb{E}_t^{\mathbb{Q}^{\$}}(1-L_{t+1}^{LC})\mathbb{E}_t^{\mathbb{Q}^{\$}}(\mathcal{E}_t/\mathcal{E}_{t+1})}$ .

*Proof.* Under the dollar risk-neutral measure  $\mathbb{Q}^*$ , we know that

$$\begin{aligned} P_t^{FC} &= \exp(-y_t^{*\$})\mathbb{E}_t^{\mathbb{Q}^*}(1 - L_{t+1}^{FC}) \\ s_t^{FCCS} &= y_t^{FC} - y_t^{*\$} = -\ln \mathbb{E}_t^{\mathbb{Q}^*}(1 - L_{t+1}^{FC}) \approx \mathbb{E}_t^{\mathbb{Q}^*} L_{t+1}^{FC}. \end{aligned} \quad (9)$$

We obtain the corollary by subtracting Equation 9 from Equations 4 and 5.  $\square$

Therefore, the LC-over-FC credit spread differential reflects the difference in expected default losses measured using the LC and dollar risk-free bond as the numeraire (Equation 7). Furthermore, if we also value the LC credit risk using the dollar risk-free bond as the numeraire, we need to add a quanto adjustment due to the covariance between currency risk and default risk (Equation 8). We will present evidence in Section 1.4.2 that the positive covariance between currency risk and default risk makes the LC credit risk measured under the LC numeraire significantly lower than under the dollar numeraire.

#### 1.2.4 Potential Financial Market Frictions

Having presented interpretations of the LC credit spread under the frictionless benchmark, we now examine how financial frictions could affect the measure. We first discuss how counterparty risk and non-deliverability of CCS contracts affects the interpretation of our LC credit spread. We then provide a brief overview of potential financial market frictions

that may have differential impacts on LC and FC credit spreads. After presenting the stylized facts about LC and FC credit spreads, we will discuss in Section 1.4.3 how these frictions may lead our actual measures of the LC risk-free rate and LC credit spread to depart from their frictionless interpretation as given by Propositions 1 and 2.

One potential concern in using CCS to construct the LC risk-free rate is that the CCS rate may reflect the risk of a counterparty default (Assumption 2). However, the impact of counterparty risk on the pricing of CCS is negligible due to a high degree of collateralization. Following the International Swap and Derivative Association Credit Support Annex, the common market practice among dealers is to post variation margins in cash with the amount equal to the mark-to-market value of the swap. The counterparty seizes collateral in the event of a default, so that counterparty risk exposure is hedged to the first order. Consistent with high collateralization, Arora et al. (2011) offer direct evidence on the counterparty risk in the CDS market. They find that a 645 basis point increase in the seller's CDS spreads only translates to a 1 basis point reduction in the quoted CDS premium.<sup>10</sup>

Aside from counterparty risk, one distinct feature of emerging market CCS is that the many countries do not allow the LC to be delivered offshore for FX derivative transactions. The CCS swap involving non-deliverable currencies is referred to as the non-deliverable swap (NDS).<sup>11</sup> The U.S. dollar is used to cash settle the NDS position, without exchanging the LC. The LC bond hedged with the NDS cannot protect the investor from capital control and currency convertibility risks. Therefore, in addition to outright default risk, the LC credit spread based on the NDS also includes these additional risks.

Furthermore, several financial market frictions could potentially affect the valuation of LC and FC credit spreads, which are all abstract from under Assumption 1. First, swapped LC and FC debt might have different liquidity risk, so the credit spread differential therefore

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<sup>10</sup>Even under the assumption that there is no collateralization, the magnitude of the bilateral counterparty risk adjustment for CCS is quite small. As shown in the calibration by Duffie and Huang (1996), for a 5-year fixed-for-fixed currency swap and 100 basis point asymmetry in the counterparty's credit risk, the bilateral credit value adjustment is about 8.6 basis points for 15 percent FX volatility.

<sup>11</sup>Among our 10 sample countries, Hungary, Mexico and Poland have deliverable CCS, and the rest of our sample countries all have non-deliverable CCS.

partly reflects differential liquidity premia. In particular, we show that the swapped LC bond can earn a liquidity premium because it goes long in the more liquid bond and short in the more illiquid swap. Second, LC and FC debt pricing can be affected by slow-moving capital and market segmentation in domestic and external debt markets, The LC debt is largely held by local institutional investors and FC debt is largely held by global investors. The arbitrage between the two markets can be incomplete due to arbitrageurs' limited capital and risk aversion. Third, we show that it is easy to short the swap rate, but more difficult to short LC than FC bonds. The swapped LC bond can also be traded at a premium over the FC bonds due to more binding short-selling constraints. Fourth, no-arbitrage violations in the currency markets can also affect the LC credit spread, but not directly affect the FC credit spread. A severe dollar shortage during the financial crisis can make synthetic dollar borrowing more costly than direct dollar borrowing.

## **1.3 New Stylized Facts on LC Sovereign Risk**

### **1.3.1 Data Sources**

The core of our dataset is daily zero-coupon swap curves and yield curves for LC and FC sovereign bonds issued by 10 different emerging market governments from January 2005 to December 2014. We use a benchmark tenor of 5 years. The choice of countries is mainly constrained by the lack of sufficient numbers of outstanding FC bonds. 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. The details on the yield curve construction and specific Bloomberg tickers used in our analysis are given in Internet Appendix 5.1.2.

### **1.3.2 Summary Statistics of LC and FC Credit Spreads**

In Figure 5, we plot LC nominal yields, swap rates, and LC and FC credit spreads for our sample emerging markets. To summarize these figures, in Column 1 of Table 1, we

present summary statistics for 5-year LC spreads from 2005 to 2014 at a daily frequency. LC credit spreads,  $s^{LCCS}$ , have a cross-country mean of 145 basis points, calculated using the mid-rates on the swaps. Brazil records the highest mean LC spreads at 339 basis points while Israel, Mexico and Peru have the lowest means at about 70 basis points.<sup>12</sup> Column 4 provides summary statistics for the liquidity of the CCS,  $ba^{CCS/2}$ , defined as half of the bid-ask spread of CCS rates, with the sample average equal to 19 basis points. The LC credit spread remains significantly positive for every country after subtracting one half of the bid-ask spread on the CCS in order to incorporate the transaction costs.

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<sup>12</sup> All mean LC credit spreads are positive and statistically significantly different from zero using Newey-West standard errors allowing for heteroskedasticity and serial correlation. Following Datta and Du (2012), missing data are treated as non-serially correlated for Newey-West implementations throughout the paper.

Table 1: Mean LC and FC Credit Spread Comparison (Percentage Points), 2005-2014

Country	Sample Start	(1) $s^{LCCS}$	(2) $s^{FCCS}$	(3) $s^{LC/FCCS}$	(4) $ba^{CCS}/2$	(5) $Corr(LCCS, FCCS)$
Brazil	Jul. 2006	3.39 (1.16)	1.67 (0.84)	<b>1.71</b> (1.06)	0.36 (0.14)	0.48
Colombia	Jun. 2005	1.59 (0.70)	1.93 (0.95)	<b>-0.34</b> (0.91)	0.15 (0.08)	0.42
Hungary	Jan. 2005	2.34 (1.41)	3.46 (2.11)	<b>-1.12</b> (0.92)	0.17 (0.08)	0.94
Indonesia	Apr. 2005	1.02 (0.81)	2.25 (1.64)	<b>-1.23</b> (1.75)	0.40 (0.34)	0.11
Israel	Feb. 2006	0.68 (0.43)	1.13 (0.46)	<b>-0.44</b> (0.26)	0.12 (0.03)	0.82
Mexico	Jan. 2005	0.67 (0.33)	1.44 (0.74)	<b>-0.77</b> (0.67)	0.06 (0.04)	0.42
Peru	Jul. 2006	0.72 (0.77)	1.74 (1.00)	<b>-1.02</b> (1.02)	0.18 (0.07)	0.36
Philippines	Mar. 2005	1.42 (0.80)	2.11 (1.08)	<b>-0.69</b> (1.15)	0.29 (0.12)	0.28
Poland	Mar. 2005	1.28 (0.69)	1.71 (0.86)	<b>-0.43</b> (0.33)	0.11 (0.05)	0.93
Turkey	May 2005	1.62 (1.56)	2.77 (1.19)	<b>-1.15</b> (1.02)	0.10 (0.06)	0.75
Total	Jan. 2005	1.45 (1.23)	2.01 (1.31)	<b>-0.56</b> (1.30)	0.19 (0.18)	0.55
Observations		17809	17809	17809	17809	

*Notes:* This table reports the starting date, mean and standard deviation of 5-year log yield spreads at daily frequency. The variables are (1)  $s^{LCCS}$ , LC credit spread; (2)  $s^{FCCS}$ , FC credit spread; (3)  $s^{LC/FCCS}$ , LC over FC credit spread, or column (2) minus column (1). (4)  $ba^{CCS}/2$ , half of bid-ask spread of cross-currency swaps. In Column 5, we report correlation between daily credit spreads. Standard deviations of the variables are reported in the parentheses.

Figure 5: 5-Year Nominal Spreads, CCS and Credit Spreads (percentage points)

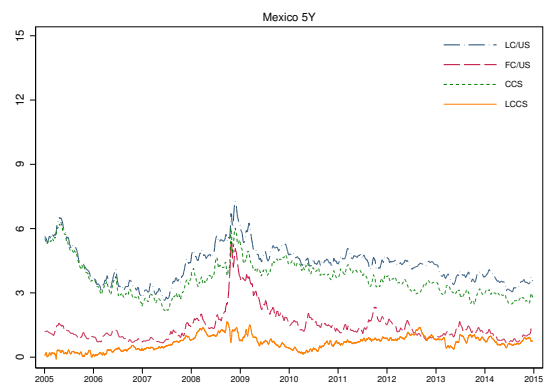
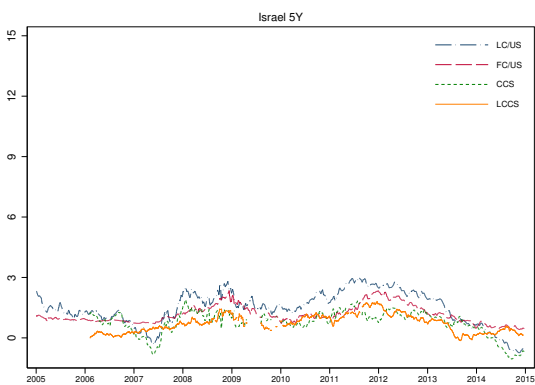
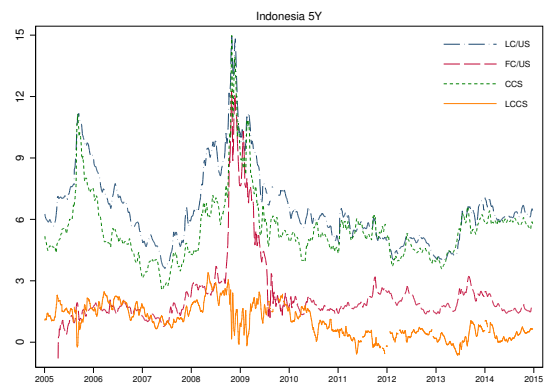
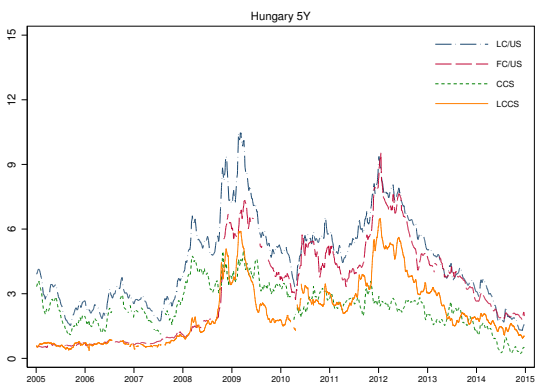
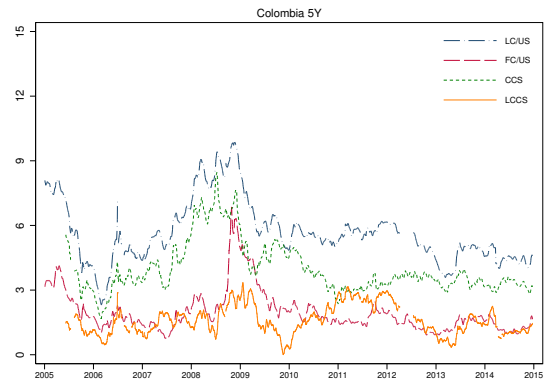
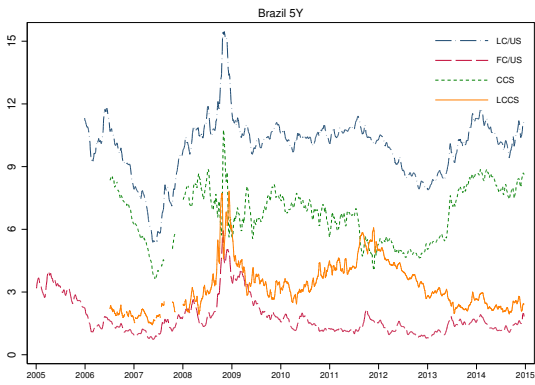
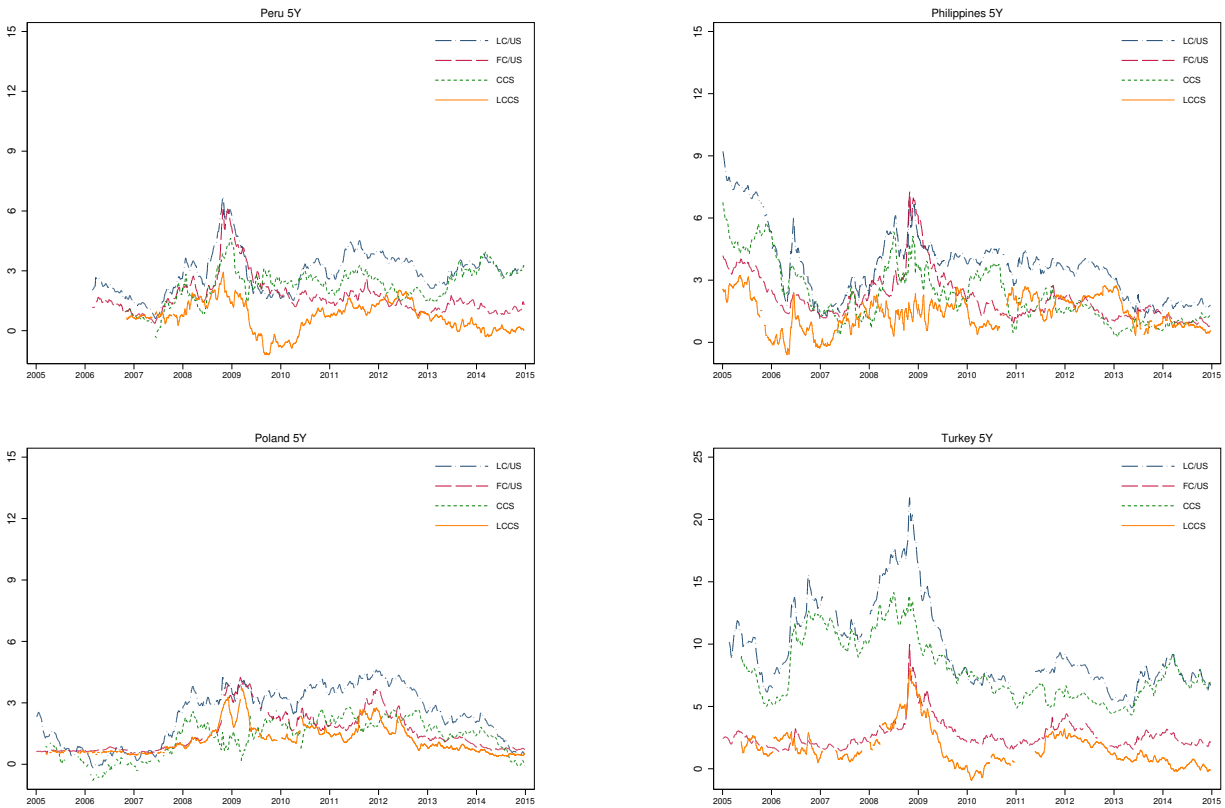


Figure 5: (continued) 5-Year Nominal Spreads, CCS and Credit Spreads (percentage points)



*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, or the FC credit spread. “CCS” denotes the zero-coupon fixed for fixed CCS rate implied by par fixed for floating CCS and plain vanilla interest rate swap rates. “LCCS” denotes the LC credit 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 27.

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,  $s^{FCCS}$ , reported in Column 2 in Table 1 have a mean of 201 basis points, 56 basis points higher than LC credit spreads based on the mid-rates for CCS. In Column 3, we compute the difference between LC and FC credit spreads by country. The LC-over-FC credit spread differential,  $s^{LC/FCCS}$ , is significantly negative for all of our sample countries except Brazil. We will discuss the Brazilian exception in detail in Section 1.4.1. Although all of our sample countries have LC bond markets open to foreign investors, foreigners may still need to incur transaction costs to buy into LC markets. In addition to taxes on capital

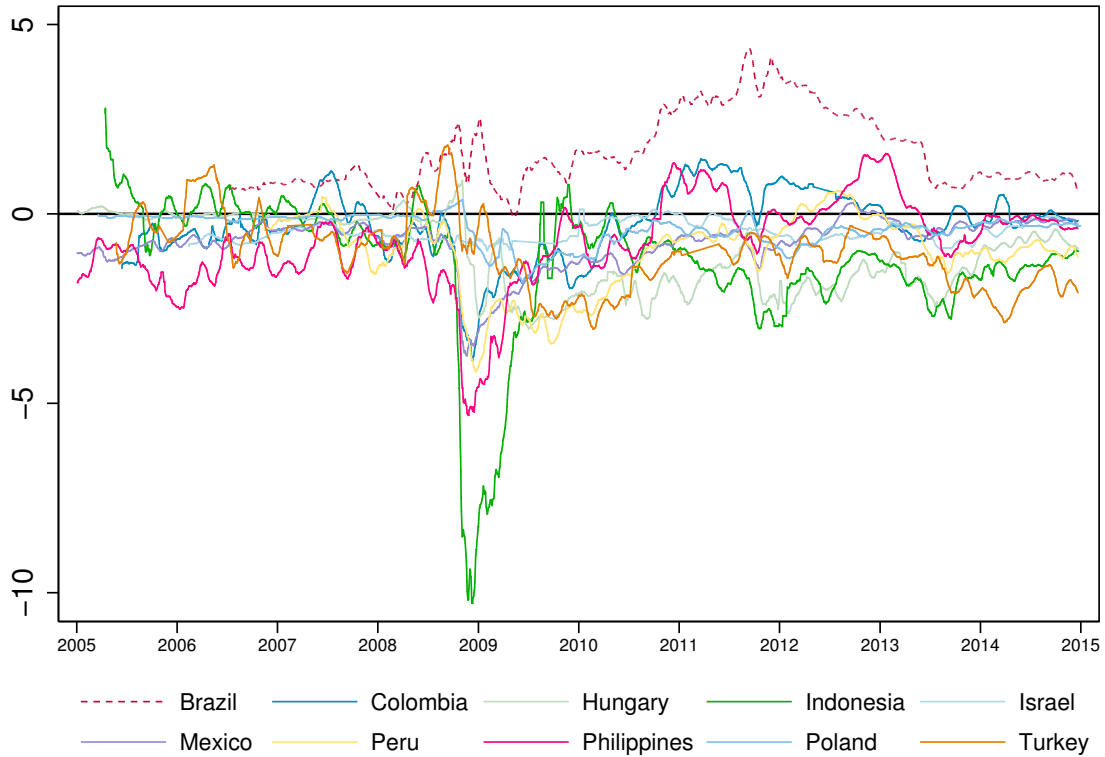
inflows, LC bonds are often subject to local taxation, whereas FC international bonds are exempt from interest withholding taxes. For 9 out of 10 countries with negative LC-over-FC credit spread differentials, the promised dollar spread on LC bonds is unambiguously lower than that on FC bonds, since swapped LC-over-FC spreads would become more negative after taking into account positive taxes on LC bonds.

Despite the mean difference in credit spreads, one might expect LC and FC credit risk to be correlated within countries, as in a downturn a country might 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 55 percent. However, there is significant cross-country heterogeneity. The correlation is highest for Hungary at 94 percent and lowest for Indonesia at 11 percent.

Figure 6 plots the difference in LC and FC credit spreads,  $s^{LC/FCCS}$ , across 10 countries over the sample period. While LC-over-FC credit spread differentials 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 largest difference between LC and FC credit spreads for any country during the crisis was Indonesia's negative 10 percentage points. 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 later.



Figure 6: LC over FC Credit Spreads (Percentage Points)



*Notes:* This figure plots 30-day moving averages of 5-year zero-coupon LC over FC credit spread differential for all 10 sample countries. Data sources and details on yield curve construction are given in Appendix Table 27.

### 1.3.3 Correlation with Global Risk Factors

**Credit Spreads** In Table 2, we conduct a principal component (PC) analysis to determine the extent to which fluctuations in LC and FC credit spreads are driven by common components or by idiosyncratic country shocks. In the first column, we see that the first PC explains less than 54% of the variation in LC credit spreads across countries. By contrast, the first PC explains over 77% of total variation in FC credit spreads (Column 2). The first three principal components explain slightly less than 78% of the total variation for LC credit spreads whereas for FC credit spreads they explain about 96%. In addition, we find that the average pairwise correlation of LC credit spreads between countries is only 43%, in contrast to 73% 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. Our result showing that an overwhelming amount of the variation in FC credit spreads is explained by the first PC echoes the findings of Longstaff et al. (2011b) on CDS spreads.

Table 2: Cross-Country Correlation of Credit Spreads, 2005-2014

Principal Components	(1) $s^{LCCS}$		(2) $s^{FCCS}$		(3) $5Y\ CDS$	
	percentage	total	percentage	total	percentage	total
First	54.28	54.28	77.35	77.35	74.57	74.57
Second	14.69	68.96	15.21	92.56	18.10	92.67
Third	9.37	78.33	3.32	95.88	2.70	97.37
Pairwise Corr.	0.43		0.73		0.71	

*Notes:* This table reports the summary statistics of the principal component analysis and the cross-country correlation matrices of monthly 5-Year LC and FC credit spreads and sovereign credit default swap spreads. The variables are (1)  $s^{LCCS}$ , LC credit spreads; (2)  $s^{FCCS}$ , FC credit spreads; (3)  $5Y\ CDS$ , five-year sovereign CDS spreads. The rows “First”, “Second”, and, “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.

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 3, 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 very high correlations with these three global risk factors, 93% with  $VIX$ , 92% with  $BBB/T$  and 76% with global macro fundamentals (or, more precisely, U.S. 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 68% correlation with  $VIX$ , 69% with  $BBB/T$  and 52% with  $CFNAI$ . In terms of correlation between raw spreads and global factors, as

shown in Panel B, VIX has a mean correlation of 61% with FC credit spreads, but only 34% 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.

Table 3: Correlation among Credit Spreads and Global Risk Factors, 2005-2014

	(A) First PC of Credit Spreads			(B) Raw Credit Spreads			(C) Global Risk Factors		
	$s^{LCCS}$	$s^{FCCS}$	5Y CDS	$s^{LCCS}$	$s^{FCCS}$	5Y CDS	BBB/T	-CFNAI	VIX
$s^{SLC/US}$	1.00			1.00					
$s^{FC/US}$	0.75	1.00		0.50	1.00				
5Y CDS	0.72	0.94	1.00	0.49	0.91	1.00			
BBB/T	0.68	0.93	0.93	0.35	0.63	0.58	1.00		
-CFNAI	0.52	0.76	0.75	0.28	0.50	0.45	0.86	1.00	
VIX	0.69	0.92	0.85	0.34	0.61	0.53	0.85	0.71	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 the 10 sample countries and global risk factors. Panel (C) reports correlations between global risk factors only. The three credit spreads are (1)  $s^{LCCS}$ , 5-year LC credit spread; (2)  $s^{FCCS}$ , 5-year FC credit 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.

**Excess Returns** Having examined the ex-ante promised yields in Tables 2 and 3, 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 contemporaneous beta regressions to examine how LC and FC excess returns vary with global and local equity markets. Since all yield spreads are for zero-coupon benchmarks, we can quickly compute various excess returns for the holding period  $\Delta t$ .<sup>13</sup> The FC-over-U.S. Treasury excess holding period return for an  $n$ -year FC bond is equal to

$$rx_{n,t+\Delta t}^{FC/US} = ns_{nt}^{FC/US} - (n - \Delta t)s_{n-\Delta t,t+\Delta t}^{FC/US}, \quad (10)$$

<sup>13</sup>For quarterly returns,  $\Delta t$  is a quarter and we approximate  $s_{n-\Delta t,t+\Delta t}$  with  $s_{n,t+\Delta t}$ .

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 U.S. Treasury bond is given by

$$rx_{n,t+\Delta t}^{LC/US} = ns_{nt}^{LC/US} - (n - \Delta t)s_{n-\Delta t,t+\Delta t}^{LC/US}. \quad (11)$$

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. 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:

$$uhrx_{n,t+\Delta t}^{LC/US} = rx_{n,t+\Delta t}^{LC/US} - (e_{t+\Delta t} - e_t). \quad (12)$$

If the dollar investor would like to hedge LC risk, we consider two types of hedging strategies. First, the dollar investor only hedges currency risk of the holding period by rolling over three-month forward contracts. The holding-period hedged LC-over-US excess return,  $hrx_{n,t+\Delta t}^{LC/US}$ , is approximately equal to the currency-specific return differential minus the ex-ante holding period forward premium:

$$hrx_{n,t+\Delta t}^{LC/US} \approx rx_{n,t+\Delta t}^{LC/US} - (f_{t,t+\Delta t} - e_t). \quad (13)$$

Second, the dollar investor hedges the currency risk of the entire duration of the bond with CCS. The swapped LC-over-US excess return,  $srx_{n,t+\Delta t}^{LC/US}$ , is approximately equal to the currency-specific return differential minus the return on the currency swap:

$$srx_{n,t+\Delta t}^{LC/US} \approx rx_{n,t+\Delta t}^{LC/US} - [n\rho_{nt} - (n - \Delta t)\rho_{n-\Delta t,t+\Delta t}].^{14} \quad (14)$$

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<sup>13</sup>For both types of hedging, we set the forward/swap hedging notional equal to the initial market value of the LC bond at the beginning of the quarter and is dynamically rebalanced every quarter. As the market value of the LC bond at time  $t + \Delta t$  might be under or over hedging notional, Equations 12 and 13 only provide a first-order approximation of actual hedged and swapped returns and do not hold exactly. We obtain very similar regression results with or without currency hedging errors.

Table 4 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 three-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 they do 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 systematic risk of LC bonds is that emerging market currencies depreciate when returns on global equities are low, as the global risk factor affects currency excess returns. Once currency risk is hedged, 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.

Table 4: Regressions of Bond Excess Returns on Equity Returns, 2005-2014

	(1)	(2)	(3)	(4)	(5)	(6)
	$rx^{FC/US}$	$hrx^{LC/US}$	$uhrx^{LC/US}$	$rx^{FC/US}$	$srx^{LC/US}$	$uhrx^{LC/US}$
<i>S&amp;P \$rx</i>	0.139*** (0.0471)	-0.0335 (0.0631)	0.212*** (0.0583)	0.227*** (0.0518)	-0.00396 (0.0287)	0.422*** (0.106)
<i>LC equity hedged \$rx</i>	0.140*** (0.0455)	0.232*** (0.0369)	0.405*** (0.0471)			
<i>LC equity swapped \$rx</i>				0.0463* (0.0254)	0.108*** (0.0220)	0.192** (0.0782)
<i>Observations</i>	1,032	1,032	1,032	1,034	1,034	1,034
<i>R-squared</i>	0.357	0.273	0.433	0.273	0.127	0.300

*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 the 5-year zero-coupon benchmark (annualized). The independent variables are *S&P \$rx*, the quarterly return on the S&P 500 index over 3-month U.S. T-bills; *LC equity hedged \$rx*, the quarterly return on the local MSCI index hedged using 3-month FX forward over 3-month U.S. T-bills; and *LC equity swapped \$rx*, the quarterly return on the local MSCI index combined with a 5-year CCS over 3-month U.S. T-bills; All regressions are run at the monthly frequency with country fixed effects using Newey-West standard errors with 24-month lags and clustering by month following Driscoll and Kraay (1998). Significance levels are denoted by \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

### 1.3.4 Alternative LC Credit Spread Measure

In this section, we show results for an alternative LC credit spread measure based on supranational bond yields denominated in emerging market local currencies. AAA-rated supranational organizations, such as the World Bank, European Investment Bank (EIB) and Kreditanstalt für Wiederaufbau (KfW), a German government-owned development bank, have issued debt in emerging market local currencies at yields lower than those on emerging market sovereign debt. Instead of using the sum of the U.S. Treasury yield and the CCS rate as the LC risk-free rate, we can also use the AAA-rated supranational yield as an alternative LC risk-free rate. We define an alternative LC credit spread as the difference between the emerging market sovereign yield and the supranational yield denominated in the same currency. We find a significantly positive LC credit spread using this alternative measure,

which does not rely on U.S. Treasury bonds or CCS rates. However, the limitation of this approach is that we need a large and liquid bond market for supranational issuance in each emerging market currency.

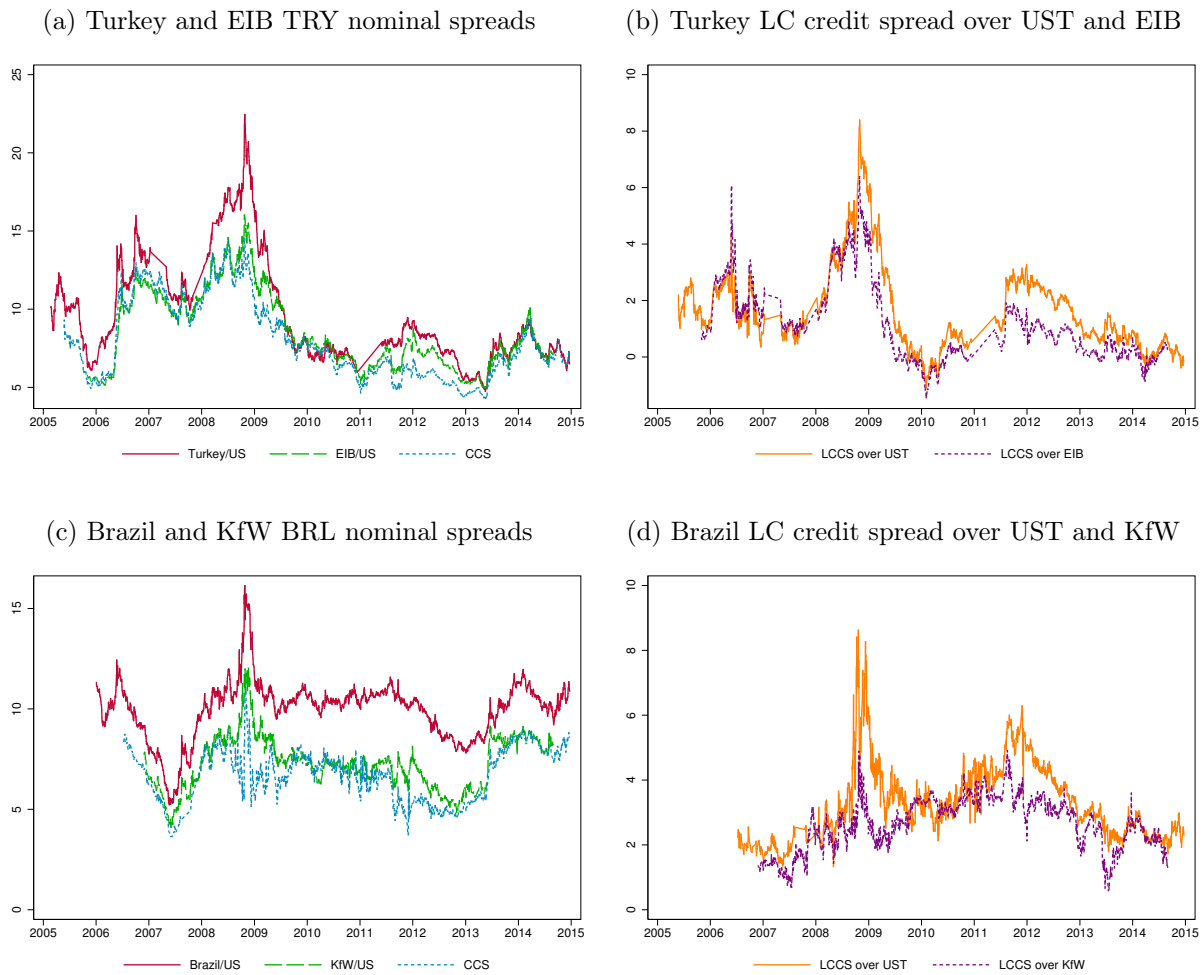
In our sample countries, using primary market issuance data in Thomson One, the Turkish lira and Brazilian real are the two most frequently chosen emerging market currencies among supranational debt issuers. Between December 2004 and July 2014, 15 supranational organizations issued 1,429 bonds in our 10 sample emerging market currencies, with a total gross notional equal to \$66.3 billion, among which 575 bonds were denominated in the Turkish lira with total notional equal to \$38.4 billion, and 474 bonds were denominated in the Brazilian real with total notional of \$21.1 billion. For the most frequent single-name issuers, the EIB issued 271 bonds in the Turkish lira and the KfW issued 122 bonds in the Brazilian real. We can construct a zero-coupon Turkish lira-denominated yield curve for bonds issued by the EIB and a Brazilian real-denominated yield curve for bonds issued by the KfW.

Figure 7(a) plots EIB Turkish lira yield spreads over U.S. Treasuries, Turkish LC sovereign bond yield spreads over U.S. Treasuries, and lira/dollar CCS rates. All yield spreads and CCS rates are zero-coupon rates for the 5-year maturity. We can see that Turkish sovereign yield spreads are generally higher than EIB yield spreads. EIB yield spreads track CCS rates very closely, suggesting very low levels of perceived default risk for the EIB. The only exception is that during the peak of the European debt crisis, the EIB spread was significantly above the CCS rate, but was still consistently below the Turkish sovereign spread. Figure 7(b) plots Turkish sovereign LC credit spreads over the U.S. Treasuries, as defined in Equation 3, and our alternative LC credit spread as the difference between Turkish sovereign bond yields and the EIB yields. LC credit spreads over U.S. Treasuries are generally higher than LC credit spreads over the EIB, potentially reflecting better liquidity, credit quality and convenience associated with U.S. Treasuries. However, the two credit spreads are highly correlated and significantly above zero. Figures 7(c) and 7(d) display similar patterns for the Brazilian real. The KfW issues bonds at slightly higher yields than the sum of the U.S.

Treasury and real/dollar NDS rates, but at significantly lower yields than those on Brazilian LC sovereign bonds. LC credit spreads over KfW yields are also significantly above zero and highly correlated with LC credit spreads over U.S. Treasuries.



Figure 7: Emerging Market Sovereign and Supranational Yield Spreads (percentage points)



*Notes:* All yield spreads in the figures are zero-coupon rates for the 5-year maturity. In Figure (a), the solid cranberry line (Turkey/US) plots the Turkish Treasury yield spread over U.S. Treasury yield spread. The dashed green line (EIB/US) plots the yield spread of Turkish lira-denominated bonds issued by the EIB. The dotted blue line (CCS) plots the fixed-for-fixed lira/dollar CCS rate. In Figure (b), the solid red line (LCCS over UST) plots the LC credit spread of the Turkish sovereign over the U.S. Treasury yield (Turkey/US-CCS), and the dotted purple line (LCCS over EIB) plots the LC credit spread over EIB, which is defined as the difference between the Turkish sovereign bond yield and the EIB yield in the Turkish lira. In Figure (c), the solid cranberry line (Brazil/US) plots the Brazilian Treasury yield spread over U.S. Treasury yield spread. The dashed green line (KfW/US) plots the yield spread of Brazilian real denominated bonds issued by KfW. The dotted blue line (CCS) plots the fixed-for-fixed real/dollar CCS rate. In Figure (d), the solid red line (LCCS over UST) plots the LC credit spread of the Brazilian sovereign over the U.S. Treasury yield (Brazil/US-CCS), and the dotted purple line (LCCS over KfW) plots the LC credit spread over KfW, which is defined as the difference between the Brazilian sovereign bond yield and the KfW yield in the Brazilian real. Zero-coupon bond yields for EIB and KfW are estimated using the Nelson-Siegel methodology based on coupon bond yields available in Bloomberg.

## 1.4 Sources of Credit Spread Differentials

In this section, we examine three main sources of credit spread differentials. First, we consider how selective defaults, capital controls and domestic jurisdiction risks impact the LC and FC credit spreads. These latter two are particularly helpful in explaining the Brazilian anomaly. Second, as the LC and FC credit spreads are pure credit risk measures under different numeraires, we discuss the impact of the covariance between currency and credit risk on the credit spread differentials. We argue that the LC credit spread understates credit risk under the dollar measure if the LC depreciates upon default relative to the non-default state. Third, we examine the impact of various financial market frictions on the credit spread differential, including liquidity, short-selling constraints, and slow-moving capital and market segmentation in debt and currency markets.

### 1.4.1 Selective Default, Capital Control and Jurisdiction Risks

Looking back at sovereign defaults in the recent history, it is ambiguous, a priori, whether we should expect higher default probabilities or haircuts on domestic LC or FC external debt. Moody's (2014) and Standard & Poor's (2014) document that, among countries not in currency unions, 21 sovereigns have defaulted since 1997, of which 5 have selectively defaulted on LC debt, 8 have selectively defaulted on FC debt, and 8 have defaulted simultaneously on LC and FC debt.<sup>15</sup> Among all the FC defaults, Nicaragua (in 2003 and 2008) and Jamaica (in 2010 and 2013) defaulted only on FC debt issued under domestic jurisdiction but exempted FC external debt under foreign laws. Therefore, the incidence of domestic LC defaults is comparable with the incidence of external FC defaults in the recent sample. In terms of the severity of default, taking the joint Argentine defaults in 2001 as an example, Moody's

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<sup>15</sup>Selective LC defaults: Mongolia (1997), Venezuela (1998), Suriname (1999), Turkey (1999) and Dominica (1999). Selective FC defaults: Indonesia (1999-2002), Pakistan (1999), Peru (2000), Moldova (2002), Nicaragua\*(2003, 2008), Dominican Republic (2005), Belize (2006, 2012), and Seychelles (2008); LC and FC joint defaults: Russia (1998-1999), Ukraine (1998-2000), Ecuador (1999), Argentina (2001), Uruguay (2003), Paraguay (2004), Grenada (2004, 2013), and Jamaica\* (2010, 2013). The asterisk denotes that the defaulted FC debt is under domestic jurisdiction.

(2014) gives a mean recovery of face value equal to 28.5 percent for the U.S. dollar debt and 17.5 percent for the peso debt.

In addition to outright defaults, as LC debt is governed under the domestic jurisdiction, our LC credit spread encompasses a broader view of “credit” risk because there are more ways for a government to avoid payments to foreign creditors, such as imposing taxes on capital outflows or suspending currency convertibility. While a systematic analysis of time variations in capital controls and jurisdiction risks for all sample countries is important, it is beyond the scope of the paper. Instead, we focus on Brazil as a specific case to illustrate how these risks may affect the LC credit spread more generally.

As a country offering one of the highest nominal interest rates in the world, Brazil has implemented several macro-prudential and exchange rate policy measures to curb portfolio investment flows and cross-border derivative trading. The Imposto sobre Operações Financeiras (IOF), or tax on financial transactions, was introduced in October 2009 and abandoned in the face of large capital outflows in June 2013. The IOF varied between 2 percent and 6 percent on foreign investment in fixed income instruments during its time in effect.

The difference between the onshore deliverable CCS and the offshore NDS rates captures currency convertibility and capital control risks. We construct the Brazilian onshore fixed-for-fixed deliverable CCS by subtracting the onshore Cupom Cambial futures (which is fixed U.S. dollar against the floating Brazilian interbank deposit rate DI) from the onshore plain-vanilla interest rate swap PRE/DI (which is fixed Brazilian real against the DI), with both legs settled in Brazilian reais.<sup>16</sup> The onshore deliverable CCS is higher than the offshore NDS because it is subject to cross-border taxation, capital control, and convertibility risks. These risks are also faced by holders of domestic LC sovereign bonds. Therefore, the LC credit spread based on the deliverable CCS provides the investor with a first-order hedge of

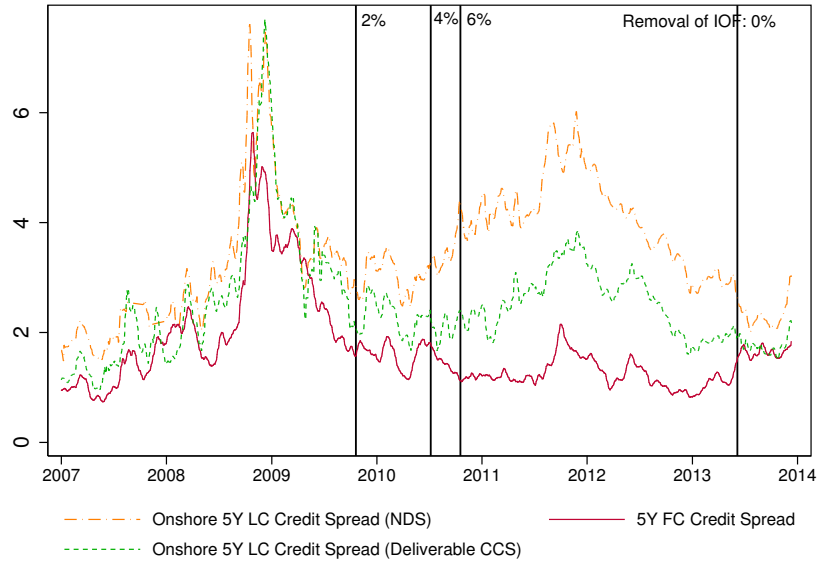
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<sup>16</sup>As the Cupom Cambial is traded on a futures exchange subject to margin calls and the PRE/DI does not involve the exchange of the principal, the counterparty risk in the deliverable CCS is even more negligible compared to the NDS.

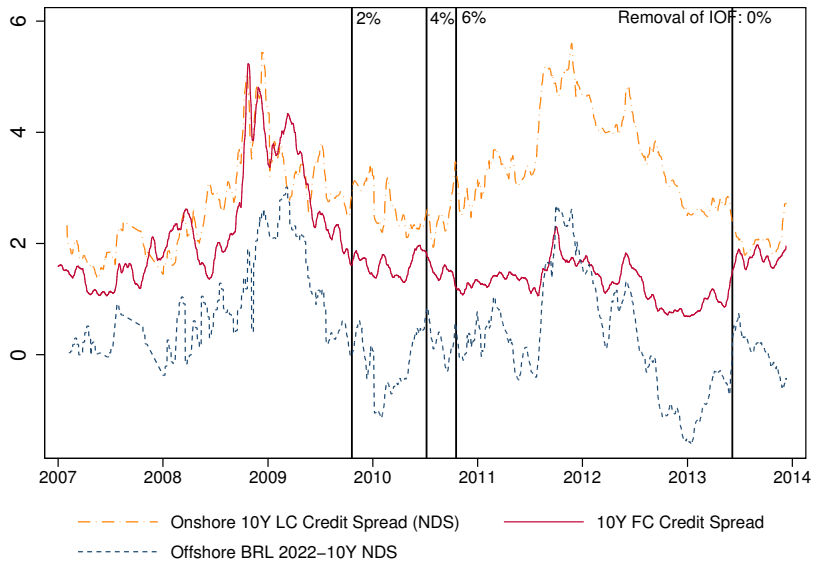
the capital control risk and thus should be lower than the LC credit spread based on the NDS.

Figure 8a plots the 5-year LC credit spreads based on the NDS and deliverable CCS compared to the FC credit spread. The four changes in the IOF tax rate are indicated by the vertical lines. The LC credit spread based on onshore deliverable CCS is lower than our conventional LC credit spread based on the NDS. The two LC credit spread measures diverged significantly during the period when the IOF was in effect, with a mean spread differential of 1.3 percent, which accounts for about one third of the LC credit spread based on the NDS and about one-half of the differential between the NDS-based LC credit spread and the FC credit spread. After the IOF was removed in June 2013, the two LC credit spread measures and the FC credit spread converged significantly with the LC credit spread based on deliverable CCS approximately equal to the FC credit spread.

Figure 8: Brazil Onshore and Offshore Credit Spread Comparison



(a) **Onshore LC Credit Spreads based on the NDS and Deliverable CCS.** The long-dashed line plots the Brazilian 5-year LC credit spread of the domestic LC bond using the NDS. The short-dashed line plots the 5-year LC credit spread of the domestic LC bond using the deliverable CCS implied by the Cupom Cambial future and the pre-DI swap. The solid lines plots the 5-year FC credit spread. One-week moving averages are used for all series.



(b) **Onshore and Offshore LC Credit Spreads.** The long-dashed line plots the Brazilian 10-year LC credit spread of the domestic LC bond using the NDS. The short-dashed line plots the yield spread on a eurobond issued by the Brazilian sovereign (denominated in BRL traded offshore and maturing in 2022) minus the 10-year NDS. The solid lines plots the 10-year FC credit spread. One-week moving averages are plotted for all series. The eurobond yield is obtained from the Luxembourg Stock Exchange and Bloomberg.

Furthermore, we note that even if convertibility and capital control risks are hedged to the first order by the onshore deliverable CCS, the LC credit spread measure based on the deliverable CCS is still higher than the FC credit spread. We attribute this difference to the additional credit risk from lending under domestic law. To see this, we examine Brazil’s four large offshore issuances of LC-denominated eurobonds, which are governed under international laws, settled in U.S. dollars and free of capital control and convertibility risks. Figure 8b shows the NDS-based offshore LC credit spread on a eurobond – denominated in the real and maturing in 2022 – is much lower than the LC credit spread on an onshore bond based on the same NDS rate. The offshore LC credit spread is also generally lower than the FC credit spread. Therefore, the general pattern that the LC credit spread is lower than the FC credit spread also holds for Brazil once we remove capital control and domestic jurisdiction risks.<sup>17</sup>

#### 1.4.2 Covariance Between Currency and Credit Risk

In this subsection, we calibrate the quanto adjustment term in Proposition 2 and Corollary 1, which allows us to change the LC credit spread from a credit risk measure under the LC numeraire to a credit risk measure under the dollar measure. We show that once we take into account the positive covariance between currency and default risk, the mean credit risk across LC and FC debt is roughly equal under the common dollar risk-neutral measure.

**A Simple Theoretical Calibration** We give a simple theoretical calibration of the size of the covariance between currency and default risk, or the quanto adjustment given in Equation 5, for a one-period bond. Under the dollar risk-neutral measure, we let  $\pi_t$  denote the risk-neutral probability of default and  $\delta$  denote the loss given default as a fraction of the face value in the LC. We let  $\mathcal{E}_{t+1}^{ND}$  and  $\mathcal{E}_{t+1}^D$  denote the spot exchange rate in the non-default and default states. To capture depreciation upon default, we consider that the LC

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<sup>17</sup>In addition to Brazil, Colombia has also issued several LC eurobonds payable in dollars and traded offshore. The offshore LC credit spread in Colombia is also lower than the FC credit spread.

depreciates by a fraction of  $\alpha \in [0, 1]$  in the default state relative to the non-default state, or,  $\frac{1}{\mathcal{E}_{t+1}^D} = (1 - \alpha)\frac{1}{\mathcal{E}_{t+1}^{ND}}$ . Following Khuong-Huu (1999), we assume that  $\alpha$  is non-stochastic for simplicity. It can be shown that the value of the exchange rates in the two states are given by<sup>18</sup>

$$\frac{1}{\mathcal{E}_{t+1}^{ND}} = \left( \frac{1}{1 - \alpha\pi_t} \right) \frac{1}{F_{t,t+1}}, \quad \text{and} \quad \frac{1}{\mathcal{E}_{t+1}^D} = \left( \frac{1 - \alpha}{1 - \alpha\pi_t} \right) \frac{1}{F_{t,t+1}}.$$

It then follows that the quanto adjustment in Equations 5 and 8 is given by:<sup>19</sup>

$$q_t = \frac{Cov_t^{\mathbb{Q}^S}(1 - L_{t+1}^{LC}, \mathcal{E}_t/\mathcal{E}_{t+1})}{\mathbb{E}_t^{\mathbb{Q}^S}(1 - L_{t+1}^{LC})\mathbb{E}_t^{\mathbb{Q}^S}(\mathcal{E}_t/\mathcal{E}_{t+1})} \approx \alpha\pi_t\delta = \alpha\mathbb{E}_t^{\mathbb{Q}^S}L_{t+1}^{LC}. \quad (15)$$

Therefore, under this simple calibration, we have

$$s_t^{LCCS} = \mathbb{E}_t^{\mathbb{Q}^{LC}}L_{t+1}^{LC} = (1 - \alpha)\mathbb{E}_t^{\mathbb{Q}^S}L_{t+1}^{LC}. \quad (16)$$

The LC credit spread is lower than the expected loss of the LC bond under the dollar risk-neutral measure by a fraction  $\alpha$ .

Before formally calibrating  $\alpha$  to empirical data in the next subsection, we perform a thought experiment to see how large  $\alpha$  would need to be in order for the mean credit spreads we observe to correspond to equal credit risk between LC and FC debt under the dollar risk-neutral measure. Under the assumption that  $\mathbb{E}_t^{\mathbb{Q}^S}L_{t+1}^{LC} = \mathbb{E}_t^{\mathbb{Q}^S}L_{t+1}^{FC}$ , by Equation 16, we have that

$$\alpha = (s_t^{FCCS} - s_t^{LCCS})/s_t^{FCCS}.$$

In our sample countries excluding Brazil, the mean LC-over-FC credit spread differential is equal to negative 81 basis points and the mean FC credit spread is 205 basis points.

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<sup>18</sup>Under these expressions, the outright forward exchange is equal to the risk-neutral expected spot rate:  $1/F_{t,t+1} = (1 - \pi_t)/\mathcal{E}_{t+1}^D + \pi_t/\mathcal{E}_{t+1}^{ND} = \mathbb{E}_t^{\mathbb{Q}^*}(1/\mathcal{E}_{t+1})$ .

<sup>19</sup>To derive Equation 15, we note that  $q_t = \frac{\mathbb{E}_t^{\mathbb{Q}^S}[(1 - L_{t+1}^{LC})/\mathcal{E}_{t+1}]}{\mathbb{E}_t^{\mathbb{Q}^S}(1 - L_{t+1}^{LC})\mathbb{E}_t^{\mathbb{Q}^S}(1/\mathcal{E}_{t+1})} - 1 = \frac{(1 - \pi_t)(\frac{1}{1 - \alpha\pi_t}) + \pi_t(1 - \delta)(\frac{1 - \alpha}{1 - \alpha\pi_t})}{(1 - \pi_t) + \pi_t(1 - \delta)} - 1 = \frac{1 - \pi\delta - \alpha\pi + \alpha\pi\delta}{(1 - \pi\delta)(1 - \alpha\pi)} - 1 \approx \alpha\pi\delta$  for small  $\pi$ .

Assuming equal credit risk across the two instruments under the common dollar risk-neutral measure, our data would imply 39 percent ( $0.81/2.05$ ) expected depreciation upon default.

**Empirical Evidence on Depreciation Upon Default** We can calibrate the magnitude of depreciation upon default using two approaches. First, following Mano (2013), we use CDS traded in different currencies on FC sovereign debt to obtain an estimate of the ex-ante risk-neutral expectation of depreciation upon default. We find that on average it is approximately 36 percent. This comparison is relevant for us if we assume either that depreciation upon default is the same for LC and FC debt, or that the two types of debt default simultaneously. Second, we perform a historical calibration for realized currency depreciation upon default using the long-history of default dates identified by Reinhart and Rogoff (2008) and Cruces and Trebesch (2013a). We obtain a historical depreciation upon default of about 25 to 30 percent relative to the counterfactual non-default state.

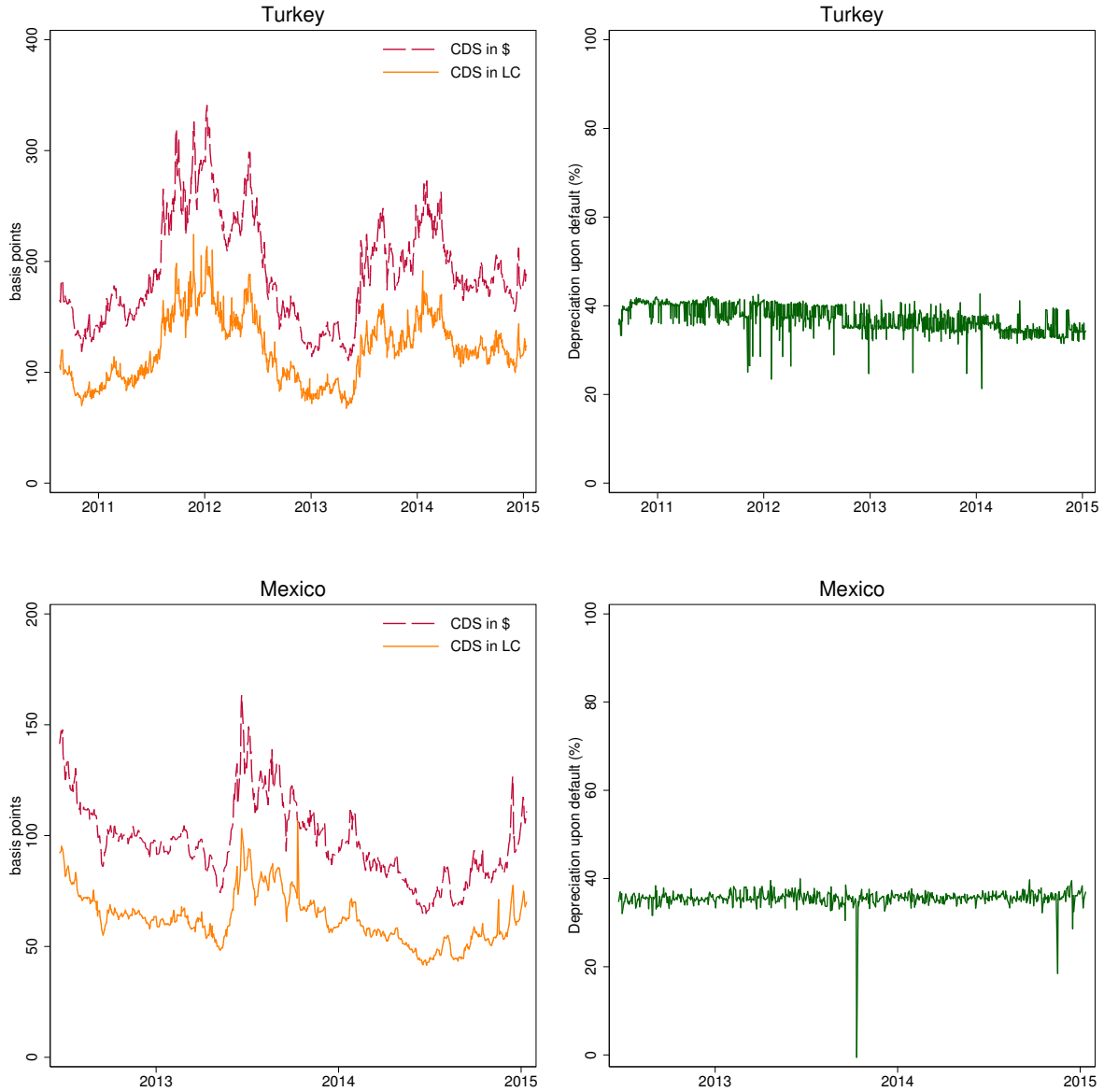
First, CDS contracts linked to the same debt instrument, but denominated in different currencies can offer a clean measure of the risk-neutral implied depreciation upon default perceived by market participants. However, the liquidity of LC-denominated quanto CDS contracts is generally very thin, with a few exceptions. Figure 9 shows CDS spreads for Mexico and Turkey denominated in the U.S. dollar and local currencies (Mexican peso and Turkish lira, respectively). LC CDS spreads are consistently below dollar CDS spreads. Despite the level difference, the two CDS spreads have a correlation of 99 percent. Given the observed mean difference between LC and dollar CDS spreads, we can compute  $\alpha$  as

$$\alpha_t = (cds_t^{\$} - cds_t^{LC})/cds_t^{\$}, \quad (17)$$

where  $cds_t^{\$}$  denotes the spread on the dollar CDS and  $cds_t^{LC}$  denotes the spread on the quanto LC CDS. The implied depreciation upon default is fairly stable throughout the entire sample, with a mean of 36 percent and a 1.9 percent standard deviation for Mexico and a mean of 37 percent and a 2.9 percent standard deviation for Turkey.



Figure 9: Sovereign CDS Spreads Denominated in LC and the U.S. Dollar



*Notes:* The left figures plot the CDS spreads in basis points for contracts denominated in the U.S. dollar (dashed red line) and contracts denominated in the Turkish lira or Mexican peso (solid orange line). The right figures plot risk-neutral expected percentage depreciation upon default calculated as  $\frac{CDS(\$) - CDS(LC)}{CDS(\$)} \times 100$ . The CDS data are from Markit.

Second, we perform a historical calibration for depreciation upon default using the realized exchange rates. The difficulty is that while we observe ex-post depreciation in the default state, we do not observe LC depreciation in the non-default counterfactual state for the same country at the same time. The empirical strategy we use is to compare depreciation

in defaulting countries with contemporaneous depreciation in ex-ante similar countries that do not default. The regression specification is as follows:

$$Dep_{t-\Delta t,t} = a_{Group(i),t} + \beta Def_{i,t} + \epsilon_{i,t},$$

where  $Dep_{t-\Delta t,t} = 1 - \mathcal{E}_{t-\Delta t}/\mathcal{E}_t$  measures 5-year backward looking LC depreciation, and  $Def_{i,t}$  is an indicator variable denoting whether a sovereign default occurs in country  $i$  at time  $t$ . The fixed effects,  $a_{Group(i),t}$ , are time fixed effects that interact with country groups based on ex-ante characteristics, such as per capita income, debt to GDP ratios and credit ratings. The coefficient  $\beta$  identifies the difference between depreciation in the default state and our constructed counterfactual non-default state. Therefore, the implied depreciation upon default relative to the non-default state is given by  $\hat{\alpha} = 1 - (1 - \bar{a} - \hat{\beta})/(1 - \bar{a})$ , where  $\bar{a}$  denotes the average of the fixed effects  $a_{Group(i),t}$ .<sup>20</sup>

Table 5 displays our estimation results. Results in Columns 1–4 are based on the annual default time obtained from Reinhart and Rogoff (2008) for the post–Bretton Woods period, 1971–2010. In Column 1, we only include year fixed effects and find that default countries on average depreciate more than 31 percent than the non-default countries, which implies an  $\alpha$  equal to 34 percent. In Column 2, we include year fixed effects interacting with three income group fixed effects. The income groups are determined by the 33 and 67 percentiles of per capita income at time  $t - 5$ . The implied  $\alpha$  decreases to 29 percent. In Column 3, we also include more fixed effects for three debt levels, as determined by the 33 and 67 percentiles of government debt to GDP ratios at time  $t - 5$ , and we obtain an  $\alpha$  estimate of 27 percent. In Column 4, we restrict ourselves to domestic default episodes, and obtain similar results of 30 percent. In Columns 5–6, we use monthly the default times between 1980 and 2014 given by Cruces and Trebesch (2013a). The estimate for  $\alpha$  is 40 percent with only monthly

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<sup>20</sup>The average FE  $\bar{a}$  in the regression measures the mean depreciation in the non-default countries; and  $\bar{a} + \hat{\beta}$  captures the mean depreciation in the default countries. Given that  $\alpha = 1 - \mathcal{E}_{t+1}^{ND}/\mathcal{E}_{t+1}^D$ , we obtain the estimate  $\hat{\alpha} = 1 - (1 - \bar{a} - \hat{\beta})/(1 - \bar{a})$ ,

fixed effects in Column 6, and it decreases to 34 percent after including S&P country credit ratings at time  $t - 5$ .<sup>21</sup>

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<sup>21</sup>Our earliest S&P sovereign credit ratings start in 1975 for select countries. Countries without S&P ratings all belong to the unrated category.

Table 5: Historical Estimates of Depreciation Upon Default

Variables	(1) RR-benchmark (1971-2010)	(2) RR-income (1971-2010)	(3) RR-income/debt (1971-2010)	(4) RR-income/debt (1971-2010)	(5) CT-benchmark (1980-2014)	(6) CT-S&P Rating (1980-2014)
$Def_{i,t}$	0.31*** (0.055)	0.26*** (0.056)	0.24*** (0.060)		0.33*** (0.049)	0.28*** (0.052)
Domestic $Def_{i,t}$				0.27*** (0.089)		
Constant	0.088*** (0.023)	0.094*** (0.020)	0.100*** (0.020)	0.096*** (0.019)	0.17*** (0.018)	0.17*** (0.015)
Observations	1,951	1,792	1,599	1,566	43,315	43,315
FE	Year	Year x Income	Year x Income x Debt	Year x Income x Debt	Month	Month x Rating
Implied $\alpha$	0.34	0.29	0.27	0.30	0.40	0.34

Notes: This table reports empirical estimates for the regression  $Dept_{t-\Delta,t,t} = a_{Group(i),t} + \beta Def_{i,t} + \epsilon_{i,t}$ . In Columns 1-4, we use annual default time from Reinhart and Rogoff (2008) for the post-Bretton Woods era (1971-2010). In Columns 5-6, we use monthly default time from Cruces and Trebesch (2013a) for 1980-2014. Different fixed effects are used for each column. The dependent variable in all regression is backward-looking 5-year exchange rate depreciation. The independent variable  $D_{i,t}$  is a binary variable indicating whether a sovereign default/restructuring occurs in country  $i$  at time  $t$ . The constant reports the average fixed effect. The fixed effect "Income" refers to one of the three income groups (the top 33, middle 34 and bottom 33 percent based on per capita income at  $t - 5$  obtained from the Total Economy Database). The fixed effect "Debt" refers to one of the three debt levels (the top 33, middle 34 and bottom 33 percent based on government debt to GDP at  $t - 5$  obtained from Reinhart and Rogoff (2008)). The fixed effect S&P rating refers to a coarse measure of credit rating given by S&P (1=AAA;2=AA+/AA/AA-; 3=A+/A/A-; 4=BBB-/BBB/BBB+; 5=BB-/BB/BB+; 6=B-/B/B+; 7=All C ratings; 8=D/SD; 9=unrated). Only the first year (month) of each default episode is used in the estimation. The row "implied  $\alpha$ " reports LC depreciation in the default state relative to the counterfactual non-default state:  $\alpha = 1 - (1 - \bar{a} - \beta)/(1 - \bar{a})$ , where  $\bar{a}$  denotes the average fixed effect estimate (the constant). The standard errors are clustered at the country level. Significance levels are denoted by \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

In summary, we estimate a 36 to 37 percent risk-neutral depreciation upon default using quanto CDS spreads and a 27 to 34 percent depreciation based on historical calibration. These empirical estimates are broadly in line with the 39 percent depreciation over default that would equalize expected default losses for LC and FC debt under the dollar risk-neutral measure. Therefore, the positive covariance between currency and default risk offers a quantitatively plausible explanation for the persistently negative LC-over-FC credit spread differentials, even if credit risk on LC and FC debt is the same under the dollar risk-neutral measure.

### 1.4.3 Financial Market Frictions

In the presence of financial market frictions, Assumption 1 fails to hold. The comparison between LC and FC credit spreads not only highlights the differential credit risk between the two types of debt, but also various financial market frictions that have differential impacts on the LC and FC credit spreads. We now discuss the impacts of the four types of frictions that we abstract from under Assumption 1: (1) differential liquidity risk; (2) market segmentation between domestic and external debt markets; (3) short-selling constraints; and (4) no-arbitrage violations in the currency markets. We will discuss how each of these frictions will cause our measures of the LC risk-free rate and LC credit spread to differ from their frictionless interpretations offered by Propositions 1 and 2.

**Liquidity Risk** In addition to differential credit risk, differential liquidity risk between the swapped LC and FC debt can also create a wedge between the two credit spreads. We assess the liquidity of swapped LC debt and FC debt by comparing bid-ask spreads, market sizes and trading volume on both types of debt. A summary table of liquidity and trading volume at the country level can be found in Appendix Table 25. We obtain bid-ask spreads on LC and FC bonds by averaging yield bid-ask spreads across all sovereign bonds with remaining maturities between 2 and 10 years in Bloomberg for each sample country. The

sample mean bid-ask spread is equal to 11.1 basis points for the LC debt and 14.5 basis points for the FC debt. The mean bid-ask spread on the 5-year currency swaps is equal to 38.2 basis points, greater than the bid-ask spread on the LC and FC bonds. In terms of market sizes and trading volume, we obtain data from the quarterly Debt Trading Volume Survey compiled by the EMTA. The survey participants consist of around 60 offshore large financial institutions, including most of the well-known investment banks and a few hedge funds. The mean reported quarterly trading volume reported in the EMTA surveys is equal to \$49 billion for LC bonds and \$25 billion for FC bonds.<sup>22</sup> We aggregate total CCS notional exchanged from the Depository Trust & Clearing Corporation (DTCC) available on the Bloomberg Swap Depository Reporting platform for 2013. The mean quarterly trading volume for CCS in our sample is about \$9 billion, lower than the trading volume of LC and FC bonds.

Therefore, investors in the synthetic swapped LC bonds have long positions in the more liquid cash market and short positions in the less liquid swap market, and hence have better overall liquidity than if they held FC bonds. The potential liquidity premium would be translated into lower spreads for swapped LC bonds. To analyze the effect of the time-varying liquidity risk on the spread differential, we perform a contemporaneous regression of changes in LC and FC credit spreads and LC-over-FC credit spread differentials on changes in bid-ask spreads on bonds and swaps in Table 6. Conditional on VIX and our host of macroeconomic controls, we find that a 1 basis point increase in the bid-ask spread of the FC bond and the currency swap significantly reduces the LC-over-FC credit spread differential by 1.5 and 2 basis points, respectively. The impact of the LC bond bid-ask on credit spread differential is also positive, although statistically insignificant.

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<sup>22</sup>Since the size of the LC bond market is about five times as large as the FC bond market, the turnover ratio (defined as the trading volume divided by total outstanding debt) by offshore participants is lower for LC debt (28 percent) than for FC bonds (74 percent). However, since foreign holdings represent 15 percent of outstanding LC debt in the sample, on average, a back-of-the-envelope calculation suggests that if local investors traded 28 percent as frequently as foreigners, the total turnover ratios for LC and FC debt would be the same.

Table 6: Regressions of Quarterly Changes in Yield Spreads, 2005-2014

	(1)	(2)	(3)	(4)	(5)
	$\Delta s^{LCCS}$	$\Delta s^{FCCS}$	$\Delta s^{LC/FCCS}$	$\Delta s^{LC/US}$	$\Delta ccs$
$\Delta VIX$	0.020	0.099***	-0.079**	0.0035	-0.017
	(0.033)	(0.013)	(0.034)	(0.034)	(0.027)
$\Delta ba^{LC}$	0.0062	0.0053**	0.00090	0.0030	-0.0032
	(0.0062)	(0.0022)	(0.0056)	(0.0071)	(0.0041)
$\Delta ba^{FC}$	0.0085	0.023**	-0.015**	0.022**	0.014
	(0.0085)	(0.011)	(0.0074)	(0.010)	(0.011)
$\Delta ba^{CCS}$	-0.0052**	0.0042**	-0.0094***	-0.0022	0.0030
	(0.0025)	(0.0020)	(0.0034)	(0.0032)	(0.0031)
$\Delta CFNAI$	-0.18**	-0.14*	-0.046	-0.17	0.010
	(0.093)	(0.071)	(0.059)	(0.16)	(0.20)
<i>Other Controls</i>					
$\Delta FC Debt/GDP$	0.18**	0.25**	-0.071	0.18*	0.0042
$\Delta LC Debt/GDP$	-0.053**	-0.018	-0.035	-0.039*	0.014
$\Delta Reserve$	0.0043	0.0015	0.0029	-0.0047	-0.0090
$\Delta IP$	-0.0063	-0.014**	0.0079**	-0.0058	0.00058
$\Delta \pi$	0.070**	0.052***	0.018	0.24***	0.17**
$\Delta \sigma_{\pi}$	0.056	0.057	-0.00060	-0.063	-0.12
$\Delta ToT$	-0.0035	0.0016	-0.0051	-0.0015	0.0020
$\Delta \sigma_{ToT}$	0.0039	0.029***	-0.025**	-0.0032	-0.0071
$\Delta \sigma_{MSCI}$	0.14**	0.18***	-0.046	0.39***	0.25***
<i>Observations</i>	347	347	347	347	347
<i>Within R-Squared</i>					
<i>Full model</i>	0.168	0.577	0.258	0.222	0.116
<i>Without VIX or Liquidity</i>	0.143	0.393	0.083	0.211	0.091
<i>With VIX and Liquidity Only</i>	0.077	0.450	0.228	0.086	0.048

*Notes:* This table reports fixed-effect panel regression results for quarterly changes in yield spreads. The dependent variables are: (1)  $\Delta s^{LCCS}$ , change in the LC credit spread spread; (2)  $\Delta s^{FCCS}$ , change in the FC credit spread; (3)  $\Delta s^{LC/FCCS}$ , change in the LC over FC credit spread; (4)  $\Delta s^{LC/US}$ , change in the LC nominal spread; (5)  $\Delta CCS$ , change in the cross-currency swap rate. The independent variables are:  $\Delta VIX$ , change in monthly standard deviation of implied volatility on S&P index options (conventional quote/ $\sqrt{12}$ );  $\Delta ba^{LC}$ ,  $\Delta ba^{FC}$  and  $\Delta ba^{CCS}$ , changes in mean bid-ask spreads on all LC and FC bonds between 2 to 10 years in Bloomberg and on 5-year par CCS in basis points, respectively;  $\Delta CFNAI$ , change in the Chicago Fed National Activity Index;  $\Delta FC(LC) Debt/GDP$ , change in FC (LC) debt to GDP ratios from the BIS debt securities statistics;  $\Delta Reserve$ , log change in FX reserves;  $\Delta IP$ , percentage change in the year-over-year (y.o.y) industrial production index;  $\Delta \pi$ , percentage change in y.o.y inflation;  $\Delta \sigma_{\pi}$ , change in 12-month rolling standard deviation of y.o.y inflation;  $\Delta ToT$ , log change in terms of trade;  $\Delta \sigma_{ToT}$  change in 12-month rolling standard deviation of  $\Delta ToT$ ; and  $\Delta \sigma_{MSCI}$ , change in 30-day rolling standard deviation of daily local MSCI equity returns. All regressions are run at the quarterly frequency with country fixed effects using Newey-West standard errors with 8-quarter lags clustered by quarter following Driscoll and Kraay (1998). Significance levels are denoted by \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Furthermore, we show that liquidity factors significantly forecast bond excess returns in Table 7. The top panel shows that the bid-ask spreads on FC bonds and offshore currency swaps predict positive excess returns on the FC bonds. Although currency swaps are not used in constructing FC excess returns, the liquidity of currency swaps is indicative of the overall offshore liquidity condition. In the middle panel for swapped LC bonds, we show that illiquidity of LC bonds positively forecasts excess returns, while illiquidity of FC bonds and currency swaps negatively forecasts excess returns. Finally, the same set of liquidity factors are powerful predictors of the FC-over-swapped LC excess returns, which suggests time-varying differential liquidity risk premia between swapped LC and FC debt.



Table 7: Forecasting Quarterly Holding-Period Excess Returns, 2005-2014

		<i>VIX</i>	<i>CFNAI</i>	<i>ba<sup>LC</sup></i>	<i>ba<sup>FC</sup></i>	<i>ba<sup>CCS</sup></i>	<i>Other Controls</i>	<i>R</i> <sup>2</sup>
<i>rx<sub>t+3</sub><sup>FC/US</sup></i>	(1)	1.67*** (0.55)					No	0.0910
	(2)		-3.07* (1.71)				No	0.0250
	(3)	2.03** (0.91)	1.760 (2.49)				No	0.0950
	(4)	1.59* (0.83)	1.990 (2.43)	0.0220 (0.042)	0.24*** (0.091)	0.15*** (0.034)	No	0.205
	(5)	1.62* (0.89)	2.890 (2.15)	0.0470 (0.067)	0.17** (0.084)	0.17*** (0.032)	Yes	0.275
<i>srx<sub>t+3</sub><sup>LC/US</sup></i>	(1)	0.480 (0.33)					No	0.00900
	(2)		-0.810 (1.19)				No	0.00200
	(3)	0.560 (0.49)	0.380 (1.63)				No	0.00900
	(4)	0.620 (0.58)	-0.160 (1.74)	0.25*** (0.068)	-0.0240 (0.10)	-0.085** (0.034)	No	0.0320
	(5)	0.850 (0.65)	1.640 (1.60)	0.25*** (0.084)	-0.140 (0.13)	-0.069** (0.034)	Yes	0.0900
<i>srx<sub>t+3</sub><sup>FC/LC</sup></i>	(1)	1.19*** (0.29)					No	0.0360
	(2)		-2.26** (0.93)				No	0.0110
	(3)	1.47*** (0.45)	1.380 (1.13)				No	0.0380
	(4)	0.97*** (0.33)	2.15** (1.05)	-0.23*** (0.083)	0.260 (0.16)	0.24*** (0.044)	No	0.187
	(5)	0.77** (0.35)	1.250 (0.87)	-0.20*** (0.070)	0.30* (0.17)	0.23*** (0.037)	Yes	0.221

*Notes:* This table reports annualized quarterly return forecasting results for  $rx_{t+3}^{FC/US}$ , FC-over-US excess returns,  $srx_{t+3}^{LC/US}$ , swapped LC over-U.S. excess returns, and  $srx_{t+3}^{FC/LC}$ , FC-over-swapped LC excess returns. *Other Controls* refer to all other macroeconomic controls used in Table 6, expressed in levels. Mark-to-market accounting is used to calculate returns for swapped LC bonds to take into account second-order currency hedging errors due to the covariance between currency and credit. The LC swap and bond positions are re-balanced at the daily frequency so that the two positions have the same market value. All regressions are run at monthly frequency with country fixed effects using Newey-West standard errors with 24-month lags clustered by month following Driscoll and Kraay (1998). Significance levels are denoted by \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

**Market Segmentation and Slow-Moving Capital** In addition to differential cash flow, liquidity risks and short-selling constraints, the strong correlation between FC credit spreads and VIX and the lack of strong correlation between LC credit spreads and risk motivate us to consider potential market segmentation between domestic and external debt markets. For emerging market 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. These domestic entities are often required by law to hold a large fraction of their portfolios in LC treasury bonds, which gives rise to a distinct local clientele demand that is absent from the external debt market.<sup>23</sup> While shocks to global risk aversion have perfect pass-through into the FC credit spread, but incomplete pass-through into the LC credit spread due to imperfect market integration and risky arbitrage, driving the credit spread differentials.

Using VIX as a proxy for global investors' risk aversion, we show in Table 6 that VIX has a smaller impact on the LC credit spread than on the FC credit spread, conditional on liquidity and macroeconomic fundamentals. The coefficient on VIX for the FC credit spread in Column 2 is five times as large as the coefficient for the LC credit spread in Column 1. The coefficient on VIX in the LC-over-FC credit spread differential regression (Column 3) is negative and statistically significant. In our estimated sample, a one standard deviation increase in  $\Delta VIX$  decreases the credit spread differential by 18 basis points. The largest spike in VIX following the Lehman Brothers bankruptcy corresponds to a 3.3 standard deviation increase in  $\Delta VIX$  over its mean, which can generate around a negative 60 basis point differential in LC and FC credit spreads.

If VIX has contemporaneous differential impacts on LC and FC credit spreads through the risk premium channel, we should also expect VIX to have differential predictive power for LC and FC excess returns. Consistent with the prediction, Table 7 shows that high

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<sup>23</sup> Kumara and Pfau (2011) document stringent caps faced by emerging market pension funds in investing in local equities and overseas assets.

VIX predicts higher FC excess returns (top panel) and positive FC-over-swapped LC excess returns (bottom panel). The positive predictive power of VIX for FC-over-swapped LC excess returns naturally gives rise to an investment strategy of going long in the FC bond and short in the swapped LC bond when VIX is high.

**Short-Selling Constraints** In this subsection, we discuss impacts of short-selling constraints on the valuation of LC and FC credit spreads. We show that it is generally more difficult to borrow LC than FC debt from global securities lenders. Markit Securities Finance (formerly known as Data Explorer) provides security-level lending information covering more than 20,000 institutional funds. We use 12 quarter-end reports from Markit Securities Finance between 2012 and 2014 to document the differences in inventories for lendable securities, actual lending amounts and average lending fees across the two types of debt.

We present the country-level summary statistics in Appendix Table 26. The average daily inventory for lendable FC sovereign bonds in our sample countries is equal to \$40 billion, which accounts for about 11 percent of total outstanding FC sovereign debt securities. The total average daily inventory for LC bonds is \$23 billion, which accounts for less than 1 percent of total outstanding LC sovereign debt securities. In addition to lower inventory levels, the actual inventory utilization rates are also significantly lower for LC debt than for FC debt. On average, only 4 percent of lendable LC bonds are actually lent out, compared with 12 percent of FC bonds. There is significant cross-country heterogeneity in the size of LC securities lending. We only observe negligible amounts (below of \$1 million) of securities lending for LC bonds in Indonesia, Israel, Mexico and Philippines. On the other hand, Hungary and Poland have sizable LC bond lending, with the average balance over \$300 million, which is comparable with lending of FC bonds. In terms of average lending fees on

the existing transactions, it costs 21 basis points to short FC bonds and 31 basis points to short LC bonds,<sup>24</sup> significantly higher than the fees for shorting FC bonds.

Following the existing literature, we know the existence of short-selling constraints can increase securities prices, either because more pessimistic investors are kept away from participating in the market (i.e., Miller, 1977) or because there are search and bargaining frictions associated with shorting securities (i.e., Duffie et al., 2002). Therefore, short-selling constraints can potentially lower LC credit spreads, more so than FC credit spreads. To arbitrage the mispricing, an investor needs to pay the borrowing cost to short LC bonds. Therefore, the short-selling constraints cannot explain away positive LC credit spreads, but can potentially explain temporarily negative LC credit spreads. The short-selling constraints can also contribute to negative LC-over-FC credit spread differentials.

**No-Arbitrage Violations in the Currency Market** In addition to segmentation between domestic and external debt markets, the potential segmentation and slow moving-capital in the FX markets can also affect our LC credit spread measure. Assuming the FX spot and forward markets are frictionless, the CIP condition would hold between risk-free rates across currencies. However, several papers have documented the failure of the short-term CIP condition between money market rates in developed markets during the financial crisis (Baba, 2009; Coffey et al., 2009 and Griffoli and Ranaldo, 2011). The CIP failures during the crisis share a common feature: The synthetic dollar borrowing cost was higher than the direct dollar borrowing cost. The authors attribute the breakdown of the no-arbitrage condition to a severe dollar shortage during the crisis.<sup>25</sup> Ivashina et al. (forthcoming) argue that the dollar shortage facing European banks during the European debt crisis prompted

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<sup>24</sup>The empirical literature on borrowing and shorting defaultable bonds is quite limited. Recently, Asquith et al. (2013) present some stylized facts for borrowing corporate bonds using a proprietary dataset from a major securities lender and show that the cost of borrowing is between 10 to 20 basis points, comparable to the cost of shorting stocks.

<sup>25</sup>We note that at the peak of the crisis, CIP deviation was much smaller at medium to long tenors than at short tenors. While the papers find an approximately 300 basis point CIP deviation based on LIBOR for the euro/dollar pair at short tenors of up to one year, the most negative 5-year cross-currency basis for the euro/dollar pair was around negative 50 basis points during the peak of the crisis.

these banks to swap euro funding into dollar funding using FX swaps, which resulted in CIP violations when there was limited capital to take the other side of the trade. More generally, Hau and Rey (2006) and Gabaix and Maggiori (forthcoming) examine the role of capital flows in determining exchange rates in imperfect financial markets.

If the dollar shortage affected our sample emerging market currencies, then the LC credit spread based on the synthetic LC risk-free rate constructed from U.S. Treasuries and CCS rates would overstate the credit risk component of the LC sovereign debt. However, the alternative LC credit spread based on the supranational yield presented in Section 1.3.4 should not be directly affected, as no swaps are used in the construction. In Appendix 5.1.3, we measure no-arbitrage violations in the FX markets for emerging markets using CIP deviations between supranational yields in emerging market currencies and the dollar. We argue that while long-term CIP deviations can be significant during the crisis, they are much smaller in size on average than LC credit spreads.

## 1.5 Conclusion

The last decade has seen a remarkable change in emerging market government finance, as major emerging markets sovereigns are increasingly borrowing in their own currency. In this paper, we introduce a new measure of LC sovereign risk, the LC credit spread, defined as the difference between the LC bond yield and the LC risk-free rate implied by the swap market. Using this new measure, we document several key findings. First, emerging market LC bonds promise to pay a significant positive credit spread over the LC risk-free rate when they borrow in their own currency, despite the sovereign's option to inflate away the debt. Second, LC bonds have lower credit spreads than FC bonds issued by the same sovereign. The LC-over-FC credit spread differential became even more negative during the peak of the global financial crisis. Third, FC credit spreads are very integrated across countries and responsive to global risk factors, but LC credit spreads are much less so.

After presenting the stylized facts, we discuss several sources of credit spread differentials: (1) selective default, jurisdiction and capital control risks; (2) covariance between currency and default risk; and (3) various financial market frictions, including illiquidity, short-selling constraints, market segmentation and slow-moving capital. We provide broad estimates for the quantitative effects of these explanations. A better understanding of LC sovereign risk and its relationship with FC sovereign risk is a fruitful area for future research.

## 2 Sovereign Risk, Currency Risk, and Corporate Balance Sheets

### 2.1 Introduction

During the 1980s, 1990s, and early 2000s, a number of sovereign debt crises engulfed emerging markets. While the details of each sovereign debt crisis were different, the broader story remained the same: the government borrowed from foreign investors in foreign currency (FC) during good times only to later default on their external debt as economic conditions deteriorated. In response to these crises, emerging market governments curtailed their FC borrowing and moved towards borrowing in their local currency (LC). Using a newly constructed comprehensive dataset on the currency composition of sovereign and corporate external debt, we find that over the last decade major emerging market sovereigns went from having around 85% of their external debt in FC to borrowing more than half of their external sovereign debt in their own currency. By contrast, even as governments were dramatically changing the way they finance themselves, the private sector continued to borrow from foreigners almost entirely in FC.

Despite their shift towards LC debt, emerging market (EM) sovereigns continue to be charged a positive credit spread when they borrow in their own currency. In our previous work (Du and Schreger, 2014b), we calculate a measure of the default-free LC interest rate using cross-currency swaps and show that emerging market sovereigns borrow at a significant credit spread above the risk-free rate in their own currency. These positive LC credit spreads suggest that nominal LC sovereign bonds are not default-free. Furthermore, LC credit spreads remain positive even for countries where the sovereign external liabilities are almost exclusively denominated in LC, such as Thailand, Malaysia and South Korea. This raises the question of why a sovereign would default on debt denominated in its own currency when it could instead inflate the debt away. The simplest answer is that it would default if it were less painful to do so than to experience inflation high enough to restore fiscal solvency.

In this paper, we argue that the private sector's continuing reliance on external FC debt raises the cost of inflating away sovereign debt and explains why sovereign default risk remains even though governments increasingly borrow in their own currency. If the private sector earns revenues in LC but has borrowed extensively in FC, a depreciation could adversely affect firm net worth, which in turn could reduce aggregate output in the presence of firm financial constraints. The idea that corporate balance sheet mismatch could make depreciations contractionary was studied extensively following the Asian Financial Crisis.<sup>26</sup> The theoretical contribution of this paper is to demonstrate how these contractionary effects working through corporate balance sheets can be a source of default risk on LC sovereign debt.

We begin by documenting the dramatic contrast between the currency denomination of sovereign and corporate external portfolios in 14 major emerging markets. We find that sovereigns are increasingly borrowing in LC from foreign investors, while corporate external liabilities still remain largely in FC. Since 2003, we find that the average fraction of external sovereign debt in LC increased from around 15% to almost 60%. However, during this same period, the share of external private sector debt in LC only increased from 7% to 10%. Figure 10 documents the sharp rise of foreign participation in LC sovereign debt markets and shows that foreign holdings now account for approximately one-third of all outstanding local currency sovereign debt.

We then demonstrate the relevance of the balance sheet channel by showing that Brazilian and Mexican firms that are more indebted in FC are more adversely affected by a currency depreciation than other firms. We do so by showing that firms with more of their liabilities in FC are more sensitive to changes in the exchange rate, measured through changes in credit spreads and excess equity returns.

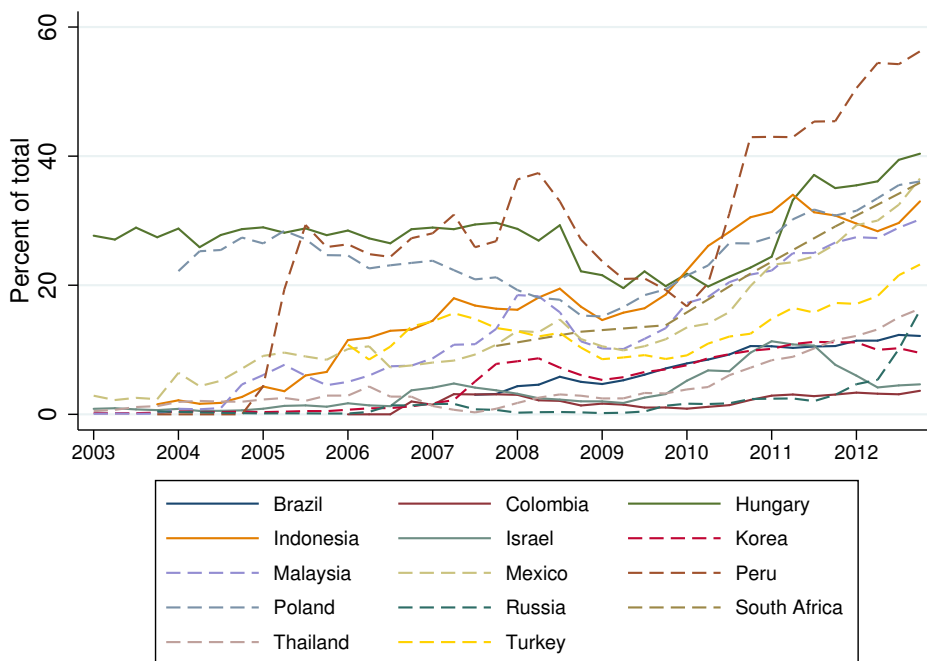
The composition of corporate balance sheets has significant implications for sovereign credit risk. We use our cross-country dataset on the currency composition of external lia-

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<sup>26</sup>See, for instance, Krugman (1999), Céspedes et al. (2004), Gertler et al. (2007), and Aghion et al. (2000, 2001, 2004). Korinek (2010) explores the effects of the private sector borrowing in foreign currency.



Figure 10: Share of Foreign Ownership of Outstanding Domestic LC Sovereign Debt Securities



*Notes:* Share of foreign ownership of domestic sovereign debt in 14 emerging markets. Data are from national sources or the Asian Development Bank, with details in the appendix.

bilities to show that a higher reliance on external FC corporate financing is associated with a higher default risk on sovereign debt. In a panel regression, conditional on the variables the literature has shown to explain sovereign credit spreads, we find that an increase in the ratio of private FC debt-to-GDP of 10% is associated with an approximately 30 basis point increase in the sovereign LC credit spread.

Motivated by the dramatic changes in emerging market borrowing and the empirical evidence on the importance of private FC debt for sovereign risk, we introduce LC sovereign debt and an entrepreneurial sector with FC external liabilities and LC revenues into the canonical Eaton and Gersovitz (1981a) sovereign default model, as formulated in a quantitative framework by Aguiar and Gopinath (2006) and Arellano (2008). The model demonstrates that the borrowing patterns of the private sector can have large effects on the nature of sovereign risk. When the private sector is highly mismatched, meaning private debt is overwhelmingly in FC but revenues are in LC, the sovereign is reluctant to allow an exchange rate depreciation

to reduce the real value of its debt, generating a “Fear of Floating” as in Calvo and Reinhart (2002). In this case, when the government considers whether to default or use inflation to reduce the fiscal burden of sovereign debt repayments, it is relatively more inclined to explicitly default than to inflate away the debt because of the effect of depreciation on the private sector.

When the sovereign is forward-looking but cannot commit to state-contingent policies, the sovereign’s inability to commit not to inflate or default generates a debt Laffer curve, where the market value of outstanding sovereign debt initially increases with the face value of debt before reaching the peak of the curve. In equilibrium, the sovereign borrows on the good side of the debt Laffer curve, where revenue is increasing with the face value of the debt. If the temptation to inflate away the debt occurs at lower borrowing levels than the temptation to default, then a government that internalizes the effect of the amount it borrows on the interest rate it is charged may never borrow enough to potentially default. We demonstrate that this is the case when the corporate sector is not overly reliant on FC external financing, meaning that sovereign debt can be free from default risk in equilibrium when there are low levels of corporate currency mismatch.

A calibration of the dynamic model to the average share of corporate debt in our panel of emerging markets produces simulated moments of currency and credit risk very similar to the cross-country mean empirical moments documented in our previous work (Du and Schreger (2014b)). The model suggests that relatively small reductions in the share of private external borrowing in FC could significantly reduce the probability of a sovereign default. The model’s prediction on the rate at which sovereign credit risk declines with the share of LC corporate debt finds strong support in the data.

This paper makes two primary contributions. First, we provide a comprehensive account of the currency composition of external liabilities by sector in emerging markets. This contributes to the work on “Original Sin,” beginning with Eichengreen and Hausmann (1999), and the evolution of the currency composition of external liabilities documented in Lane and

Shambaugh (2010). A series of recent papers document the rapid growth in foreign participation in domestic LC sovereign debt markets, for example, Burger and Warnock (2007), Burger et al. (2012), Burger et al. (2014) and Arslanalp and Tsuda (2014). We combine data on foreign participation in domestic sovereign debt markets with data on international debt securities and cross border loans and demonstrate how including foreign ownership of domestic debt in calculations of external debt significantly changes the aggregate currency composition of sovereign external liabilities. Vulnerabilities in the emerging market corporate sector coming from external foreign currency borrowing have recently been highlighted by the BIS in Avdjiev et al. (2014) and Chui et al. (2014). We argue that these vulnerabilities in the corporate sector are a source of sovereign risk. The second major contribution of the paper is that we offer a new explanation for why nominal sovereign debt may not be default free. The history of sovereign default on domestic debt is addressed in detail in Reinhart and Rogoff (2008, 2011). We contribute to the large literature on the determinants of sovereign credit risk by demonstrating how the borrowing patterns of the private sector affect sovereign risk.<sup>27</sup> The theoretical section contributes to the international finance literature on sovereign default by introducing LC sovereign debt and a mismatched corporate sector into the Aguiar and Gopinath (2006) and Arellano (2008) formulation of the Eaton and Gersovitz (1981a) model. We build on recent papers that introduce long-term bonds into this framework, such as Hatchondo and Martinez (2009), Arellano and Ramanarayanan (2012), and Chatterjee and Eyigungor (2012). Our corporate sector builds on Céspedes et al. (2004) and Gertler et al. (2007), who study a Bernanke et al. (1999) financial accelerator in the open economy when firms potentially borrow in foreign currency. Our contribution is to integrate a simplified version of this channel into a sovereign default framework to examine how the cost of depreciation arising from this balance sheet channel can affect sovereign risk. We contribute to a growing literature on the default risk on nominal debt, including recent work by Aguiar et al. (2013), Corsetti and Dedola (2013), Araujo et al. (2013) and Sunder-

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<sup>27</sup>See, for instance, Edwards (1984), Eichengreen and Mody (1998), Hilscher and Nosbusch (2010b), Longstaff et al. (2011b) and Uribe and Yue (2006).

Plassmann (2013), by exploring a channel through which differences in private borrowing behavior explain why the risk of sovereign default on nominal debt varies across countries.

Our paper is organized as follows. In Section 2.2, we review the evidence of credit risk on LC denominated debt documented in our earlier work (Du and Schreger, 2014b). Section 2.3 constructs measures of the currency composition of external sovereign and corporate portfolios and examines the contrasting behavior of sovereign and corporate external borrowing. Section 2.4 provides empirical evidence on the effect of corporate FC liabilities on the vulnerability of firms to exchange rate depreciation and the relationship between private FC debt and sovereign default risk. Sections 2.5 and 2.6 present a new sovereign default model featuring LC sovereign debt and FC corporate financing. Section 2.7 concludes.

## 2.2 Measuring Credit Risk on LC Sovereign Debt

The first challenge in examining the default risk on LC sovereign debt is to measure it separately from currency risk. When a country borrows in a foreign currency, for instance the US dollar, the credit spread is measured as the difference between the yield a borrowing government pays and the yield on a U.S. Treasury bond of the same duration. However, when a government borrows in its own currency, the difference in the yield it pays versus what the U.S. government pays to borrow in dollars might be compensating investors for the risk that the local currency depreciates (“currency risk”) as well as the risk that the sovereign explicitly defaults on the debt (“credit risk”). In our previous work, Du and Schreger (2014b), we propose a way to measure the credit risk on LC sovereign debt in emerging markets that separates the credit risk from the currency risk. We define the LC credit spread ( $s_t^{LCCS}$ ) as the gap between an emerging market sovereign bond yield ( $y_t^{LC}$ ) and the LC risk-free rate implied by the U.S. Treasury bond yield ( $y_t^*$ ) and the fixed-for-fixed LC/USD cross currency swap rate ( $\rho_t$ ),

$$s_t^{LCCS} = y_t^{LC} - (y_t^* + \rho_t), \quad (18)$$

The way to understand the LC risk-free rate ( $y_t^* + \rho_t$ ) is to think of it as the nominal interest rate that the US government (assumed to be default-free) would pay if it issued a bond in an emerging market currency. The fixed-for-fixed LC/USD cross currency swap rate  $\rho_t$  is the interest rate differential an investor receives when converting fixed dollar cash flows into fixed LC cash flows. When dealing with zero-coupon bonds,  $\rho_t$  is simply the long-horizon forward premium. By using cross currency swaps to convert the fixed dollar cash flows from a US Treasury into fixed LC cash flows, we construct a synthetic LC instrument that is free from sovereign default risk. The LC credit spread measures how much an emerging market sovereign pays to borrow relative to this default-free benchmark in its own currency. In other words, the LC credit spread measures the deviation from long-term covered interest rate parity between a nominal sovereign bond and a US Treasury.

If emerging market sovereign debt were free from credit risk, the LC credit spread should equal zero in the absence of arbitrage. However, when we look at emerging markets, we see that they borrow at a significant credit spread even in their own currency. From 2005-2012, for 13 emerging markets,<sup>28</sup> the mean LC credit spread is 128 basis points for five-year bonds. This is in stark contrast to a developed economy like the United Kingdom, where the mean LC credit spread is under 10 basis points on average over the same time period.

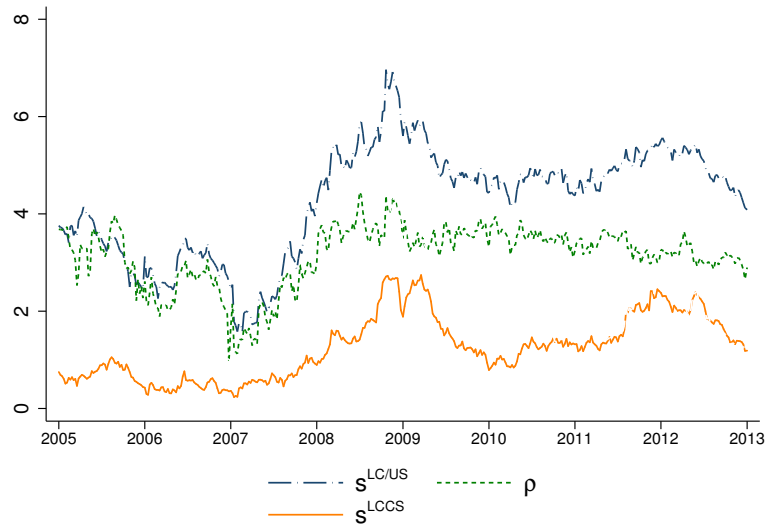
Throughout the paper, we refer to  $s^{LCCS}$  as the credit risk of an LC bond and  $\rho$  as the currency risk component of the bond. Using the LC credit spread definition given in Equation 18, we can decompose the nominal yield differential between an emerging market sovereign LC bond and a U.S Treasury ( $s^{LC/US}$ ) into a credit and a currency component:

$$s_t^{LC/US} = s_t^{LCCS} + \rho_t. \tag{19}$$

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<sup>28</sup>The included countries are Brazil, Colombia, Hungary, Indonesia, Israel, South Korea, Malaysia, Mexico, Peru, Poland, South Africa, Thailand and Turkey. Russia is excluded as the local currency debt market was not investable for foreigners during much of the period. See Du and Schreger (2014b) for details on the segmentation of Russia's domestic debt market.

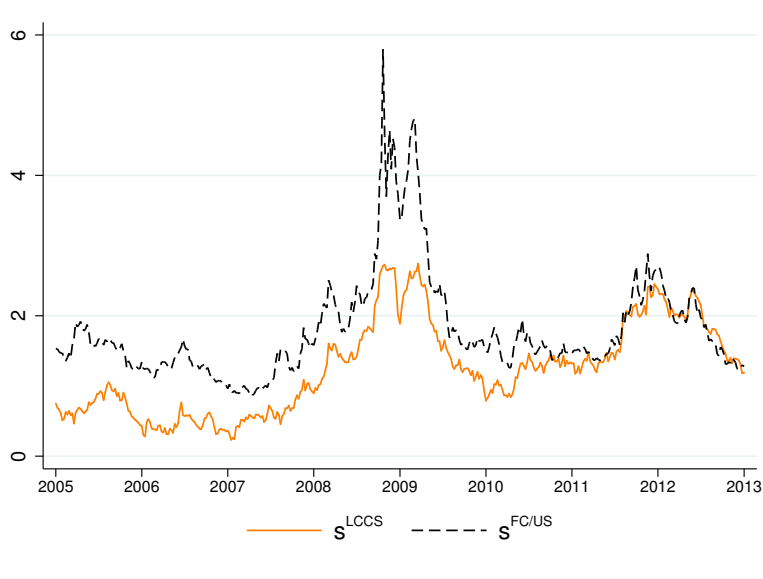
Figure 11: Currency Risk, Credit Risk and the Nominal Spread on LC Sovereign Debt: Cross-Country Average



Notes:  $s^{LC/US}$  is the nominal spread between a 5 year LC sovereign bond and a 5 year US Treasury.  $\rho$  is the fixed-for-fixed 5-year zero coupon cross-country swap rate.  $s^{LCCS}$  is the local currency credit spread, the difference between  $s^{LC/US}$  and  $\rho$ . The countries included are Brazil, Colombia, Hungary, Israel, South Korea, Mexico, Malaysia, Peru, Philippines, Poland, Thailand, Turkey and South Africa. All data is from Bloomberg.

In Figure 11, we plot the cross-country average of the nominal spread  $s^{LC/US}$ , credit risk  $s^{LCCS}$  and currency risk  $\rho$  on nominal LC sovereign debt. This broad pattern, with around 75% of the nominal spread composed of currency risk and the remaining 25% composed of credit risk, will be the key moment of interest in the dynamic model. In appendix Table 28, we report summary statistics for currency and credit risk in each of our sample countries.

Figure 12: Credit Risk on LC and FC Sovereign Debt: Cross-Country Average



Notes:  $s^{LCCS}$  is the local currency credit spread, the difference between  $s^{LC/US}$  and  $\rho$ .  $s^{FC/US}$  is the foreign currency credit spread derived from credit default swaps. The countries included are Brazil, Colombia, Hungary, Israel, South Korea, Mexico, Malaysia, Peru, Philippines, Poland, Thailand, Turkey and South Africa. CDS data are from Markit and LC nominal yields and cross currency swap rates from Bloomberg.

In this paper, we do not consider selective defaults across LC and FC sovereign debt and abstract from the effects various capital market frictions in affecting sovereign credit spread measures.<sup>29</sup> In Figure 12, we plot a time series of the cross-country mean LC credit spread and the spread on FC debt (implied from credit default swaps (CDS)) for our sample countries. LC and FC credit spreads are strongly correlated, and have even recently converged to the same level on average. Because LC credit spreads measure default risk on LC debt and CDS spreads measure default risk on FC debt, the convergence of the credit spreads on the two types of debt suggests a market expectation for simultaneous default and restructuring. Indeed, between 1996-2012 Jeanneret and Souissi (2014) document 31 defaults on LC debt, 27 defaults on FC debt, with 15 of these instances being simultaneous default on both types of debt.

<sup>29</sup>We address the effects of factors such as capital controls, liquidity in the currency swap market, counterparty risk, and incomplete integration between domestic and external debt markets in detail in Du and Schreger (2014b).

## 2.3 The Changing Composition of Emerging Market External Portfolios

In this section, we combine various national and international data sources to construct measures of the currency composition of the external liabilities of the sovereign and corporate sectors in 14 major emerging markets. We document that emerging market sovereigns have shifted away from borrowing externally in foreign currency to borrowing primarily in LC. However, the external liabilities of the corporate sector remain heavily dollarized.

### 2.3.1 Dataset Construction and Definitions

The goal of this section is to construct a measure of the currency composition of emerging market external debt by the government and corporate sector. We define “external debt” as any public or private debt issued by emerging market entities and owed to nonresidents, regardless of the market of issuance. We can then classify external debt along three dimensions: currency, market of issuance, and sector. First, in terms of the currency classification, LC refers to debt for which the principal and coupons are denominated in the currency of the country of issuance and foreign currency debt is debt for which the principal and coupons are denominated in another country’s currency. Second, in terms of the market of issuance classification, international debt is defined as debt issued under foreign law in international markets and domestic debt is debt issued in domestic markets under domestic law. Finally, in terms of the sector classification, government debt is debt issued by central and local governments and social security funds and corporate debt is debt issued by the private sector of the economy. Table 8 illustrates the relationship between currency, market and sector classifications of emerging market external debt.



Table 8: Currency, Market and Sector Classification of External Debt

Government Debt			Corporate Debt		
	LC	FC		LC	FC
Domestic	LC Dom	FC Dom	Domestic	LC Dom	FC Dom
International	LC Int	FC Int	International	LC Int	FC Int

*Notes:* “LC Dom” refers to local currency domestic debt; “FC Dom” refers to foreign currency domestic debt; “LC Int” refers to local currency international debt; and “FC Int” refers to foreign currency international debt.

In the rest of this subsection, we discuss the construction of different components of external debt by currency and sector for debt securities and cross-border loans and deposits. We restrict our analysis to private lending to emerging markets, excluding official loans made by bilateral and multilateral organizations.

**Debt Securities** In this section, we discuss the construction of the amount of external debt securities outstanding by currency. We start with international debt. We assume that all international debt securities are held by nonresidents and thus count toward external debt. We obtain the amount of international debt securities outstanding for the sovereign and corporate sectors from the BIS debt securities statistics. The BIS does not report the currency composition of international debt securities at the country level. We address this data gap as follows. Only a few countries (Brazil, Colombia, Mexico, Peru and Russia) have ever issued LC denominated bonds in the international market. We construct amounts outstanding for these individual LC issuances and treat the rest of BIS sovereign international debt securities as FC. We obtain currency shares of corporate international debt securities by aggregating the entire universe of individual corporate bonds recorded in the Thomson One bond database for our sample countries.<sup>30</sup>

Second, in terms of non-resident holdings of domestic debt by currency, we assume that nonresident holdings of FC domestic debt are equal to zero. This assumption is reasonable

<sup>30</sup>The dataset includes all major characteristics of a bond deal, including issuance and maturity dates, currency of denomination and the market of issuance, etc. For each sample country, we aggregate net issuance of corporate bonds by currency (LC and FC) and by market (onshore and offshore) since 1998 to estimate outstanding amounts in each category.

because the outstanding amount of FC domestic debt is negligible.<sup>31</sup> The dataset of non-resident holdings of domestic LC sovereign debt for our 14 emerging markets comes from individual central banks, finance ministries, and the Asian Development Bank. The detailed data sources are given in the appendix. In simultaneous work, Arslanalp and Tsuda (2014) compiled a dataset of foreign holdings of domestic debt from similar sources, focusing on how this change affected emerging market vulnerability to funding shocks. There is no comparable national data available on foreign holdings of domestic corporate debt. Our estimation is based on our data on non-resident holdings of domestic LC sovereign debt and the U.S. Treasury International Capital (TIC) data. The TIC data measures U.S. investor holdings of corporate and sovereign debt and is the only ownership source of corporate debt we have by currency.<sup>32</sup> To approximate foreign holdings of domestic LC corporate debt, we make the assumption that U.S. investors compose an equal share of foreign investors in domestic corporate and domestic sovereign debt. For example, if U.S. investors account for 25 percent of total nonresident holdings of domestic LC sovereign debt for a given country, and hold \$250 million of LC corporate debt, we estimate that total foreign holdings of domestic LC corporate debt are equal to \$1 billion.<sup>33</sup>

**External Loans and Deposits** In addition to debt securities, we also consider cross-border loans and deposits as part of external debt. The data on total external loans and deposits come from the BIS Locational Banking Statistics (LBS).<sup>34</sup> The level of external loans for country  $i$  is given by the total claims of all BIS reporting countries against counterparty country  $i$ . Most developed and large developing countries are BIS reporting countries, and thus aggregate lending of BIS reporting countries to country  $i$  represents the majority of

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<sup>31</sup>For the countries with data available, we see that nonresident holdings of indexed and FC domestic debt are very small relative to nonresident holdings of LC domestic debt.

<sup>32</sup>We use the currency shares of corporate and sovereign debt calculated by Bertaut and Tabova (2014), which provides longer time series than the data published by the U.S. Treasury.

<sup>33</sup>More details on the TIC data and estimation of non-resident holdings of LC corporate debt securities can be found in Appendix 5.2.2.

<sup>34</sup>More details on the LBS dataset can be found in Appendix 5.2.2.

private sector cross-border loans from the rest of the world to country  $i$ . These portions of the data are publicly available.

To estimate the currency composition of these external loans, we use the restricted BIS Locational Banking Statistics, which classifies the currency of cross-border loans and deposits into reporting countries' home currencies, dollar, euro, yen, British pound, Swiss francs and residual currencies. From an emerging market country  $i$ 's perspective, the amount of loans and deposits denominated in the residual currencies of the reporting countries gives a very good proxy of the level of loans and deposits denominated in the LC of country  $i$ . To obtain the sectoral breakdown of cross-border loans, we construct the sovereign/corporate share by aggregating the entire universe of cross-border loans outstanding in the Thomson loan database.<sup>35</sup>

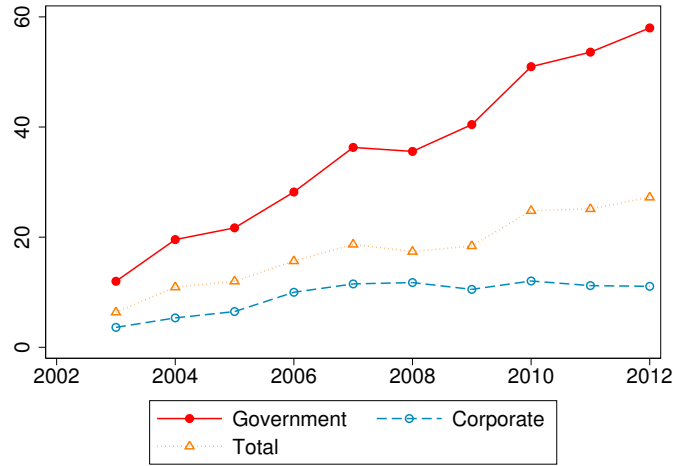
### 2.3.2 Comparison between Sovereign and Corporate Currency Portfolios

By combining these various sources, we find that the share of LC sovereign debt in the external portfolio increased from 15 percent to 60 percent over the past decade. Figure 13 plots the cross-country mean of the share of sovereign, corporate and total debt in LC from 2003-2012. However, EM sovereigns are not issuing debt in their own currency in international markets. Instead, foreign investors are buying sovereign debt issued under domestic law. While the share of FC is shrinking dramatically for sovereign external liabilities, external emerging market corporate debt remains primarily in FC. The shares of LC in corporate debt and private external bank loans have increased at a much slower pace, reaching about 10 percent in 2012. These aggregate numbers mask a substantial degree of cross-country heterogeneity, as can be seen in Table 9 and Appendix Figure 29. For instance, by 2012 over 90% of Thailand's external sovereign debt to private creditors was in LC, but less than 15% of Colombia's external sovereign debt was in LC. Despite this cross-country heterogeneity,

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<sup>35</sup>We define the loan deal cross-border if at least one bookrunner of the deal is a foreign bank.

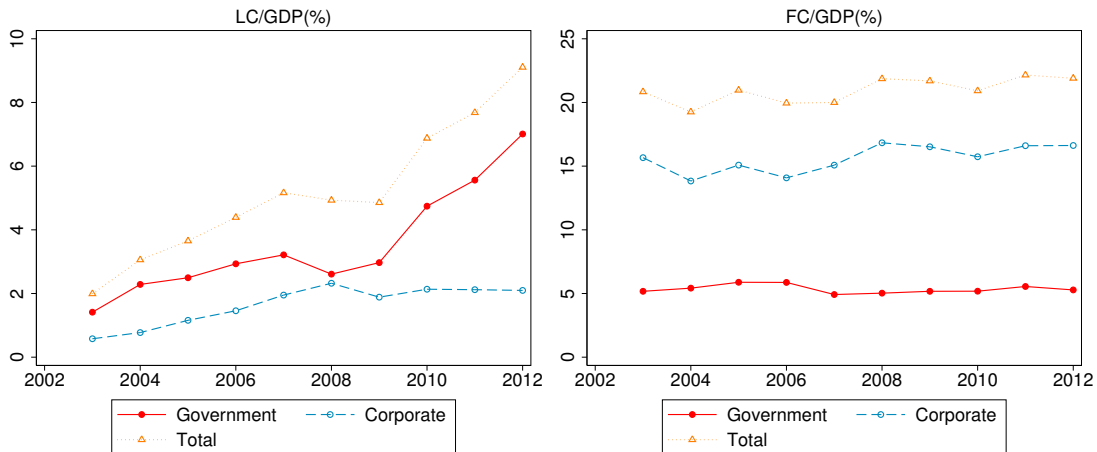
Figure 13: Share of External Debt in LC (Mean of 14 sample countries)



*Notes:* This figure plots the cross-country mean of the share of external debt by sector in LC. The cross-country mean gives each country in the sample an equal weight. Within each country, the share of total debt in LC is the weighted average of the share of sovereign and corporate debt in LC, weighted by the amount of each type of debt outstanding. The countries included in the sample are Brazil, Colombia, Hungary, Indonesia, Israel, South Korea, Malaysia, Mexico, Peru, Poland, Russia, South Africa, Thailand and Turkey.

in all of our sample countries, the sovereign borrows more in LC as a share of total external debt than does the private sector.

Figure 14: External Debt/GDP by Currency and Sector



*Notes:* The left panel plots the cross-country mean of amount of external LC debt outstanding, as a share of GDP, for the government, private sector, and the sum of the two. The right panel plots the cross-country mean of amount of external FC debt outstanding for the same three categories. The cross-country mean equally weights all countries in the sample. The countries in the sample are Brazil, Colombia, Hungary, Indonesia, Israel, South Korea, Malaysia, Mexico, Peru, Poland, Russia, South Africa, Thailand and Turkey.

In Figure 14, we plot the cross-country mean LC/GDP and FC/GDP ratios by year. While we see in the right panel that the FC/GDP ratios are stable across time, the LC/GDP

Table 9: Share of External Borrowing in Local Currency

	Sovereign		Corporate	
	2004	2012	2004	2012
Brazil <sup>^^</sup>	34.8	66.8	4.2	5.3
Colombia <sup>^</sup>	12.2	15.1	16.2	7.7
Hungary	50.9	48.2	6.5	10.6
Indonesia	25.3	46.0	5.5	8.4
Israel	5.8	37.6	1.4	6.4
Korea	8.1	83.1	3.1	4.2
Malaysia	22.9	89.2	5.6	9.3
Mexico	12.6	71.3	4.6	11.7
Peru	0.0	46.4	0.3	6.7
Poland	53.0	46.3	19.5	19.8
Russia	0.1	37.7	0.8	11.2
South Africa <sup>^^</sup>	42.8	77.0	26.4	32.6
Thailand	17.0	97.9	6.1	9.0
Turkey <sup>^</sup>	38.9	49.3	9.0	12.0

*Notes:* <sup>^</sup> indicates that 2006 data is used for the 2004 column and <sup>^^</sup> indicates that 2007 data is used for the 2004 column because that is the first year of data availability. Each value represents the percentage of external borrowing for the sovereign or corporate sector that is in LC at the end of each year.

ratio has nearly quintupled for sovereigns over the last decade. However, even as the growth of sovereign external LC borrowing has dramatically increased, corporate external LC borrowing has stayed very low. At the end of 2012 for our 14 sample countries, of the roughly \$1 trillion of EM external sovereign debt outstanding, 60% is in LC and 40% is in foreign currency. Foreign holdings of domestic LC sovereign debt account for 95 percent of sovereign external LC liabilities. Of the roughly \$1.9 trillion in external EM corporate debt outstanding, approximately 90% is denominated in foreign currency. In contrast to the sovereign, 90 percent of corporate external LC liabilities take the form of direct issuance of LC corporate international debt and cross-border loans, as opposed to foreign investment in local currency debt markets.

## 2.4 Firm-Level and Macro Effects of Corporate FC Liabilities

Having documented the changing external borrowing patterns in emerging markets, we now provide evidence that this currency composition matters. We will examine the importance of

FC corporate debt at the firm-level and at the country-level. Using Brazilian and Mexican firm-level data, we show that firms more heavily indebted in foreign currency are more vulnerable to depreciation. At the country level, we provide evidence on the linkage between corporate balance sheets and sovereign credit risk. We first present cross-country evidence that countries with a higher reliance on FC corporate financing tend to have higher sovereign credit risk. We then show in a panel regression with country fixed effects that an increase in the corporate FC debt-to-GDP ratio is associated with an increase in the sovereign credit spread.

### 2.4.1 Firm-Level Evidence

The dollarization of external liabilities for the corporate sector poses a particular concern if it is not matched by FC assets, FC revenues, or FX derivative hedging. Firms may have FC revenues and hence issue FC debt to hedge the currency risk of their revenues.<sup>36</sup> In addition to operational hedging, firms can enter into FX derivative contracts to hedge their currency exposure.<sup>37</sup> Despite rapid growth of FX derivatives markets over the past decade, in Appendix Section 5.2.4, we use data from the Depository Trust and Clearing Corporation (DTCC) to argue that these currency derivative markets are currently much smaller than the amount of FC debt outstanding in most of emerging markets, making it very unlikely these liabilities are fully hedged. Despite operational and derivative hedging possibilities, we use firm-level data from Brazil and Mexico and document that reliance on FC liabilities remains a significant explanatory variable for cross-sectional variations in firm vulnerability to exchange rate depreciation.

We show the values of firms with more FC liabilities are more sensitive to exchange rate movements. In particular, firms with more FC liabilities experience larger increases in credit spreads and lower equity returns in response to currency depreciation. While we make no

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<sup>36</sup>Michaux (2012) presents evidence of such firm-level hedging for Mexico.

<sup>37</sup>See, for instance, Kamil (2009) on firm incentives to hedge currency risk under difference exchange rate regimes.

claim that the currency composition of firm liabilities is exogenous or is necessarily sub-optimal from a private perspective, the goal is to show that the corporate sector does not perfectly hedge its currency exposure and so firms that borrow more in dollars load more heavily on the exchange rate. If the debt composition were chosen only with the goal of hedging operations and assets, then we would not expect to see any differential loading of firms with more FC debt on the exchange rate.

The question of which firms are more sensitive to exchange rate movements is one that has been addressed in the macroeconomics and development literature with a focus on investment. A number of past studies, such as Aguiar (2005), Cowan et al. (2011), and papers surveyed in Galindo et al. (2003) and Frankel (2005, 2010) find support for the idea that mismatched firms invest less following a depreciation. However, some counterexamples exist, such as Bleakley and Cowan (2008). In the finance literature, a large literature has examined equity market exposure to currency risk without directly focusing on the cross-sectional relationship between foreign currency liabilities and the sensitivity of firm value to exchange rate depreciation (See, for instance, Adler and Dumas (1984), Bartram et al. (2010), Bodnar and Wong (2003), Griffin and Stulz (2001), Dominguez and Tesar (2006), Chue and Cook (2008), and Kedia and Mozumdar (2003)).

We focus on Brazil and Mexico because firms in these two countries report the currency composition of their liabilities in their quarterly accounting statements. We obtain fixed-coupon dollar corporate bond yields and equity returns at the firm-level and match them to corporate balance sheet data. All data are from Bloomberg and more details on the firm-level data can be found in Appendix 5.2.3. Rather than examining real variables like output and investment, we look instead at market-based measures of changes in the firm value, stock returns and changes in credit spreads. The advantage of using asset prices over slow-moving output and investment variables is that we are able to focus on asset price and exchange rate movements for the exact same horizon. To measure the firm's reliance of FC financing,

we construct two versions of our key balance sheet variable, the FC Liability Ratio ( $FCLR$ )

$$FCLR^{Liab} = \frac{\text{Foreign Currency Liabilities}}{\text{Total Liabilities}}$$

$$FCLR^{Asset} = \frac{\text{Foreign Currency Liabilities}}{\text{Total Assets}}$$

We normalize the amount of FC liabilities by both total assets and total liabilities to measure firm reliance on FC debt that is comparable across firms. We measure the quarterly exchange rate depreciation

$$\Delta e_{t+1} = \log(\mathcal{E}_{t+1}) - \log(\mathcal{E}_t),$$

where  $\Delta e_{t+1} > 0$  corresponds to a depreciation of the LC.

**Corporate Debt and Equity Returns** For every publicly traded Brazilian and Mexican company, we collect all available equity return data and secondary market bond prices from 2000 to the present. For bonds, the primary object we work with is the bond's yield to maturity, which we will denote  $y_t^{Corp}$ . For every date with bond pricing data, we match the bond to a zero-coupon Treasury with the same remaining maturity. We use the Nelson-Siegel-Svensson coefficients estimated by Gurkaynak et al. (2007) to calculate the yield to maturity on a U.S. Treasury bond, defined as  $y_t^{US}$ . We then calculate the credit spread between the corporate bond and a US Treasury as

$$s_{i,j,t}^{Corp/US} = y_{i,j,t}^{Corp} - y_t^{US}$$

where  $i$  indicates the firm and  $j$  indicates in the individual corporate bond, and  $t$  indicates the quarter of the observation.

The change in the credit spread is given by

$$\Delta s_{i,j,t+1}^{Corp/US} = s_{i,j,t+1}^{Corp/US} - s_t^{Corp/US}.$$



Because equity returns are calculated in LC, we calculate the excess return as the return over the local risk-free rate, using the 3-month deposit rate from Global Financial Data as the short-term local risk-free rate. We denote the excess holding period return over the risk-free rate as  $R_{i,t+1}$ .

We examine the change in the credit spread and the excess equity return over a quarterly holding period using non-overlapping quarters. The key specification we run is

$$Y_{i,j,t+1} = \alpha + \beta_0 \Delta e_{t+1} + \beta_1 (\Delta e_{t+1} \cdot FCLR_{i,t}) + \delta_0 W_{t+1} + \delta_1 (W_{t+1} \cdot FCLR_{i,t}) + \gamma (\Delta e_{t+1} \cdot Z_{i,t}) + \epsilon_{i,j,t+1}, \quad (20)$$

where  $Y_{i,j,t+1}$  is either the change in the corporate credit spread  $\Delta s_{i,j,t+1}^{Corp/US}$  or the excess holding period equity return  $R_{i,t+1}$ ,  $W_{t+1}$  is a common country level factor, such as the equity market return or the change in the sovereign bond index.  $Z_{i,t}$  is a vector of corporate observables such firm size (log of market capitalization) or Market/Book value. As indicated by the timing subscripts, we use contemporary values of balance sheet variables and characteristics to look at changes in next period's credit spreads and equity returns.

The key coefficient is  $\beta_1$ , the coefficient on the interaction between the change in the exchange rate and the FCLR. If firms that borrow in dollars are not hedged, and so corporate dollar borrowing indicates a balance sheet mismatch, we would expect firms with more FC debt to perform worse following a depreciation. When our dependent variable is equity returns, this means that we would expect  $\beta_1 < 0$  so that firms with a higher fraction of their liabilities in FC have lower equity returns when the exchange rate depreciates ( $\Delta e > 0$ ). When our dependent variable is corporate credit spreads, we would expect  $\beta_1 > 0$  so that firms with a higher fraction of their liabilities in FC see their credit spreads increase more when the exchange rate depreciates ( $\Delta e > 0$ ). In all regressions, we exclude financial firms and utilities, include industry and country fixed effects, and estimate two-way clustered standard errors by firm and quarter.

In Table 10, we run this regression for equity returns for our two measures of the FCLR, using  $FCLR^{Asset}$  in the first six columns and  $FCLR^{Liab}$  in the second six. In columns 1 and 6, where we only include  $\Delta e_{t+1}$ , we find that the coefficient on  $\Delta e_{t+1} X FCLR$  is large and negative, indicating that if the exchange rate depreciates by 1%, firms with an  $FCLR^{Asset}$  of 50% underperform by 78 basis points and firms with an  $FCLR^{Liab}$  of 50% underperform by 43 basis points, relative to a firm with no FC liabilities. In columns 2 and 7, we interact  $FCLR$  with other factors, firm size and the Market/Book ratio and we control directly for the  $FCLR$  and see that the key interaction coefficient is essentially unchanged. In columns 3 and 8, we control for market returns and find that our estimated coefficient is roughly halved in each specification, with  $\beta_1$  losing statistical significance in the  $FCLR^{Liab}$  specification. In columns 4 and 9, we introduce an interaction between the market return and the  $FCLR$  ratio, and find that this interaction is strongly positive, indicating that firms with more FC debt load more heavily on the market. The exchange rate interaction coefficient remains negative, but becomes insignificant. However, as shown in Brusa et al. (2014), the exchange rate is an important factor in pricing equity returns, and the differential loading of firms with more FC debt on the market rather than the exchange rate directly is not inconsistent with these firms being more vulnerable to depreciation. In fact, it may explain why these firms load more heavily on the market as the exchange rate and market returns are highly correlated.<sup>38</sup> To account for this, in columns 5 and 10, we orthogonalize the market return on the exchange rate, assigning the common variation to the exchange rate. Once again, the coefficient on the  $\Delta e_{t+1} X FCLR^{Asset}$  is strongly significant while the version for  $FCLR^{Liab}$  remains negative, but insignificant.

In Table 11, we examine the change in credit spreads. Rather than conditioning on the market return for equities, we use changes in country-level spreads of the JP Morgan Emerging Market Bond Index (EMBI). The EMBI serves as a proxy for the aggregate credit

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<sup>38</sup>Since 1998, the quarterly correlation between the stock market index return and the change in the exchange rate is 49% in Mexico and 41% in Brazil.

conditions at the country level.<sup>39</sup> Since secondary bond market prices are much sparser than equity returns and not all listed firms have issued dollar debt securities, we reduce our sample from 334 firms to 56. However, the results are more consistent for the bond regressions than for the equity regressions. Across all 8 regression specifications for the two types of balance sheet measures, the interaction coefficient between the FCLR and FX changes remains statistically significant and fairly stable. In our preferred specification, with the EMBI is orthogonalized on the exchange rate (columns 5 and 10), conditional on a host of controls, we find that a firm with an  $FCLR^{Asset}$  of 50% would see its credit spread rise 20 basis points more than a firm with no FC debt following a 1% depreciation of the exchange rate. In the version of the regression using the  $FCLR^{Liab}$ , and a firm a 50% FCLR would be see its credit spread rise 16 basis points more than a firm with no FC debt.

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<sup>39</sup>We do not use the Corporate EMBI because the time series is too short. However, this measure also has its drawbacks as it is commonly used as a measure of sovereign credit risk.

Table 10: Depreciation and the Equity Excess Returns

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Assets $R_{i,t+1}$	Assets $R_{i,t+1}$	Assets $R_{i,t+1}$	Assets $R_{i,t+1}$	Assets $R_{i,t+1}$	Liab. $R_{i,t+1}$	Liab. $R_{i,t+1}$	Liab. $R_{i,t+1}$	Liab. $R_{i,t+1}$	Liab. $R_{i,t+1}$
$\Delta e_{t+1} \times FCRLR_t$	-155.9*** (53.32)	-146.5*** (52.14)	-85.67** (41.62)	-30.03 (36.32)	-87.79*** (33.34)	-85.31** (33.59)	-78.39** (33.24)	-37.17 (30.74)	-10.93 (27.12)	-38.05 (25.33)
$\Delta e_{t+1}$	-60.45** (30.43)	-39.78 (60.06)	-7.107 (26.24)	-13.51 (26.96)	-84.26*** (27.62)	-61.35** (29.39)	-43.80 (59.90)	-11.09 (27.02)	-17.51 (27.71)	-89.22*** (28.21)
$\Delta e_{t+1} \times Size_t$		-3.038	0.440	0.415	0.426		-2.652	0.584	0.649	0.663
$\Delta e_{t+1} \times (M/B)_t$		0.0157	0.0193**	0.0188**	0.0187**		0.0104	0.0162*	0.0157*	0.0155*
$FCRLR_t$		-6.882***	-6.530**	-7.524***	-6.272**		-3.819**	-3.728**	-4.209***	-3.596**
$R_{t+1}^M$			80.99***	72.99***				81.14***	73.94***	
$R_{t+1}^M \times FCRLR_t$			(5.007)	(5.651)				(4.905)	(5.654)	
				58.89***					27.69**	
				(18.48)					(12.59)	
$\widetilde{R}_{t+1}^M$					72.59***					73.55***
$\widetilde{R}_{t+1}^M \times FCRLR_t$					61.70***					29.11**
Constant	1.063	2.369	2.308*	2.399*	2.628*	1.063	2.369	2.308*	2.399*	2.628*
Observations	9,264	8,824	8,824	8,824	8,824	9,264	8,824	8,824	8,824	8,824
R-squared	0.060	0.066	0.210	0.212	0.212	0.060	0.066	0.210	0.212	0.212
Firms	357	334	334	334	334	357	334	334	334	334

Notes: The table reports regression results of equity returns on exchange rate changes, market returns, firm characteristics and various interactions. Each regression contains industry and country fixed effects. Firm-quarter two-way clustered standard errors are used in all specifications.  $R_{i,t+1}$  is the excess quarterly holding period return on firm  $i$  between periods  $t$  and  $t+1$  over the local deposit rate.  $\Delta e_{t+1}$  is the log change in the change rate between the end of quarter  $t+1$  and  $t$ , with positive numbers indicating a depreciation of the exchange rate.  $R_{t+1}^M$  is the return of the local equity index (the Mexbol for Mexico and the Bovespa for Brazil) between periods  $t$  and  $t+1$ .  $\widetilde{R}_{t+1}^M$  is the component of the market return between periods  $t$  and  $t+1$  orthogonal to the change in the exchange rate.  $FCRLR$  is the ratio of FC liabilities divided by either total assets or total liabilities. "Assets" in the column heading (columns 1-6) indicates the denominator is total assets, and "Liab." in the column heading (columns 7-12) indicates the denominator is total liabilities.  $Size$  is the log of market capitalization and  $(M/B)$  is the market capitalization to book value of the firm.  $X$  indicates an interaction term. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Standard errors for some variables suppressed for space.

Table 11: Depreciation and the Change in Corporate Credit Spreads

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Assets $\Delta s_{i,t+1}^{Corp/US}$	Assets $\Delta s_{i,t+1}^{Corp/US}$	Assets $\Delta s_{i,t+1}^{Corp/US}$	Assets $\Delta s_{i,t+1}^{Corp/US}$	Liab. $\Delta s_{i,t+1}^{Corp/US}$	Liab. $\Delta s_{i,t+1}^{Corp/US}$	Liab. $\Delta s_{i,t+1}^{Corp/US}$	Liab. $\Delta s_{i,t+1}^{Corp/US}$
$\Delta e_{t+1} \times FCLR_t$	43.63** (17.85)	27.48** (13.81)	27.44* (14.34)	39.83** (16.28)	36.62*** (11.46)	26.21*** (9.088)	26.34*** (9.497)	32.56*** (10.10)
$\Delta e_{t+1}$	0.493	-1.342	-1.336	2.239	-2.745	-4.252	-4.286	-0.365
$\Delta EMBI_{t+1}$		0.509***	0.508***			0.558**	0.560**	
$\Delta EMBI_{t+1} \times FCLR_t$		1.773** (0.858)	1.776** (0.819)			0.895** (0.404)	0.890** (0.383)	
$FCLR_t$			3.891 (91.71)	-8.345 (94.83)			-12.59 (53.31)	-18.62 (55.29)
$\Delta \widetilde{EMBI}_{t+1}$				0.517*** (0.178)				0.562** (0.231)
$\Delta \widetilde{EMBI}_{t+1} \times FCLR_t$				1.742** (0.842)				0.885** (0.392)
Maturity	1.484	0.957	1.044	1.008	-1.568	-0.0150	0.908	0.951
Maturity X $FCLR_t$	-1.910	-0.257	-0.535	-0.433	1.718	1.025	0.610	0.586
Observations	2,444	2,444	2,444	2,444	2,444	2,444	2,444	2,444
R-squared	0.213	0.275	0.275	0.275	0.231	0.288	0.288	0.288
Firms	56	56	56	56	56	56	56	56

Notes: The table reports regression results of changes in the credit spread on corporate dollar bonds on exchange rate changes, market returns, firm characteristics and various interactions. Each regression contains industry and country fixed effects. Firm-quarter two-way clustered standard errors are used in all specifications.  $\Delta s_{i,t+1}^{Corp/US}$  is the change in the credit spread on a dollar bond of firm  $i$  between periods  $t$  and  $t + 1$ .  $\Delta e_{t+1}$  is the log change in the exchange rate between the end of quarter  $t + 1$  and  $t$ , with positive numbers indicating a depreciation of the exchange rate.  $FCLR$  is the ratio of FC liabilities divided by either total assets or total liabilities. "Assets" in the column heading (columns 1-5) indicates the denominator is total assets, and "Liab." in the column heading (columns 6-10) indicates the denominator is total liabilities.  $\Delta EMBI_{t+1}$  is the change in the sovereign's JP Morgan EMBI spread.  $\Delta \widetilde{EMBI}_{t+1}$  is the change in EMBI orthogonal to the change in the exchange rate. Maturity is the years of remaining maturity on the bond. Bonds with less than 3 months maturity remaining are excluded from the analysis.  $X$  indicates an interaction term. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Standard errors for some variables suppressed for space.

### 2.4.2 Sovereign Risk and Corporate Balance Sheets

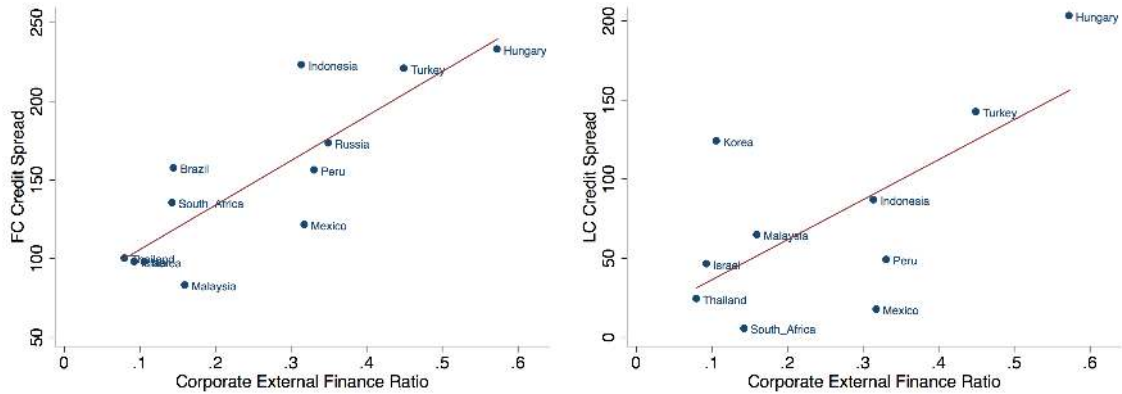
While the previous subsection provided evidence that firms with more FC debt are more vulnerable to depreciations, we now examine the question of whether more FC corporate debt at the country level is associated with a higher level of sovereign default risk. To do so, we will examine the relationship between the sovereign LC credit and the FC credit spread (from CDS markets) and the country's debt composition. At the country level we find evidence that a higher reliance on external FC corporate debt is associated with a higher risk of sovereign default.

**Unconditional Correlation** We first look at the unconditional cross-country correlation between corporate reliance on FC external financing and the sovereign credit spread. In order to measure the corporate sector's reliance on external finance, we construct the "Corporate External Finance Ratio", which we define as

$$\text{Corporate External Finance Ratio} = \frac{\text{Corporate External FC Borrowing}}{\text{Total Corporate Borrowing}},$$

where "Total Corporate Borrowing" is the sum of corporate domestic debt securities from BIS Securities Statistics, World Bank domestic bank lending to the domestic private sector, and external borrowing. By normalizing the level of corporate external FC borrowing by total corporate borrowing, we are able to control for the cross-country heterogeneity in the depth of domestic financial market and uncover the importance of external FC financing in the overall corporate financing for each sample country.

Figure 15: Corporate External Borrowing and Sovereign Default Risk, 2005-2012



*Notes:* Left panel plots the mean sovereign FC credit spread derived from CDS markets (y-axis) against the mean corporate external finance ratio (x-axis). Right panel plots the mean sovereign LC credit spread (y-axis) against the mean corporate external finance ratio on the (x-axis). Each observation is the mean of year-end observations in each country from 2005-12. Russia and Brazil are included in the FC figure but are excluded from LC figure. As discussed in detail in Du and Schreger (2014b), capital controls are the dominant factor in the Brazilian LC credit spread and the Russian LC bond market is not investable during this period.

In Figure 15, we plot the mean credit spread from 2005-2012 against the mean Corporate External Finance Ratio. In the left panel, we use the sovereign FC credit spread as the measure of sovereign credit risk, and in the right hand panel we use the sovereign LC credit spread. In both panels, we see a strong positive relationship between corporate external borrowing and sovereign credit spreads. The cross-sectional correlation between the mean Corporate External Finance Ratio and sovereign LC credit spread is 67.3%, and the correlation is 83.6% between the mean Corporate External Finance Ratio and sovereign FC credit spread. While just a correlation, these figures present suggestive evidence on the relationship between corporate borrowing and sovereign risk across countries.

**Panel Regression Evidence** In Table 12, we use a panel regression framework to examine whether a higher reliance on FC external corporate debt is associated with more sovereign default risk. Here, we focus on within country variation, examining whether increases in FC sovereign debt/GDP, LC sovereign debt/GDP and FC private debt/GDP are associated with higher sovereign default spreads. We estimate the following regression at the quarterly

frequency:

$$Spread_{i,t+1} = \alpha + \beta_1 \left( \frac{FC Gov}{GDP} \right)_t + \beta_2 \left( \frac{LC Gov}{GDP} \right)_t + \beta_3 \left( \frac{FC Private}{GDP} \right)_t + \gamma X_{i,t} + \delta_i + \epsilon_{i,t},$$

where  $\delta_i$  is a country fixed effect and  $X_{i,t}$  is a vector of time-varying country level or global variable. As an alternative to global variables, we also introduce quarter fixed effects. For common global variables, we follow Hilscher and Nosbusch (2010b) in including four time series to proxy for such factors as global risk aversion, world interest rates, and liquidity. Those variables are the VIX index, the BBB-Treasury Spread, the 10-Year Treasury Yield, and the TED Spread. In addition, we follow the recent IMF paper by Csonto and Ivaschenko (2013) and include the US Federal Funds Rate.<sup>40</sup> Standard errors are calculated following Driscoll and Kraay (1998) with 4-quarter lags to account for within-country serial correlation and clustering by quarter to correct for spatial correlation across countries.<sup>41</sup>

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<sup>40</sup>All global variables are from FRED, Federal Reserve Economic Data, from the Federal Reserve Bank of St. Louis.

<sup>41</sup>When time fixed effects are included, we follow Vogelsang (2012).



Table 12: Sovereign Credit Spreads and External Debt

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Quarter, LC	Quarter, LC	Quarter, FC	Quarter, FC	Annual, LC	Annual, LC	Annual, FC	Annual, FC
$\frac{FC Gov}{GDP}$	12.53*** (3.716)	12.40*** (3.832)	15.74** (6.248)	18.31** (6.830)	5.743 (6.008)	5.487 (7.205)	8.881 (7.665)	11.07 (8.577)
$\frac{LC Gov}{GDP}$	6.787*** (2.091)	8.574*** (2.003)	4.334 (2.683)	1.453 (2.998)	6.315*** (2.091)	4.942* (2.330)	-1.563 (3.473)	0.735 (3.383)
$\frac{FC Private}{GDP}$	2.234** (1.133)	2.724** (1.255)	3.486*** (0.623)	2.183*** (0.715)	4.079*** (1.213)	3.873** (1.319)	5.114*** (1.244)	4.681*** (1.379)
VIX		2.578**		0.177		5.620***		-4.283*
Fed Funds Rate		7.367*		-13.19**		18.85**		-26.64***
BBB-Treasury Spread		12.92**		35.70***		1.089		41.03***
10-Year Treasury Yield		-24.63**		7.699		-50.35***		14.35
Ted Spread		20.26*		11.41		-4.582		48.01**
Constant	297.2*** (26.98)	212.0*** (53.81)	56.65*** (18.22)	-65.51* (38.03)	236.8*** (34.17)	284.8*** (51.03)	36.17 (31.64)	-6.020 (59.39)
Observations	357	350	427	400	94	93	111	111
R-squared	0.712	0.659	0.768	0.721	0.762	0.751	0.702	0.731
Countries	12	12	13	13	13	13	14	14
Time FE	Yes	No	Yes	No	Yes	No	Yes	No

Notes: The table reports panel regression results of the level of the LC and FC credit spread on country level and global variables. All specifications contain country fixed effects. Heteroskedasticity autocorrelation spatial correlation robust Driscoll and Kraay (1998) standard errors with a 4 quarter lag. Standard errors follow Vogelsang (2012) when time fixed effects are used.  $\left(\frac{FC Gov}{GDP}\right)$ ,  $\left(\frac{LC Gov}{GDP}\right)$  and  $\left(\frac{FC Private}{GDP}\right)$  are the FC sovereign debt/GDP ratio, the LC sovereign debt/GDP ratio, and the FC private debt/GDP ratio. These variables are constructed in Section 2.3, with the data sources and methods described there and in Appendix 5.2.2. The VIX, Fed Funds Rate, BBB-Treasury Spread, 10-Year Treasury Spread, and Ted Spread are all from FRED of the Federal Reserve Bank of St. Louis. VIX is the 30 day implied volatility of the S&P, the Fed Funds Rate is the effective overnight Federal Funds Rate, the BBB-Treasury Spread is the option-adjusted spread of the Bank of America Merrill Lynch US Corporate BBB Index over US Treasuries, the 10-Year Treasury Spread is the 10-Year Treasury Constant Maturity Rate, and the Ted Spread is the spread between 3-month dollar Libor and the 3-Month Treasury Bill. South Africa only included in annual regressions because of data availability. Russia only included in CDS regressions because LC debt not investable during much of sample. Standard errors on global controls omitted for space.\*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

We run the regression for two types of spreads, sovereign LC credit spreads and sovereign FC credit spreads derived from CDS markets, at a quarterly and annual frequency.<sup>42</sup> We include country fixed effects in each regression and examine changes within countries. Because we only have annual data for the external debt composition of South Africa, we exclude the country from the quarterly regressions. In columns 1 and 2, our dependent variable is the sovereign LC credit spread at a quarterly frequency, where column 1 includes quarter fixed effects and column 2 instead controls directly for global factors. At a quarterly frequency, we find that a 1% of GDP increase in the sovereign FC debt/GDP ratio is associated with a 12.5 basis point increase in the LC credit spread. By contrast, a 1% of GDP increase in the LC sovereign debt-to-GDP ratio is associated with a 7-9 basis point increase. Furthermore, we find that increases in the amount of corporate FC debt are associated with higher sovereign credits spreads. We find that a 1% point increase in the FC corporate debt-to-GDP ratio is associated with a 2.2-2.7 basis point increase in the LC credit spread. Because the FC corporate debt-to-GDP ratio is more volatile within countries than sovereign debt, this actually explains an important share of the variation. For the estimates in column 1, a one standard deviation increase in the sovereign FC debt-to-GDP ratio is associated with a 57 basis point increase in the LC credit spread, and a one standard deviation increase in the private FC debt-to-GDP ratio is associated with a 28 basis point increase in the LC credit spread.

In Columns 3 and 4, we run the same regressions as in the first two columns, replacing the sovereign LC credit spread with the sovereign FC credit spread as our dependent variable. While default on sovereign FC debt is not the concern of this paper, if countries were to default on the two types of debt simultaneously, we should expect the regressions to be similar when we use the LC or FC credit spread as our dependent variable. We find that this is indeed the case, as a 1% point increase in the FC corporate debt/GDP ratio is associated with a 2.2-4.1 basis point increase in the FC credit spread.

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<sup>42</sup>The reason for using CDS instead of the underlying bonds is because FC debt markets have shrunk so much in some countries, such as Thailand, that it is becoming difficult to estimate a consistent FC yield curve.

In columns 5-8, we run the same regressions at an annual frequency and find the results for the importance of private FC debt are further strengthened. Because only annual data is available for the currency composition of South Africa’s external sovereign debt, the country is excluded from our quarterly regressions. However, when we look at annual data in columns 5-8, we are able to include South Africa in our analysis. In these regressions, the global controls are year averages. At an annual frequency, we find that a 1% increase in the private FC debt/GDP ratio is associated with a 4 basis point increase in the LC credit spread and a 5 basis point increase in the FC credit spread.<sup>43</sup>

## 2.5 A Model of Sovereign Risk and Corporate Balance Sheets

Motivated by these empirical findings, we now formally examine the interplay between sovereign risk and corporate balance sheets. Our main empirical motivations for the model are as follows. First, sovereigns are increasingly borrowing in LC and firms borrow overwhelmingly in FC. However, a positive credit spread on LC sovereign debt remains. Second, firms with more FC debt are vulnerable to exchange rate movements, evidence that the corporate sector does not completely hedge currency risk. Third, higher levels of FC corporate debt are associated with a higher risk of default on sovereign LC debt. We argue that a mismatched corporate sector is one reason why a sovereign would choose to explicitly default on LC sovereign debt rather than inflating it away. In this section, we introduce LC sovereign debt and a mismatched corporate sector into the standard model of sovereign debt, and demonstrate how corporate currency mismatch generates sovereign default risk.

We microfound the mismatched corporate sector by introducing a class of agents that we call “entrepreneurs.” These entrepreneurs are the only agents in the economy capable of producing an intermediate input used for the production of tradable goods. These entrepreneurs borrow from foreign lenders to make a fixed investment at the start of the period, produce a non-stochastic amount of the tradable good, and use the proceeds from the sale of these

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<sup>43</sup>In Appendix Table 30, we include additional country-specific variables found to price sovereign risk in the previous literature and show that the main results are largely unchanged.

goods to repay their foreign loans. They then invest to produce intermediate goods that are used to produce more of the tradable output. The key financial friction in the model is that entrepreneurs' investment in intermediate goods is limited by their net worth. In order to keep the model simple while modeling currency mismatch, this entrepreneurial net worth comes from the profits entrepreneurs make from selling their tradable output every period. The key mismatch in the model arises because entrepreneurs are committed to sell a fraction of their tradable endowment in fixed LC prices. This means that inflation reduces the real value of their sales without commensurately reducing the real value of their liabilities. Inflation, therefore, reduces the real value of these firms' profits and thereby reduces the amount they can invest in the production of intermediate inputs. This, in turn, reduces aggregate tradable output.

Before turning to our model, we will briefly review the literature on FC sovereign debt to facilitate comparison of our theory to the existing literature.

### 2.5.1 Benchmark Model with FC Debt

Following the contributions of Aguiar and Gopinath (2006) and Arellano (2008), who introduced Eaton and Gersovitz (1981a) into a quantitative setting, many subsequent papers have worked in a similar framework.<sup>44</sup> In this general formulation, a government borrows from foreign lenders on behalf of its citizens. It does so to smooth consumption fluctuations across states and possibly to front-load consumption, if it is less patient than foreign lenders. The key friction in the model is that the government lacks commitment and each period has the option of defaulting on its sovereign debt. If it defaults, it faces a punishment, generally modeled as a temporary loss of output and exclusion from financial markets. We will consider the case of an endowment economy, where output  $y$  follows a Markov process.<sup>45</sup>

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<sup>44</sup>See, for instance, Arellano et al. (2013), Bianchi et al. (2012), Borri and Verdelhan (2011), Cuadra and Sapriza (2008), Cuadra et al. (2010), D'Erasmus (2011), Hatchondo et al. (2009), Hatchondo et al. (2014), Na et al. (2014), Salomao (2013), and Yue (2010).

<sup>45</sup>Mendoza and Yue (2012a) study a production economy where aggregate productivity follows a Markov process, as in this paper.

The government objective is to maximize the expected discounted utility of consumption for the representative agent

$$\max_{b', D} E \left[ \sum_{t=0}^{\infty} \beta^t u(C_t) \right]$$

where the sovereign has two policies: how much to borrow ( $b'$ ) and whether or not to default (an indicator  $D$  for default). We assume that the sovereign can borrow from a continuum of risk-neutral investors by issuing exponentially decaying perpetuities with a promised coupon structure

$$\kappa \cdot [1, \delta, \delta^2, \dots]$$

where  $\delta \leq 1$  controls the speed with which promised coupon payments decline, and thereby the duration of the bond. If  $\delta = 0$ , this is the one-period debt considered by Aguiar and Gopinath (2006) and Arellano (2008). We use the modeling device of Lorenzoni and Werning (2013) and normalize the coupon payments by  $\kappa = 1 + r^* - \delta$ , where  $r^*$  is the risk free rate. Multiplying the coupon payments by  $\kappa$  guarantees that one unit of risk-free debt sells for a price of 1, regardless of the bond's duration.<sup>46</sup>

This debt has a recursive structure that allows us to compactly write consumption in repayment states. If the government repays its debt, households consume the sum of the aggregate endowment  $y$  and net revenue raised from new bond issuances minus coupon payments  $\kappa b$ . Because one unit of debt issued last period is equivalent to  $\delta$  units of debt issued today, if the government chooses a gross debt issuance  $b'$ , net issuances are equal to  $b' - \delta b$ . The price the government receives for its debt is a function of today's endowment  $y$  and government debt issuance  $b'$ . This allows us to write the bond price as  $q^{FC}(y, b')$ . Because the government receives a price  $q^{FC}(y, b')$  for each unit of debt, net revenue raised

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<sup>46</sup>To see this, note that with risk-neutral pricing the price of risk free debt  $q^* = E_t \left[ \sum_{s=0}^{\infty} \frac{\kappa \delta^s}{(1 + r^*)^{1+s}} \right] = \frac{\kappa}{1 + r^* - \delta} = 1$ .

is  $q^{FC}(y, b')(b' - \delta b)$ . Therefore, consumption in repayment states is given by:

$$C_R = y - \kappa b + q^{FC}(y, b')(b' - \delta b)$$

The cost of defaulting on the debt is twofold: first, output is reduced from  $y$  to  $y - \phi(y)$ , where  $\phi$  is some cost that potentially increases with the underlying state  $y$ .<sup>47</sup> If the government defaults, no debt repayments are due, but consumption is reduced by some amount  $\phi(y)$ :

$$C_D = y - \phi(y)$$

The second cost of default is that the government is excluded from sovereign debt markets for a stochastic time period following default. After the government defaults, each period it has some exogenous probability  $\lambda$  of being “redeemed,” ending the output loss and regaining access to credit markets.

To calculate the price schedule of defaultable  $FC$  debt, we need to calculate the present value of the defaultable cash flows. The details of this bond pricing can be found in Appendix Section 5.2.8. We can write the bond price schedule recursively as:

$$q^{FC}(y, b') = \frac{E[(1 - D(y', b'))(\kappa + \delta q^{FC}(y', b''(y', b')))] | y, b']}{1 + r^*}$$

where the expectation is taken over next period’s exogenous state  $y'$ , conditional on today’s state  $y$ . Note that the sovereign’s choice of borrowing next period  $b''(y', b')$  appears in next period’s bond price schedule. This captures the fact that the sovereign cannot commit today to how much to borrow but does internalize that it will re-optimize tomorrow.

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<sup>47</sup>Following the Bulow and Rogoff (1989b) critique, there has been a large literature examining the costs of default. See, for instance, Arteta and Hale (2008), Rose (2005), and the survey in Borensztein and Panizza (2008). Hebert and Schreger (2014) present evidence from the recent Argentine default on the effects of default on domestic firm performance.

This problem admits a simple recursive structure with  $V^R$ ,  $V^D$  and  $V$  denoting the value function conditional on repayment, default, and overall, respectively.

$$\begin{aligned}
V^R(y, b) &= \max_{b'} u(C_R(y, b, b')) + \beta EV(y', b') \\
V^D(y) &= u(C_D(y)) + \beta (\lambda EV^R(y', 0) + (1 - \lambda) EV^D(y')) \\
V(y, b) &= \max\{V^R(y, b), V^D(y)\}
\end{aligned}$$

where

$$\begin{aligned}
C_R(y, b, b') &= y - \kappa b + q^{FC}(y, b')(b' - \delta b) \\
C_D(y) &= y - \phi(y) \\
q^{FC}(y, b') &= \frac{E[(1 - D(y', b'))(\kappa + \delta q^{FC}(y', b''(y', b')))] | y, b'}{1 + r^*}
\end{aligned}$$

The value function in repayment  $V^R$  is the value of repaying the outstanding sovereign debt and choosing how much to borrow optimally. Optimal borrowing  $b'$  weighs the consumption gains today against the losses of reducing the continuation value tomorrow, because higher borrowing today implies more liabilities tomorrow. The value function in default  $V^D$  is the value of consuming the reduced output today, but not having to repay the outstanding sovereign debt. With probability  $\lambda$ , the government is redeemed, output losses cease and the government can re-enter sovereign debt markets. However, with probability  $(1 - \lambda)$  the government remains locked out of sovereign debt markets for another period. The value function  $V$  is the upper envelope of  $V^R$  and  $V^D$ , the best the sovereign can do by choosing whether to default or repay.

Following Arellano (2008), we can define a recursive Markov equilibrium in this economy as a set of policy functions for consumption  $\tilde{c}(y, b)$ , government debt issuance  $\tilde{b}(y, b)$ , default sets  $\tilde{D}(y, b)$ , and a bond price function  $q^{FC}(y, b')$  such that

1. Taking government policies as given, household consumption  $\tilde{c}(y, b)$  satisfies the resource constraint
2. Taking the bond price schedule as given, government policy functions satisfy the government's optimization problem
3. The bond price schedule is consistent with foreign lenders earning zero expected profits.

Because of the important non-linearities, this problem is solved numerically using global solution methods. Hatchondo et al. (2010) analyze the quantitative properties of various techniques. One of the strengths of our model with LC sovereign debt is that our microfoundation will generate a recursive representation nearly equivalent to the FC version above, allowing us to numerically solve the model in the same way as the FC debt literature.

### **2.5.2 Introducing LC Sovereign Debt**

We make two changes to the framework outlined in the previous subsection. First, we introduce LC sovereign debt and give the sovereign another policy tool, the inflation rate, with which to reduce real repayments on the debt. Second, rather than working with an endowment economy, we introduce a production economy and treat aggregate productivity as the exogenous state variable. We will begin by discussing how we introduce these two new features. We will then discuss our microfoundation of the production economy that causes currency depreciation to reduce output. We will then briefly study a static example for intuition before solving the dynamic model numerically. After solving for the sovereign's policy functions and the bond price schedule, we will present the intuition for why reducing corporate currency mismatch can eliminate sovereign default risk in equilibrium. We demonstrate that a calibrated version of the model can generate the simulated moments of currency and credit risk similar to that observed in the data. Finally, we examine the model's predictions on the effect of reducing corporate currency mismatch on equilibrium sovereign default risk.



**Setup** As in the model with FC debt, we assume that the sovereign's objective is to maximize the discounted utility stream of consumption for the representative agent:

$$\max_{b', \zeta, D} E \left[ \sum_{t=0}^{\infty} \beta^t u(C_t) \right].$$

The sovereign maximizes this objective function by choosing how much to borrow ( $b'$ ), whether to default on the outstanding debt ( $D$ ), and, now, how much of the existing debt to inflate away  $\zeta$ . We assume that the sovereign borrows with exponentially decaying nominal LC perpetuities with promised LC cash flows:

$$P_t \kappa [1, \delta, \delta^2, \dots]$$

where  $P_t$  indicates today's price level. Because PPP will hold in our model, a foreign lender values this stream of coupons by dividing through by the LC price level at the time the coupons are paid to calculate their value in FC:

$$\kappa \left[ \frac{P_t}{P_{t+1}}, \delta \frac{P_t}{P_{t+2}}, \delta^2 \frac{P_t}{P_{t+3}}, \dots \right]$$

Defining  $\frac{P_{t+1}}{P_t} = 1 + \pi_{t+1}$ , with  $\pi$  being the net inflation rate, we can define the inflation tax  $\zeta_{t+1} = \frac{\pi_{t+1}}{1 + \pi_{t+1}}$ . Working with the inflation tax rather than the inflation rate is simply a matter of convenience. The FC value of the coupons can then be written compactly as

$$\kappa \left[ (1 - \zeta_{t+1}), \delta \prod_{s=1}^2 (1 - \zeta_{t+s}), \delta^2 \prod_{s=1}^3 (1 - \zeta_{t+s}), \dots \right], \quad (21)$$

The bond price is equal to the discounted expected value of all future cash flows:

$$\begin{aligned} q_t^{LC} &= E_t \left[ \frac{\kappa \cdot (1 - D_{t+1}) (1 - \zeta_{t+1})}{1 + r^*} + \frac{\delta \kappa \cdot (1 - D_{t+1}) (1 - D_{t+2}) (1 - \zeta_{t+1}) (1 - \zeta_{t+2})}{(1 + r^*)^2} + \dots \right] \\ &= \frac{E_t \left[ (1 - D_{t+1}) (1 - \zeta_{t+1}) (\kappa + \delta q_{t+1}^{LC}) \right]}{1 + r^*} \end{aligned} \quad (22)$$

The details of this bond pricing can be found in Appendix Section 5.2.8. As was the case for FC debt, the bond price is a function of today's exogenous state  $A$  and amount of debt issued  $b'$ .

$$q^{LC}(A, b') = \frac{E [(1 - D(A', b')) (1 - \zeta(A', b')) (\kappa + \delta q^{LC}(A', b''(A', b')))] | A, b']}{1 + r^*}.$$

This expectation is taken after the state  $A$  and borrowing  $b'$  have been realized, but tomorrow's state  $A'$  and tomorrow's borrowing level  $b''$  are not yet known.  $D(A', b')$  is an indicator variable for default. In the event of default,  $D = 1$ , and the holder of the bond receives nothing. In repayment states,  $D = 0$ , and the expectation is taken over losses from inflation  $\zeta$ , which are a function of tomorrow's state  $A'$  and the debt level  $b'$ . If the bonds were only one period, then this would be sufficient. However, because these are long-term bonds, lenders must account for future inflation and default risk reducing the value of future repayments. The recursive pricing structure makes this calculation feasible, because rather than calculating expected future inflation and default over all future periods, investors only need to form an expectation over inflation, default, and the price of the bond tomorrow. The bond price next period is dependent not just on the aggregate state  $A'$ , but also on the level of debt the sovereign will issue next period. This feature makes long-term debt more computationally demanding than using short-term debt but generates more interesting and realistic dynamics.

The second change we make is that we introduce a production economy where output is a Cobb-Douglas function of intermediate goods ( $X$ ) and labor ( $L$ )

$$y = AX (\zeta)^\gamma L^{1-\gamma}$$

The output costs of inflation and depreciation will come through reduced intermediate good provision and will be discussed in detail in the next subsection. For now, we simply write  $X$

as a function of  $\zeta$ . Consumption in repayment is given by:

$$C^R = \underbrace{A_t X(\zeta)^\gamma L^{1-\gamma}}_{\text{Output}} - \underbrace{(1-\zeta)\kappa b}_{\text{Coupon Payments}} + \underbrace{q^{LC}(A, b') [b' - (1-\zeta)\delta b]}_{\text{Net revenue from bond issuance}}. \quad (23)$$

The term  $(1-\zeta)\kappa b$  gives the real value of coupon payments this period. Therefore, the real amount paid (measured in tradables) is the coupon per bond  $\kappa$ , scaled by the number of bonds outstanding  $b$ , times the real value of the local currency, which is  $(1-\zeta)$ . The next term  $q^{LC}(A, b') [b' - (1-\zeta)\delta b]$  is the net revenue raised from bond issuance. Net issuances are just the gross issuance  $b'$  minus the equivalent number of today's bonds from the previous period,  $(1-\zeta)\delta b$ .  $(1-\zeta)$  denotes the measure of existing bonds not inflated away,  $\delta$  the speed with which coupon payments decay, and  $b$  is the number of these perpetuities the government issued last period. If  $b' - (1-\zeta)\delta b > 0$ , then the sovereign has positive net issuance, and if  $b' - (1-\zeta)\delta b < 0$  then the sovereign is repaying the outstanding debt.

In order to determine the sovereign's optimal policy, we need to know how output varies with the chosen inflation rate. Our microfoundation for  $X(\zeta)$  is the focus of the next subsection.

**Entrepreneurs' Problem** We assume there is a continuum of identical households and, similar to the microfoundation of Gertler and Karadi (2011), we assume that within each household there are two types of agents. While Gertler and Karadi (2011) assume the household is made up of workers and bankers, we assume that a fraction  $1-\gamma$  of household members are “workers” and  $\gamma$  are “entrepreneurs.”

At the beginning of the period entrepreneurs have access to projects that require a fixed investment to return a fixed amount  $\omega$  of the tradable good. To finance the investment in the project, entrepreneurs borrow intra-period from foreign lenders. The key assumption is that conditional on producing, entrepreneurs are committed to sell a share of their output at a fixed LC per-unit price. Because they have set their prices in LC but have to repay a real amount, inflation (depreciation) reduces the real value of their profits. Therefore, we

are assuming that goods prices are sticky for a longer period than it takes entrepreneurs to borrow and invest. While the entrepreneurs are constrained to sell a fraction of their output in fixed LC prices, the single consumption good is also traded internationally with flexible prices. This implies that purchasing power parity holds, and changes in the domestic price level are equal to changes in the nominal exchange rate. This will allow us to talk about inflation and depreciation interchangeably. Entrepreneurs' profits from the sale of the tradable good in the first stage of the period constitute their net worth when they want to invest in intermediate good production in the second stage. We assume that no external finance can be used for the production of intermediate goods, and so changes in net worth will determine the amount of intermediate goods entrepreneurs can produce. This in turn will determine aggregate production.<sup>48</sup>

The closest paper in the literature to our entrepreneurial sector is Céspedes et al. (2004), who study a Bernanke et al. (1999) financial accelerator in an open economy environment. Céspedes et al. (2004) demonstrate that depreciations are less expansionary, and potentially contractionary, when entrepreneurs are indebted in FC but earn revenues in sticky LC prices. In their model, informational frictions create an external finance premium that is falling in net worth. A lower net worth that leads to a higher premium on external borrowing thereby reduces aggregate investment. While we are after a similar channel, we make a starker assumption. In particular, we assume that entrepreneur net worth comes only from their profits from the sale of their output in the first stage, net of external debt repayment. We then assume that only this net worth can be used to finance intermediate good production, and no external financing can be used in the second stage when they invest in intermediate good production. By making these simplifications, we can solve the entrepreneurs' subproblem in closed form, avoiding the need for local approximation methods. This facilitates the

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<sup>48</sup>In Appendix 5.2, we consider a version of the model that includes domestic sales of the sticky price good produced by entrepreneurs. This allows domestic consumers to capture some of the gains of inflation.

introduction of the mismatched entrepreneurial sector into the inherently non-linear sovereign default problem.<sup>49</sup>

At the beginning of the period, entrepreneurs borrow a fixed amount from foreign lenders with a share  $\alpha_P$  in LC. Entrepreneur's borrow significantly less than they will produce  $\omega$ , so we do not consider them defaulting on their debt.<sup>50</sup> However, their profit  $\Pi$  is a function of the inflation rate. The amount produced per project is denoted by  $\omega$  and the face value of promised repayments is given by  $Z$ . A share  $\alpha_P$  of the face value of the debt is denominated in LC and  $(1 - \alpha_P)$  is denominated in FC. We assume that entrepreneurs are committed to sell a share  $\mu$  of their output at a fixed LC price  $P_{t-1}$  and may set the price of the remaining  $(1 - \mu)$  optimally. We can write the real value of entrepreneurial profits as:

$$\Pi = \gamma \left( \frac{P_{t-1}}{P_t} (\mu\omega - \alpha_P Z) + (1 - \mu)\omega - (1 - \alpha_P) Z \right),$$

where  $P_{t-1}$  is the price level entering the period and  $P_t$  is the price level that the sovereign sets after the realization of aggregate productivity. This expression for their profits captures the fact that only the value of LC repayments are affected by inflation. Using our earlier definition of the inflation tax  $\zeta$ , we can rewrite this equation as:

$$\Pi = \gamma ((1 - \zeta_t) (\mu\omega - \alpha_P Z) + (1 - \mu)\omega - (1 - \alpha_P) Z).$$

Because the tradable good is the numeraire, the profit per entrepreneur represents their net worth measured in tradable goods. We assume that entrepreneurs have access to a linear production technology that allows them to invest to produce intermediate goods  $X$ ,

$$X = \xi I$$

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<sup>49</sup>Here, we assume that the firms with sticky prices are intermediate good producers while it is more common to think consumer goods prices are sticky. This assumption is made for tractability.

<sup>50</sup>When we turn to the sovereign's problem, we will see that an optimizing sovereign would not choose a level of inflation in equilibrium that leaves entrepreneurs unable to repay their debt.

where  $\xi$  is the productivity of the intermediate good production technology and  $I$  denotes the units of tradable goods invested. The key financial friction is that we assume entrepreneurs cannot access external finance to invest in intermediate good provision, so we must have that investment is less than net worth:

$$I \leq \Pi.$$

We will consider the case where this constraint binds in every state, and so entrepreneurs will invest the maximum amount possible and we have  $I = \Pi$ . We can therefore write the amount of intermediates produced in equilibrium as:

$$X(\zeta) = \xi\gamma((1 - \zeta)(\mu\omega - \alpha_P Z) + (1 - \mu)\omega - (1 - \alpha_P)Z). \quad (24)$$

In default states, inflation  $\zeta = 0$ , and so if we have  $X_D = \xi I_D$  and  $I_D \leq \Pi_D$ , equilibrium intermediate good provision in default states will be given by:

$$X_D = \xi\gamma(\omega - Z).$$

**Introducing Entrepreneurs into the Dynamic Model** Having presented the relationship between the sovereign choice of inflation and intermediate good provision  $X(\zeta)$ , we can introduce the production economy into the dynamic model. After entrepreneurs produce the intermediate goods, they rejoin their household. Each household has access to a production technology that combines intermediate goods from the entrepreneurs and labor from the workers to produce a final good. As discussed previously, this production technology is Cobb-Douglas in intermediates and (inelastically-supplied) labor. This delivers consumption in repayment states of

$$C^R = AX(\zeta)^\gamma L^{1-\gamma} - (1 - \zeta)\kappa b + q^{LC}(A, b')[b' - (1 - \zeta)\delta b]$$

$$\text{where } X(\zeta) = \xi\gamma((1 - \zeta)(\mu\omega - \alpha_P Z) + (1 - \mu)\omega - (1 - \alpha_P)Z)$$

Before we can determine when the sovereign finds it optimal to default, we first need to calculate the best the sovereign can do by repaying and choosing the optimal inflation rate. This problem is kept tractable because our microfoundation of the entrepreneurs' problem delivers a simple closed form expression for the inflation policy function, conditional on any choice of borrowing tomorrow and the bond price schedule. Conditional on the choice of borrowing being  $b'$ , the sovereign chooses inflation to maximize static consumption (equation 23). Taking the FOC of consumption in repayment states with respect to inflation delivers an inflation policy function:

$$\zeta(A, b, b') = \max \left[ \frac{\omega - Z - \left( \gamma (\mu\omega - \alpha_P Z) \left( \frac{A (\xi\gamma)^\gamma}{b (\kappa + \delta q^{LC}(A, b'))} \right) \right)^{1/(1-\gamma)}}{(\mu\omega - \alpha_P Z)}, 0 \right]. \quad (25)$$

This captures the tradeoffs the sovereign faces in choosing the optimal inflation rate. First, inflation is countercyclical, as a lower aggregate productivity makes it more tempting to inflate away the debt. Second, the larger today's debt service,  $\kappa b$ , the higher the optimal inflation rate. Third, the term  $\delta b q^{LC}(A, b')$  captures the present value of outstanding long-term debt than can be inflated away. Because the expression for inflation is for a fixed amount of debt to be issued  $b'$ , net revenue raised  $q^{LC}(A, b')(b' - (1 - \zeta)\delta b)$  is increasing with the amount of debt inflated away. Therefore, the higher the price a sovereign will receive for new bond issuances, the more tempting it is to inflate away the existing debt. Of course, this temptation will be captured by the bond price schedule in equilibrium.

While the inflation choice can thus be reduced to a static optimization problem, the choice of the debt level is inherently dynamic as this debt level is the endogenous state variable in the next period. Before turning to this problem, we need to briefly discuss how the economy operates during a sovereign default as the optimal amount to borrow depends critically on how costly default is. Consumption in default is simply output in default, and

from the entrepreneurs' problem, we have

$$\begin{aligned}
C_D &= A_D(A) X_D^\gamma L^{1-\gamma} \\
X_D &= \xi\gamma(\omega - Z) \\
A_D(A) &= A - \phi(A)
\end{aligned}$$

where  $\phi(A)$  is a non-negative function capturing how much aggregate productivity drops in default. This is the production economy equivalent of the loss of output  $\phi(y)$  discussed in models of FC borrowing. Follow the existing literature discussed in the FC sovereign debt section, we can write the government's problem recursively as

$$\begin{aligned}
V^R(A, b) &= \max_{b'} u(C_R(A, b, b')) + \beta EV(A', b') \\
V^D(A) &= u(C_D(A)) + \beta (\lambda EV^R(A', 0) + (1 - \lambda) EV^D(A')) \\
V(A, b) &= \max_{D \in \{0,1\}} (1 - D) V^R(A, b) + D V^D(A)
\end{aligned} \tag{26}$$

where

$$\begin{aligned}
C_R(A, b, b') &= AX(\zeta(A, b, b'))^\gamma - \kappa b \cdot (1 - \zeta(A, b, b')) + q^{LC}(A, b') [b' - (1 - \zeta(A, b, b')) \delta b] \\
C_D(A) &= A_D(A) X_D^\gamma \\
X(A, b, b') &= \xi\gamma [(1 - \zeta(A, b, b')) (\mu\omega - \alpha Z) + (1 - \mu)\omega - (1 - \alpha)Z] \\
X_D &= \xi\gamma(\omega - Z) \\
\zeta(A, b, b') &= \max \left[ \frac{\omega - Z - \left( \gamma (\mu\omega - \alpha_P Z) \left( \frac{A (\xi\gamma)^\gamma}{b(\kappa + \delta q^{LC}(A, b'))} \right) \right)^{1/(1-\gamma)}}{(\mu\omega - \alpha_P Z)}, 0 \right] \\
q^{LC}(A, b') &= \frac{E [(1 - D(A', b')) (1 - \zeta(A', b')) (\kappa + \delta q^{LC}(A', b''(A', b')))] | A, b']}{1 + r^*} \\
A_D(A) &= A - \phi(A).
\end{aligned}$$



This recursive representation is nearly identical to that discussed in model with FC debt. The value function in repayment states  $V^R$  is today's flow utility and the expectation of tomorrow's value function. In the event a country defaults or remains in bad credit history, there are no choices to be made and the country's period utility is just  $u(C_D(A))$ . Finally, the value function today is the upper envelope of the two: the sovereign remains in  $V^R$  if it prefers to repay the debt rather than explicitly default, and if it prefers to default, the relevant value function is  $V^D$ . In addition, it captures the fact that conditional on a choice of  $b'$ , the optimal inflation policy function is pinned down analytically, conditional on the equilibrium bond price schedule  $q(A, b')$ .

One of the primary benefits of the way in which we introduce LC debt and the entrepreneurial sector into the canonical model is that our model is a generalization of the existing FC literature. If we were to restrict inflation to always be zero, then this setup collapses exactly to the model with FC debt. With no inflation  $X = X_D = \bar{X}$ , and so output would be equivalent to an endowment economy, with changes in the endowment proportional to changes in productivity  $A$ . Because of this, we will be able follow the existing literature in our numerical solution of the model.

**Equilibrium Definition** We study the Recursive Markov Equilibrium for this economy where all decision rules are functions only of the state variables  $A$  and  $b$ . An equilibrium is a set of policy functions for consumption  $\tilde{c}(A, b)$ , debt issuance  $\tilde{b}(A, b)$ , default  $\tilde{D}(A, b)$  and inflation  $\tilde{\zeta}(A, b)$ , and a price function for debt  $q(A, b')$  such that:

1. Taking as given the government policy functions, household consumption satisfies the resource constraint
2. Taking the bond price function  $q(A, b')$  as given, the government's policy functions satisfy the sovereign's optimization problem
3. The bond price function satisfies the risk-neutral foreign lenders' zero-profit condition.

The government's lack of commitment is captured by the fact that equilibrium policy functions are restricted to be functions of today's state variables  $A$  and  $b$ , and cannot be history dependent. Instead, the government policy functions must satisfy the government's optimization problem period-by-period.

### 2.5.3 Bond Pricing, Currency Risk and Credit Risk

Just as we are able to measure the currency and credit risk on local currency sovereign debt in the data by pricing a synthetic default-free local currency bond, in the model our decomposition of currency and credit risk will rely on pricing an instrument in zero net supply. Even though the only debt actually issued by the government is a defaultable local currency bond, we can still price a default-free local currency bond. This will be the theoretical counterpart to our empirical version of combining a US Treasury with a cross-currency swap to approximate the interest rate at which a risk-free entity would borrow if it issued a single unit of debt in an EM currency. To do so, we simply have to calculate what the price global investors would pay for the *default-free* sequence of LC cash flows in equation 21. The price is the discounted risk-neutral expected value of the cash flows, conditional on the time  $t$  information set,

$$\begin{aligned} q_t^{*LC} &= E_t \left[ \frac{\kappa \cdot (1 - \zeta_{t+1})}{1 + r^*} + \frac{\delta \kappa \cdot (1 - \zeta_{t+1}) (1 - \zeta_{t+2})}{(1 + r^*)^2} + \dots \right] \\ &= \frac{E_t [(1 - \zeta_{t+1}) (\kappa + \delta q_{t+1}^{*LC})]}{1 + r^*} \end{aligned} \quad (27)$$

and so once again the bond has a simple recursive representation.<sup>51</sup> Just as is the case for the defaultable LC bond price  $q_t^{LC}$ , the default-free LC bond price is a function of today's exogenous productivity level  $A$  and the amount of defaultable debt issued  $b'$ . It is important to note that the payoff on this bond is a function of the sovereign's inflation choice, and therefore its payoffs are a function of government policy just like the defaultable debt. The

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<sup>51</sup>Additional details can be found in Appendix Section 5.2.8.

key difference is that this default-free debt is not issued by the sovereign and therefore cannot be defaulted on. However, by suppressing the state variables, equation 27 hides the complications in pricing this debt. To solve for default-free LC bond price schedule, we need to account for the payoff a creditor receives from owning this bond in sovereign default states. Although this is not a concern for defaultable bonds, as once the government defaults the value of the debt goes to zero, we need to consider these periods for default-free debt. To see this, it is easiest to write the bond price schedule for default-free LC debt when the sovereign is in default and when it is not in default, with subscript  $D$  indicating default states and  $R$  indicating repayment states.

$$q_R^{*LC}(A, b') = \frac{E[(1 - \zeta(A', b'))(\kappa + \delta((1 - D(A', b'))(q_R^{*LC}(A', b''(A', b')))) + D(A', b')q_D^{*LC}(A')) \mid A, b']}{1 + r^*}$$

$$q_D^{*LC}(A) = \frac{\kappa + \delta E[\lambda q_R^{*LC}(A', 0) + (1 - \lambda)q_D^{*LC}(A') \mid A, b']}{1 + r^*}$$

This makes clear that the default-free bond price does still depend on the government's default policy function through its effect on the government's incentive to inflate in the future.<sup>52</sup> In other words, the expectation of next period's bond price differs depending on whether the country is currently in good or bad financial standing:

$$E_t(q_{t+1}^{*LC} \mid D = 0) = E_t[(1 - D(A', b'))q_R^{*LC}(A', b''(A', b')) + D(A', b')q_D^{*LC}(A')]$$

$$E_t(q_{t+1}^{*LC} \mid D = 1) = E_t[\lambda q_{t+1,R}^{*LC}(A', 0) + (1 - \lambda)q_{t+1,D}^{*LC}(A')]$$

where  $D = 0$  means the country is in good standing and  $D = 1$  means the country is in bad standing. Because this default-free debt is not issued by the sovereign, and the payoff on this debt in no way affects the decisions of the sovereign, its price can simply be computed by solving the above fixed point problem while taking the equilibrium sovereign policy functions as given. While the price of default-free LC debt during periods of sovereign default is an important element in pricing the debt, we will focus on comparing the default-free LC bond

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<sup>52</sup>Na et al. (2014) demonstrate that in the presence of downward rigid nominal wages, a government might find it optimal to devalue following a sovereign default. We abstract from this feature that would generate inflation upon default and there is no incentive to inflate after default here.

price to the defaultable LC bond price in non-default states, as the latter price is not defined when the sovereign is locked out of international debt markets.

In order to connect the bond prices to the empirical currency and credit spread decomposition discussed in Section 2.2, we need to convert these bond prices to yields. To do so, we can define the yield-to-maturity (YTM) of bond type  $j$  at time  $t$  as  $r_t^j$ , as the rate of return that equates the present value of the bond's promised cash flows to its price:

$$q_t^j = \sum_{s=1}^N \frac{CF_{t+s}}{(1+r_t^j)^s}$$

where  $CF_{t+s}$  is the promised cash flow of the bond at time  $t+s$ . Because the bonds we are looking at have an exponentially declining coupon structure, this calculation is particularly simple and becomes:

$$r_t^j = \frac{\kappa}{q_t^j} - (1 - \delta) \quad (28)$$

This allows us to calculate the credit risk (LC credit spread, equation 18), currency risk (cross-currency swap rate), and to decompose the nominal yield into currency and credit risk:

$$\begin{aligned} \rho_t &= r_t^{*LC} - r^* \\ s_t^{LCCS} &= r_t^{LC} - r_t^{*LC} \\ s_t^{LC/US} &= r_t^{LC} - r^* \\ &= s_t^{LCCS} + \rho_t \end{aligned}$$

where  $r_t^{LC}$  is the YTM on a defaultable LC sovereign bond,  $r_t^{*LC}$  is the YTM on the (zero net supply) default-free LC bond, and  $r^*$  is the FC risk-free rate, which we assume to be constant. By calculating these three spreads in the model, we will be able to compare the model-implied moments to their empirical counterparts.

### 2.5.4 Static Example

Because the dynamic model will need to be solved numerically, we will first consider a static example to provide intuition. We can characterize the static problem analytically, and allow us to see the tradeoffs in the dynamic model in a more transparent way. This example can be thought of a special case of the dynamic model, where the sovereign enters the period with some inherited debt, but experiences a preference shock such that it fully discounts the future, setting  $\beta = 0$ , and loses the ability to issue new debt. By working in a static framework, the model is simplified in two major ways. First, there is no sovereign borrowing decision. Second, in a static framework a sovereign cannot be locked out of credit markets, and so the only costs of default are the productivity loss.

**The Sovereign's Problem and Bond Pricing** In the static model, the sovereign's goal is simply to choose the policy to maximize household consumption in the period. If the sovereign were to repay its debt, it would be choose inflation to maximize

$$\max_{\zeta} C_R = AX (\zeta)^\gamma L^{1-\gamma} - (1 - \zeta) b$$

where  $b$  is debt issued last period maturing today, and  $X(\zeta)$  is defined exactly as in Equation 24. To reduce the clutter of notation, we will normalize  $\xi = 1/\gamma$  and set  $\mu = 1$ , even though we will not impose these restrictions in the calibrated dynamic model. The first order condition of this equation delivers an inflation policy function:

$$\zeta^* = \begin{cases} \frac{\omega - Z}{(\omega - \alpha_P Z)} - \left(\frac{\gamma A}{b}\right)^{\frac{1}{1-\gamma}} (\omega - \alpha_P Z)^{\frac{\gamma}{1-\gamma}} & A < A_0 \\ 0 & A \geq A_0 \end{cases} \quad (29)$$

where inflation is 0 for productivity levels above  $A_0$ , given by

$$A_0 = \frac{(\omega - Z)^{1-\gamma} b}{\gamma (\omega - \alpha_P Z)}. \quad (30)$$

When  $A < A_0$ , inflation is decreasing with aggregate productivity  $A$  and increasing with the share of LC corporate debt  $\alpha_P$ . We can plug the inflation policy function into the expression for consumption to calculate the consumption policy function  $C_R(A)$ . Having calculated the consumption policy function in repayment, we now need to calculate when this consumption level is higher than the sovereign could achieve in default. In default, the sovereign no longer has any incentive to inflate, allowing us to write consumption in default as

$$C_D = A_D(A) (\omega - Z)^\gamma.$$

The sovereign will choose to default whenever consumption in default is higher than the highest level of consumption the sovereign could achieve by choosing the optimal inflation rate. We can now explicitly solve for the productivity threshold  $A_{crit}$ , below which the sovereign defaults, by solving for the level of productivity where the sovereign is exactly indifferent between repaying and defaulting:

$$C_R(A_{crit}) = C_D(A_{crit}).$$

We relegate the exact expression for  $A_{crit}$  to Appendix 5.2 and will discuss which factors affects the threshold. The threshold  $A_{crit}$  is important because it determines the range of aggregate states  $A$  in which the sovereign finds it optimal to default. If we define the CDF of the productivity distribution as  $F(A)$ , the probability of sovereign default is the probability that  $A < A_{crit}$ , or,  $F(A_{crit})$ . To better understand the risks facing lenders, it is helpful to think about what affects the price of defaultable LC debt, and in particular what affects the currency and credit risk on the debt, as in equation 19. We start by computing the

nominal spread of the LC sovereign bond over the U.S. Treasury bond implied from the model. Because there is no issuance in this static model, we assume that at the start of the period, a continuum of risk-neutral foreign lenders can trade the outstanding debt in secondary market. Normalizing the risk-free rate to 0 for now, the price of the defaultable LC sovereign bond is given by the expectation of the real value of debt repayments, the product of the probability of repayment and one minus the inflation tax:

$$q^{LC} = E[(1 - D(A))(1 - \zeta(A))],$$

where  $D(A)$  is an indicator variable for default for each level of aggregate productivity  $A$  and  $\zeta(A)$  is the inflation rate in these same states.<sup>53</sup> By taking logs of both sides, we can write the (log) spread on the LC sovereign debt over the dollar risk free rate as:

$$s^{LC/US} = -\log\left(\int_0^\infty (1 - D(A))(1 - \zeta(A)) f(A) dA\right),$$

where  $f(A)$  is the probability density function (PDF) of the productivity distribution. Because inflation and default occur in separate states, this can be further simplified as

$$s^{LC/US} = -\log\left(1 - F(A_{crit}) - \int_{A_{crit}}^{A_0} \zeta(A) f(A) dA\right),$$

where  $A_0$  is the productivity level above which inflation is 0 (given by equation 30), and  $A_{crit}$  is the productivity level below which the sovereign defaults. After taking a first-order approximation, we have

$$s^{LC/US} \approx \int_{A_{crit}}^{A_0} \zeta(A) f(A) dA + F(A_{crit}). \quad (31)$$

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<sup>53</sup>Both  $D(A)$  and  $\zeta(A)$  are also functions of  $b$ , but  $b$  is known at the time the expectation is taken.

Assuming relative purchasing power parity holds, so that expected inflation is equal to the expected depreciation rate, the currency risk component of the LC bond is given by

$$\rho = \int_0^\infty \zeta(A)f(A)dA = \int_{A_{crit}}^{A_0} \zeta(A)f(A)dA \quad (32)$$

The credit risk component of the LC bond, or the LC credit spread defined in Equation 18, is given by

$$s^{LCCS} = s^{LC/US} - \rho = F(A_{crit}), \quad (33)$$

is equal to the default probability of the bond.<sup>54</sup> Substituting Equations 32 and 33 into Equation 31, we have the currency and credit risk decomposition of the LC nominal spread:

$$s^{LC/US} = \rho + s^{LCCS}.$$

We can examine the effect of the corporate currency composition on each component of the nominal spread by differentiating the credit risk  $s^{LCCS}$  and the currency risk  $\rho$  on a defaultable nominal bond with respect to  $\alpha_P$ .

**Proposition 3.** *For sufficiently convex default costs, the LC credit spread is falling and currency risk is rising with the share of LC corporate debt.*

$$\begin{aligned} \frac{\partial s^{LCCS}}{\partial \alpha_P} &= \frac{f(A_{crit})}{1 - F(A_{crit})} \frac{\partial A_{crit}}{\partial \alpha_P} \leq 0 \\ \frac{\partial \rho}{\partial \alpha_P} &= \frac{\int_{A_{crit}}^{A_0} \frac{\partial \zeta(A)}{\partial \alpha_P} f(A) dA - \zeta(A_{crit}) f(A_{crit}) \frac{\partial A_{crit}}{\partial \alpha_P}}{1 - \int_{A_{crit}}^{A_0} \zeta(A) f(A) dA} \geq 0 \end{aligned}$$

Proof: See Appendix 5.2.

Default risk falls with the share of LC corporate debt as long as increases in the share  $\alpha_P$  reduce the default threshold  $A_{crit}$ . In the appendix, we prove that  $A_{crit}$  is indeed the unique threshold and that this threshold falls with increases in the LC debt share for the

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<sup>54</sup>Given zero inflation upon default, the covariance between currency risk and inflation risk is equal to 0.



default costs used in the literature. The intuition for this result is that while the currency composition of debt has no impact on consumption in default states, in repayment states consumption increases with the LC share as real repayments on LC debt at the default threshold are  $(1 - \zeta(A_{crit}))$ . Because a higher LC share raises consumption in repayment states but not default states, the sovereign would strictly prefer repayment at the old  $A_{crit}$ , meaning that more LC debt shifts the default threshold down. We know that inflation is increasing with  $\alpha_P$  by direct inspection of Equation 29. Differentiating the LC credit spread with respect to  $\alpha_P$ , we find that the more the threshold moves with changes in the LC share and the higher the density of the threshold,  $f(A_{crit})$ , the larger is the decrease in the LC credit spread. Currency risk increases with the LC share (strictly, as long as  $\zeta(A) > 0$  for some  $A$ ) for two reasons. First, the inflation rate increases for every state with positive inflation. Second, an increase in inflation also comes from shifting the default threshold, meaning there is now inflation in states where the risk was previously only default. Both forces increase currency risk. As the credit risk decreases with the LC share and currency risk increases with the LC share, the aggregate effect on the nominal spread depends on the relative magnitude of the two opposing forces and the underlying productivity distribution, and hence is ambiguous. In Appendix 5.2, we consider a version of the static model with some inherited FC sovereign debt.

## 2.6 Quantitative Results

### 2.6.1 Calibration and Numerical Solution

Having discussed the intuition behind the model through our static example, we now turn to solving the dynamic model numerically. In this section, we will outline the functional form assumptions, parameter calibrations and solution method.

We assume a CRRA utility function with a coefficient of relative risk aversion  $\sigma$  and we will assume that log productivity follows an AR(1) process

$$u(c) = \frac{c^{1-\sigma} - 1}{1-\sigma}$$

$$\ln A_t = \mu_z (1 - \rho_z) + \rho_z \ln A_{t-1} + \epsilon_t, \quad 0 < \rho_z < 1 \text{ and } \epsilon_t \sim N(0, \sigma_\epsilon^2).$$

We follow Chatterjee and Eyigungor (2012) and use the flexible form for default costs

$$A_D = A - \phi(A)$$

$$\phi(A) = \max \{0, d_0 A + d_1 A^2\}, \quad d_1 \geq 0$$

If  $d_1 = 0$  and  $d_0 > 1$ , this is simply the proportional default costs used in Aguiar and Gopinath (2006). If  $d_1 \geq 0$  and  $d_0 < 0$ , then the default costs become closer to the Arellano (2008) costs because when  $A \leq -\frac{d_0}{d_1}$ , the default costs are zero but when  $A$  is above that threshold the default costs are convex in  $A$ . However, because here we have  $A_D$  increasing with  $A$  rather than staying constant, the default costs are less kinked than in Arellano (2008).

Table 13: Calibration (Quarterly)

Parameter	Value	Description
$\gamma$	1/3	Mean of Domestic/Total Corp. Financing in 2012Q4
$Z$	.51	External Corp/GDP of 17%
$\omega$	1.5017	$X = 1$ if $\zeta = 0$ , inflation differential at 2000-2012 mean
$\xi$	3.025	$X = 1$ if $\zeta = 0$ , inflation differential at 2000-2012 mean
$\alpha_P$	.1	10% of Corporate Debt in LC
$\delta$	.9595	Risk-Free Sovereign Duration of 5 years
$\beta$	.95	Discount Factor
$\mu$	.75	Share of fixed prices
$d_0, d_1$	[0.0174, 0.0160]	Default costs: 3% cost in bad state, 3.75% in best state
$\sigma$	2	CRRA
$\rho$	.9	AR(1) persistence (A&G 2006)
$\sigma_z$	.034	S.D. of Log of Aggregate Productivity (A&G 2006)
$\lambda$	10%	Probability of redemption ((A&G 2006))
$r^*$	1%	Risk-free rate

Notes: A&G 2006 refers to Aguiar and Gopinath (2006).

We calibrate the model to a quarterly frequency. The parameter values are documented in Table 13. We set the intermediate good share  $\gamma$  to  $1/3$  so that the labor share is  $2/3$ . We set the amount of foreign currency external corporate financing  $Z$  to  $.51$ , so that in the absence of inflation the mean debt/output ratio is equal to  $17\%$ , the mean private external debt/GDP ratio documented in Section 2.3. We calibrate mean entrepreneur output and the efficiency of the intermediate good production technology  $\xi$  so that in the absence of inflation,  $X = 1$  and the model collapses to the endowment economy with FC sovereign debt discussed earlier. This requires  $\xi = 1/\gamma(\omega - Z)$ , meaning that the choice of  $\xi$  and  $\omega$  only involves setting one parameter. We set  $\xi$  and  $\omega$  to match the average inflation differential between the 13 EMs and the United States from 2000-2012. This delivers  $\xi = 3.025$  and  $\omega = 1.5017$ . We set the default costs to match the historical average credit spread on foreign currency debt (from CDS) over the last decade of  $2\%$  when we solve a version of the model with only FC debt. The implied default costs correspond to an aggregate productivity loss of  $3\%$  in the worst state and  $3.75\%$  in the best state. This is within the range used in the literature, as in Aguiar and Gopinath (2006) the proportional cost is equal to  $3\%$ , in Hatchondo and Martinez (2009) it is equal to  $10\%$ , and in Arellano (2008), in the low states it is  $0\%$  and in high states it can exceed  $20\%$ . We can then set  $\alpha_P$  to  $10\%$  to match the mean share of LC corporate debt in total external corporate debt in the data. We set the quarterly discount factor  $\beta = .95$ , a standard value in this literature with long-term debt. In order to generate default in equilibrium, the sovereign has to be less patient than international investors. This leads the sovereign try to front-load consumption, generating default risk in equilibrium. This low discount factor can be understood as capturing a government that is more impatient than individuals for political economy reasons.<sup>55</sup>

To calibrate the productivity process, we follow Aguiar and Gopinath (2006), setting the autocorrelation  $\rho_z = 0.9$  and  $\sigma_z = 0.034$ . We follow Tauchen (1986) to discretize the productivity process. We set  $\delta = .9595$  to set the risk-free duration of the LC bonds to 5

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<sup>55</sup>See Cuadra and Sapriza (2008) for a model that explicitly models political economy frictions in an Eaton and Gersovitz (1981a) sovereign debt model.

years when the quarterly risk-free rate is 1%.<sup>56</sup> This duration is close to the cross-country average calculated in appendix Table 29. For the probability of re-entry into credit markets, we follow Aguiar and Gopinath (2006) and set the probability of re-entry  $\lambda$  to 10%, consistent with the evidence in Gelos et al. (2011).<sup>57</sup> The share of sticky price goods  $\mu$  is set to .75, a common calibration parameter for Calvo pricing.

To solve the model, we use value function iteration over a discretized state space. Because our recursive representation is identical to the model studied in Hatchondo and Martinez (2009), Chatterjee and Eyigungor (2012), and a one-bond version of Arellano and Ramaranarayanan (2012), with one additional constraint on the policymaker (equation 25), we can simply follow the solution methods used in the FC sovereign debt literature. The state space for productivity shocks is discretized to a 25 state grid. The state space for bonds is discretized into 451 grid points. A finer grid is used for the endogenous state variable to keep the discretization from impacting the sovereign's choices. Following the recommendations in Hatchondo et al. (2010), we iterate backwards from the solution of the final period of the finite-horizon model so that we select the equilibrium bond price of the finite horizon model. To improve the convergence properties of the solution, we follow Chatterjee and Eyigungor (2012) and introduce a small i.i.d. component to the productivity process. Chatterjee and Eyigungor (2012) show that in sovereign debt models with long-term bonds large changes in the bond issuance policy function can achieve roughly the same welfare level, so that small changes in the bond price can lead the bond issuance policy function to change significantly. These discontinuities arise from the non-convexity of the budget set. The introduction of a

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<sup>56</sup>The risk free Macaulay duration of bond is given by  $D = \sum_{n=1}^{\infty} n \frac{C_n (1+r^*)^{-n}}{q}$ , where  $C_n$  is the coupon payment due in period  $n$ . In our framework with exponentially declining coupons,  $D = \frac{1+r^*}{1+r^*-\delta}$ .

<sup>57</sup>This implies that on average sovereigns are excluded from financial markets for 2.5 years. Other authors, such as Benjamin and Wright (2013), find a longer exclusion period. Cruces and Trebesch (2013b) calculate the mean time to for market re-access following is 5.1 years and the median is 3 years, so our calibration of  $\lambda$  implies a shorter period of exclusion. However, the parameter for market re-access  $\lambda$  also determines the length that the country suffers the output costs of default. Estimates of the output cost of default, as in Borensztein and Panizza (2009) and Yeyati and Panizza (2011), imply a much shorter duration. Therefore, we are inclined to follow Aguiar and Gopinath (2006), setting  $\lambda = 10\%$ , for a relatively short punishment period.

small i.i.d. component to the productivity process acts to convexify the budget set and improve convergence without significantly affecting the business cycle properties of the model. In the event of default, we set this i.i.d. component to its lowest value, slightly increasing the cost of default.<sup>58</sup>

After solving for the equilibrium policy functions and the defaultable LC bond price, we price the synthetic default-free LC bond as in section 2.5.3. With our policy functions and bond price schedules in hand, we can calculate the model-implied moments by simulating the model 20 times for 3000 quarters per simulation. We discard the first 500 periods of each simulation.

## 2.6.2 Quantitative Results and Key Mechanisms

In this section, we will discuss the quantitative results and the model’s key mechanisms. First, we will compare the model’s simulated moments to their empirical counterparts. Second, we will explore the mechanisms at work in the model, focusing on why a higher share of LC corporate debt reduces sovereign default risk in equilibrium. We will demonstrate how the sovereign’s equilibrium inflation and default policy functions vary with the share of LC corporate debt and how these policy functions generate different bond price schedules for the government. We will then examine how the sovereign optimally responds to these bond price schedules and its own future default and inflation incentives when deciding how much to borrow. We will use the debt Laffer curve, the equilibrium schedule of the market value of sovereign debt  $q \cdot b'$ , to provide intuition for why there is no sovereign default risk in equilibrium when the corporate sector is less mismatched.

**Quantitative Results** In Table 14, we report the key moments for 8 different calibrations of  $\alpha_P$ , as well as a version of the model with only FC sovereign debt, where the corporate debt composition is irrelevant. In the first row, we report the sample average local currency

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<sup>58</sup>As in Chatterjee and Eyigungor (2012), we set a bounded support of this i.i.d. shock at .006 and find it is sufficient to achieve faster convergence for our calibration.

credit spread ( $s^{LCCS}$ ), nominal spread ( $s^{LC/US}$ ), and the share of credit risk in the nominal spread ( $s^{LCCS}/s^{LC/US}$ ). These are the average of currency and credit spreads for 13 countries from 2005-2012<sup>59</sup> calculated following the methodology discussed in Section 2.2. Each country receives equal weight in computing the sample average. The final column, external sovereign debt-to-GDP, is again just the simple cross-country average, with the external debt/GDP ratio calculated using our data discussed in Section 2.3. The remaining rows of the table report the simulated moments for the five alternative calibrations of the model, with the baseline calibration in blue with  $\alpha_P$  set to its sample average of 10%. In our baseline calibration, we come quite close to matching the average cross-country empirical moments, with an average local currency credit spread of 1.10% as compared to 1.28% in the data, and a nominal spread of 3.33% as compared to a mean of 4.77% in the data. In addition, in the baseline calibration we generate a ratio of external sovereign debt to annual GDP of 8.7%, very close to the 9% found in the data. By changing  $\alpha_P$  from 10% to 50%, we see that credit risk disappears completely for the reasons discussed in the previous section. One key finding of the quantitative model, is that there is a fairly narrow region of the parameter space where both inflation and default are observed in equilibrium. Therefore relatively small changes to the corporate debt composition may have large effects on the risk of sovereign default. In this calibration, we find that the nominal spread on LC sovereign debt does not dramatically increase with the share of LC corporate debt. The mechanisms behind these results are the focus of the next subsection.

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<sup>59</sup>Russia is excluded because its LC debt was not investable for much of the period.

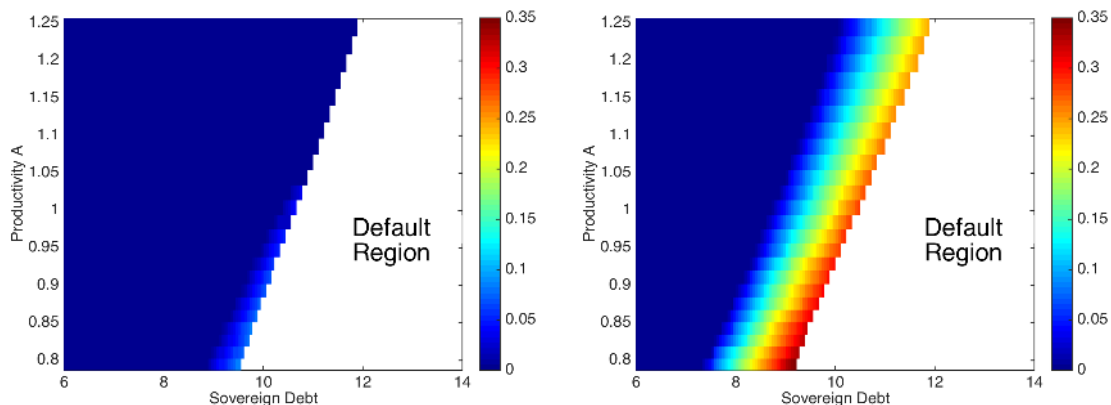
Table 14: Key Moments

	Share LC Debt $\alpha_P$	Mean LCCS $s^{LCCS}$	Mean Nom. Spread $s^{LC/US}$	Credit Share $s^{LC/US}/s^{LCCS}$	Sov. Debt/GDP $B/Y$
Data	10%	1.28	4.77	26.8%	9%
FC Debt	-	2.0	2.0	100%	9.8%
Model	0%	1.89	2.66	70.9%	8.9%
Model	5%	1.67	2.98	55.9%	8.8%
Model	10%	1.10	3.33	32.9%	8.7%
Model	15%	0.88	3.73	23.6%	8.5%
Model	20%	0.30	4.09	7.3%	8.4%
Model	25%	0.05	4.28	1.2%	8.2%
Model	30%	0.00	4.31	0.1%	8.0%
Model	50%	0.00	4.34	0.0%	7.1%

*Notes:* This table reports the empirical and model generated moments of currency and credit risk. The first row, Data, reports the mean local currency credit spread  $s^{LCCS}$ , nominal spread  $s^{LC/US}$ , share of credit risk in the nominal spread  $s^{LC/US}/s^{LCCS}$  and external debt-to-GDP ratio  $B/Y$  for the 13 countries in our dataset from 2005-2012. All subsequent rows report the mean model-generated parameters for different calibrations. The row labeled FC debt refers to a version of the model where the sovereign cannot choose to inflate, and so the LC share  $\alpha_P$  is irrelevant. The next 8 columns refer to different calibrations of the model, with the share of corporate debt in LC  $\alpha_P$  given by the first column. Our baseline results refer to the case when  $\alpha_P = 10\%$ .

**Equilibrium Policy Functions and Bond Prices** In order to better understand the mechanisms at work in the model, we will begin by looking at the sovereign's policy functions for two different levels of currency mismatch,  $\alpha_P = 10\%$  (baseline) and  $\alpha_P = 50\%$  (low mismatch). In Figure 16, we plot the sovereign's equilibrium default and inflation policy functions for different levels of debt outstanding and aggregate productivity. The legend on the right side of each figure indicates the level of inflation, where warmer colors mean higher inflation and crimson indicates explicit default. In the left panel, we plot the baseline case where 10% of corporate debt is in LC and we see that there is only a small range of low positive inflation before the sovereign chooses to explicitly default on its debt. This is in sharp contrast to the right panel of Figure 16, where half of corporate debt is in LC. Here, we see a wider range of positive inflation before the sovereign actually chooses to default on the debt.

Figure 16: Inflation Policy Function and Default Region:  $\alpha_P = 10\%$  (Left),  $\alpha_P = 50\%$  (Right)

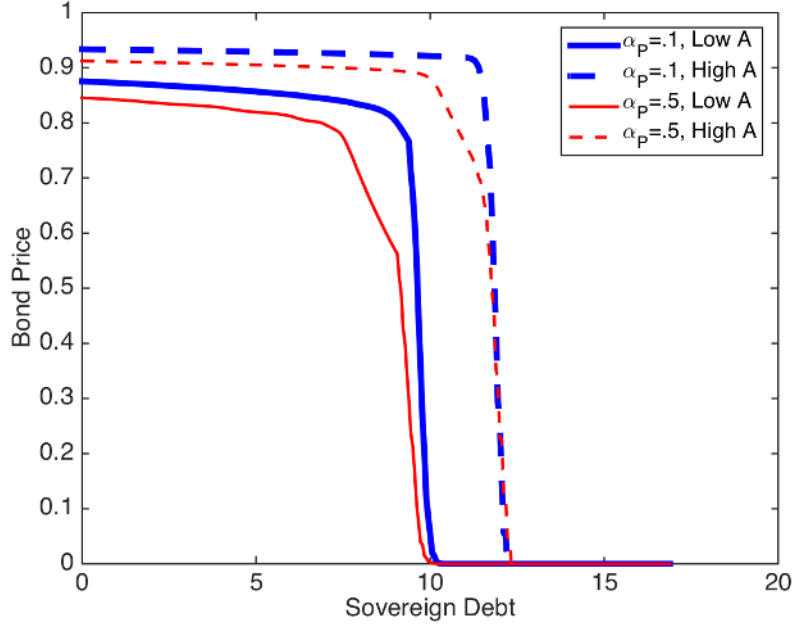


*Notes:* This figure plots the inflation policy function and the default set for two calibrations of the dynamic model. The left panel sets the share of LC private debt  $\alpha_P = 10\%$  and the right panel sets  $\alpha_P = 50\%$ . The coloring of the figure indicates the equilibrium inflation rate the sovereign chooses for a given amount of inherited debt and productivity level. The white region in the lower right hand corner denotes the region where the sovereign explicitly defaults and the dark blue in the upper left hand corner denotes repayment and zero inflation. In between, as the colors get warmer, the inflation rate is rising. The inflation rate corresponding to each color is given by the bar to the right of each figure.

Because lenders recognize the incentives facing the sovereign, these policy functions are embodied in the bond price schedules that ensure that foreign lenders break even in expectation. In Figure 17, we plot the bond price schedule the sovereign faces in good and bad states for two levels of corporate mismatch. The thick blue lines plot the case where 10% of private sector debt is in LC and the thin red lines plot the case where 50% of private sector debt is in LC, with the dashed lines indicating the high productivity state. With only 10% of debt in LC, the narrow band of positive inflation from the policy function is reflected in the bond price schedule as the government borrows at a relatively high price (low spread) at lower levels of debt before the bond price sharply declines. This reflects the fact that the default threshold is very steep in the amount of debt outstanding. Therefore, there is only a small region of the bond price schedule where the sovereign significantly compensates the lender for currency risk and, as the amount of debt issued increases, the bond price very sharply declines as the sovereign approaches the default threshold. By contrast, when half of corporate debt is in LC, we initially see a more gradual decline in the bond price as the



Figure 17: Bond Price Schedule



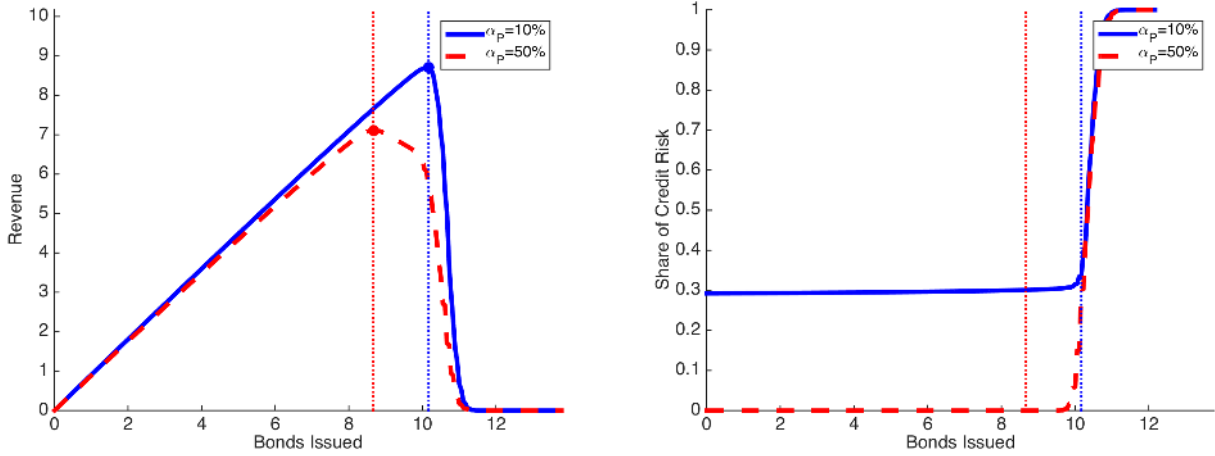
*Notes:* This figure plots the bond price schedule  $q(A, b')$  for two calibrations of the model. The x-axis denotes the amount of sovereign bonds a government can issue  $b'$  and the y-axis the bond price  $q$ . The thick blue lines refer to the baseline calibration of the model when the share of corporate debt in LC  $\alpha_P = 10\%$  and the thin red lines refer to the calibration of the model when  $\alpha_P = 50\%$ . The dashed lines refer to the case when aggregate productivity  $A$  is at its highest value and the solid lines refer to the case when aggregate productivity is at its lowest value.

sovereign compensates the lender for the increasing currency risk, and then a sharper decline as default risk becomes more prevalent.

**Debt Laffer Curve** While these policy functions and bond price schedules are useful for seeing the options facing the sovereign, to understand the difference in equilibrium currency and credit risk in these two economies we have to examine how the sovereign actually borrows when facing these different incentives. In particular, we have to look at the equilibrium bond issuance policy function  $\tilde{b}(A, b)$ . We will find it particularly useful to focus on the amount of debt the sovereign chooses to issue relative to the amount of debt that would maximize the market value of the debt. In order to do so, we will define the gross revenue curve (the market value of the debt), as the quantity of debt times its price  $q(A, b') \cdot b'$ .<sup>60</sup>

<sup>60</sup>The net revenue raised is only the amount raised from net issuances,  $q(b', A) \cdot (b' - (1 - \zeta) \delta b)$ . Of course, in the case of one period debt,  $\delta = 0$  and so gross and net revenue from total bond issuance  $b'$  coincide.

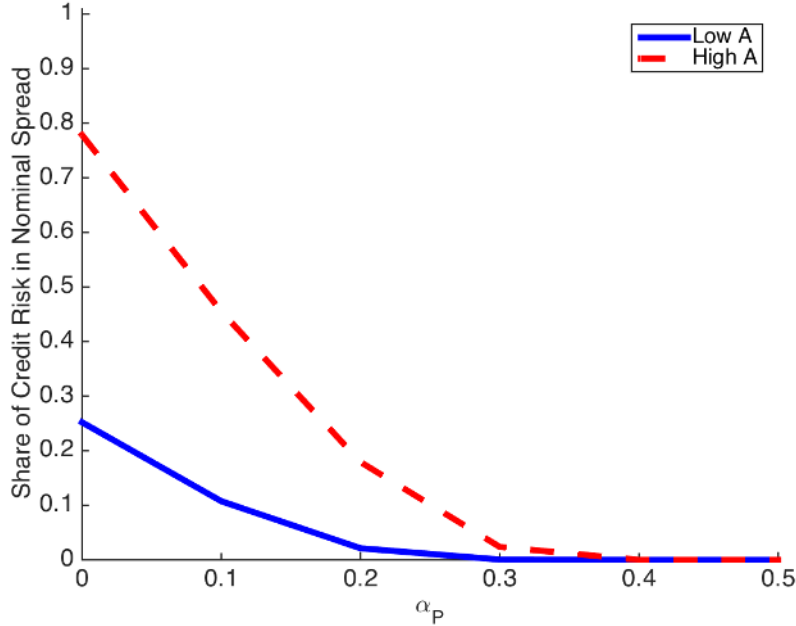
Figure 18: The Debt Laffer Curve (Left) and the Share of Credit Risk (Right)



Notes: The left panel of the figure plots the Revenue Curve ( $q \cdot b'$ ) against the bond issuance curve ( $b'$ ) for the case when  $\alpha_P = .1$  and  $\alpha_P = .5$ . The blue curve plots the case where  $\alpha_P = .1$  and the red curve plots the case where  $\alpha_P = .5$ . All figures are plotted for when  $A = \bar{A}$ . The vertical dashed lines are plotted at the peak of the two debt Laffer Curves. In the right panel, the two curves plot the share of credit risk in the nominal spread  $\frac{s^{LCCS}}{s^{LC/US}}$  for each level of borrowing  $b'$ . The vertical lines are the same as in the left panel, denoting the peak of the debt Laffer curve. The credit share plot is plotted in dashed lines after the peak of the debt Laffer curve.

In the left panel of Figure 18, we plot the gross revenue curve for  $\alpha_P = 10\%$  and  $\alpha_P = 50\%$  when aggregate productivity  $A$  is at its mean. We see that in both cases the sovereign faces a debt Laffer curve: revenue initially increases with the quantity of debt and then declines as the bond price sharply falls with amount of debt issued. The dotted vertical lines indicate the peak of the debt Laffer curves for the two parameterizations. Because the cost of default is assumed to be independent of the stock of debt, as the face value of debt increases, the sovereign chooses to default in more states. Eventually the bond price goes to zero, as the debt level is high enough that the sovereign will default in the next period regardless of how productive the economy is. As the bond price goes to zero, the market value of outstanding debt  $q \cdot b'$ , also goes to zero. In the right panel of Figure 18, we plot the share of credit risk in the nominal spread for the two parameterizations for each level of borrowing  $b'$ . Using the notation from Section 2.2, we define the credit share as  $(s^{LCCS}/s^{LC/US})$ , the LC credit spread divided by the nominal spread. This credit share tells us what fraction of the spread a government pays over the risk-free rate is compensation for the risk that it may default on

Figure 19: Share of Credit Risk at Peak of Laffer Curve



*Notes:* This figure plots the share of credit risk in the nominal spread ( $s^{LCCS}/s^{LCUS}$ ) at the peak of the debt Laffer curve for different levels of  $\alpha_P$ , the share of corporate debt in LC. The dashed red line plots the case when aggregate productivity  $A$  is at its peak and the blue line plots the case when aggregate productivity  $A$  is at its trough.

its debt. The vertical dotted lines are plotted at the peak of the debt Laffer curve, as in the left panel. This plot shows that when  $\alpha_P = 10\%$ , the credit share is positive for all levels of borrowing, increasing slightly as the government approaches the peak of the debt Laffer curve, and then going to 100% at borrowing levels slightly above the peak. By contrast, when  $\alpha_P = 50\%$ , the credit share is 0 for all borrowing levels below the peak of the debt Laffer curve, and it only becomes positive at debt levels well above the peak of the debt Laffer curve. In other words, debt issued when  $\alpha_P = 10\%$  always contains credit risk, but when  $\alpha_P = 50\%$ , the debt is free from default risk unless the sovereign borrows far onto the declining side of the debt Laffer curve. However, if in equilibrium the sovereign issued past the peak of the debt Laffer curve in the region with positive credit risk, then there would be credit risk on debt issued below the peak of the debt Laffer curve. This is because with long-term debt, the bond price today reflects the probability of default in all future periods.

In Figure 19, we plot the share of credit risk in the nominal spread at the peak of the Laffer curve for different levels of  $\alpha_P$ . We see that the credit share gradually falls with the share of private debt in LC. We plot this share for two levels of aggregate productivity, the highest realization and the lowest realization. We see that for each level of productivity, there is a higher share of credit risk when all private debt is in FC than when more private debt is LC. As the share of debt in LC increases, the share of credit risk in the nominal sovereign spread converges to zero for all productivity levels, meaning that the debt Laffer curve peaks because of currency risk alone.<sup>61</sup> In other words, the total amount of resources that can be raised from lenders is not at all constrained by the risk of a sovereign default and is solely constrained by the temptation to inflate away the debt. In parameterizations of the model that do not generate credit risk at the peak of the debt Laffer curve, we observe no default risk in equilibrium.

In theory, the sovereign may actually choose to borrow past the peak of the debt Laffer curve. This is because if the sovereign borrows using long-term debt, it may be able to raise additional net revenue by borrowing on the declining side of the debt Laffer curve. Despite this possibility, we will show this rarely happens in our calibrated model. It is more convenient to discuss this issue using the terminology of Lorenzoni and Werning (2013), and define our debt Laffer curve as the “stock Laffer curve” and define another object called the “issuance Laffer curve.” The stock Laffer curve,  $q(A, b') \cdot b'$ , is the total market value of outstanding debt as a function of gross issuance  $b'$  (“stock” because it refers to the total stock of outstanding debt). The issuance Laffer curve  $q(A, b') \cdot (b' - (1 - \zeta) \delta b)$  captures the

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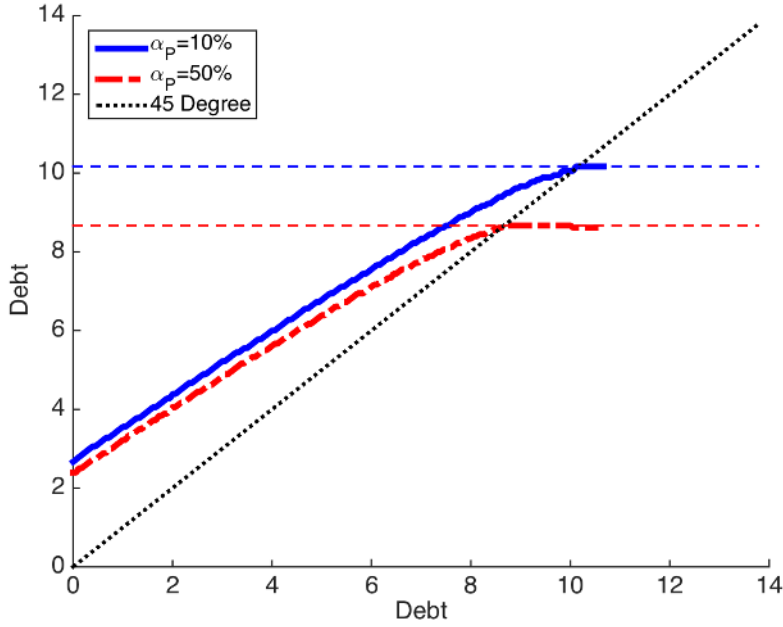
<sup>61</sup>It may at first seem surprising that the share of credit risk in the nominal spread is a higher share in good states than in bad states, but it is important to remember that this does not imply that in equilibrium we will see more defaults in good states than bad states. Instead, this reflects the fact that default is generally caused by an unexpected deterioration in the aggregate state. Because we have assumed a bounded productivity distribution, in the lowest state, there can be no unexpected drop in the worst state. This means that when the government borrows in the worst state, the probability of defaulting in the next period has to be zero: the worst shock possible is to remain in the same state. Because, conditional on debt outstanding, the sovereign defaults when aggregate productivity is below a given threshold, if the sovereign defaulted in this state, it would default in all states and the bond price would be zero. The credit risk in the nominal spread instead represents the probability of future default, that the economy exits the worst state and then experiences a negative shock, leading to default in the future. Therefore, if the sovereign only had access to one-period debt, conditional on being in the lowest state, there can be no credit risk on sovereign debt.

change in new revenue the sovereign raises with new net issuance. Because existing creditors bear the debt dilution losses (the change in the value of outstanding debt  $\delta q(A, b')b$  as the sovereign increases  $b'$ ), the issuance Laffer curve can still be increasing even after the sovereign has issued debt past the peak of the stock Laffer curve. This difference between the two Laffer curves could theoretically lead the sovereign to borrow on the declining side of the stock Laffer curve. This is more likely to happen the larger is the sovereign's inherited debt stock  $b$  and the smaller the slope of the bond price schedule with respect to  $b'$ . In Figure 20, however, we plot the equilibrium bond issuance functions,  $\tilde{b}(\bar{A}, b)$  for  $\alpha_P = 10\%$  and  $\alpha_P = 50\%$ . The dashed lines are the bond issuance levels denoting the peak of the stock Laffer curves for each parameterization of the model. In both cases, as long as the sovereign began the period on the increasing side of the stock Laffer curve, it will not find it optimal to issue on the declining side of the curve.<sup>62</sup> This explains why when there is no credit risk at the peak of the stock Laffer curve, we observe no sovereign default in equilibrium.

**Theory and Data** The results in Table 14 show that the model predicts that sovereign credit risk declines very sharply with the share of private LC debt. In order to assess the empirical relevance of this theoretical prediction, we need to examine the relationship between the share of external corporate debt in LC and sovereign default risk on nominal debt. To do so, we regress the LC credit spread on the empirical counterpart of  $\alpha_P$ , the share of external corporate debt in LC, the share of external sovereign debt in LC (which we denote  $\alpha_G$ ), and the external sovereign and corporate debt-to-GDP ratios. In addition, while we have assumed risk-neutral pricing in the theory, a number of papers, such as Longstaff et al. (2011b) and Hilscher and Nosbusch (2010b) demonstrate the importance of global factors in determining sovereign spreads. Therefore, we alternately control for the global covariates discussed in Section 2.4.2 or use time fixed effects.

<sup>62</sup>We further explore difference between stock and issuance Laffer curves Appendix 5.2.9. In Appendix Figure 32, we examine the difference between the stock and issuance Laffer curves. In Appendix Figure 33, we show that the equilibrium bond issuance function stays weakly below the issuance level at the peak of stock Laffer peak and well below the peak of the issuance Laffer curve.

Figure 20: Debt Laffer Curve and Debt Issuance Policy



*Notes:* This figure plots the bond issuance policy function  $\tilde{b}(\bar{A}, b)$  for average productivity  $\bar{A}$  when  $\alpha_P = 10\%$  (thick solid blue) and  $50\%$  (thin dashed red). Last period's debt issuance  $b$  is on the x-axis and this period's issuance  $b'$  is on the y-axis. The thin dashed red and blue lines are plotted at the level at which the debt Laffer curve  $q(\bar{A}, b') b'$  is maximized for  $\alpha_P = 10\%$  and  $50\%$ , respectively. The dotted black line is the 45 degree line, so that when the bond issuance policy functions are above the dotted black line  $\tilde{b}(\bar{A}, b) > b$ .

In Table 15, we estimate a panel regression of the form:

$$Spread_{i,t} = \beta_0 + \beta_1 \cdot \alpha_P + \beta_2 \cdot \alpha_G + \beta_3 \left( \frac{Ext. Sov. Debt}{GDP} \right) + \beta_4 \left( \frac{Ext. Corp. Debt}{GDP} \right) + \delta X_t + \epsilon_{i,t}$$

where  $X_t$  is a vector of time-varying global variables.<sup>63</sup> In Columns 1-4, we estimate the regression at a quarterly frequency, forcing us to drop South Africa from the sample. In Columns 5-8, we estimate the regression at an annual frequency. Because Brazil's LC credit spread is significantly higher than other countries', in columns 3, 4, 7 and 8 we exclude Brazil. When we estimate the quarterly or annual specifications including Brazil, we find that a 1% increase in the share of external LC corporate debt is associated with a 6-8 basis

<sup>63</sup>Although the model only includes LC sovereign debt, the FC sovereign debt share might have been an important omitted variable and so it is included here. However, the results are largely unchanged when this control is omitted.

point reduction in the local currency credit spread. In addition, a 1% of GDP increase in the total amount of sovereign debt outstanding is associated with an increase in the LC credit spread between 3 and 6 basis points. When we exclude Brazil from the sample, we find that a 1% increase in the share of external LC corporate debt is associated with a 3-4 basis point reduction in the local currency credit spread, roughly half the size as when Brazil is included.

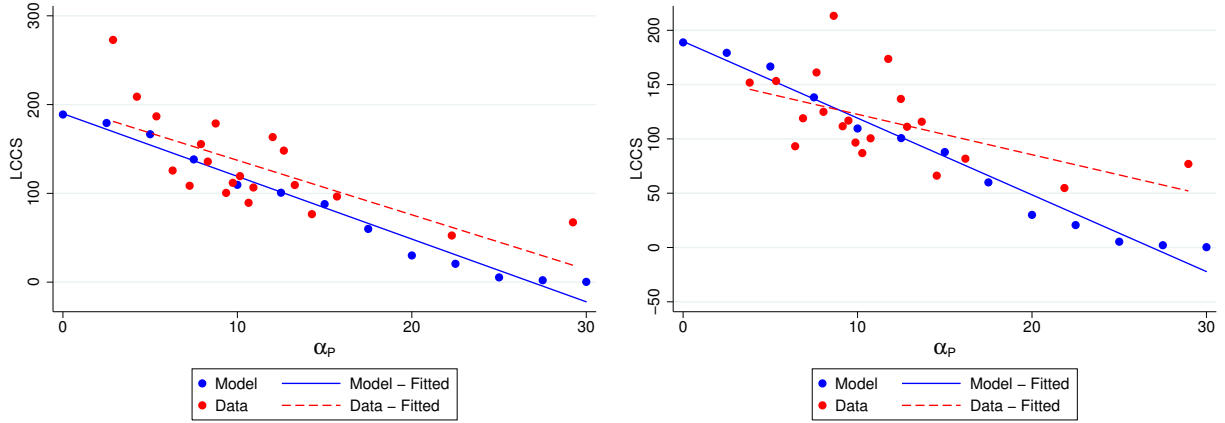
Table 15: Panel Regression: Share of External LC Corporate Borrowing and Sovereign Default Risk

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
All	All	Ex. BRL	Ex. BRL	All	All	All	Ex. BRL	Ex. BRL
Quarter	Quarter	Quarter	Quarter	Quarter	Annual	Annual	Annual	Annual
LCCS	LCCS	LCCS	LCCS	LCCS	LCCS	LCCS	LCCS	LCCS
$\alpha_P$ Share of External Corporate Debt in LC	-7.886*** (2.379)	-8.231*** (2.370)	-3.243*** (1.136)	-3.441*** (1.054)	-6.558*** (0.627)	-6.092*** (0.682)	-3.988*** (0.855)	-3.554*** (0.852)
Share of External Sovereign Debt in LC	0.812** (0.320)	0.597* (0.353)	0.0956 (0.277)	-0.0493 (0.303)	0.541* (0.252)	0.417* (0.238)	-0.0367 (0.238)	-0.139 (0.217)
External Sovereign Debt/GDP	5.960*** (2.020)	5.628*** (1.898)	3.349** (1.389)	3.121** (1.306)	4.256*** (0.504)	3.713*** (0.655)	3.080*** (0.524)	2.686*** (0.433)
External Corporate Debt/GDP	-0.983* (0.535)	-0.832 (0.554)	0.902 (0.645)	1.007 (0.664)	-0.481 (0.839)	-0.153 (0.630)	0.767 (0.987)	1.041 (0.813)
VIX	2.535**		2.463*		5.858***		5.907***	
Fed Funds Rate	6.412		9.192**		16.56**		20.05***	
BBB-Treasury Spread	12.74**		11.26**		2.022		2.944	
10-Year Treasury Yield	-27.42***		-33.53***		-54.08***		-54.79***	
Ted Spread	30.21**		21.59*		8.775		-10.69	
Constant	117.1*** (37.06)	138.8*** (12.24)	105.7*** (35.75)	19.23** (8.836)	162.5*** (17.38)	23.92** (10.57)	139.5*** (11.69)	3.721 (13.79)
Observations	353	362	331	340	97	100	91	94
R-squared	0.397	0.462	0.419	0.498	0.433	0.457	0.457	0.501
Countries	12	12	11	11	13	13	12	12
Time FE	No	Yes	No	Yes	No	Yes	No	Yes

Notes: The table reports panel regression results of the level of the LC credit spread on country level and global variables. All specifications contain country fixed effects. Heteroskedasticity autocorrelation spatial correlation robust Driscoll and Kraay (1998) standard errors with a 4 quarter lag are computed following Vogelsang (2012). The share of external corporate and sovereign debt in LC and the Sovereign and Corporate debt/GDP ratios are constructed in Section 2.3, with the data sources and methods described there and in Appendix 5.2.2. The VIX, Fed Funds Rate, BBB-Treasury Spread, 10-Year Treasury Spread, and Ted Spread are all from FRED of the Federal Reserve Bank of St. Louis. VIX is the 30 day implied volatility of the S&P, the Fed Funds Rate is the effective overnight Federal Funds Rate, the BBB-Treasury Spread is the option-adjusted spread of the Bank of America Merrill Lynch US Corporate BBB Index over US Treasuries, the 10-Year Treasury Spread is the 10-Year Treasury Constant Maturity Rate, and the Ted Spread is the spread between 3-month dollar Libor and the 3-Month Treasury Bill. Standard errors on global controls omitted for space. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.



Figure 21: LC Credit Spread and the Share of Private Debt in LC



*Notes:* The figures plots the empirical and model generated relationship between the LC credit spread and the share of corporate debt in LC,  $\alpha_P$ . The empirical plots (dashed red, and red dots) are derived by orthogonalizing the LC credit spread on the variables in column 5 and 7 in Table 15 and then plotting them as a binned scatterplot. The left panel includes all countries and the right panel excludes Brazil. The model observations (solid blue, and blue dots) are generated by solving the model for different values of  $\alpha_P$  and calculating the simulated mean LC credit spread, as in Table 14.

In Figure 21, we plot two binned scatterplots of the local currency credit spread against the share of corporate debt in LC, after orthogonalizing the LC credit spread on the covariates used columns 5 and 7 of Table 15. We can then regress the residuals on  $\alpha_P$  and plot the estimated local currency credit spread, averaged across 20 quantiles. These data points are in red, as is the dashed linear fit connecting them. The left panel includes all countries for which we could compute the LC credit spread and the right panel excludes Brazil. We also plot the mean model-implied LCCS against each level of  $\alpha_P$ , with the model-implied moments in blue along with a linear fit. Here, we restrict  $\alpha_P$  to be less than the maximum observed country average, which is 30% for South Africa. In a univariate regression of the orthogonalized LC credit spread on a constant and  $\alpha_P$ , the model implied constant is 189.8 and the slope coefficient on  $\alpha_P$  is -7.065. Using the orthogonalized LC credit spread for the binned scatter plot, the empirical estimates are an intercept of 198.7 basis points and a slope of -6.15, neither of which is significantly different that the model-implied slope and intercept. However, the right panel of Figure 21 indicates that Brazil is an important driver of the remarkable equivalence of the empirical and model-implied slope. Because Brazil's LC

credit spread may be driven more by capital control risk than credit risk,<sup>64</sup> we also run the regressions excluding Brazil. When we exclude Brazil, the fit is worsened, but the patterns in the data and model remain quite similar. In both cases, we continue to find support for the model's prediction that relatively small reductions in the share of FC corporate debt lead to large reduction in sovereign credit risk.

## 2.7 Conclusion

This paper examines why a country would default on its sovereign debt when the government could instead inflate it away. We argue that a government is more inclined to default than inflate when the currency mismatch of the corporate sector implies large adverse balance sheet effects from a currency depreciation. In making this argument, we use a new dataset on the currency composition of emerging market external borrowing to show that the corporate sector remains reliant on external FC debt even as sovereigns have swiftly moved towards borrowing in their own currency. We provide evidence that firms with more FC liabilities are more vulnerable to depreciation. We then show that a higher level of external FC corporate debt is associated with higher sovereign credit risk. Motivated by these empirical findings, we provide an explanation for why sovereign default risk remains on LC debt by presenting a model where mismatched corporate balance sheets increase the cost of inflating away sovereign debt and make default relatively more appealing. We embed a corporate balance sheet channel in the canonical Eaton and Gersovitz (1981a) sovereign debt model and demonstrate how higher shares of LC private debt can reduce the default risk on LC sovereign debt in equilibrium by affecting the cost of inflation relative to default and the sovereign's endogenous issuance decision. A calibration of the model matches the patterns of currency and credit risk on LC sovereign debt documented in Du and Schreger (2014b). The model implies that reductions in the share of FC external debt would significantly reduce sovereign default risk on LC debt.

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<sup>64</sup>We discuss this issue in detail in Du and Schreger (2014b).

## 3 The Costs of Sovereign Default: Evidence from Argentina

### 3.1 Introduction

A fundamental question in international macroeconomics is why governments repay their debt to foreign creditors, given the limited recourse available to those creditors. The seminal paper of Eaton and Gersovitz (1981b) argues that reputational concerns alone are sufficient to ensure that sovereigns repay their debt. Because a default leads to a loss of international reputation, defaulting countries are excluded from sovereign bond markets and can no longer share risk. Eaton and Gersovitz (1981b) argue that countries repay their debt to maintain their international reputation and access to credit markets. In a famous critique, Bulow and Rogoff (1989b) demonstrate that reputational contracts alone cannot be sustained in equilibrium without some other type of default cost or punishment. Following this critique, hundreds of papers have been written trying to identify these costs of default. The fundamental identification challenge is that governments usually default in response to deteriorating economic conditions, which makes it hard to determine if the default itself caused further harm to the economy.

The case of *Republic of Argentina v. NML Capital* provides a natural experiment to disentangle the causal effect of sovereign default. Following Argentina's sovereign default in 2001, NML Capital, a subsidiary of Elliott Management Corporation, purchased defaulted bonds and refused to join other creditors in restructurings of the debt during 2005 and 2010. Instead, because the debt was issued under New York law, NML sued the Argentine state in US courts to receive full payment. To compel the Argentine government to repay the defaulted debt in full, the US courts blocked Argentina's ability to pay its restructured creditors until NML and the other holdout creditors were paid in full. The Argentine government resisted paying the holdouts in full, even though the required payments would not be particularly large relative to the Argentine economy. As a result, rulings in favor of NML

raised the probability that Argentina would default on its restructured bonds, while rulings in favor of Argentina lowered this probability.

Because the court rulings were not responding to private information about the underlying economic circumstances in Argentina, we can use them to examine the effect of changing default probabilities on Argentine firms. We use credit default swaps (CDS) to measure the change in the risk neutral probability of default. Compiling rulings from the United States District Court for the Southern District of New York, the Second Court of Appeals, and United States Supreme Court, we identify sixteen rulings that potentially changed the probability of default. We find that, for every 1% increase in the 5-year cumulative default probability, the US dollar value of an index of Argentine American Depository Receipts (ADRs) falls 0.55%.<sup>65</sup> Between January 3, 2011, when our data starts, and July 30, 2014, when Argentina defaulted, the risk-neutral 5-year default probability increased from roughly 40% to 100%. Our estimates imply that this episode reduced the value of the Argentine firms in our index by 33%.

We begin our analysis by studying these legal rulings in an event study framework. We find economically significant negative returns for the ADRs of Argentine firms in response to legal rulings in favor of NML, and positive returns in response to rulings in favor of Argentina. We find these effects when using two-day event windows, and when using narrower windows that vary in size depending on the announcement time of the rulings. We also find that a measure of the “blue rate,” the unofficial exchange rate between Argentine pesos and US dollars, depreciates in response to rulings in favor of NML and appreciates in response to rulings in favor of Argentina.

The event study approach is subject to the concern that other factors may have changed during the relevant event windows. To alleviate this concern, following Rigobon (2003) and Rigobon and Sack (2004), we identify the effect of changes in the default probability on equity returns through heteroskedasticity. We assume that on days in which US courts rule

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<sup>65</sup>American Depository Receipts are shares in foreign firms that trade on US stock exchanges in US dollars.

on *Republic of Argentina v. NML Capital* and related court cases, the variance of shocks to the probability of default is higher than on other days. Using this identification strategy, we find results consistent with our event study approach. We interpret our results as providing evidence that sovereign default causes economically significant harm to corporations from the defaulting country.

To better understand how a sovereign default affects the economy, we examine which types of firms are harmed more or less by an increase in the probability of default. We sort firms along the dimensions suggested by the theoretical sovereign debt literature, as well as on some additional firm characteristics. We find suggestive evidence that banks, exporters, and foreign-owned firms are hurt more by increases in the probability of sovereign default than would be expected, given their “beta” to the Argentine market. Our results do not necessarily imply that these types of firms are hurt more in absolute terms by an increase in the probability of default than other firms, although this is indeed the case for banks. Instead, our results show that these firms are hurt more by an increase in the risk of a sovereign default than they would be by a “typical” shock that had the same impact on a broad index of Argentine stocks.<sup>66</sup>

This paper contributes to a large literature examining the costs of sovereign default. The question of the cost of sovereign default is surveyed in Borensztein and Panizza (2008). Using quarterly data, Yeyati and Panizza (2011) find that output generally falls in anticipation of a sovereign default and the default itself tends to mark the beginning of the recovery. Bulow and Rogoff (1989a) argue that default is costly because foreign lenders can disrupt trade, a channel for which Rose (2006), Borensztein and Panizza (2010), and Zymek (2012) find empirical support. Gennaioli et al. (2014), Acharya et al. (2014a), Bocola (2013) and Perez (2014) present models of the disruptive effect of default on the financial system and

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<sup>66</sup>We calculate the effect of sovereign default conditional on the index because we do not want to imply that all high-beta firms are hurt more by sovereign default risk than other firms, simply because their value falls more than the broad index in response to an increase in sovereign risk. We find that exporters are more adversely affected by sovereign default than implied by their market beta, but they are not actually hurt more in absolute terms than non-exporters.

the consequent disruption of macroeconomic activity. Mendoza and Yue (2012b) present a general equilibrium strategic default model, building on the framework of Aguiar and Gopinath (2006) and Arellano (2008), where default is costly because it reduces the ability of domestic firms to import intermediate goods, reducing their productivity. Cole and Kehoe (1998) argue that a sovereign default causes the government to lose its reputation not just in regards to the repayment debt, but also more generally. Arteta and Hale (2008) observe that during a sovereign default, external credit to the private sector is reduced. Schumacher et al. (2014) study sovereign debt litigation across a range of countries over the past 40 years. They find that creditor litigation is associated with a decline in international trade, sovereign exclusion from financial markets, and a longer time before the default is resolved. The Argentine case studied here differs from most of the cases studied in Schumacher et al. (2014) as this litigation also changed the probability of a new default, in addition to affecting the government’s ability to resolve an ongoing default.

This paper is structured as follows: Section 2 discusses the case of *Republic of Argentina v. NML Capital*. Section 3 describes the data and presents summary statistics for the behavior of CDS and equity returns on event and non-event days. Section 4 presents our estimation framework, the identifying assumptions, and our results. Section 3.5 discusses industries and firm characteristics that are associated with larger responses to changes in the probability of sovereign default. Section 3.6 presents the interpretation of the results. Section 7 concludes.

## **3.2 Argentina’s Sovereign Debt Saga**

### **3.2.1 The Argentine Default of 2001 and the Restructurings of 2005 and 2010**

Following decades of rampant inflation, in 1991 the Argentine government adopted the “convertibility plan,” introducing a currency board in an attempt to irrevocably fix the peso-dollar exchange rate at one-to-one. This meant that the government legally committed itself not to print any currency that was not backed one-to-one by a US dollar in reserves. While inflation

fell following the convertibility plan, the government continued to run a deficit, largely financed through external dollar borrowing. In 2001, Argentina entered a deep recession, with unemployment reaching 14.7% in the fourth quarter.<sup>67</sup> In December 2001, after borrowing heavily from the IMF, Argentina defaulted on over \$100 billion in external sovereign debt and devalued the exchange rate by 75%.<sup>68</sup>

The Argentine government then spent three years in failed negotiations with the IMF, the Paris Club, and its private creditors. In January 2005, Argentina presented a unilateral offer to its private creditors, which was accepted by the holders of \$62.3 billion of the defaulted debt.<sup>69</sup> To strengthen its bargaining position, the Argentine legislature passed the “Lock Law,” prohibiting the government from reopening the debt exchange or making any future offers on better terms.<sup>70</sup> After the first round of restructuring, holdout creditors were still owed \$18.6 billion of principal, the Paris Club of creditors was owed \$6.3 billion, and the IMF was owed \$9.5 billion.<sup>71</sup> Despite the existence of the holdout creditors, S&P declared the end of the Argentine default in June 2005 and upgraded Argentina’s long-term sovereign foreign currency credit rating to B-. In 2006, Argentina fully repaid the IMF, and Argentina reached an agreement with the Paris Club creditors in May 2014.<sup>72</sup>

In December 2010, Argentina offered another bond exchange to the holdout private creditors. Holdout private creditors who were owed \$12.4 billion of principal agreed to the exchange. Following the exchange, on December 31, 2010, the remaining holdout creditors were owed an estimated \$11.2 billion, split between \$6.8 billion in principal and \$4.4 billion in accumulated interest.<sup>73</sup> At this point, Argentina had restructured over 90% of its original debt.

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<sup>67</sup>Data from Global Financial Data.

<sup>68</sup>Daseking et al. (2005).

<sup>69</sup>Hornbeck (2013).

<sup>70</sup>This Lock Law would feature prominently in Judge Griesa’s interpretation of the *pari passu* clause, presenting evidence that holdouts were not on the same footing as the holdout creditors.

<sup>71</sup>Hornbeck (2013).

<sup>72</sup><http://www.reuters.com/article/2014/05/29/us-argentina-debt-parisclub-idUSKBN0E90JI20140529>

<sup>73</sup>Hornbeck (2013).

### 3.2.2 Argentina vs. the “Vultures”

Following the 2010 debt exchange, the remaining holdout creditors, termed “vultures” by the Argentine government, continued their legal battle. One line of attack was on the Argentine government’s reserve assets, with the creditors arguing the country’s reserves, held at the Federal Reserve Bank of New York, should be subject to attachment. While a district court initially agreed with the creditors, in 2011 the appellate court overturned the ruling.<sup>74</sup> The second line of attack, focused on the *pari passu* clause, was the one that eventually culminated in Argentina’s recent default. The *pari passu* clause requires equal treatment of all bondholders. The creditors, led by NML Capital,<sup>75</sup> argued that the Argentine government breached this clause by paying the exchange bondholders and refusing to honor the claims of the holdouts. In addition, the holdouts asserted that the “Lock Law,” by making explicit the government’s policy of pledging not to re-open negotiations or pay any money, effectively subordinated them to the restructured bondholders.

The case took several years to work its way through the US courts, going from the United States District Court for the Southern District of New York (“Southern District”), to the United States Court of Appeals for the Second Circuit (“Second Circuit”), all the way to the United States Supreme Court. The numerous rulings that these three courts issued between December 2011, when Judge Thomas P. Griesa of the Southern District first ruled in favor of the holdouts on the *pari passu* issue,<sup>76</sup> until July 2014 when Argentina defaulted. For the purposes of this study, we view the various rulings as events that made it more or less likely that Argentina would be unable to pay the restructured bondholders, if it did not also repay the holdouts. Because of the Argentine government’s unwillingness to pay

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<sup>74</sup>Hornbeck (2013)

<sup>75</sup>Elliott Management Corporation, the parent company of NML, has a long history in litigating against defaulting countries. See Gulati and Klee (2001) for a discussion of Elliot’s litigation against Peru and Panizza et al. (2009) for an excellent literature review on the law and economics of sovereign default.

<sup>76</sup>See the decision at <http://blogs.reuters.com/felix-salmon/files/2012/04/2011-12-07-Equal-Treatment-Liability-Order.pdf>



the holdouts in full, rulings in favor of NML increased the probability of a default on the restructured bonds, while rulings in favor of Argentina reduced the probability of default.<sup>77</sup>

Following Griesa's initial ruling in December 2011, a year of legal wrangling ensued over what this ruling actually meant and how it would be enforced. Griesa clarified that Argentina was required to repay the holdouts as long as it was continuing to pay the exchange bondholders (using a "ratable" payment formula). Argentina was not willing to comply with this ruling, and continued to pay the exchange bondholders without paying the holdouts. Griesa then ordered the financial intermediaries facilitating Argentina's payments to stop forwarding payments to the restructured bondholders until Argentina paid the holdouts. As a result, even if Argentina wanted to pay the restructured creditors, it could not do so without repaying the holdouts, as its trustee would not be allowed to disburse the funds delivered for the coupon payment. In late 2012, Griesa ordered Argentina to negotiate with the holdouts, but the holdouts and the courts rejected Argentina's offer of a deal comparable to the 2005 and 2010 bond exchanges. Argentina then twice appealed to the Supreme Court, with the Supreme Court declining to hear either appeal. Following the decline of the second appeal on June 16, 2014, Griesa's orders were implemented, and Argentina had only two weeks before a coupon to the restructured creditors was due. Against the court orders, Argentina actually sent this coupon payment to the bond trustee, Bank of New York Mellon (BNYM), but due the court order, BNYM did not forward to the payment to the restructured bond holders. Argentina legally missed the coupon payment on June 30, which began a 30-day grace period. After negotiations failed, Argentina entered default on July 30, 2014.

### **3.2.3 A Simple Interpretation**

In the simplest interpretation of the unfolding court events, Argentina was forced to default by the US court system. This was the interpretation offered by a number of commentators

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<sup>77</sup>We use the term default to refer to a "credit event," as defined in the credit default swap contracts we study. Defaults come in many varieties, from a temporary cessation in payments to complete repudiation.

in the financial press.<sup>78</sup> Under this interpretation, Argentina could not pay its debts because the US courts forbade financial intermediaries from facilitating the coupon payment. As a result, the court rulings did nothing but change the probability of a default.

We also argue that these legal rulings do not reveal information about the underlying state of the economy (or other unobserved fundamentals), except insofar as they change the probability of default. The key assumption is that Judge Griesa (and the second circuit and Supreme Court) have no information advantage over the market with respect to the state of the Argentine economy.<sup>79</sup>

Under this interpretation, we can use credit default swaps to measure the market-implied changes in the probability of default following the court rulings. Any effect these rulings have on other variables, such as equity returns, is caused by the change in the probability of default. By comparing these two quantities (the change in default probability and the stock return), we can estimate the effect of default on the value of the firm.

This interpretation motivates our empirical strategy. We look at the stock returns in windows around each of these events, and estimate how changes in the risk of sovereign default are related to changes in the valuation of Argentine firms. We employ several different empirical methods, which are described in detail in the next two sections. After presenting our empirical results, we will discuss alternative interpretations of the legal rulings and our results. We will also discuss several important details about the Argentine debt situation that are relevant for the interpretation of our results.

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<sup>78</sup>For instance, Matt O'Brien of the Washington Post wrote "Argentina was forced to default now, because it wouldn't pay the bonds it had defaulted on in 2001" (<http://www.washingtonpost.com/blogs/wonkblog/wp/2014/08/03/everything-you-need-to-know-about-argentinas-weird-default/>).

<sup>79</sup>In the event study literature that focuses on Federal Reserve monetary policy announcements, there is some concern that the Federal Reserve has more information than market participants about the state of the economy. These sorts of concerns are unlikely to apply in this paper.

## 3.3 Data and Summary Statistics

### 3.3.1 Stock Market and CDS Data

Our dataset consists of daily observations of financial variables from January 3, 2011 to July 29, 2014 (the day before Argentina most recently defaulted). We study the returns of US dollar-denominated ADRs issued by Argentine firms, which are traded in the United States, as well the Argentine peso-denominated equities traded in Argentina. The ADRs trade on the NYSE and NASDAQ, are relatively liquid, and can be traded by a wide range of market participants<sup>80</sup>. However, using only the ADRs limits the number of firms that can be included in our analysis. To study the cross-sectional patterns of Argentine firms, we also examine the returns of firms traded only in Argentina. In order to ensure sufficient data quality, we limit our study of local Argentine equities to firms with a 2011 market capitalization at least 200 million pesos, and for which the equity price changes on at least half of all trading days in our sample. The full list firms included in our analysis, along with select firm characteristics, can be seen in Table 16.

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<sup>80</sup>Several market participants have told us that capital controls and related barriers are significant impediments to their participation in local Argentine equity markets.

Table 16: Firms Included in Analysis

Company	Ticker	Industry	Exports	Imports	Market Cap	ADR	Foreign
Aluar	ALU	Manufacturing	19.4	13.1	9443.0		
Banco Santander Rio	BIO	Banks	1.5	0.4	12786.1	Y	Y
Boldt	BOL	Telecoms			1537.5		
Banco Patagonia	BPT	Banks	1.5	0.4	3488.4	Y	Y
Banco Macro Bansud	BSU	Banks	1.5	0.4	9379.2	Y	
Carlos Casado	CAO	Real Estate	0.0	0.0	378.1	Y	
Endesa Costanera	CEC	Utilities	0.1	3.2	702.6		Y
Celulosa	CEL	Chemicals	11.2	19.2	760.3		
Central Puerto Rights	CEP	Utilities	0.1	3.2	1814.4		
Grupo Clarin	CLR	Telecoms	0.4	1.3	5633.4	Y	
Sociedad Comercial Del Plata	COM	Diverse	1.5	0.4	212.3		
Capex	CPX	Utilities	0.1	3.2	1087.8		
Cresud	CRE	Non-Durables	14.5	2.1	3495.9	Y	
Edenor	EDC	Utilities	0.1	3.2	1894.5	Y	
BBVA Banco Frances	FRA	Banks	1.5	0.4	7723.6	Y	Y
Pampa Energia	FRG	Utilities	0.1	3.2	3417.2	Y	
Gp Finance Galicia	GGA	Banks	1.5	0.4	7125.7	Y	
Hipotecario Naci	HPD	Banks	1.5	0.4	3540.0	Y	
Solvay Indupa	IND	Chemicals	11.2	19.2	1218.0		Y
IRSA	IRS	Real Estate	0.0	0.0	3350.5	Y	
Juan Minetti	JMI	Manufacturing	3.6	5.3	1633.5		Y
Ledesma	LED	Non-Durables	14.5	2.1	4004.0		
Metrogas	MET	Utilities	0.1	3.2	677.3	Y	
Mirgor	MIR	Manufacturing	10.1	11.2	512.0	Y	
Molinos Rio De La Plata	MOL	Non-Durables	19.5	2.8	8014.4		
Quickfood	PAY	Non-Durables	19.5	2.8	641.9		Y
Petrobras Energia	PER	Energy	25.5	2.1	8228.4	Y	Y
IRSA Propiedades Comerciales	SAM	Real Estate	0.0	0.0	2960.1	Y	
Moli Juan Semino	SEI	Non-Durables	19.5	2.8	325.5		
Siderar	SID	Manufacturing	19.4	13.1	10893.1		Y
Sa San Miguel	SMG	Non-Durables	19.5	2.8	491.1		
Telecom Argentina	TEC	Telecoms	2.7	8.1	21754.8	Y	Y
Transportadora De Gas Del Sur	TGS	Energy	25.5	2.1	2558.3	Y	
Transportadores De Gas Del Norte	TN4	Utilities	0.1	3.2	540.4		
Transener	TRA	Utilities	0.1	3.2	640.3		
YPF	YPF	Energy	14.2	8.4	74532.8	Y	

*Notes:* This table lists the 35 firms used in the analysis of local equities, and one firm (ticker SAM) whose ADR is included in our ADR sample, but whose local stock returns do not pass our data quality requirement. Ticker indicates the company's ticker in Datastream. Exports (Imports) denotes the percentage of exports (imports) of total output for the firm's primary industry. Both Exports and Imports are calculated by classifying the firm into one of the 37 industries in the OECD STAN Input-Output Table according the SIC code of the firm's primary industry. Market Cap is the firm's average end-of-quarter market capitalization in 2011 from Bloomberg, measured in Argentine pesos. ADR Sample indicates whether the ADR is included in our sample of ADRs. Foreign is an indicator for whether the firm is owned by a non-Argentine parent company.

Our primary measure of the performance of the Argentine equity market comes from the MSCI Argentina index, an index of six Argentine ADRs. As of November 28, 2014, the companies included in the index (with their index weights in parentheses), are: YPF (30.56%); Telecom Argentina (22.11%); Banco Macro (18.64%); Grupo Financiero Galicia (16.11%); BBVA Banco Frances (7.50%); and Petrobras Argentina (5.09%). In addition, we construct our own indices of ADRs covering different sectors of the Argentine economy. We classify Argentine firms by whether they are a bank, a non-financial firm, or a real estate holding company. The industry classifications are based on the Fama-French 12 industry classification and are described in detail at the end of this section. We give equal weighting to each ADR included in our three indices. The financial index is composed of the ADRs of BBVA Banco Frances (ADR ticker BFR); Banco Macro (BMA); and Grupo Financiero Galicia (GGAL). The industrial index is composed of Cresud (CRESY); Empresa Distribuidora y Comercializadora Norte (EDN); Pampa Energia (PAM); Petrobras Argentina (PZE); Telecom Argentina (TEO); Transportador Gas Sur (TGS); and YPF (YPF). The real estate index is composed of Alto Palermo (APSA, local ticker SAM) and IRSA (IRS). Alto Palermo is the only firm included in the ADR-based analysis but excluded from the local equity analysis. It is excluded because the local price data does not meet the data quality requirements. The classification of the 35 firms included in the analysis of local equities can be found in Table 16. Because the MSCI Argentina Index is heavily tilted toward financial and energy firms, for our analysis of local returns, we construct an index equally weighting all of the returns of each of the 35 firms.

We use credit default swap (CDS) spreads to measure the market-implied risk-neutral probability of default. A CDS is a financial derivative where the seller of the swap agrees to insure the buyer against the possibility that the issuer defaults. Once a third party, generally the International Swaps and Derivatives Association (ISDA), declares a credit event, an auction occurs to determine the price of the defaulted debt. The CDS seller then

pays the buyer the difference between the face and auction value of the debt. In appendix Section 5.3.3, we provide details on how we impute risk-neutral default probabilities from the term structure of CDS spreads using the ISDA Standard Model. We focus on the 5-year cumulative default probability, the risk-neutral probability that Argentina defaults within 5 years of the CDS contract initiation.

Our CDS data is from Markit, a commercial data provider. We use a “sameday” CDS spread as of 9:30 am EST, which we refer to as the “open,” and a composite end-of-day spread, which we refer to as the “close.”<sup>81</sup> The composite end-of-day spread is gathered over a period of several hours from various market makers, and is the spread used by those market makers to value their own trading books. The composite end-of-day spread uses updated expectations about the recovery rate<sup>82</sup>, whereas the sameday spread is built under the assumption that the expected recovery rate has not changed from the previous day’s close. Markit uses a data cleaning process to ensure that both the sameday and composite end-of-day quotes are reasonable approximations of market prices.

Because we want to capture the abnormal variation in Argentine CDS and equity returns caused by changes in the probability of default, we need to account for other global factors that may affect both measures. To proxy for global risk aversion, we use the VIX index, the 30-day implied volatility on the S&P 500.<sup>83</sup> We use the S&P 500 to measure global equity returns and we use the MSCI Emerging Markets Asia ETF to proxy for factors affecting emerging markets generally. We use the Asian index to ensure that movements in the index are not directly caused by fluctuations in Argentine markets. To control for aggregate credit market conditions, we use the Markit CDX High Yield and Investment Grade CDS indices.<sup>84</sup> These controls are included in all specifications reported in this paper, although our results are qualitatively similar when using a subset of these factors, or no controls at all.

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<sup>81</sup>We have also run our results with a 3:30pm “sameday” quote, instead of the composite end-of-day. Our point estimates are similar, but the standard errors are larger.

<sup>82</sup>Markit surveys CDS dealers at the end of each day to gather expected recovery rates.

<sup>83</sup>See Longstaff et. al. (2011) for discussion of VIX and variation in sovereign CDS spreads.

<sup>84</sup>We use the continuous on the run series from Thomson Reuters Datastream. More information on these indices can be found at <https://www.markit.com/news/Credit%20Indices%20Primer.pdf>.

In order to examine the channels through which a sovereign default can affect domestic firms, in section 3.5 we will sort firms along a number of dimensions. We begin by classifying firms according to their Fama-French industry classifications available on Kenneth French's website.<sup>85</sup> We sort firms into their corresponding Fama-French industries according to the SIC code of their primary industry, available from Datastream. After this initial sort, we only have one firm, Boldt, classified as Business Equipment, and so we combine it with the telecommunications firms. The "Finance" Fama-French 12 industry classification is also too broad for our purposes, as it combines banks, holding companies, and real estate firms. We therefore split the nine firms initially classified as "Finance" according to their Fama-French 49 industry classification. This gives us six banks, two real estate firms, and one "Trading" firm, Sociedad Comercial del Plata. Because Sociedad Comercial del Plata is a diversified holding company, and is the only company in the Fama-French 49 industry classification of "Trading," we rename its industry "Diversified", and do not merge it with any other industry classification. After these modifications, we end up with six banks, two chemical firms, one diversified firm, three energy firms, four manufacturing firms, six non-durables firms, two real estate firms, three telecoms and eight utilities.

The next dimension along which we will sort firms is their exporter status. Bulow and Rogoff (1989a) posited that default was costly because foreign creditors have the ability to interfere with a country's trade. To test this channel, we examine if exporting firms are particularly hurt by an increase in the probability of default. Unfortunately, this task is complicated by the fact that publicly available data sources do not comprehensively report firm-level exports. We instead rely on industry-level measures. We use the OECD STAN Input-Output Tables for Argentina to calculate what share of each industry group's output is exported. The Input-Output Table covers 37 industries, each of which covers at least one two-digit ISIC industry, and some of which, such as "Agriculture, hunting, forestry and fishing", cover up to five two-digit ISICs. After we calculate the share of exports for each

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<sup>85</sup>Classifications available here. We use the versions formatted by Dexin Zhou.

of these 37 industries, we classify our 35 firms into one of these industries according to the SIC code of its primary output. Unfortunately, the most recent Input-Output Table for Argentina uses data from 1995, so our export analysis assumes that the relative tradability of different products has not changed too much over the past 20 years.<sup>86</sup> When we construct a zero-cost long-short portfolio, going long exporters and short non-exporters, we will classify firms as exporters if exports accounted for at least 10% of their primary industries' revenues in our Input-Output table, and non-exporters otherwise.

In order to examine the channel proposed by Mendoza and Yue (2012b) that a sovereign default is costly because it reduces the ability of firms to import intermediate goods for production, we calculate the share of intermediate inputs imported for each industry. We again use the OECD STAN Input-Output Tables to calculate the reliance on imported intermediate goods for 37 industries, and then match each of our firms to these industries using their primary SIC code. As with exports, we rely on the 1995 Input-Output Table. For portfolio construction, we classify firms as non-importers if imported intermediates are less than 3% of total sales in their primary industry, and as importers otherwise.

The next cut of the data divides firms among those that are subsidiaries of foreign corporations and those that are not. We classify firms as foreign-owned if the headquarters of their ultimate parent is any country other than Argentina in Bloomberg (Field `ULT_PARENT_CNTRY_DOMICILE`). There are a number of reasons the effect of sovereign default might be different for foreign-owned and domestic firms. For instance, if a sovereign default has a large effect on the domestic banking system, perhaps foreign affiliates might have a relatively easier time accessing finance than domestically owned firms. A similar effect is documented for multinational and local firms following an exchange rate depreciation in Desai et al. (2008), with multinational firms cutting investment less than domestic firms, presumably because external financing helps multinational mitigate the balance sheet effect.

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<sup>86</sup>For those firms that report data on revenue from exports, there is a strong correlation between reported exports as a share of sales and the imputed share of exports from the 1995 input-output table. These results are available upon request.



On the other hand, if defaulting costs Argentina its “general reputation,” as in Cole and Kehoe (1998), it may be more inclined to seize the assets of foreign firms. In this case, we would expect foreign-owned firms to underperform. We use the most recent ownership of this variable and cannot account for the possibility that an Argentine firm was only recently purchased by a foreign parent.

The final variable we use to classify our local equities is an indicator for whether or not the firms have an ADR. The reason for this is that ADRs are a potentially important way for residents to evade the government’s capital controls. We might expect firms with ADRs to outperform firms without ADRs because the former is a valuable vehicle for acquiring foreign currency offshore. This feature of ADRs is addressed in detail by Auguste et al. (2006)

### **3.3.2 Definition of Events and Non-Events**

We build a list of legal rulings issued by Judge Griesa, the Second Circuit, and the Supreme Court. We have created this list using articles in media (the Wall Street Journal, Bloomberg News, and the Financial Times), LexisNexis searches, and publicly available information from the website of a law firm (Shearman) that practices sovereign debt law.

In appendix Table 5.3.5, we list all of these events and links to the relevant source material. Unfortunately, for many of the events, we are unable to determine precisely when the ruling was issued. We employ several methods to determine the timing of rulings. First, we examine news coverage of the rulings, using Bloomberg News, the Financial Times, and LexisNexis searches. Sometimes, contemporaneous news coverage specifically mentions when the ruling was released. Second, we use the date listed in the ruling (usually next to the judge’s signature). Third, many of rulings are released in the PDF electronic format, and have a “creation time” and/or “modification time” listed in the meta-information of the PDF file. In appendix Table 5.3.5, we list the information used to determine the approximate time of each ruling.

For most of our analysis, we use two-day event windows. Consider the Supreme Court ruling on Monday, June 16th, 2014. The two-day event window, applied to this event, would use the CDS spread change from the close on Friday, June 13th to the close on Tuesday, June 17th. It would use stock returns (for both ADRs and local stocks) from 4pm EDT on Friday, June 13th to 4pm EDT on Tuesday, June 17th<sup>87</sup>.

For one section of our analysis, we use narrower window sizes, when possible. We classify events into several types based on when they occurred. We classify events as close-to-close, open-to-open, close-to-open, and open-to-close. For the Supreme Court ruling on June 16th, 2014, the event occurred in the morning of the 16th, after the stock market opened. In the appendix, we classify this ruling as “open-to-close” meaning that we will use the CDS spread change from 9:30am EDT on Monday the 16th to roughly 4pm EST on Monday the 16th, and the ADR returns from 9:30am EDT on Monday the 16th to 4pm EDT on Monday the 16th. If we had instead classified the event as “close-to-close,” we would compare the 4pm EDT close on Friday the 13th to the 4pm EDT close on Monday the 16th. The “close-to-open” and “open-to-open” windows are defined in a similar way.

We choose our sample of non-events to be a set of two-day default probability changes and stock returns (based on closes), non-overlapping, at least two days away from any event, and at least two days away from any of the “excluded events.” “Excluded events” are legal rulings that we do not use, but also exclude from our sample of “non-events.” For three of the legal rulings, we could not find any contemporaneous media coverage, and are therefore unable to determine when the event was known to market participants. For one legal ruling, we could not find the ruling itself, only references to it in media coverage. One of the legal rulings was issued on the Friday in October 2012 shortly before “Superstorm Sandy” hit New York, and another the night before Thanksgiving.<sup>88</sup> Finally, one of the legal rulings was issued at the beginning of an oral argument, in which Argentina’s lawyers may have

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<sup>87</sup>For events occurring outside of daylight savings time in the eastern time zone, the local stocks close at 5pm ART (3pm EST), while the ADRs use 4pm EST. We make no attempt to correct for this.

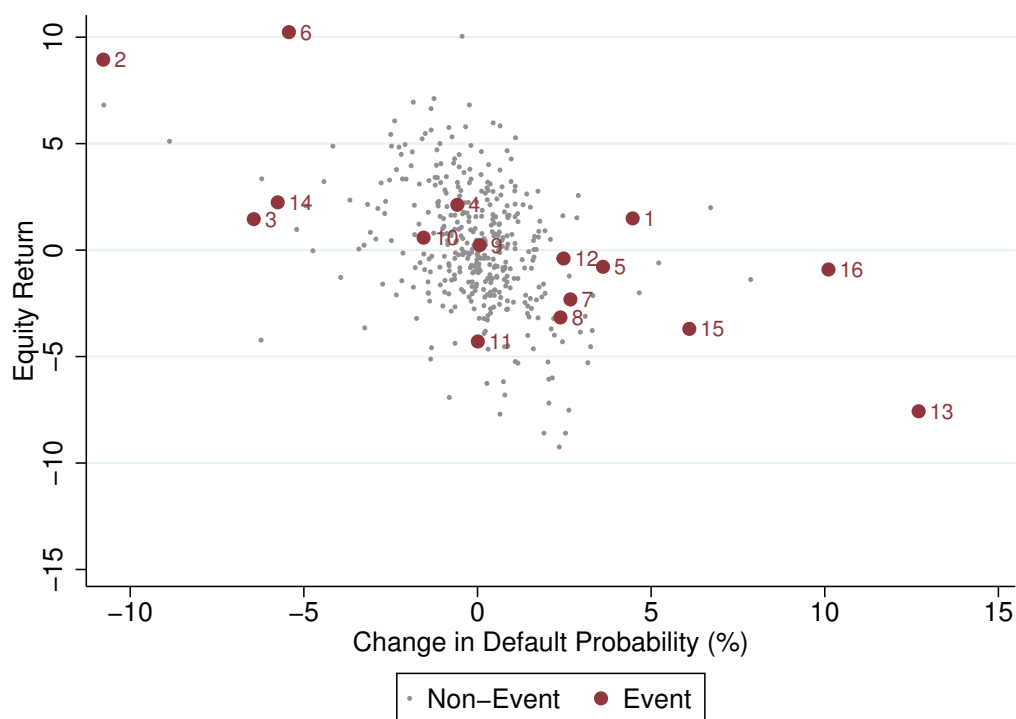
<sup>88</sup>The ruling issued the night before Thanksgiving is problematic in several ways (see the appendix for details).

revealed information about Argentina’s intentions. We exclude this day because it violates our identification assumptions. For the heteroskedasticity-based identification strategy we employ, removing these legal rulings increases the validity of our identifying assumption that the variance of shocks induced by legal rulings is higher on event days than non-event days. However, our results are robust to including these days in the set of non-events.

### **3.3.3 Summary of Events and Non-Events**

In Figure 22, we plot the two-day change in the 5-year default probability and the two-day return of MSCI Argentina index over our sample. Small data points in gray/light are non-events and the maroon/dark dots cover event windows in which a US court made a legal ruling regarding Argentina’s debt. In most of our analysis, and in this plot, we use two-day return windows. As a result, there is some risk that other shocks occurred during the event window. In Figure 22, the event labeled “1” is affected by this issue. In our analysis that uses small window sizes, this event is no longer an outlier. The details on each event can be found in Appendix A. In appendix 5.2.2, we present a similar figure for the different sectors of the Argentine economy, the exchange rate, and Mexican and Brazilian CDS changes and equity returns.

Figure 22: Default Probability Change and Equity Returns during Events and Non-Events



Event Number	Two-Day Window End Date	$\Delta D$ (%)	Equity Return (%)
1	November 27, 2012	4.47	1.49
2	November 29, 2012	-10.78	8.94
3	December 05, 2012	-6.44	1.45
4	December 07, 2012	-0.58	2.13
5	January 11, 2013	3.61	-0.78
6	March 04, 2013	-5.43	10.24
7	March 27, 2013	2.68	-2.32
8	August 26, 2013	2.39	-3.16
9	October 04, 2013	0.06	0.23
10	October 08, 2013	-1.55	0.58
11	November 19, 2013	0.01	-4.29
12	January 13, 2014	2.48	-0.39
13	June 17, 2014	12.70	-7.57
14	June 24, 2014	-5.75	2.24
15	June 27, 2014	6.10	-3.70
16	July 29, 2014	10.11	-0.91

Notes: This figure plots the change in change in the risk-neutral probability of default and returns on the MSCI Argentina Index on event and non-event two-day windows. Each event and non-event day is a two-day event or non-event as described in the text. The numbers next to each maroon/dark dot references each event-day in the Table below the figure. The procedure for classifying events and non-events is described in the text.

### 3.3.4 Exchange Rates

Argentina has capital controls, and its official exchange rate has diverged from the “blue market” exchange rate. Argentina also imposes deposit requirements on foreigners who own local securities. One consequence of these capital controls is that is very unprofitable for foreigners to purchase local Argentine stocks. Instead, foreigners who wish to invest in Argentine companies purchase ADRs. Argentine citizens can also use ADRs, as a means of circumventing capital controls. By purchasing local shares, converting them to ADRs, and then selling them in dollars in the U.S., Argentine citizens can gain access to US dollar currency without government approval (Auguste et al. (2006)). The convertibility of ADRs effectively establishes a shadow exchange rate. We find (in unreported results) that the implied exchange rate computed using ADR and local stock market prices does not vary significantly across firms. In our results, we report an “ADR Blue Rate,” which computes the implied exchange rate for each of the six firms in the MSCI Argentina index, and weighs them using the weights of that index, described previously.<sup>89</sup>

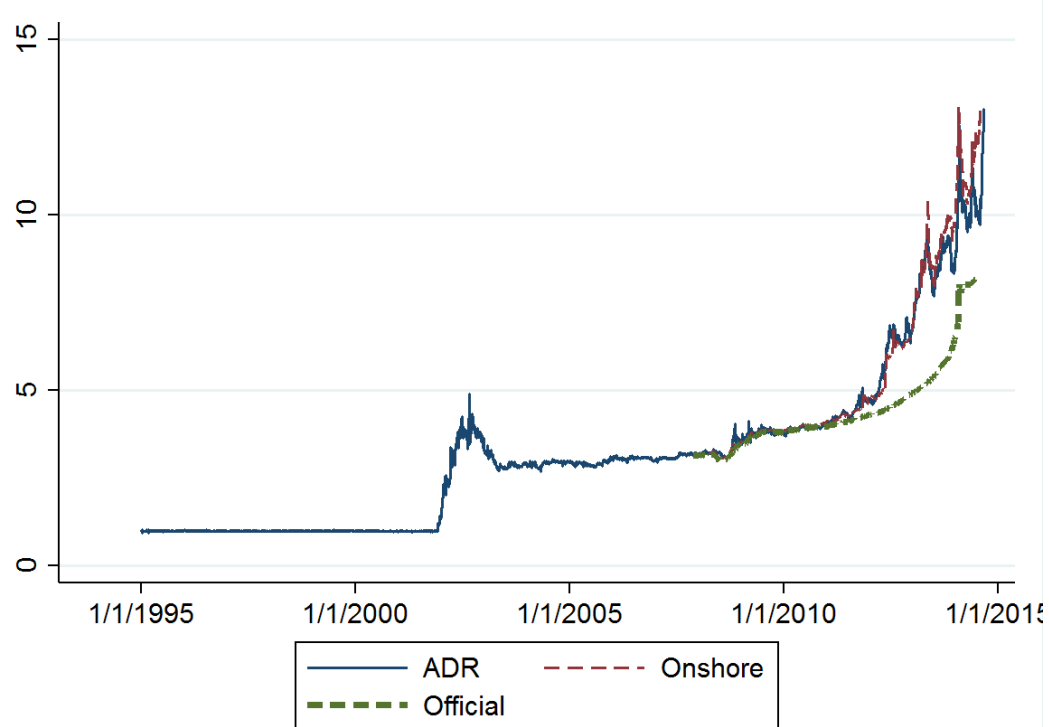
There is a second way to measure the “blue market” exchange rate, which is to poll currency dealers in Argentina. For Argentine households and firms who cannot purchase dollars from the government at the official rate, and cannot execute the ADR-based currency conversion, these dealers are one way to secure dollars. Datastream, a data provider, polls these dealers and computes a “blue rate” based on their responses.

In Figure 23, we show the time series of the official exchange rate, the ADR-based blue rate, and the “Onshore” blue rate computed by Datastream.

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<sup>89</sup>To compute the ADR blue rate, we need prices for both the ADRs and the corresponding locally traded Argentine stocks. As a result, the ADR blue rate is available only on days when both markets are open. This results in smaller sample in our regressions.

Figure 23: Official, Onshore Blue, and ADR Exchange Rates (ARS/USD)



Notes: This figure plots the three versions of the ARS/USD exchange rate. ADR refers to the version of the “blue market” rate calculated by comparing the ADR share price in dollars with the underlying local stock price in pesos, Onshore is the exchange rate available through Argentine FX bureaus, and Official is the government’s official exchange rate.

The recent divergence between the ADR-based blue rate and the onshore blue rate coincides with the rise in the default probabilities experienced by Argentina. In our empirical results, we attempt to estimate whether increases in the default probability caused the blue rate to diverge from the official rate, and whether increases in the default probability caused the ADR blue rate to diverge from the onshore blue rate. We find statistically significant evidence that increases in the default probability cause the blue rate to diverge from the official rate, immediately after a legal ruling. We do not find statistically significant evidence that increases in default probability cause the ADR blue rate to diverge from the onshore blue rate.

### 3.4 Framework

Our goal is to estimate the causal effect of sovereign default on equity returns. The key identification concerns are that stock returns might have an effect on default probabilities, and that unobserved common shocks might affect both the probability of default and stock returns. In our context, one example of the former issue is that poor earnings by large Argentine firms might harm the fiscal position of the Argentine government, and therefore alter the probability of default. An example of the latter issue is a shock to the market price of risk, which could cause both CDS spreads and stock returns to change.

We consider these issues through the lens of a simultaneous equation model (following Rigobon and Sack (2004)). While our actual implementation uses multiple assets and controls for various market factors, for exposition we discuss only a single asset,  $r_t$ , and the change in the risk-neutral probability of default,  $\Delta D_t$ , and ignore constants.<sup>90</sup> For exposition, we will refer to this asset,  $r_t$ , as the equity market. The model we consider is

$$\Delta D_t = \gamma r_t + \kappa_D F_t + \epsilon_t \quad (34)$$

$$r_t = \alpha \Delta D_t + \kappa F_t + \eta_t \quad (35)$$

where  $F_t$  is an unobserved factor that moves both the probability of default and equity returns,  $\epsilon_t$  is a shock to the default probability, and  $\eta_t$  is a shock to the equity market return.<sup>91</sup> The goal is to estimate the parameter  $\alpha$ , the impact of a change in the probability of default on equity market returns. If one were to simply run the regression in equation 35

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<sup>90</sup>This is equivalent to treating abnormal returns and abnormal default probability changes as observed. Abnormal returns are the excess returns after projecting the return on to observable factors, and abnormal default probability changes are defined similarly. In our econometrics, we account for the estimator error associated with this projection when computing standard errors.

<sup>91</sup>We assume these shocks and unobserved factors are independent.

using OLS, the coefficient estimate would be

$$\begin{aligned}\hat{\alpha} &= \frac{\text{cov}(\Delta D_t, r_t)}{\text{var}(\Delta D_t)} \\ &= \alpha + (1 - \alpha\gamma) \frac{\kappa(\kappa_D + \gamma\kappa)\sigma_F^2 + \gamma\sigma_\eta^2}{(\kappa_D + \gamma\kappa)^2\sigma_F^2 + \gamma^2\sigma_\eta^2 + \sigma_\epsilon^2}\end{aligned}\tag{36}$$

where  $\sigma_\epsilon^2$  is the variance of the default probability shock,  $\sigma_\eta^2$  is the variance of equity return shock, and  $\sigma_F^2$  is the variance of the common shock.<sup>92</sup> There are two sources of bias: simultaneity bias and omitted variable bias. The simultaneity bias exists if  $\gamma \neq 0$  and  $\sigma_\eta > 0$ , and omitted variable bias exists if  $\kappa \neq 0$ ,  $\kappa_D \neq 0$ , and  $\sigma_F > 0$ . In order for the OLS regression to be unbiased, equity market returns must have no effect on default probabilities and there must be no omitted common shocks. These assumptions are implausible in our context, but we present this OLS regression in Section 3.4.1 for comparison purposes.

We can rely on more plausible assumptions by adopting an event study framework (see, for instance, Kuttner (2001) or Bernanke and Kuttner (2005)). We can make the identifying assumption that changes to Argentina’s probability of default on during the event windows (time periods in which a US court makes a ruling in the case of the *Republic of Argentina v. NML Capital*) are driven exclusively by those legal rulings, or other idiosyncratic default probability shocks ( $\epsilon_t$ ).<sup>93</sup> Under this assumption, we can directly estimate equation 35 using OLS on these ruling days. We will pursue this strategy in Section 3.4.3.

Finally, we will consider a heteroskedasticity-based identification strategy, following Rigobon (2003) and Rigobon and Sack (2004). This does not require the complete absence of common and idiosyncratic shocks during event windows. This strategy instead relies on the weaker identifying assumption that the variances of the common shocks  $F_t$  and equity return shocks  $\eta_t$  are the same on non-event days and event days, whereas the variance of the shock to the

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<sup>92</sup>This expression is the one presented in Rigobon and Sack (2004).

<sup>93</sup>Rigobon and Sack (2004) demonstrate that the event study makes the identification assumption that on event days, the ratio of the default shock variance  $\sigma_\epsilon$  to both the equity return shock  $\sigma_\eta$  and the common shock  $\sigma_F$  is infinite. If this assumption holds, we can see from equation 36 that  $\hat{\alpha}$  is an unbiased estimator of  $\alpha$ .



probability of default  $\epsilon_t$  is higher on event days than non-event days. The variance of  $\epsilon_t$  is assumed to be higher because of the impact of the legal rulings, which are modeled as  $\epsilon_t$  shocks under the exclusion restriction. Under this assumption, we can identify the parameter  $\alpha$  by comparing the covariance matrices of abnormal returns and default probability changes on event days and non-event days.

In order to see how we can use this strategy to identify our key parameter of interest, we first solve for the reduced form of equations 34 and 35:

$$\begin{aligned} r_t &= \frac{1}{1 - \alpha\gamma} ((\alpha\kappa_D + \kappa) F_t + \eta_t + \alpha\epsilon_t) \\ \Delta D_t &= \frac{1}{1 - \alpha\gamma} ((\kappa_D + \gamma\kappa) F_t + \gamma\eta_t + \epsilon_t) \end{aligned}$$

We can then divide all days in our sample into two types of days, event ( $E$ ) and non-event ( $N$ ) days. For each of the two types of days  $j \in \{E, N\}$ , we can estimate the covariance matrix of  $[r_t, \Delta D_t]$ , denoted  $\Omega_j$ :

$$\Omega_j = \begin{bmatrix} \text{var}_j(r_t) & \text{cov}_j(r_t, \Delta D_t) \\ \text{cov}_j(r_t, \Delta D_t) & \text{var}_j(\Delta D_t) \end{bmatrix}$$

Calculating these moments using the reduced form equations, we can then write the covariance matrix on day type  $j$  as

$$\Omega_j = \left( \frac{1}{1 - \alpha\gamma} \right)^2 \begin{bmatrix} \alpha^2 \sigma_{\epsilon,j}^2 + \sigma_\eta^2 + (\alpha\kappa_D + \kappa)^2 \sigma_F^2 & \alpha \sigma_{\epsilon,j}^2 + \gamma \sigma_\eta^2 + ((\alpha\kappa_D + \kappa) (\gamma\kappa + \kappa_D)) \sigma_F^2 \\ \alpha \sigma_{\epsilon,j}^2 + \gamma \sigma_\eta^2 + ((\alpha\kappa_D + \kappa) (\gamma\kappa + \kappa_D)) \sigma_F^2 & \sigma_{\epsilon,j}^2 + \gamma^2 \sigma_\eta^2 + (\kappa_D + \gamma\kappa)^2 \sigma_F^2 \end{bmatrix}$$

We can then define the difference in the covariance matrices on event and non-event days as  $\Delta\Omega = \Omega_E - \Omega_N$ , which simplifies to

$$\Delta\Omega = \lambda \begin{bmatrix} \alpha^2 & \alpha \\ \alpha & 1 \end{bmatrix} \quad (37)$$

where  $\lambda = \left( \frac{\sigma_{\epsilon,E}^2 - \sigma_{\epsilon,N}^2}{(1 - \alpha\gamma)^2} \right)$ . This provides us with a number of ways to estimate the coefficient of interest  $\alpha$  that we will examine in Section 3.4.5. Although we have described our framework where the only asset is the market, in Appendix 5.3.4 we demonstrate how an equivalent system can be derived in a multi-asset framework.

The heteroskedasticity-based approach is our preferred estimation procedure. If the identification assumptions required for the OLS or event study hold, the heteroskedasticity-based strategy will also be valid, but the converse is not true. However, the event study approach does have one advantage over the heteroskedasticity approach (as we have implemented it). For the heteroskedasticity approach, we use two-day event days, because those are the smallest uniformly-sized windows that all of our events can fit into. However, as discussed earlier, all of our events can in fact fit into smaller windows (open-close, open-open, close-open, or close-close), but those windows are not the same size for each event. Using the event study approach, we present results defined using these narrower windows. If the identification assumptions required for this event study hold, this approach may have more power than the heteroskedasticity-based approach.

We begin by presenting the OLS estimates, as point for comparison with our subsequent results.

### 3.4.1 OLS Estimates

In this section, we assume the OLS identifying assumption:  $F_t = 0$  and  $\gamma = 0$  in equations 34 and 35 above. The model can be written as

$$r_t = \alpha \Delta D_t + \eta_t$$

where  $\alpha$  is the coefficient of interest, and  $Cov(\Delta D_t, \eta_t) = 0$ . We can estimate this equation with OLS.

Table 17: OLS Results

	(1)	(2)	(3)	(4)
	Index	Banks	Non-Financial	Real estate
$\Delta D$	-46.41***	-49.89***	-35.74***	-11.53
Robust SE	(6.318)	(8.111)	(6.077)	(8.023)
95% CI	[-61.8,-28.7]	[-66.0,-34.0]	[-51.7,-17.4]	[-27.9,6.1]
Observations	413	413	413	413
R-squared	0.389	0.345	0.305	0.071

	(5)	(6)	(7)
	FX (ADR)	FX (On.)	FX (Official)
$\Delta D$	30.26***	11.55***	3.863
Robust SE	(4.573)	(4.019)	(1.740)
95% CI	[18.1,43.3]	[3.4,19.4]	[-13.1,8.6]
Observations	368	413	413
R-squared	0.182	0.029	0.072

Notes: This table reports the results for the OLS regression of equity returns and foreign exchange (FX) rate on changes in the risk-neutral default probability ( $\Delta D$ ) and the covariates discussed in the text. The column headings denote the outcome variable. Index is the MSCI Argentina Index, Banks is our equally weighted index of Argentine bank ADRs, Non-Financial is our equally weighted index of Argentine non-financial ADRs, and Real Estate is our equally weighted index of Argentine real estate holding companies. FX (ADR) is the ARS/USD exchange rate derived from the ratio of ADR prices (in USD) to the price of the underlying equity (in ARS). FX (On.) is the ARS/USD exchange rate offered by onshore currency dealers. FX (Official) is the exchange rate set by the Argentine government. The coefficient on  $\Delta D$  is the effect on the percentage returns of an increase in the 5-year risk-neutral default probability from 0% to 100%, implied by the Argentine CDS curve. Standard errors and confidence intervals are computed using the stratified bootstrap procedure described in the text. The underlying data is based on the two-day event windows and non-events described in the text. Significance levels: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

In our actual implementation, we include a constant and the vector of controls  $X_t$  discussed in 3.3.1. We estimate the OLS model for the returns of the MSCI Argentina Index, our three ADR industry groups, and our three measures of the exchange rate.

The results in Table 17 imply that a 1% increase in the probability of default is associated with a 0.46% fall in the MSCI Argentina Index. In Appendix Table 34, we see increases in the probability of an Argentine default are associated with increases in Brazilian and Mexican CDS spreads and declines in the Brazilian and Mexican equity markets. This correlation points to the importance of omitted common factors. In our heteroskedasticity-based estimates presented below and in the appendix, we show that the legal rulings have no

measurable impact on Brazilian and Mexican CDS or equity markets. The method we use to construct standard errors and confidence intervals is discussed below in Section 3.4.4. For the OLS estimates, it is essentially equivalent to heteroskedasticity-robust standard errors and confidence intervals based on first-order approximations.

### 3.4.2 Case Study: Announcement

We begin our discussion of the event study approach with a single event. On June 16, 2014, the U.S. Supreme Court denied two appeals and a petition from the Republic of Argentina. This denial had several effects. First, it allowed the holdouts to pursue discovery against all of Argentina's foreign assets, not just those in the United States. Second, the court declined to review Judge Griesa's interpretation of the *pari passu* clause and his orders demanding equal treatment. The denial of Argentina's petition meant that Judge Griesa could prevent the Bank of New York, the payment agent on Argentina's restructured bonds, from paying the coupons on those bonds, unless Argentina also paid the holdouts. Because Argentina had previously expressed its unwillingness to pay the holdouts, this news meant that Argentina was more likely to default.

This event is ideal for our purposes because we are able to precisely determine the time the news was released. The Supreme Court announces multiple orders in a single public session, and simultaneously provides copies of those orders to the press. Prior to releasing the official opinion, the court announces the order. SCOTUSBlog, a well-known legal website that provides news coverage and analysis of the Supreme Court, had a "live blog" of the announcements on that day. At 9:33am EST, SCOTUSBlog reported that "Both of the Argentine bond cases have been denied. Sotomayor took no part."<sup>94</sup> At 10:09am, the live blog stated that Argentina's petition had been denied. At 10:11am, the live blog provided a link to the ruling.

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<sup>94</sup>See [http://live.scotusblog.com/Event/Live\\_blog\\_of\\_orders\\_and\\_opinions\\_\\_June\\_16\\_2014?Page=0](http://live.scotusblog.com/Event/Live_blog_of_orders_and_opinions__June_16_2014?Page=0)

In Figure 24, we plot the returns of the Argentine ADRs, underlying equities and the percentage change in the sovereign CDS spread. The ADRs begin trading in New York at 9:30am but trading of the underlying local stocks does not begin in Argentina until 10:30am EST. To compare the returns on the underlying local stocks with the ADRs, we weight the return of the underlying stocks according to their weight in the MSCI Argentina Index of ADRs. Finally, we include 1-minute interval data on the mid-price (halfway between the bid and ask) on 5-year Republic of Argentina Senior Credit Default Swaps, from Bloomberg.<sup>95</sup>

From 9:30am to 10:30am, the MSCI index of ADRs fell 6% and the sameday 5-year CDS spread (measured by Markit) increased by 693 basis points (bps), implying a 9.8% increase in the risk-neutral probability of default over the next 5 years. When the Argentine stock market opened, the index of equities opened 6.2% lower than it closed the previous night. Under the standard event study assumptions, this implies that a 1% increase in the probability of default causes a 0.63% fall in ADR prices, and virtually no change in the ADR-based blue rate.

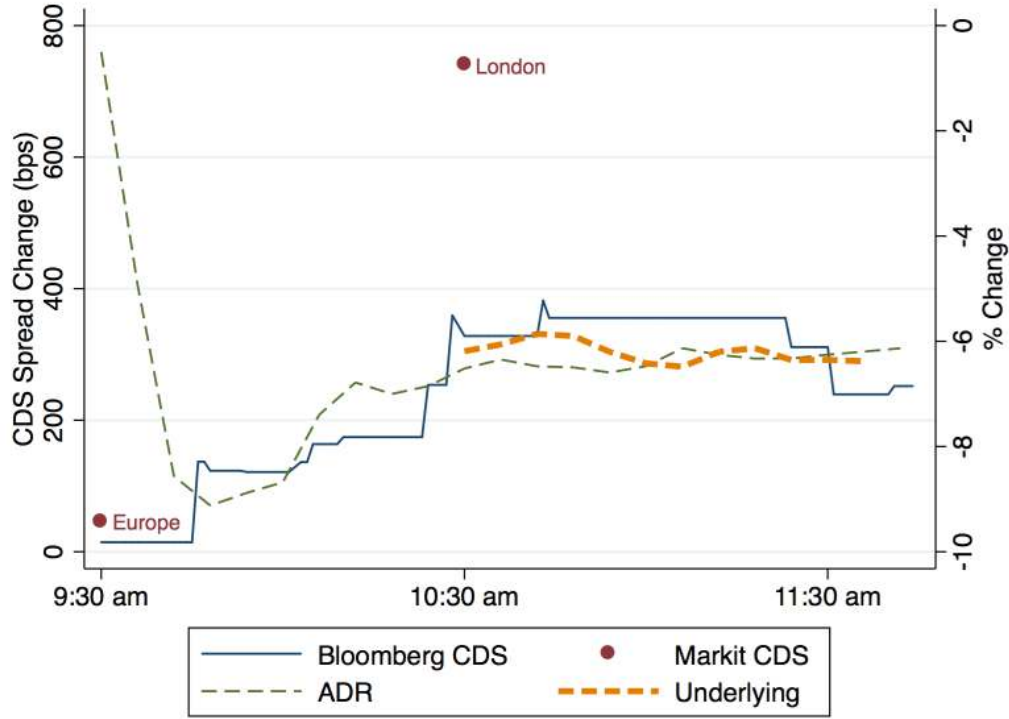
### 3.4.3 Event Study

Following the discussion in Section 3.4, we present the results of three event studies. Each event study uses the same identification assumptions, outlined above. The first event study uses two-day windows around events. We begin by presenting summary statistics for the returns of the MSCI Argentina Index and the changes in 5-year risk-neutral default probabilities, during event windows and non-event windows.

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<sup>95</sup>We believe that the CDS data ultimately comes from the “screen” of an inter-dealer broker. It is not clear that these rates represent the actual market in the CDS. We use the Bloomberg data only for this figure, and rely on Markit data for our regressions. During the one-hour interval from 9:30am to 10:30am, the Markit sameday CDS spread increased by substantially more than the CDS spread reported by Bloomberg, although both changes are large relative to typical hourly movements.

Figure 24: Event Data from June 16, 2014, 9:30-11:30am EST



Notes: This figure plots the change in the CDS spread over the previous night’s close (“CDS”, left axis, basis points), the change in the price of the MSCI Argentina Index against the previous night’s close (“ADR”, right axis, %), and the change in the price of an index of Argentine stocks with the same weightings as in the ADR based MSCI Index over the previous night’s close (“Underlying”, right axis, %). The Markit CDS points are labeled with the name of the reporting market, with European markets reporting at 9:30am EST and London Markets reporting at 10:30am EST.

Our event study methodology follows the one described in Campbell et al. (1997). Let  $N$  denote the set of non-event days, and let  $L1 = |N|$ . We first estimate the factor model on the non-event days,

$$r_{i,t} = \mu_i + \omega_i^T X_t + \nu_{i,t},$$

and generate a time series of abnormal returns,  $\hat{r}_{i,t} = r_{i,t} - \hat{\mu}_i - \hat{\omega}_i^T X_t$ , where  $X_t$  is the vector of controls discussed in Section 3.3.1. We also estimate the variance of the abnormal returns associated with the factor model (assuming homoskedastic errors),  $\hat{\sigma}_i^2 = \frac{1}{L1} \sum_{t \in N} \hat{\nu}_{i,t}^2$ . We next estimate a factor model for the change in the probability of default,  $\Delta D_t$ , and create a time series of abnormal default probability changes,  $\hat{d}_t$ . We then classify our event days

Table 18: Summary Statistics

Day Type	Mean $\Delta D$ (%)	SD $\Delta D$ (%)	Mean Equity (%)	Equity SD (%)
Event	0.88	6.13	0.26	4.50
Non-Event	-0.01	1.79	0.01	3.17

Day Type	Cov( $\Delta D, Equity$ )	# of Days
Event	-21.26	16
Non-Event	-2.37	397

Notes: This table reports the mean default probability change, the standard deviation of default probability changes, the mean MSCI Argentina Index return, the standard deviation of that return, and the covariance of default probability changes and that return during events and non-events. The underlying data is based on the two-day event windows and non-events described in the text.

into three categories, based on the abnormal default probability change during the event window. Let  $\sigma_d$  denote the standard deviation of the abnormal default probability changes. If the probability increases by at least  $\sigma_d$ , we label that day as an “higher default” event. If the probability decreases by at least  $\sigma_d$ , we label that event as a “lower default” event. If the default probability change is less, in absolute value, than  $\sigma_d$ , we label that as a “no news” event.

For each type of event, we report the cumulative abnormal return and cumulative abnormal default probability change over all events of that type (higher default, lower default, no news). We also report two statistics that are described in Campbell et al. (1997). In this event study (but not the next one we discuss), which does not aggregate returns across different ADRs, the two statistics are identical, up to a small sample size correction. Define  $E_{\{h,l,n\}}$  as the set of event days of each type. The first statistic,  $J1$ , is computed, for event type  $j$  and ADR  $i$ , as

$$J1_{ij} = \frac{\sum_{t \in E_j} \hat{r}_{i,t}}{\sqrt{|E_j| \hat{\sigma}_i^2}}.$$

Under the null hypothesis that the events have no effect on the stock returns,  $J1_{ij}$  is asymptotically distributed as a standard normal. However, because we have so few events in each category, asymptotic normality will be a poor approximation, if the abnormal returns are themselves far from normal. This is one reason we prefer the variance-based estimators discussed in the next section.

Table 19: Standard Event Study: Index

Shock Type	# Events	CAR (%)	$\Delta D$ (%)	$J_1$	$J_2$
Higher Default	8	-18.12	44.21	-2.46**	-2.45**
No News	3	-2.56	-0.03	-0.57	-0.56
Lower Default	5	23.59	-29.48	4.05***	4.04***

Notes: CAR indicates cumulative abnormal return over the event windows,  $\Delta D$  is the change in the risk-neutral probability of default, and the test statistics  $J_1$  and  $J_2$  are described in the text and in Campbell et al. (1997), pp. 162. A shock type of higher default indicates that this event raised the default probability by more than one two-day standard deviation, a shock type of lower default indicates that this event lowered the default probability by more than one two-day standard deviation, and a shock type of no news indicates a day with a legal ruling in which the default probability did not move at least one two-day standard deviation in either direction. The underlying data is based on the two-day event windows and non-events described in the text. The p-values are the p-values for a two-sided hypothesis test assuming normality. Significance levels: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

The second statistic,  $J_2$ , is nearly identical to  $J_1$  for this event study (they will be different in the next event study we describe). For each event, we can define a standardized cumulative abnormal return,

$$z_{i,t} = \sqrt{\frac{|E_j| - 4}{|E_j| - 2}} \frac{\hat{r}_{i,t}}{\sqrt{\hat{\sigma}_i^2}},$$

where the first term represents a small-sample correction. The statistic  $J_2$  is defined as

$$J2_{ij} = \frac{\sum_{t \in E_j} z_{i,t}}{\sqrt{|E_j|}}.$$

This statistic is also asymptotically standard normal under the null hypothesis, subject to the same caveat about return normality. In Table 19, we present these two statistics for the MSCI Argentina Index.

The results of this event study are broadly similar to the OLS estimates. In the 8 event days where the default probability significantly increased, the cumulative increase in the default probability was 44.21% and the stock market experienced a cumulative abnormal return of -18.12%. Assuming a linear relationship between default probabilities and equity returns, this implies that a 1% increase in the probability of default causes a 0.41% fall in the stock market. During the 5 days where the default probability significantly declined, the cumulative fall in the default probability was 29.48% with a cumulative abnormal return



of 23.6%. This implies a 1% fall in the probability of default causes an 0.80% rise in the stock market. Treating the movements symmetrically and adding together the absolute value of the change in default probability and cumulative abnormal returns, we find that a 1% increase in the probability of default causes a 0.57% fall in the equity market. While the large window sizes used in this study raise concerns about the validity of the identification assumptions, we will see that this estimate is very close to the results we find from our heteroskedasticity-based estimates.

The next event study we present uses four different window sizes, discussed earlier. Our data set includes one additional event (17 instead of 16), because one of the two-day windows in fact contained two separate legal rulings on consecutive days. Conceptually, the event study is almost identical, except that we must study each type of event (higher default, lower default, no news) for each window size. That is, we separately estimate abnormal returns and abnormal default probability changes for each window size  $s \in S$ , the set of window sizes. We classify events based on the standard deviation of abnormal default probability changes for the associated window size. Let  $E_{js}$  denote an event of type  $j$  (higher default, lower default, no news) with window size  $s$  (close-to-close, open-to-open, close-to-open, and open-to-close). The abnormal return  $\hat{r}_{i,t,s}$  is the abnormal return for ADR  $i$  at time  $t$  with window size  $s$ , and  $\hat{\sigma}_{is}^2$  is the variance of the abnormal returns for that window size. The  $J1$  statistic is computed as

$$J1_{ij} = \frac{\sum_{s \in S} \sum_{t \in E_{js}} \hat{r}_{i,t,s}}{\sqrt{\sum_{s \in S} |E_{js}| \hat{\sigma}_{is}^2}}.$$

Asymptotically, subject to the same caveats mentioned previously, this statistic is distributed as a standard normal. The second statistic,  $J2$ , is constructed in a similar fashion. However, the standardized cumulative abnormal returns are now defined with respect to the event window size,

$$z_{i,t,s} = \sqrt{\frac{|E_{js}| - 4}{|E_{js}| - 2}} \frac{\hat{r}_{i,t,s}}{\sqrt{\hat{\sigma}_{is}^2}},$$

Table 20: Heterogenous-Window Event Study: Index

Shock Type	# Events	CAR (%)	$\Delta D$ (%)	$J_1$	$J_2$
Higher Default	5	-13.70	14.61	-3.71***	-3.34***
No News	7	-5.26	4.91	-1.06	-1.03
Lower Default	5	20.14	-32.58	5.31***	5.26***

Notes: CAR indicates cumulative abnormal return over the event window,  $\Delta D$  is the change in the risk-neutral probability of default, and the test statistics  $J_1$  and  $J_2$  are described in the text and in Campbell et al. (1997), pp. 162. This study pools events across different window sizes (open-open, open-close, close-open, close-close). A shock type of higher default indicates that this event raised the default probability by more than one standard deviation, where the standard deviation is defined for non-events with the same window size. A shock type of lower default indicates that this event lowered the default probability by more than one standard deviation, and a shock type of no news indicates a day with a legal ruling in which the default probability did not move at least one standard deviation in either direction. The underlying data is based on the event windows and non-events described in the text, and uses the narrowest windows possible with our data and uncertainty about event times. The p-values are the p-values for a two-sided hypothesis test assuming normality. Significance levels: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

and the  $J_2$  statistic is

$$J2_{ij} = \frac{\sum_{s \in S} \sum_{t \in E_{js}} z_{i,t,s}}{\sqrt{\sum_{s \in S} |E_{js}|}}.$$

This statistic is also, subject to the same caveats, asymptotically standard normal. It is not the same as the  $J_1$  statistic, because of the heterogeneity in window size. If the cumulative abnormal returns occur mostly in shorter windows (which have smaller standard deviations), the  $J_2$  statistic will be larger in absolute value than the  $J_1$  statistic. If the reverse is true, the  $J_1$  statistic will be larger. The size of the window may depend in part on the court releasing the opinion, the urgency with which the opinion was required, and other endogenous factors. It is not obvious whether the  $J_1$  or  $J_2$  statistic should be preferred. Fortunately, the results presented in Table 20 using the two statistics are similar.

In the 5 event days where the default probability significantly increased, the cumulative probability of default rose 14.61% and the stock market had a cumulative abnormal return of -13.7%. This estimate implies that a 1% increase in the probability of default causes a 0.94% fall in equity returns. During the 5 days where the default probability significantly declined, the cumulative fall in the default probability was 32.58% with a cumulative abnormal equity return of 20.14%. This implies a 1% fall in the probability of default causes an 0.62% rise

in the stock market. When we again treat up and down movements symmetrically, we find that a 1% increase in the probability of default causes a 0.72% fall in the equity market.

Finally, we present “IV-style” event study. This study uses the two-day events and non-events described previously. The second stage equation we wish to estimate is equation 35, discussed above. The instrument we use is  $\mathbf{1}(t \in E)\Delta D_t$  (and  $\mathbf{1}(t \in E)$ ), where  $E$  is the set of event days and  $\mathbf{1}(\cdot)$  is the indicator function. The first-stage regression is

$$\Delta D_t = \chi \mathbf{1}(t \in E)\Delta D_t + \rho \mathbf{1}(t \in E) + \mu_D + \omega_D^T X_t + \tau_t,$$

where  $\tau_t$  is a composite of the three unobserved shocks  $(\varepsilon_t, F_t, \nu_t)$  on the non-event days. Under the event study assumptions, the unobserved shocks  $\varepsilon_t$  and  $F_t$  (in the second stage) are not correlated with the change in the default probability on event days.

The IV-style event study has the advantage that of offering an interpretable coefficient,  $\hat{\alpha}$ , that estimates the change in stock prices given a change in the default probability. It also takes into account the magnitude of the default probability changes on each event day, whereas the event studies discussed earlier treat each event in a category equally. However, it is not *a priori* clear that the impact of the default probability on stock returns should be linear, and therefore not obvious that this approach is superior to the two-day event study. The similarity of the two results suggests linearity is not a bad assumption. Because the IV-style event study uses two-day event windows, it requires stronger identification assumptions than the heterogenous-window event study. The standard errors and confidence intervals for this approach are described in Section 3.4.4, below.

Using this method, we find that a 1% increase in the probability of default causes a 0.55% fall in the MSCI Argentina Index, a 0.59% fall in financial stocks, a 0.33% fall in industrial stocks, and only a 3% fall in REIT-eligible stocks. While the coefficient differences are suggestive, we will defer a discussion of whether they are significantly different from one another until Section 3.4.5. We also find that a 1% increase in the probability of default

Table 21: IV-Style Event Study

	(1)	(2)	(3)	(4)
	Index	Banks	Non-Financial	Real Estate
$\Delta D$	-55.18***	-59.14***	-31.61***	-3.124
Robust SE	(10.84)	(13.92)	(10.41)	(13.76)
95% CI	413	413	413	413
Observations	[-78.6,-28.4]	[-82.5,-32.3]	[-56.6,-7.2]	[-27.0,23.3]
1st Stage F-Stat	211.2	211.2	211.2	211.2

	(5)	(6)	(7)
	FX (ADR)	FX (On.)	FX (Official)
$\Delta D$	35.07***	15.60***	-0.188
Robust SE	(7.577)	(6.896)	(3.000)
95% CI	368	413	413
Observations	[12.0,59.5]	[4.7,27.0]	[-4.1,4.1]
1st Stage F-Stat	212.2	211.2	211.2

Notes: This table reports the results for the variance-based estimator estimated as the ratio of  $\lambda\alpha$  to  $\lambda$ . This estimator is called the “CDS-IV” estimator because it depends on the excess variance of the CDS spread on event days. The column headings denote the outcome variable. Index is the MSCI Argentina Index, Banks is our equally weighted index of Argentine bank ADRs, Non-Financial is our equally weighted index of Argentine non-financial ADRs, and Real Estate is our equally weighted index of Argentine real estate holding companies. FX (ADR) is the ARS/USD exchange rate derived from the ratio of ADR prices (in USD) to the price of the underlying equity (in ARS). FX (On.) is the ARS/USD exchange rate offered by onshore currency dealers. FX (Official) is the exchange rate set by the Argentine government. The coefficient on  $\Delta D$  is the effect on the percentage returns of an increase in the 5-year risk-neutral default probability from 0% to 100%, implied by the Argentine CDS curve. Standard errors and confidence intervals are computed using the stratified bootstrap procedure described in the text. The underlying data is based on the two-day event windows and non-events described in the text. Significance levels: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

causes a 0.35% depreciation of the ADR blue rate, a 0.16% depreciation of the onshore blue rate, and has no effect on the official exchange rate.

### 3.4.4 Standard Errors and Confidence Intervals

To construct confidence intervals for our coefficient estimates, we employ the bootstrap procedure advocated by Horowitz (2001). The advantage of this procedure is that it offers “asymptotic refinements” for the coverage probabilities of tests, meaning that it is more likely to achieve the desired rejection probability under the null hypothesis. Our estimators (except for the OLS) are effectively based on a small number of the data points (the events), and therefore these refinements may provide significant improvements over first-order asymp-

otics. As a practical matter, our confidence intervals are in almost all cases substantially wider than those based on first-order asymptotics. Nevertheless, these “asymptotic refinements” are still based on asymptotic arguments, and there is no guarantee that they are accurate for our data. We also find (in unreported results) that our confidence intervals for our coefficient of interest,  $\alpha$ , are similar to confidence intervals constructed under normal approximations, using a bootstrapped standard error.

We use 1000 repetitions of a stratified bootstrap, resampling with replacement from our set of events and non-events, separately, so that each bootstrap replication contains 16 events and 397 non-events.<sup>96</sup> In each bootstrap replication, we compute the (asymptotically pivotal) t-statistic  $t_k = \frac{\hat{\alpha}_k - \hat{\alpha}}{\hat{\sigma}_k}$ , where  $\hat{\alpha}$  is the point estimate in our actual data sample,  $\hat{\alpha}_k$  is the point estimate in bootstrap replication  $k$ , and  $\hat{\sigma}_k$  is the heteroskedasticity-robust standard deviation estimate of  $\hat{\alpha} - \alpha$  from bootstrap sample  $k$ . We then determine the 2.5th percentile and 97.5th percentile of  $t_k$  in the bootstrap replications, denoted  $\hat{t}_{2.5}$  and  $\hat{t}_{97.5}$ , respectively. The reported 95% confidence interval for  $\hat{\alpha}$  is  $[\hat{t}_{2.5}\hat{\sigma} + \hat{\alpha}, \hat{t}_{97.5}\hat{\sigma} + \hat{\alpha}]$ , where  $\hat{\sigma}$  is the heteroskedasticity-robust standard deviation estimate of  $\hat{\alpha} - \alpha$  from our original data sample. We construct 90% and 99% confidence intervals in a similar fashion, and use them to assign asterisks in our tables.<sup>97</sup> In the tables, we report the 95% confidence interval and the heteroskedasticity-robust standard error from our dataset ( $\hat{\sigma}$ ).

### 3.4.5 Variance-based Analysis

Our final set of analysis is based on the difference between the covariance matrices in equation 37. There are several potential ways to estimate  $\alpha$  based on  $\Delta\Omega$ . Two such estimators, which we call the CDS-IV and Returns-IV estimators, respectively, are defined as

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<sup>96</sup>The number of events and non-events listed apply to the ADRs. The exchange rates have a slightly different number of events and non-events, due to holidays, missing data, and related issues.

<sup>97</sup>These asterisks represent an “equal-tailed” test that  $\alpha \neq 0$ .

$$\begin{aligned}\hat{\alpha}_{CIV} &= \frac{\Delta\Omega_{1,2}}{\Delta\Omega_{2,2}} = \frac{\text{cov}_E(\Delta D_t, r_t) - \text{cov}_N(\Delta D_t, r_t)}{\text{var}_E(\Delta D_t) - \text{var}_N(\Delta D_t)} \\ \hat{\alpha}_{RIV} &= \frac{\Delta\Omega_{1,1}}{\Delta\Omega_{1,2}} = \frac{\text{var}_E(r_t) - \text{var}_N(r_t)}{\text{cov}_E(\Delta D_t, r_t) - \text{cov}_N(\Delta D_t, r_t)}\end{aligned}$$

As shown in Rigobon and Sack (2004), these estimators can be implemented in an instrumental variables framework. More generally, (37) provides us with three moment conditions.

$$\Delta\Omega_{1,1} - \lambda\alpha^2 = 0, \tag{38}$$

$$\Delta\Omega_{1,2} - \lambda\alpha = 0, \tag{39}$$

$$\Delta\Omega_{2,2} - \lambda = 0. \tag{40}$$

The GMM estimator uses all three moment conditions.

The Returns-IV estimator uses an “irrelevant instrument” under the null hypothesis that  $\alpha = 0$ . The estimator  $\hat{\alpha}_{RIV}$  is the ratio of the sample estimates of  $\Delta\Omega_{1,1}$  and  $\Delta\Omega_{1,2}$ , both of which are zero in expectation under the null hypothesis. The denominator,  $\Delta\Omega_{1,2}$ , is the covariance between the default probability, which is the variable being instrumented for, and the instrument. Under the null hypothesis, this covariance is zero, meaning that the instrument is irrelevant. As a result, the behavior of the  $\hat{\alpha}_{RIV}$  estimator under the null hypothesis is not characterized by the standard IV asymptotics, and our confidence intervals will not have the correct coverage probabilities.<sup>98</sup> The CDS-IV estimator does not suffer from this issue. The estimator  $\hat{\alpha}_{CIV}$  is based on the ratio of the sample estimates of  $\Delta\Omega_{1,2}$  and  $\Delta\Omega_{2,2}$ . Under the null hypothesis that  $\alpha = 0$  and  $\lambda > 0$ , the CDS-IV instrument is still relevant, and the standard asymptotics for  $\hat{\alpha}_{CIV}$  apply. The GMM estimator,  $\hat{\alpha}_{GMM}$ , which uses all three moments, can be thought of as a geometric average of the CDS-IV and Returns-IV estimators. When  $\alpha \neq 0$ , using all three moments is advantageous because

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<sup>98</sup>When  $\alpha$  is near, but not equal, to zero, weak identification asymptotics may be a better characterization of the sample distribution of  $\hat{\alpha}_{RIV}$ .

it takes advantage of all available information and makes over-identifying tests possible. However, under the null hypothesis that  $\alpha = 0$ , using the Returns-IV estimator in any way is problematic. The two-step GMM procedure, implemented using standard asymptotics to estimate the optimal weighting matrix, would generally not correctly estimate the variances, because of the irrelevant instrument. As a result, the weight matrix might effectively place excessive weight on the Returns-IV estimator, relative to the CDS-IV estimator, and end up providing problematic results. For these reasons, we use the CDS-IV estimator as our preferred estimation procedure. We report the results for the other two methods in the appendix.

The CDS-IV instrument is relevant under the assumption that  $\lambda > 0$ . We formally test this assumption using a one-sided F-test of the ratio of  $(\Omega_E)_{22}$  to  $(\Omega_N)_{22}$ , which is the ratio of the variance of changes in the default probability on event days and non-event days. We test the alternate hypothesis that this ratio is greater than 1 (implying  $\lambda > 0$ ) against the null hypothesis that it is equal to one. In our sample, this F-statistic is 11.78, well above the 99th percentile, one-sided, bootstrapped critical value of 1.98.<sup>99</sup> The relevance of the CDS-IV instrument is also suggested by the weak-identification F-test of Stock and Yogo (2005) (not to be confused with the F-test for  $\lambda > 0$ ) shown in Table 22. In Table 22, we present the results of our CDS-IV estimation. The standard errors and confidence intervals use the bootstrap procedure described previously.

We find that increases in the 5-year risk-neutral default probability cause statistically and economically significant declines in the MSCI Argentina Index, bank ADRs, and non-financial ADRs. In contrast, we do not find a statistically significant effect on the ADRs of Argentine real-estate holding companies, although we cannot rule out economically significant effects. The point estimates in Table 22 are very close to those reported in Table 21, with a 1% increase in the probability of default causing a 0.55% fall in the broad index, a 0.59% fall in bank stocks, a 0.30% fall in non-financial stocks, and 0.006% fall in real

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<sup>99</sup>We use the bootstrapping procedure for pivotal statistics described by Horowitz (2001), and in our section on standard errors and confidence intervals.

Table 22: CDS-IV

	(1)	(2)	(3)	(4)
	Index	Banks	Non-Financial	Real Estate
$\Delta D$	-54.52***	-59.21***	-29.59**	-0.601
Robust SE	(11.60)	(14.88)	(11.15)	(14.73)
95% CI	[-81.1,-25.3]	[-84.3,-31.0]	[-55.9,-2.9]	[-28.3,31.4]
Observations	413	413	413	413
1st Stage F-Stat	171.9	171.9	171.9	171.9

	(5)	(6)	(7)
	FX (ADR)	FX (On.)	FX (Official)
$\Delta D$	35.20**	16.17***	-0.579
Robust SE	(7.951)	(7.375)	(3.212)
95% CI	[7.5,62.1]	[4.3,28.7]	[-2.6,4.9]
Observations	368	413	413
1st Stage F-Stat	178.7	171.9	171.9

Notes: This table reports the results for the variance-based estimator estimated as the ratio of  $\lambda\alpha$  to  $\lambda$ . This estimator is called the “CDS-IV” estimator because it depends on the excess variance of the CDS spread on event days. The column headings denote the outcome variable. Index is the MSCI Argentina Index, Banks is our equally weighted index of Argentine bank ADRs, Non-Financial is our equally weighted index of Argentine non-financial ADRs, and Real Estate is our equally weighted index of Argentine real estate holding companies. FX (ADR) is the ARS/USD exchange rate derived from the ratio of ADR prices (in USD) to the price of the underlying equity (in ARS). FX (On.) is the ARS/USD exchange rate offered by onshore currency dealers. FX (Official) is the exchange rate set by the Argentine government. The coefficient on  $\Delta D$  is the effect on the percentage returns of an increase in the 5-year risk-neutral default probability from 0% to 100%, implied by the Argentine CDS curve. Standard errors and confidence intervals are computed using the stratified bootstrap procedure described in the text. The underlying data is based on the two-day event windows and non-events described in the text. Significance levels: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

estate stocks. Increases in the probability of default also cause significant depreciation of the peso blue rate, measured with ADRs or by polling onshore currency dealers. However, there was no corresponding same-day change in the official exchange rate.<sup>100</sup> The increase in the risk-neutral default probability from 40% to 100%, which is roughly what Argentina experienced, would cause more than a 30% fall in the ADR index, by our estimates.

We formally test whether financial ADRs fall more than industrial ADRs, whether bank ADRs fall more than real estate ADRs, and whether industrial ADRs fall more than real estate ADRs. We construct these one-sided t-tests using the same bootstrap procedure

<sup>100</sup>We cannot rule out the possibility that the official exchange responds subsequently. This non-result is consistent with our identifying assumption that actions by Argentina’s government, unrelated to the legal rulings, are not more likely on event days than other days.



for pivotal statistics discussed earlier. We find that both the bank ADRs and industrial ADRs fall more than the real estate ADRs (at the 95% confidence level), but cannot reject the hypothesis that bank and industrial ADRs respond equally to changes in the default probability.

We also test whether the blue rates depreciate relative to the official rate, in response to increases in the default probability. We find that the difference between the onshore blue rate and the official exchange rate is significant at the 95% level, while the difference between the ADR-based blue rate and the official rate is significant at the 90% level. We cannot rule out the hypothesis that the two blue rates respond equally to increases in the default probability.

Our results are consistent with the hypothesis that Argentina's default would cause significant harms to Argentina's economy. In the next section, we examine which sectors of the Argentine economy are more adversely affected.

### **3.5 Cross-Sectional Evidence**

In this section, we examine which firm characteristics are associated with larger or smaller responses to the default shocks. The cross-sectional pattern of responses across firms can help shed light on the mechanism by which sovereign default affects the economy. First, we examine how different industries respond to default shocks. Second, we examine the heterogeneous firm responses to an increase in the probability of default, through the lens of different theories on the channel by which sovereign default affects the broader economy.

In their seminal contribution, Eaton and Gersovitz (1981b) argue that the reason governments repay their debt is to maintain their reputation and ensure continued access to international bond markets. Because this access allows governments to smooth income fluc-

tuations, it is valuable and is generally sufficient to guarantee repayment.<sup>101</sup> Because of the threat of attachment from outstanding creditors, Argentina had not issued a new international bond in thirteen years and was unlikely to do so soon. This suggests that the effect of default that we measure is different than the reputational mechanism posited in Eaton and Gersovitz (1981b).<sup>102</sup> Instead, this points to the importance of alternative theories of sovereign default costs, examined in the literature following Bulow and Rogoff (1989b). We will attempt to examine the empirical relevance these hypothesized costs of sovereign default by examining whether four groups of firms are particularly affected by default: exporters, importers, banks, and foreign-owned companies.

First, motivated by Bulow and Rogoff (1989a), we will examine whether or not firms that are reliant on exports are particularly hurt. Bulow and Rogoff (1989a) argue that in the event of a sovereign default, foreign creditors can interfere with a country's exports. We would therefore expect exporters to underperform in response to increases in the probability of default. Using aggregate data, Rose (2006) and others have found support for this channel. Second, motivated by Mendoza and Yue (2012b), we will examine whether or not firms that are reliant on imported intermediate goods are particularly hurt by default. Mendoza and Yue (2012b) argue that a sovereign default reduces aggregate output because firms cannot secure financing to import goods needed for production, and so are forced to use domestic intermediate goods, which are imperfect substitutes. This would lead us to expect firms that are relatively more reliant on imported intermediate goods would underperform in response to a default shock. Third, motivated by Gennaioli et al. (2014), Acharya et al.

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<sup>101</sup>Tomz (2007) provides a historical account to argue in favor of the reputational model of sovereign debt. English (1996) argues that the experience of US states in the 1840s provides evidence in favor of the reputational model of sovereign default by arguing that no direct sanctions were available to creditors. The Eleventh Amendment prevents foreign creditors from suing US states to receive payments on defaulted debt, constitutionally guaranteed interstate free trade prevents foreign creditors from locking defaulters out of trade markets, and the US federal government prevents foreign creditors from using force to collect on the debt. English demonstrates that defaulting states are unable to borrow again for a number of years, concluding that the concern for maintaining a reputation for repayment is therefore the only explanation for continued repayment.

<sup>102</sup>We are not providing evidence against the importance of the the type of reputational concerns in Eaton and Gersovitz (1981b), but rather arguing that this particular default is not likely to be affected by such concerns.

(2014a), Bolton and Jeanne (2011), Bocola (2013) and Perez (2014), we will examine whether financial firms are more adversely affected. While these papers are not explicitly about whether banks are hurt more than other firms, they posit that the aggregate decline in output following a sovereign default occurs because of the default's effect on bank balance sheets. This leads to a reduction in financial intermediation and a reduction in aggregate production. If this argument or something like it were correct, we would expect banks to be hurt disproportionately by an increase in the probability of default. Finally, motivated by Cole and Kehoe (1998), we examine whether foreign-owned firms underperform following an increase in the probability sovereign default. Cole and Kehoe (1998) argue that even if the loss of a reputation for repayment alone is not sufficient to motivate countries to repay their debt, if their "general reputation" is lost by defaulting on sovereign debt, foreigners would become less willing to trust the defaulting government. This theory would lead us to expect increases in the risk of sovereign default to cause foreign-owned firms to underperform, as foreigners perceive a higher risk that Argentina will act disreputably in other arenas, such as investment protection. Our empirical approach is similar to several papers in the literature studying the cross-section of firms' responses to identified monetary policy shocks, using an event study for identification. Bernanke and Kuttner (2005) study U.S. stock market data and find that the response of various industry portfolios to a monetary policy shock is proportional to that industry's CAPM beta. Put differently, the ensemble of shocks that generate returns outside of the event windows have a similar cross-sectional pattern of returns to the monetary policy shock. Gorodnichenko and Weber (2013) find that a measure of the stickiness of firms' prices is correlated with the squared magnitude of firms' response to squared monetary policy shocks. We apply similar strategies to our context. First, we explore the abnormal returns for various industries in response to a default probability shock, controlling for the abnormal return of the Argentine market. Second, we form portfolios based on firm characteristics suggested by theory and then study the abnormal returns of those portfolios, again controlling for the abnormal return of the Argentine market.

Our procedures are motivated by a modified version of the model in equations 35 and 34. We derive both models from a single underlying system of equations, presented in the appendix, Section 5.3.4. The modified version of the those equations has the return of the Argentine market index,  $r_{m,t}$ , on the right-hand side, in addition to the observable factors  $X_t$  and unobservable factors  $F_t$ . We denote the return of a particular stock or portfolio as  $r_{i,t}$ :

$$\Delta D_t = \mu_D + \omega_D X_t + \gamma r_{i,t} + \gamma_m r_{m,t} + \kappa_D F_t + \epsilon_t \quad (41)$$

$$r_{i,t} = \mu_i + \omega_i X_t + (\alpha_i - \beta_i \alpha_m) \Delta D_t + \beta_i r_{m,t} + \kappa_i F_t + \eta_{i,t}. \quad (42)$$

The parameter  $\alpha_m$  is the response of the Argentine market index,  $r_{m,t}$ , to the default shock. For the purposes of our study, this two equation system has exactly the same form as the system described in Section 3.4. The Argentine market return,  $r_{m,t}$ , is an observable common factor, no different from the S&P 500 or other observable factors in  $X_t$ . The Rigobon (2003) procedure, applied to this system, identifies the coefficient  $(\alpha_i - \beta_i \alpha_m)$ , which can be interpreted as the excess sensitivity of the portfolio to the default shock, above and beyond what would be expected from the Argentine market's exposure to the default shock, and the sensitivity of the portfolio to the Argentine market. In this sense, our approach generalizes the CAPM-inspired analysis of Bernanke and Kuttner (2005) to a model with multiple exogenous shocks.

We begin by studying the response of industry portfolios to default shocks, controlling for the response of the Argentine market. To increase our sample size of firms, we use local Argentine stock returns, rather than ADRs. We convert the local stock returns, denominated in pesos, into dollars using the ADR-based blue rate described previously. For stocks with ADRs, the converted return will be nearly identical to the ADR return.<sup>103</sup> The use of the ADR-based exchange rate requires that both the New York and Buenos Aires stock markets

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<sup>103</sup>As mentioned previously, the implied exchange rate between various stock-ADR pairs does not vary substantially across firms.

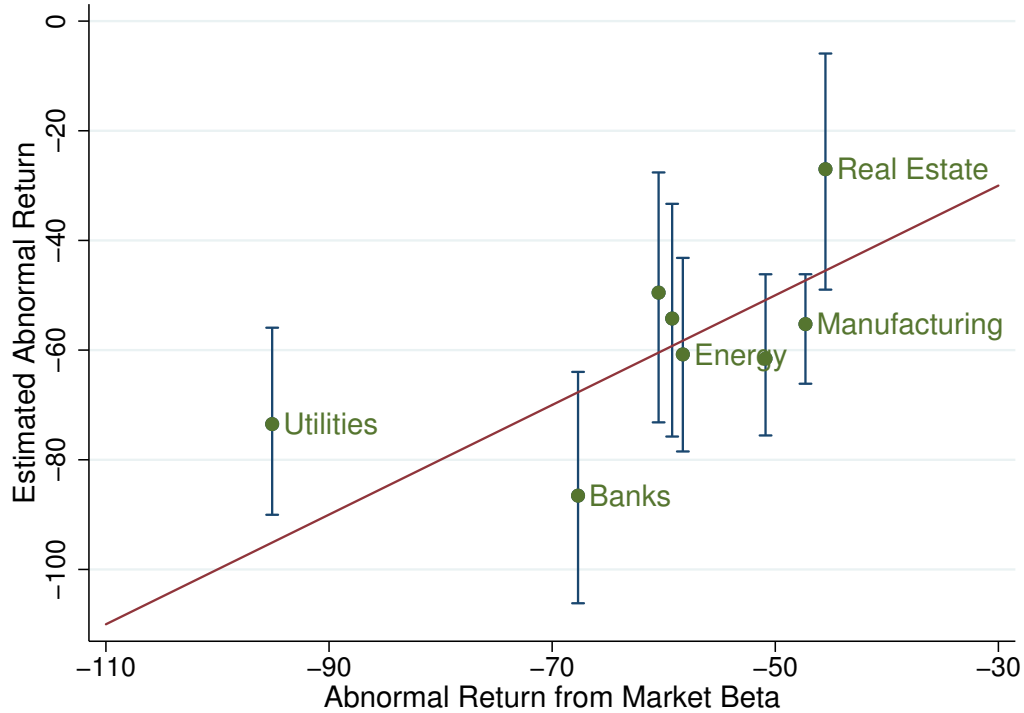
be open, which reduces the size of our sample. However, the events in our sample remain the same, with one exception.<sup>104</sup>

We group these firms into equal-weighted industry portfolios, using the industry definitions described in Section 3.3.1. We also construct an equal-weighted index of all of the firms in our sample, which is restricted to firms passing a data quality test also described in Section 3.3.1. We use this equal-weighted index as our measure of the Argentine market return. In Figure 25 and Table 23 below, we display estimates of the excess sensitivity of the industry portfolios to the default shock, using the CDS-IV estimator and the bootstrapped confidence intervals described in the previous sections.

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<sup>104</sup>The treatment of the events around Monday, June 23, 2014 is different when using ADR and local stock data, as the result of an Argentine holiday on June 20th. The ADR data uses a two-day window from the close of June 20 to the close of June 24, whereas the local stock data uses the close of Jun 19 to June 23.

Figure 25: Estimated Response to Default Shocks: Industries



*Notes:* Industry classifications are based on the Fama-French 12 industry categories with the modifications described in Section 3.1. The labels for chemical firms, diverse firms, non-durables producers, and telecoms are suppressed. On the the x-axis, we plot the expected abnormal return for each portfolio, calculated as the beta of each long-short portfolio on the index times  $\alpha_M$ , the effect of an increase in the probability of default in the abnormal return of the index. On the y-axis, we plot the sum of the expected abnormal return and  $(\alpha_i - \beta_i\alpha_M)$ , the additional sensitivity of each portfolio to an increase in the probability of default. Values above the line indicates that the portfolio over-performed following increases in the probability of default, relative to what would be implied by the portfolio's market beta. Values below the line indicate underperformance. The ranges indicate bootstrapped 90% confidence intervals.

Three industries (banks, real estate, and utilities) stand out as over- or under-sensitive to default shocks. However, care must be taken when interpreting the results. First, the confidence intervals around these estimates are very wide. Our point estimates suggest that a 10% increase in the probability of default would cause bank stocks to fall by roughly 2% more than would be expected, given their beta to the Argentine index, and would cause real estate stocks and utilities to fall by 2% less than would be expected. However, the standard deviation of these estimates is almost 1%, and only the utilities' out-performance

Table 23: Cross-Section: Industry Returns

	(1)	(2)	(3)	(4)	(5)	(6)
	Index	Banks	Chemicals	Diverse	Energy	Manufact.
$\Delta D$	-63.91***	-18.86	5.006	10.94	-2.495	-7.965
	(8.173)	(8.277)	(13.95)	(19.06)	(9.932)	(7.299)
Index Beta		1.059	.927	.946	.912	.74
95% CI	[-81.3,-44.3]	[-42.0,6.4]	[-21.0,30.3]	[-19.1,36.2]	[-23.7,18.4]	[-21.4,3.4]
Observations	356	358	358	358	358	358
F_Stat	259.5	173.5	173.5	173.5	173.5	173.5

	(7)	(8)	(9)	(10)	(11)
	Non-Durables	Non-Financial	Real Estate	Telecoms	Utilities
$\Delta D$	-7.726	2.82	18.5	-10.67	21.61**
	(6.884)	(1.852)	(9.692)	(9.91)	(8.763)
Index Beta	.739	1.008	.712	.796	1.488
95% CI	[-25.2,6.8]	[-3.7,9.0]	[-6.7,43.0]	[-26.9,7.6]	[1.6,41.1]
Observations	358	358	358	358	358
F-Stat	173.5	173.5	173.5	173.5	173.5

Notes: This table reports the results for the “CDS-IV” estimator. The column headings denote the outcome variable. Index is the equal-weighted index of local equities in Table 16. The industry classifications are based on Fama-French with modifications described in Section 3.3.1. The coefficient on  $\Delta D$  is the effect on the percentage returns of an increase in the 5-year risk-neutral default probability from 0% to 100%, implied by the Argentine CDS curve. Index beta is the coefficient on the equal-weighted index of Argentine local equities, as described in Section 3.5. Standard errors and confidence intervals are computed using the stratified bootstrap procedure described in the text. The underlying data is based on the two-day event windows and non-events described in the text. Significance levels: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

is significant at the 95% confidence interval. The uncertainty around our point estimates is driven by the small number of events we study, and the idiosyncratic variation in stocks’ response to the different legal announcements. Second, our confidence intervals have not been adjusted for multiple testing; the fact that one industry has significant over- or under-performance at the 95% confidence level is not surprising, given the number of tests being performed.

That said, our point estimates are economically large. Taken at face value, our results suggest that as Argentina went from a 40% to 100% probability of defaulting, its banks’ value fell by 11% more (in dollar terms) than would have been expected, given a 38% fall in the dollar value of the equal-weighted index. The excessive sensitivity of bank stocks to default risk is consistent with the theories of Gennaioli et al. (2013, 2014), Bocola (2013),

and Bolton and Jeanne (2011). We interpret our data as providing suggestive evidence for these theories<sup>105</sup>.

We next consider which characteristics of non-financial firms are associated with over- or under-performance in response to default shocks. As discussed in Section 3.3.1, we form zero-cost, long-short portfolios of non-financial firms based on the export intensity of their primary industry, the import intensity of their primary industry, whether they are a listed subsidiary of a foreign firm, and whether they have an associated ADR. An import-intensive industry is not the opposite of an export-intensive one; some industries are classified as neither import nor export intensive, whereas others are both import and export intensive.<sup>106</sup> Finally, we compare firms with and without ADRs.

In these portfolios, we equally weight firms within the “long” and “short” groups. For example, we classify 12 of our 26 non-financial firms<sup>107</sup> as high export intensity, and 14 of 26 as low export intensity. We equally weight these firms, so that the “long” portfolio has a 1/12 weight on each high export intensity firm, and the short portfolio has a 1/14 weight on each low export intensity firm. We then form the long-short portfolio, and determine whether the portfolio over- or under-performs after a default shock, using the CDS-IV estimator and bootstrapped confidence intervals discussed previously.

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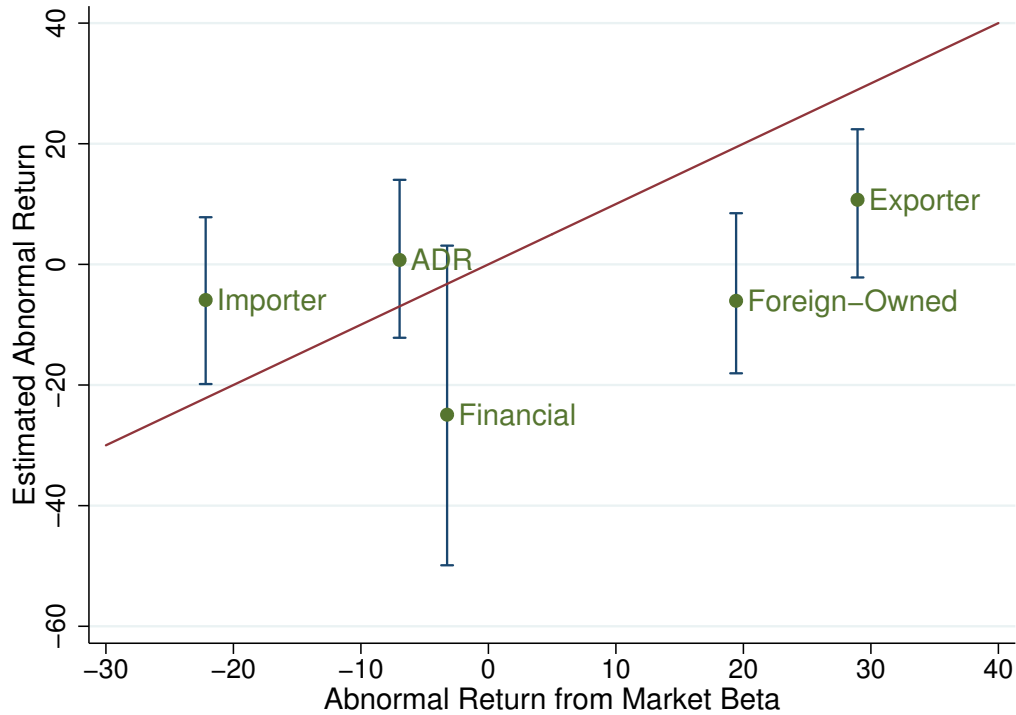
<sup>105</sup>Regarding the outperformance of utilities, one market participant suggested to us that pressure on the Argentine government’s foreign reserves, exacerbated by the default, might lead them to liberalize utility prices. In the status quo, underpriced electricity (for example) leads to over-consumption, which results in excessive importation of utilities’ inputs. Excessive imports reduce the Argentine government’s foreign reserves position, and their inability to borrow makes it difficult to replenish these reserves. This story is one possible explanation for why utility companies could indirectly benefit from a sovereign default, relative to other companies.

<sup>106</sup>The correlation in our sample of non-financial firms is 0.16.

<sup>107</sup>We in fact have 27 non-financial firms, but one is a technology firm. The technology firm’s industry classification did not exist when the input/output table we use to construct the data was generated.



Figure 26: Estimated Response to Default Shocks: Long-Short



*Notes:* Each label denotes a zero-cost long short portfolio. Exporter is a portfolio going long export-intensive non-financial firms and short non-export-intensive non-financial firms. Importer is defined equivalently for importers. Financial goes long banks and short non-financial firms. Foreign-owned firms goes long non-financial firms with a foreign parent and short domestically-owned non-financial firms. ADR goes long non-financial firms with an American Depository Receipt and short non-financial firms without one. The data sources are described in Section 3.3.1. On the the x-axis, we plot the expected abnormal return for each portfolio, calculated as the beta of each long-short portfolio on the index times  $\alpha_M$ , the effect of an increase in the probability of default in the index. On the y-axis, we plot the sum of the expected abnormal return and  $(\alpha_i - \beta_i\alpha_M)$ , the additional sensitivity of each portfolio to an increase in the probability of default. Values above the line indicates that the portfolio over-performed following increases in the probability of default, relative to the abnormal return implied by the portfolio's market beta. Values below the line indicate underperformance. The ranges indicate bootstrapped 90% confidence intervals.

In Figure 26 and Table 24, we find that firms whose primary industry is export-intensive under-perform, while firms whose primary industry is import intensive over-perform expectations, given their exposure to the equal-weighted index and the index's response to the default probability shock. We find that our long-short exporter portfolio underperforms 0.18% more for each 1% increase in the risk-neutral probability of default than would be expected given the portfolio's loading on the market index. However, our results about import

Table 24: Cross-Section: Long-Short Portfolios

	(1)	(2)	(3)	(4)	5)
	Exporter	Importer	Financial	Foreign-Owned	ADR
$\Delta D$	-18.24**	16.27*	-21.68	-25.47***	7.698
	(9.401)	(7.912)	(10.01)	(7.974)	(7.527)
Index Beta	-.453	.347	.0507	-.304	.109
95% CI	[-32.8,-3.4]	[-.1,32.4]	[-50.8,10.3]	[-40.2,-8.0]	[-7.9,24.1]
Observations	358	358	358	358	358
F-Stat	173.5	173.5	173.5	173.5	173.5

Notes: This table reports the results for the “CDS-IV” estimator. The column headings denote the outcome variable. Each column is a zero-cost long short portfolio. Exporter is a portfolio going long export-intensive non-financial firms and short non-export-intensive non-financial firms. Importer is defined equivalently for importers. Financial goes long banks and short non-financial firms. Foreign-owned firms goes long non-financial firms with a foreign parent and short domestically-owned non-financial firms. ADR goes long non-financial firms with an American Depositary Receipt and short non-financial firms without one. The data sources are described in Section 3.3.1. The coefficient on  $\Delta D$  is the effect on the percentage returns of an increase in the 5-year risk-neutral default probability from 0% to 100%, implied by the Argentine CDS curve. Index beta is the coefficient on the equal-weighted index of Argentine local equities, as described in Section 3.5. Standard errors and confidence intervals are computed using the stratified bootstrap procedure described in the text. The underlying data is based on the two-day event windows and non-events described in the text. Significance levels: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

intensive firms are not robust to changes in the portfolio formation threshold. In unreported results, we find that using a 4% threshold for import intensity, instead of 3%, results in all of the utilities being reclassified from high import intensity to low import intensity. Because the utilities responded far less to default shocks than their beta would predict, their reclassification is sufficient to change the sign of the results. In contrast, we find that the results for exporters are qualitatively robust to variations in the threshold.

The over- or under-performance of the export and import portfolios is not an ideal test of the theories. In the context of the Bulow and Rogoff (1989a) theory, if we do not observe that exporting firms under-perform, it may be because the firms we observe are not the ones whose exports would be seized, or because our export-intensive and non-export-intensive firms also differ on some other characteristic that predicts over- or under-performance<sup>108</sup>. The reverse is also true; a significant result does not necessarily validate the theory, but might instead be found because of a correlation across firms between exporting and some other firm characteristic.

<sup>108</sup>Essentially, an omitted variables problem

We also find that non-financial foreign subsidiaries, of which there are seven, substantially underperform relative to non-financial firms that are not foreign subsidiaries. The long-short portfolio falls 0.25% more in response to a 1% increase in the risk-neutral probability of default than would be expected given the portfolio's loading on the index. This result is consistent with the general reputation theory of Cole and Kehoe (1998), implying that foreign investors become more reluctant to invest, although there are many other possible interpretations. We do not find that non-financial firms with an ADR substantially under- or out-perform non-financial firms without ADRs.

We interpret this cross-sectional analysis as lending modest support to several of the theories in the existing literature that try to understand the costs of sovereign default. The theories are not exclusive; sovereign default may harm the financial system, impede trade, and weaken a country's reputation in many areas. Our estimates are insufficiently precise to reject any of these theories, or speak to their quantitative importance. Nevertheless, our approach does have the advantage over the existing literature that we can pinpoint the direction of causality, from sovereign default to performance, in a way that would be very difficult using aggregate or annual data.

### 3.6 Interpretation

We begin by describing an imaginary “ideal experiment” to identify the causal effect of default on economic activity. We will then discuss the ways in which our research design does and does not approach this ideal. We will offer alternative interpretations of the effect of the legal rulings, and discuss their implications for the interpretation of our results. We also discuss several additional aspects of Argentina's situation that are relevant.<sup>109</sup>

The ideal experiment would randomly induce one of two otherwise-identical groups of countries to default on their debt. These groups of countries would have characteristics similar to those of typical sovereign borrowers. The treatment (default) would be ran-

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<sup>109</sup>Alfaro (2014) examines the implications of the legal rulings on future sovereign debt restructurings.

domly assigned, so that it would be uncorrelated with the underlying state of the countries' economies. The treatment would induce a country to default, but would otherwise neither encourage nor impair other actions by that country's government, firms, or households. The null hypothesis in this experiment is that default does not affect economic activity. The alternative hypothesis is that default impairs economic activity, through some unspecified channel.

We emphasize the idea of "inducing" a country to default because we view default as a choice of the government. For the purposes of understanding why sovereign borrowers repay their debts, we would like to understand the consequences of them choosing not to repay. These consequences include the effects of whatever mitigating actions a country might take after having decided to default. These consequences also include the effects of firms, households, and other agents changing their behavior as a result of the default. The government's actions could include renegotiating with creditors, finding other means to borrow, balancing budgets via taxes or reduced spending, taking actions that affect the convertibility of the currency, among other actions. When we refer to the causal effects of sovereign default, we include the anticipated effects of whatever policies the government is expected to employ as a result of having defaulted.

Our research design differs from this ideal experiment in a variety of ways. First, we study Argentina, a country whose experience with sovereign debt is very different from most other countries. Argentina is in some sense in default for the entirety of our sample, depending on the definition of "default." It has an unusual currency regime. Argentina defaulted for convoluted legal reasons. Additionally, the way in which Argentina acts to mitigate the consequences of its default might be different from the way other countries would respond in similar circumstances. Second, there is the issue of whether the default is exogenous to Argentina's economic circumstances. Third, our outcome variables are not perfect measures of economic activity. Fourth, these legal rulings might have effects on firms' stock prices, through channels other than changes in the likelihood of default (the exclusion

restriction may not hold). If the legal rulings compelled Argentina to repay a large amount of money, relative to its economy or foreign reserves, then firms' stock prices might fall due to the burdens of debt repayment and associated reduction in economic activity, rather than through any default-related effects.

In the remainder of this section, we will discuss each of these issues in more detail.

### **3.6.1 The Options Available to Argentina**

It is not clear that Argentina was forced to default. Prior to these legal rulings, Argentina had several feasible courses of action with respect to its restructured debt and the holdouts. It could maintain the status quo, in which it was subject to attachment orders and other actions by the holdouts, while it continued to pay its restructured creditors. It could attempt to negotiate with the holdouts, and completely resolve its default. Finally, it could choose to default on its restructured creditors.

The cumulative effect of these legal rulings changed the menu of options available to Argentina. The status quo option, in which Argentina continued to pay its restructured bondholders without paying the holdouts, became infeasible.<sup>110</sup> Instead, Argentina could make payments on its debt, which would be divided between the restructured bondholders and the holdouts according to the "ratable payment" formula devised by Judge Griesa. Alternatively, it could attempt to negotiate with the holdouts, to avoid defaulting on its restructured bondholders. Finally, it could default on the restructured bondholders.

Argentina effectively chose the third option (default). It made a payment to the Bank of New York Mellon (BNYM), the trustee for its restructured bonds, that was sufficient to pay the restructured bondholders, without paying anything to the holdouts. Judge Griesa's order prohibited BNYM from forwarding this payment to the restructured bondholders, and Argentina missed a coupon payment. After the 30-day grace period, Argentina was declared in default by the rating agencies.

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<sup>110</sup>This infeasibility might be temporary or permanent— it is not clear as of this writing.

As of this writing, how the situation will be resolved is unclear. One recent proposal involves replacing BNYM with another, non-U.S. trustee, who would not be subject to the U.S. courts' orders, and could continue to pay the restructured bondholders. Another complication concerns the treatment of euro-denominated bondholders, whose coupon payments are included in the amount held by BNYM. These bondholders have argued that BNYM acted contrary to Belgian and U.K. law, and that they should continue to be paid.

The cumulative effect of the legal rulings raised the probability of default on the restructured bonds and/or payment of the holdouts, relative to the probability that the status quo would continue. If Argentine firms would be affected by payment of the holdouts, holding default or no default fixed, then the exclusion restriction of our experiment would not hold.

One possibility is that the legal rulings might change the probability or size of a settlement with the holdouts, and this could affect the firms. Under the null hypothesis, if the government somehow repaid the holdouts without fiscal consequences (say, using a gift from abroad), there would be no effect on firms. In reality, because the government would need to raise taxes, cut spending, or borrow to repay the holdouts, an increase in the probability or size of a settlement with the holdouts could harm firms.

To get a sense of whether this is reasonable, we consider the extent to which the bonds owned by the holdouts appreciated, on our event days. Based on preliminary findings, we believe that the increase in the expected value of the holdout bonds is dwarfed by the cumulative losses of the Argentine firms.<sup>111</sup> This suggests that if, in expectation, the entirety of the burden of repayment fell on these firms, that would only explain a small part of the stock market declines. A very large “multiplier” for the loss of equity value associated with the debt burden would be required for this argument to apply.

More generally, the legal rulings could have had other effects. However, Argentine corporations are legally independent from the Argentine government, and their assets cannot be

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<sup>111</sup>These calculations are available upon request.

attached by the holdouts.<sup>112</sup> The ruling affects them only to the extent that it changes the behavior of the Argentine government or other actors. This still leaves open several possible effects. The legal rulings could have provoked the government of Argentina into a sequence of actions unrelated to sovereign default. They could have influenced the probability that the current government of Argentina stays in power in the next election. The legal rulings could have changed the law regarding sovereign debt generally.

We can muster evidence against this last effect. In the appendix, Section 5.3.2, we show that the stock markets and sovereign CDS spreads of Brazil and Mexico did not respond to these legal rulings (our estimates are close to zero, and relatively precise). This is in contrast to the OLS estimates, which show that those financial variables are correlated with the Argentine risk-neutral probability of default, presumably due to common shocks affecting Latin America or emerging markets more generally. This evidence suggests that, whatever changes to sovereign debt law occurred as the result of these rulings, they did not materially impact other Latin American countries that issue debt in New York.

However, we cannot rule out every possible channel through which these rulings might have affected firms, other than via sovereign default. Ex-post, it appears that the primary response of the Argentine government to these rulings was default. We are unaware of any direct consequences for Argentine firms. Consistent with this interpretation, S&P did not downgrade any Argentine firms immediately upon the sovereign's default (Standard and Poor's 2014a). However, it subsequently downgraded a variety of firms, arguing that deteriorating economic conditions reduced those firms' credit quality (Standard and Poor's 2014b).

### **3.6.2 How Much Would Argentina Have to Repay?**

To meet the precise demands of the courts, Argentina needed to pay its litigating creditors only \$1.5 billion. However, the \$1.5 billion owed to the litigating creditors was only around

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<sup>112</sup>There was litigation regarding whether the Argentine central bank qualified as independent from a legal perspective, but no such litigation for any of the companies listed in the stock index.

10% of the estimated \$15 billion holdout debt outstanding.<sup>113</sup> Presumably, if Argentina paid NML and its co-litigants in full, the other holdout creditors would demand repayment on similar terms. Even if we assume that Argentina would need to pay the full \$15 billion, that represented only 3% of GDP,<sup>114</sup> and 45% of foreign currency reserves.<sup>115</sup>

However, it is possible that if Argentina did indeed pay the holdouts in full, it would then owe the restructured creditors a large payment as well. During its 2004-2005 debt restructuring, Argentina sought to convince its creditors that the unilateral offer it made was the best offer they would ever receive. Argentina included a “Rights Upon Future Offers” (RUFO) clause in the bond prospectus of the restructured debt.<sup>116</sup> The RUFO clause entitled restructuring creditors to terms at least as good as anything holdouts would receive in the future:

Under the terms of the Pars, Discounts and Quasi-pars, if following the expiration of the Offer until December 31, 2014, Argentina voluntarily makes an offer to purchase or exchange or solicits consents to amend any Eligible Securities not tendered or accepted pursuant to the Offer, Argentina has agreed that it will take all steps necessary so that each holder of Pars, Discounts or Quasi-pars will have the right, for a period of at least 30 calendar days following the announcement of such offer, to exchange any of such holder’s Pars, Discounts or Quasi-pars for the consideration in cash or in kind received in connection with such purchase or exchange offer or securities having terms substantially the same as those resulting from such amendment process, in each case in accordance with the terms and conditions of such purchases, exchange offer or amendment process.<sup>117</sup>

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<sup>113</sup>See Gelpern (2014a).

<sup>114</sup>The CIA World Factbook reports Argentina’s 2013 GDP as \$484.6 billion. However, this calculation uses the official exchange rate, which may overstate the size of Argentina’s economy.

<sup>115</sup>The CIA World Factbook reports Argentina’s foreign exchange and gold reserves at \$33.65 billion as of December 31, 2013.

<sup>116</sup>Olivares-Caminal (2013) refers to this as the “most favored creditor clause.”

<sup>117</sup>Full bond prospectus available at <http://www.sec.gov/Archives/edgar/data/914021/000095012305000302/y04567e424b5>.



In other words, if Argentina made an offer to the holdouts that was better than what the restructured creditors received, the restructured creditors would be entitled to the better deal, provided the offer occurred before December 31, 2014. Argentina claimed that this RUFO clause meant that it could not pay NML the \$1.5 billion owed without incurring hundreds of billions in additional liabilities. There is one crucial word in the RUFO that makes the whole matter more complicated: *voluntarily*. If Argentina offered the holdouts a better deal because US courts would otherwise have blocked its payments to the restructured bondholders, would that be voluntary or involuntary? Indeed, some observers noted that Argentina’s counsel told the Second Circuit Court of Appeals that Argentina “would not voluntarily obey” court rulings to pay the holdouts in full.<sup>118</sup> In addition, other commenters noted that the RUFO appeared to have some loopholes, allowing Argentina to potentially settle with the holdouts without triggering the clause.<sup>119</sup> Finally, exchange bondholders could waive their right to exercise the RUFO, and because it takes 25% of exchange bondholders to trigger the clause, the whole issue could have been rendered moot if the exchange bondholders could be persuaded that this was preferable to having their coupon payments blocked.<sup>120</sup> Of course, this possibility assumes Argentina would have paid any amount to the holdouts, a questionable proposition given the domestic politics surrounding the holdouts.<sup>121</sup>

For the purposes of interpreting our results, the RUFO clause complicates matters in two ways. First, if the RUFO clause was binding and could not have been easily circumvented, negotiation with the holdouts may not have been feasible. In this case, it would be correct to say that the legal rulings forced Argentina to default (the simple interpretation offered above). Second, if the RUFO clause was binding, but the legal rulings compelled Argentina to involuntarily pay the holdouts (and therefore circumvented the RUFO clause), they might

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<sup>118</sup><http://ftalphaville.ft.com/2013/03/06/1411442/raising-the-rufo-in-argentine-bonds/>

<sup>119</sup>See the comment’s from Barclay’s reported in FT Alphaville: <http://ftalphaville.ft.com/2013/03/06/1411442/raising-the-rufo-in-argentine-bonds/>

<sup>120</sup>See Gelpern (2014b).

<sup>121</sup>See Gelpern (2014b).

have made renegotiation feasible when it was not previously feasible. Finally, if the RUFO clause was not binding, it does not alter the interpretation of the rulings discussed above.

The RUFO clause expired on December 31, 2014 but, as of the time of this draft, a settlement has not yet been reached.

### **3.6.3 Are the Legal Rulings Exogenous?**

We argue that the rulings of the courts are not influenced by news about the Argentine economy. Formally, the interpretation of the laws in question does not depend on the state of the Argentine economy. Substantively, because the amount required to repay the holdouts in full was small relative to the Argentine economy, news about the Argentine economy's prospects would not materially change their ability to pay. Moreover, even if the judges were responding to economic fundamentals, under the null hypothesis that default does not affect fundamentals, the judges would have no information advantage over market participants. It follows that the effects of economic news on the judges' rulings would be anticipated by the market prior to those rulings, and any response by the market to the judges' rulings would not reflect news about fundamentals.

More subtle interactions between the state of the Argentine economy and the legal rulings might complicate the interpretation of our analysis. For example, if bad news about the Argentine economy causes the market response to the legal rulings to be larger than it otherwise would have been, our estimates will reflect some sort of average effect, where the averaging occurs over states of the economy. Relatedly, the underlying state of the economy might influence the Argentine government's decision about whether to negotiate with the holdouts or default, and therefore interact with the legal rulings to determine the extent to which the default probability and stock prices change. These issues emphasize that our estimates should be considered average treatment effects, relevant to Argentina.

It is important that our event study avoid announcements by the Argentine government, because such announcements might be responding to news about fundamentals, or affect corporations in ways other than through default. In the case of the Supreme Court decision discussed earlier, the Argentine government did not respond immediately to the ruling.<sup>122</sup> More generally, we include as events only orders by a judge or judges. We exclude orders that were issued during oral arguments, because those events also include opportunities for lawyers representing Argentina to reveal information.

Our identifying assumption is that the variance of “legal shocks” is higher on days when a US court rules on the dispute between NML and Argentina while the variance of all other shocks remain the same. However, if in addition to shocks to economic fundamentals, and legal shocks, we imagine that there are “political shocks” which move the probability of Argentina defaulting on its debt, then it could be that the variance of these shocks are higher on event days because the government is more likely to make a pronouncement revealing how likely it is to default following a ruling by Judge Griesa.<sup>123</sup>

### 3.6.4 Interpreting Stock Returns

We view the response of stock prices to default shocks through the lens of the Campbell-Shiller decomposition. One reason ADR or local equity prices might decline is that default reduces the expected growth rate of corporate dividends, by harming the Argentine economy. Another reason that prices might decline is that higher default probabilities cause an increase in the required returns of Argentine firms. Because Argentina is small, relative to the world economy, and the ADRs are traded by investors in the U.S., there is no reason to expect

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<sup>122</sup>See the following Bloomberg story: [Link](#).

<sup>123</sup>Based on news stories, we believe that such “political shocks” are no more likely on event days than non-event days. In the future, we hope to use news stories to determine a set of dates that correspond to political shocks, and test whether such events are more likely on event days than non-event days. Even if such political events are more likely one event days, our research design is valid. In this case, we would be identifying the causal effect of the rulings on default, inclusive of both the ruling’s direct effect and the Argentine government’s endogenous response. Alternatively, if the political events were more likely on event days but unrelated to the issue of default, or affected firms through some mechanism other than default, our identification would fail. However, there is no apparent reason for political events to be more likely on event days, unless they are related primarily to the legal rulings.

that the legal rulings we identify alter the stochastic discount factor of the marginal investor. We also use controls for various risk factors known to predict financial market returns, to isolate the abnormal returns on Argentine ADRs that cannot be attributed to changes in the stochastic discount factor. Based on these arguments, we believe that the negative returns on Argentine ADRs associated with increases in default risk reflect reductions in expected dividend growth.<sup>124</sup>

Assume that the above arguments are correct, and adverse legal rulings cause reductions in expected ADR dividend growth by increasing the likelihood of default. The most straightforward interpretation of this result is that default will harm the Argentine economy, and this is what reduces expectations of dividend growth. However, there are other possible interpretations that we cannot rule out. Default may lead to changes in the corporate share of income in Argentina, without harming the overall economy. This story, and others like it, cannot be ruled out because our outcome variable is the price of a financial asset that may not be representative of the Argentine economy.

In order to examine the different responses of firms to increases in the probability of sovereign default, we also study the response of local equities. While we convert their prices to dollars using the ADR-implied blue rate, we cannot rule out that the returns may be affected by the risk of capital controls, particularly if only domestic residents own the securities. This would also affect the ADR-implied blue rate. Nevertheless, we do not find a significant difference in the response between how the local equity price of firms with and without ADRs response to increases in the probability of default. This makes us optimistic that the segmentation effects are relatively minor.

### **3.6.5 Was Argentina Already in Default?**

Although the debt exchanges of 2005 and 2010 eventually achieved a participation rate of 91.3%, above the level generally needed by a sovereign to resolve a default and reenter

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<sup>124</sup>Theoretically, the returns could also be caused by increases in the exposure of the ADRs to priced risk factors (an increase in “beta”).

capital markets,<sup>125</sup> Argentina remained unable to borrow internationally. This is because the ongoing creditor litigation had resulted in an attachment order, which would allow the holdouts to confiscate the proceeds from a new bond issuance.<sup>126</sup> However, ratings agencies took a different view, and on June 1, 2005, S&P declared the end of the Argentine default and gave them a sovereign foreign currency credit rating of B-.

There are several complications arising from Argentina’s ambiguous international standing. If the costs of default for Argentina were lower than that of a typical sovereign debtor, because Argentina was already unable to borrow in international markets, then our estimates understate the costs for the typical sovereign. On the other hand, because Argentina chose to default despite an ability to pay, the costs might be higher than is typical. Complicating the story further is that the Argentine government was still able to borrow in local markets, and via inter-country loans. In the aggregate, the country of Argentina was able to run a current account deficit, because its households, firms, and even local governments were able to borrow internationally, despite the inability of its federal government to do so. Therefore, even if the federal government of Argentina was in default for our entire sample, it is not clear that (as a country) it was locked out of international markets, before or after the latest default. These complications emphasize the uniqueness of Argentina’s circumstances.

### 3.7 Conclusion

For several decades, one of the most important questions in international macroeconomics has been “why do governments repay their debts?” Using an identification strategy that exploits the timing of legal rulings in the case of *Republic of Argentina v. NML Capital*, we present evidence that a sovereign default significantly reduces the value of domestic firms. We provide suggestive evidence that exporters, banks, and foreign-owned firms are particularly hurt by sovereign default.

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<sup>125</sup>Hornbeck (2013).

<sup>126</sup>Hornbeck (2013).

## 4 References

- ACHARYA, V., I. DRECHSLER, AND P. SCHNABL (2014a): “A pyrrhic victory? Bank bailouts and sovereign credit risk,” *The Journal of Finance*, 69, 2689–2739.
- ADLER, M. AND B. DUMAS (1984): “Exposure to currency risk: definition and measurement,” *Financial management*, 41–50.
- AGHION, P., P. BACCHETTA, AND A. BANERJEE (2000): “A simple model of monetary policy and currency crises,” *European Economic Review*, 44, 728–738.
- (2001): “Currency crises and monetary policy in an economy with credit constraints,” *European Economic Review*, 45, 1121–1150.
- (2004): “A corporate balance-sheet approach to currency crises,” *Journal of Economic Theory*, 119, 6–30.
- AGUIAR, M. (2005): “Investment, devaluation, and foreign currency exposure: The case of Mexico,” *Journal of Development Economics*, 78, 95–113.
- AGUIAR, M., M. AMADOR, E. FARHI, AND G. GOPINATH (2013): “Crisis and commitment: Inflation credibility and the vulnerability to sovereign debt crises,” *Working Paper*.
- AGUIAR, M. AND G. GOPINATH (2006): “Defaultable debt, interest rates and the current account,” *Journal of International Economics*, 69, 64–83.
- ALFARO, L. (2014): “Sovereign Debt Restructuring: Evaluating the Impact of the Argentina Ruling,” *Harvard Business Law Review (Forthcoming)*.
- ARAUJO, A., M. LEON, AND R. SANTOS (2013): “Welfare analysis of currency regimes with defaultable debts,” *Journal of International Economics*, 89, 143–153.
- ARELLANO, C. (2008): “Default Risk and Income Fluctuations in Emerging Economies,” *American Economic Review*, 98, 690–712.

- ARELLANO, C., X. MATEOS-PLANAS, AND J. V. RIOS-RULL (2013): “Partial Default,” *Working paper*.
- ARELLANO, C. AND A. RAMANARAYANAN (2012): “Default and the Maturity Structure in Sovereign Bonds,” *Journal of Political Economy*, 120, 187–232.
- ARORA, N., P. GANDHI, AND F. A. LONGSTAFF (2011): “Counterparty Credit Risk and the Credit Default Swap Market,” *Journal of Financial Economics*, 103, 280–293.
- ARSLANALP, S. AND T. TSUDA (2014): “Tracking global demand for emerging market sovereign debt,” *IMF Working Paper*.
- ARTETA, C. AND G. HALE (2008): “Sovereign debt crises and credit to the private sector,” *Journal of International Economics*, 74, 53–69.
- ASQUITH, P., A. SU, T. COVERT, AND P. PATHAK (2013): “The Market for Borrowing Corporate Bonds,” *Journal of Financial Economics*, 107, 155–182.
- AUGUSTE, S., K. M. DOMINGUEZ, H. KAMIL, AND L. L. TESAR (2006): “Cross-border trading as a mechanism for implicit capital flight: ADRs and the Argentine crisis,” *Journal of Monetary Economics*, 53, 1259–1295.
- AVDJIEV, S., M. K. CHUI, AND H. S. SHIN (2014): “Non-Financial Corporations from Emerging Market Economies and Capital Flows,” *BIS Quarterly Review December*.
- BABA, N. (2009): “Dynamic Spillover of Money Market Turmoil from FX Swap to Cross-Currency Swap Markets: Evidence from the 2007–2008 Turmoil,” *Journal of Fixed Income*, 18, 24–38.
- BAO, J., J. PAN, AND J. WANG (2011): “The illiquidity of corporate bonds,” *Journal of Finance*, 86, 911–946.

- BARTRAM, S. M., G. W. BROWN, AND B. A. MINTON (2010): “Resolving the exposure puzzle: The many facets of exchange rate exposure,” *Journal of Financial Economics*, 95, 148–173.
- BENJAMIN, D. AND M. L. WRIGHT (2013): “Recovery before redemption: A theory of delays in sovereign debt renegotiations,” *Working Paper*.
- BERNANKE, B. S., M. GERTLER, AND S. GILCHRIST (1999): “The financial accelerator in a quantitative business cycle framework,” *Handbook of Macroeconomics*, 1341–1393.
- BERNANKE, B. S. AND K. N. KUTTNER (2005): “What explains the stock market’s reaction to Federal Reserve policy?” *The Journal of Finance*, 60, 1221–1257.
- BIANCHI, J., J. C. HATCHONDO, AND L. MARTINEZ (2012): “International reserves and rollover risk,” Tech. rep., National Bureau of Economic Research.
- BLEAKLEY, H. AND K. COWAN (2008): “Corporate Dollar Debt and Depreciations: Much ado about Nothing?” *Review of Economics and Statistics*, 90, 612–626.
- BOCOLA, L. (2013): “The Pass-Through of Sovereign Risk,” *Manuscript, University of Pennsylvania*.
- BODNAR, G. M. AND M. F. WONG (2003): “Estimating exchange rate exposures: issues in model structure,” *Financial Management*, 35–67.
- BOLTON, P. AND O. JEANNE (2011): “Sovereign default risk and bank fragility in financially integrated economies,” *IMF Economic Review*, 59, 162–194.
- BORENSZTEIN, E. AND U. PANIZZA (2008): *The costs of sovereign default*, 8-238, International Monetary Fund.
- (2009): “The Costs of Sovereign Default,” *IMF Staff Papers*, 56, 683–741.



- (2010): “Do sovereign defaults hurt exporters?” *Open Economies Review*, 21, 393–412.
- BORRI, N. AND A. VERDELHAN (2011): “Sovereign Risk Premia,” *Working Paper*.
- BRUSA, F., T. RAMADORAI, AND A. VERDELHAN (2014): “The International CAPM redux,” *Available at SSRN 2462843*.
- BULOW, J. AND K. ROGOFF (1989a): “A Constant Recontracting Model of Sovereign Debt,” *The Journal of Political Economy*, 97.
- (1989b): “Sovereign Debt: Is to Forgive to Forget?” *The American Economic Review*, 43–50.
- BURASCHI, A., M. MEGUTURK, AND E. SENER (forthcoming): “The Geography of Risk Capital,” *Review of Financial Studies*.
- BURGER, J. D., R. SENGUPTA, F. E. WARNOCK, AND V. C. WARNOCK (2014): “US investment in global bonds: As the Fed pushes, some EMEs pull,” *National Bureau of Economic Research Working Paper*.
- BURGER, J. D. AND F. E. WARNOCK (2007): “Foreign participation in local currency bond markets,” *Review of Financial Economics*, 16, 291–304.
- BURGER, J. D., F. E. WARNOCK, AND V. C. WARNOCK (2012): “Emerging local currency bond markets,” *Financial Analysts Journal*, 68.
- CALVO, G. A. AND C. M. REINHART (2002): “Fear of floating,” *The Quarterly Journal of Economics*, 117, 379–408.
- CAMPBELL, J. Y., A. W. LO, AND C. MACKINLAY (1997): *The econometrics of financial markets*, Princeton University Press.

- CÉSPEDES, L. F., R. CHANG, AND A. VELASCO (2004): “Balance Sheets and Exchange Rate Policy,” *American Economic Review*, 94, 1183–1193.
- CHAMON, M., C. TREBESCH, AND J. SCHUMACHER (2014): “Foreign Law Bonds: Can They Reduce Sovereign Borrowing Costs?” *Working Paper*.
- CHATTERJEE, S. AND B. EYIGUNOR (2012): “Maturity, indebtedness, and default risk,” *American Economic Review*, 102, 2674–2699.
- CHEN, L., D. LESMOND, AND J. WEI (2007): “Corporate yield spreads and bond liquidity,” *Journal of Finance*, 62, 119–149.
- CHUE, T. K. AND D. COOK (2008): “Emerging market exchange rate exposure,” *Journal of Banking and Finance*, 32, 1349–1362.
- CHUI, M. K., I. FENDER, AND V. SUSHKO (2014): “Risks related to EME corporate balance sheets: the role of leverage and currency mismatch,” *BIS Quarterly Review September*.
- COFFEY, N., W. B. HRUNG, AND A. SARKAR (2009): “Capital Constraints, Counterparty Risk, and Deviations from Covered Interest Rate Parity,” *Working Paper*.
- COLE, H. L. AND P. J. KEHOE (1998): “Models of sovereign debt: Partial versus general reputations,” *International Economic Review*, 55–70.
- CORRADIN, S. AND M. RODRIGUEZ-MORENO (2014): “Limits to Arbitrage: Empirical Evidence from Euro Area Sovereign Bond Markets,” *Working Paper*.
- CORSETTI, G. AND L. DEDOLA (2013): “The Mystery of the Printing Press: Self-fulfilling Debt Crises and Monetary Sovereignty,” *Working Paper*.
- COWAN, K., E. HANSEN, AND L. HERRERA (2011): “Currency mismatches, balance-sheet effects and hedging in Chilean non-financial corporations,” *IDB Working Paper*.

- CRUCES, J. AND C. TREBESCH (2013a): “Sovereign Defaults: The Price of Haircuts,” *American Economic Journal: Macroeconomics*, 5, 85–117.
- CRUCES, J. J. AND C. TREBESCH (2013b): “Sovereign defaults: The price of haircuts,” *American Economic Journal: Macroeconomics*, 5, 85–117.
- CSONTO, B. AND V. IVASCHENKO (2013): “Determinants of Sovereign Bond Spreads in Emerging Markets: Local Fundamentals and Global Factors vs. Ever-Changing Misalignments,” *International Monetary Fund Working Paper no. 13-164*.
- CUADRA, G., J. M. SANCHEZ, AND H. SAPRIZA (2010): “Fiscal policy and default risk in emerging markets,” *Review of Economic Dynamics*, 13, 452–469.
- CUADRA, G. AND H. SAPRIZA (2008): “Sovereign default, interest rates and political uncertainty in emerging markets,” *Journal of International Economics*, 76, 78–88.
- DA-ROCHA, J.-M., E.-L. GIMENEZ, AND F.-X. LORES (2012): “Self-fulfilling crises with default and devaluation,” *Economic Theory*.
- DASEKING, C., A. R. GHOSH, T. D. LANE, AND A. H. THOMAS (2005): *Lessons from the Crisis in Argentina*, International monetary fund.
- DATTA, D. D. AND W. DU (2012): “Nonparametric HAC Estimation for Time Series Data with Missing Observations,” *International Finance Discussion Paper No.1060, Board of Governors of the Federal Reserve System*.
- D’ERASMO, P. (2011): “Government Reputation and Debt Repayment in Emerging Economies,” *Working Paper*.
- DESAI, M. A., C. F. FOLEY, AND K. J. FORBES (2008): “Financial constraints and growth: Multinational and local firm responses to currency depreciations,” *Review of Financial Studies*, 21, 2857–2888.

- DIDIER, T. AND M. GARCIA (2003): “Very High Interest Rates and the Cousin Risks: Brazil During the Real Plan,” in *Macroeconomic Reforms: The 2nd Generation*, ed. by J. Gonzales and A. O. Krueger, University of Chicago Press.
- DIEBOLD, F. AND C. LI (2006): “Forecasting the Term Structure of Government Bond Yields,” *Journal of Econometrics*, 130, 337–364.
- DOMINGUEZ, K. M. AND L. L. TESAR (2006): “Exchange rate exposure,” *Journal of International Economics*, 68, 188–218.
- DRISCOLL, J. C. AND A. KRAAY (1998): “Consistent covariance matrix estimation with spatially dependent panel data,” *Review of Economics and Statistics*, 80, 549–560.
- (2014b): “Local Currency Sovereign Risk,” *Working Paper, Harvard University*.
- (2014c): “Sovereign Risk, Currency Risk, and Corporate Balance Sheets,” *Working Paper*.
- DUFFIE, D. (2010): “Asset Pricing Dynamics with Slow-Moving Capital,” *Journal of Finance*, 65, 1237–1267.
- DUFFIE, D., N. GARLEANU, AND L. H. PEDERSEN (2002): “Securities lending, shorting, and pricing,” *Journal of Financial Economics*, 66, 307–339.
- DUFFIE, D. AND M. HUANG (1996): “Swap Rates and Credit Quality,” *Journal of Finance*, 51, 921–949.
- DUFFIE, D., L. H. PEDERSEN, AND K. J. SINGLETON (2003): “Modeling Sovereign Yield Spreads: A Case Study of Russian Debt,” *Journal of Finance*, 58, 119–160.
- EATON, J. AND M. GERSOVITZ (1981a): “Debt with potential repudiation: Theoretical and empirical analysis,” *Review of Economic Studies*, 48, 289–309.

- (1981b): “Debt with potential repudiation: Theoretical and empirical analysis,” *The Review of Economic Studies*, 289–309.
- EDWARDS, S. (1984): “LDC foreign borrowing and default risk: An empirical investigation, 1976-80,” *The American Economic Review*, 726–734.
- EICHENGREEN, B. AND R. HAUSMANN (1999): “Exchange Rates and Financial Fragility,” in *New Challenges for Monetary Policy*, Federal Reserve Bank of Kansas City, 329–68.
- EICHENGREEN, B. AND R. HAUSMANN, eds. (2005): *Other People’s Money: Debt Denomination And Financial Instability In Emerging Market Economies*, University of Chicago Press.
- EICHENGREEN, B. AND A. MODY (1998): “What explains changing spreads on emerging-market debt: fundamentals or market sentiment?” *National Bureau of Economic Research Working Paper*.
- ENGLISH, W. B. (1996): “Understanding the costs of sovereign default: American state debts in the 1840’s,” *The American Economic Review*, 259–275.
- FLETCHER, D. J. AND L. W. TAYLOR (1994): “A non-parametric analysis of covered interest parity in long-date capital markets,” *Journal of International Money and Finance*, 13, 459–475.
- (1996): “Swap Covered Interest Parity in Long-Date Capital Markets,” *Review of Economics and Statistics*, 78, 530–538.
- FRANKEL, J. A. (2005): “Contractionary currency crashes in developing countries,” *National Bureau of Economic Research Working Paper*.
- (2010): “Monetary policy in emerging markets: A survey,” in *Handbook of Monetary Economics*, ed. by B. Friedman and M. Woodford, vol. 3B, 14–39.

- GABAIX, X. AND M. MAGGIORI (forthcoming): “International Liquidity and Exchange Rate Dynamics,” *Quarterly Journal of Economics*.
- GALINDO, A., U. PANIZZA, AND F. SCHIANTARELLI (2003): “Debt composition and balance sheet effects of currency depreciation: a summary of the micro evidence,” *Emerging Markets Review*, 4, 330–339.
- GARCIA, M. AND A. LOWENKRON (2005): “Cousin Risks: The Extent and the Causes of Positive Correlation between Country and Currency risks,” *Working Paper, PUC-Rio*.
- GELOS, R. G., R. SAHAY, AND G. SANDLERIS (2011): “Sovereign borrowing by developing countries: What determines market access?” *Journal of International Economics*, 83, 243–254.
- GELPERN, A. (2014a): “After Argentina,” Credit Slips Blog.
- (2014b): “Argentina: The RUFO Crazy,” Credit Slips Blog.
- GENNAIOLI, N., A. MARTIN, AND S. ROSSI (2013): “Banks, government bonds, and default: what do the data say?” .
- (2014): “Sovereign default, domestic banks, and financial institutions,” *The Journal of Finance*, 69, 819–866.
- GERTLER, M., S. GILCHRIST, AND F. M. NATALUCCI (2007): “External constraints on monetary policy and the financial accelerator,” *Journal of Money, Credit and Banking*, 39, 295–330.
- GERTLER, M. AND P. KARADI (2011): “A model of unconventional monetary policy,” *Journal of monetary Economics*, 58, 17–34.
- GOLDBERG, L. S. AND C. TILLE (2008): “Vehicle currency use in international trade,” *Journal of International Economics*, 76, 177–192.

- GOPINATH, G., O. ITSKHOKI, AND R. RIGOBON (2010): “Currency choice and exchange rate pass-through,” *American Economic Review*, 304–336.
- GORODNICHENKO, Y. AND M. WEBER (2013): “Are sticky prices costly? Evidence from the stock market,” *National Bureau of Economic Research Working Paper*.
- GREENWOOD, R. AND D. VAYANOS (2014): “Bond Supply and Excess Bond returns,” *Review of Financial Studies*, 27, 663–713.
- GRIFFIN, J. M. AND R. M. STULZ (2001): “International competition and exchange rate shocks: a cross-country industry analysis of stock returns,” *Review of Financial Studies*, 14, 215–241.
- GRIFFOLI, T. M. AND A. RANALDO (2011): “Limits to Arbitrage During the Crisis: Funding Liquidity Constraints and Covered Interest Parity,” *Working Paper*.
- GROMB, D. AND D. VAYANOS (2002): “Equilibrium and welfare in markets with financially constrained arbitrageurs,” *Journal of Financial Economics*, 66, 361–407.
- GULATI, G. M. AND K. N. KLEE (2001): “Sovereign piracy,” *The Business Lawyer*, 635–651.
- GURKAYNAK, R. S., B. SACK, AND J. H. WRIGHT (2007): “The U.S. Treasury Yield Curve: 1961 to the Present,” *Journal of Monetary Economics*, 54, 2291–2304.
- HATCHONDO, J. C. AND L. MARTINEZ (2009): “Long-duration bonds and sovereign defaults,” *Journal of International Economics*, 79, 117–125.
- HATCHONDO, J. C., L. MARTINEZ, AND H. SAPRIZA (2009): “Heterogeneous Borrowers in Quantitative Models of Sovereign Default,” *International Economic Review*, 50, 1129–1151.
- (2010): “Quantitative properties of sovereign default models: solution methods matter,” *Review of Economic Dynamics*, 13, 919–933.

- HATCHONDO, J. C., L. MARTINEZ, AND C. SOSA PADILLA (2014): “Voluntary sovereign debt exchanges,” *Journal of Monetary Economics*, 61, 32–50.
- HAU, H. AND H. REY (2006): “Exchange Rates, Equity Prices, and Capital Flows,” *Review of Financial Studies*, 19, 273–317.
- HEBERT, B. AND J. SCHREGER (2014): “The Costs of Sovereign Default: Evidence from Argentina,” *Working Paper, Harvard University*.
- (2010b): “Determinants of sovereign risk: Macroeconomic fundamentals and the pricing of sovereign debt,” *Review of Finance*, 235–262.
- HORNBECK, J. (2013): “Argentina’s Defaulted Sovereign Debt: Dealing with the ‘Holdouts’,” *Congressional Research Service*.
- HOROWITZ, J. L. (2001): “The bootstrap,” *Handbook of econometrics*, 5, 3159–3228.
- ISDA (2012): “Credit Derivative Physical Settlement Matrix,” *International Swaps and Derivatives Association*.
- IVASHINA, V., D. SCHARFSTEIN, AND J. STEIN (forthcoming): “Dollar Funding and the Lending Behavior of Global Banks,” *Quarterly Journal of Economics*.
- JANKOWITSCH, R. AND P. STEFAN (2005): “Currency dependence of corporate credit spreads,” *Journal of Risk*, 8, 1–24.
- JEANNERET, A. AND S. SOUISSI (2014): “Sovereign Defaults by Currency Denomination,” *Working Paper*.
- (2009): “How do exchange rate regimes affect firms’ incentives to hedge currency risk in emerging markets?” *International Monetary Fund Working Paper*.
- KEDIA, S. AND A. MOZUMDAR (2003): “Foreign currency-denominated debt: An empirical examination,” *The Journal of Business*, 76, 521–546.



- KHUONG-HUU, P. (1999): “The Price of Credit,” *Risk*, 68–71.
- KORINEK, A. (2010): “Excessive dollar borrowing in emerging markets: Balance sheet effects and macroeconomic externalities,” *Available at SSRN 967524*.
- KRUGMAN, P. (1999): “Balance Sheets, the Transfer Problem, and Financial Crises,” *International Tax and Public Finance*, 6, 459–472.
- KUMARA, A. S. AND W. D. PFAU (2011): “Would emerging market pension funds benefit from international diversification,” *Annals of Finance*, 1–17.
- KUTTNER, K. N. (2001): “Monetary policy surprises and interest rates: Evidence from the Fed funds futures market,” *Journal of monetary economics*, 47, 523–544.
- LANE, P. R. AND J. C. SHAMBAUGH (2010): “Financial exchange rates and international currency exposures,” *The American Economic Review*, 518–540.
- LEE, M. (2007): “Bloomberg Fair Value Market Curves,” in *International Bond Market Conference, Taipei*.
- LETTAU, M., M. MAGGIORI, AND M. WEBER (2014): “Conditional Risk Premia in Currency Markets and Other Asset Classes,” *Journal of Financial Economics*, 14, 197–225.
- LONGSTAFF, F. A., J. PAN, L. H. PEDERSEN, AND K. J. SINGLETON (2011a): “How Sovereign Is Sovereign Credit Risk?” *American Economic Journal: Macroeconomics*, 3, 75–103.
- (2011b): “How Sovereign is Sovieregn Credit Risk?” *American Economic Journal: Macroeconomics*, 3, 75–103.
- LORENZONI, G. AND I. WERNING (2013): “Slow Moving Debt Crises,” *NBER Working Paper*.

- (2014): “Countercyclical Currency Risk Premia,” *Journal of Financial Economics*, 111, 527–553.
- LUSTIG, H. AND A. VERDELHAN (2007): “The Cross Section of Foreign Currency Risk Premia and Consumption Growth Risk,” *American Economic Review*, 97, 89–117.
- MANO, R. (2013): “Exchange Rates Upon Sovereign Defaults,” *Working Paper*.
- MCBRADY, M. R. AND M. J. SCHILL (2007): “Foreign currency-denominated borrowing in the absence of operating incentives,” *Journal of Financial Economics*, 86, 145–177.
- MENDOZA, E. G. AND V. Z. YUE (2012a): “A general equilibrium model of sovereign default and business cycles,” *The Quarterly Journal of Economics*, 127, 889–946.
- (2012b): “A general equilibrium model of sovereign default and business cycles,” *Quarterly Journal of Economics*, 127.
- MICHAUX, M. (2012): “Trade, Exchange Rate Exposure, and the Currency Composition of Debt,” *AFA Denver Meetings Paper*.
- MILLER, E. (1977): “Risk, Uncertainty, and Divergence of Opinion,” *Journal of Finance*, 32, 1151–1168.
- MOODY’S (2014): “Sovereign Default and Recovery Rates, 1983-2013,” *Moody’s Investors Service Credit Policy*.
- NA, S., S. SCHMITT-GROHÉ, M. URIBE, AND V. Z. YUE (2014): “A Model of the Twin Ds: Optimal Default and Devaluation,” Tech. rep., National Bureau of Economic Research.
- NELSON, C. AND A. SIEGEL (1987): “Parsimonious Modeling of Yield Curves,” *Journal of Business*, 60, 473–489.
- OLIVARES-CAMINAL, R. (2013): “The pari passu clause in sovereign debt instruments: developments in recent litigation,” *Panel 1–Policy panel*, 121.

- (2008b): “Default and recovery implicit in the term structure of sovereign CDS spreads,” *The Journal of Finance*, 63, 2345–2384.
- PANIZZA, U., F. STURZENEGGER, AND J. ZETTELMEYER (2009): “The economics and law of sovereign debt and default,” *Journal of Economic Literature*, 651–698.
- PEREZ, D. J. (2014): “Sovereign Debt, Domestic Banks and the Provision Of Public Liquidity,” *Manuscript, Stanford University*.
- POPPER, H. (1993): “Long-term covered interest parity: evidence from currency swaps,” *Journal of International Money and Finance*, 12, 439–448.
- REINHART, C. M. AND K. S. ROGOFF (2008): *This Time is Different: Eight Centuries of Financial Folly*, Princeton University Press.
- (2011): “The Forgotten History of Domestic Debt,” *The Economic Journal*, 121, 319–350.
- RIGOBON, R. (2003): “Identification through heteroskedasticity,” *Review of Economics and Statistics*, 85, 777–792.
- RIGOBON, R. AND B. SACK (2004): “The impact of monetary policy on asset prices,” *Journal of Monetary Economics*, 51, 1553–1575.
- ROSE, A. K. (2005): “One reason countries pay their debts: renegotiation and international trade,” *Journal of development economics*, 77, 189–206.
- (2006): “Size really doesn’t matter: In search of a national scale effect,” *Journal of the Japanese and International Economies*, 20, 482–507.
- SALOMAO, J. (2013): “Sovereign Debt Renegotiation and Credit Default Swaps,” *Working Paper*.

- SCHUMACHER, J., C. TREBESCH, AND H. ENDERLEIN (2014): “Sovereign defaults in court,” *Available at SSRN 2189997*.
- SHLEIFER, A. AND R. VISHNY (1997): “The Limits of Arbitrage,” *Journal of Finance*, 52, 35–55.
- STANDARD AND POOR’S (2014a): “Argentine Nonsovereign Entities Ratings Unaffected Following The Sovereign’s Downgrade,” Tech. rep., Ratings Direct.
- (2014b): “Several Rating Actions Taken On 13 Argentine Companies; Off Watch Negative; Outlook Negative,” Tech. rep., Ratings Direct.
- STANDARD & POOR’S (2014): “Sovereign Defaults and Rating Transition Data, 2013 Update,” *Standard Poor’s Ratings Direct*.
- STOCK, J. H. AND M. YOGO (2005): “Testing for weak instruments in linear IV regression,” *Identification and inference for econometric models: Essays in honor of Thomas Rothenberg*, 1.
- SUNDER-PLOSSMANN, L. (2013): “Inflation, default, and the denomination of sovereign debt,” *Working Paper*.
- TAUCHEN, G. (1986): “Finite state markov-chain approximations to univariate and vector autoregressions,” *Economics letters*, 20, 177–181.
- TOMZ, M. (2007): *Reputation and international cooperation: sovereign debt across three centuries*, Princeton University Press.
- URIBE, M. AND V. Z. YUE (2006): “Country spreads and emerging countries: Who drives whom?” *Journal of international Economics*, 69, 6–36.
- VOGELSANG, T. J. (2012): “Heteroskedasticity, autocorrelation, and spatial correlation robust inference in linear panel models with fixed-effects,” *Journal of Econometrics*, 166, 303–319.

- WHITE, R. (2013): “The Pricing and Risk Management of Credit Default Swaps, with a Focus on the ISDA Model,” *OpenGamma Quantitative Research*.
- YEYATI, E. L. AND U. PANIZZA (2011): “The elusive costs of sovereign defaults,” *Journal of Development Economics*, 94, 95–105.
- YUE, V. Z. (2010): “Sovereign default and debt renegotiation,” *Journal of international Economics*, 80, 176–187.
- ZYMEK, R. (2012): “Sovereign default, international lending, and trade,” *IMF Economic Review*, 60, 365–394.

## 5 Appendix

### 5.1 Appendix: Local Currency Sovereign Risk

#### 5.1.1 FX Hedging Error for a Swapped LC bond

In this section, we show that the pricing impact of the FX hedging error associated with the swapped LC bond in Figure 4 is exactly equal to the quanto adjustment  $-q_t = -\frac{cov_t^{\mathbb{Q}^S}(1-L_{t+1}, 1/\mathcal{E}_{t+1})}{\mathbb{E}_t^{\mathbb{Q}^S}(1-L_{t+1})\mathbb{E}_t^{\mathbb{Q}^S}(1/\mathcal{E}_{t+1})}$ . We let  $L_{t+1}$  denote default loss at time  $t+1$ , such that  $L_{t+1} = 0$  in the repayment state, and  $L_{t+1} = \delta_{t+1}$  in the default state. The price of the swapped LC bond is given by (the hedging error term is highlighted in blue):

$$\begin{aligned}
\frac{P_t^{LC}}{\mathcal{E}_t} F_{t,t+1} &= \exp(-y_t^{*\$}) \mathbb{E}_t^{\mathbb{Q}^S} \left[ 1 - L_{t+1} + L_{t+1} \left( 1 - \frac{F_{t+1}}{\mathcal{E}_{t+1}} \right) \right] \\
&= \exp(-y_t^{*\$}) \left\{ \mathbb{E}_t^{\mathbb{Q}^S}(1 - L_{t+1}) + \mathbb{E}_t^{\mathbb{Q}^S}[L_{t+1} - L_{t+1}F_{t+1}/\mathcal{E}_{t+1}] \right\} \\
&= \exp(-y_t^{*\$}) \mathbb{E}_t^{\mathbb{Q}^S}(1 - L_{t+1}) \left[ 1 + \frac{\mathbb{E}_t^{\mathbb{Q}^S}[L_{t+1}/F_{t+1} - L_{t+1}/\mathcal{E}_{t+1}]}{\mathbb{E}_t^{\mathbb{Q}^S}(1 - L_{t+1})/F_{t+1}} \right] \\
&= \exp(-y_t^{*\$}) \mathbb{E}_t^{\mathbb{Q}^S}(1 - L_{t+1}) \left\{ 1 + \frac{\mathbb{E}_t^{\mathbb{Q}^S}[(1 - L_{t+1})/\mathcal{E}_{t+1}] - \mathbb{E}_t^{\mathbb{Q}^S}(1 - L_t)\mathbb{E}(1/\mathcal{E}_t)}{\mathbb{E}_t^{\mathbb{Q}^S}(1 - L_{t+1})\mathbb{E}_t^{\mathbb{Q}^S}(1/\mathcal{E}_{t+1})} \right\} \\
&= \exp(-y_t^{*\$}) \mathbb{E}_t^{\mathbb{Q}^S}(1 - L_{t+1}) \left\{ 1 + \frac{Cov_t^{\mathbb{Q}^S}(1 - L_{t+1}, 1/\mathcal{E}_{t+1})}{\mathbb{E}_t^{\mathbb{Q}^S}(1 - L_{t+1})\mathbb{E}_t^{\mathbb{Q}^S}(1/\mathcal{E}_{t+1})} \right\} \\
&= \exp(-y_t^{*\$}) \mathbb{E}_t^{\mathbb{Q}^S}(1 - L_{t+1})(1 + q_t)
\end{aligned}$$

Therefore, we have

$$y_t^{LC} - \rho_t = y_t^{*\$} + \mathbb{E}_t^{\mathbb{Q}^S} L_{t+1} - q_t.$$

The impact of the hedging error is given by  $-q_t$ . The LC credit spread is equal to

$$s_t^{LCCS} = (y_t^{LC} - \rho) - y_t^{\$} = \mathbb{E}_t^{\mathbb{Q}^S} L_{t+1} - q_t.$$

### 5.1.2 Yield Curve Construction

Zero-coupon LC and FC yield curves for our sample countries are obtained or constructed from three main sources.<sup>127</sup> 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 (Nelson and Siegel, 1987 and 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 sovereign bonds for our sample countries. LC curve estimation follows the Diebold and Li (2006) formulation of Nelson and Siegel (1987). The FC curve is estimated based on individual bond yields in the U.S. dollar and synthetic dollar yields for bonds denominated in the euro, yen, and British pound. The vast majority of our FC bonds in the sample are denominated in the U.S. dollar. In the case of FC bonds denominated in other currencies, the CCS is used to compute the synthetic dollar yield. 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 with over-extrapolation. When the Bloomberg BFV curves exist, our estimated yield curves track them very closely. 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

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<sup>127</sup>Full details on LC and FC yield curve construction are given in Table 27.

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.

A spreadsheet with Bloomberg tickers for BFV curves and interest rate swaps and the CCS used in the construction of our LC credit spread measures is posted online. The readers can use these tickers to obtain real-time LC credit spread measures. We include a few more countries outside our 10 sample countries (Thailand, Malaysia, South Africa and South Korea), which have well developed LC bond and swap markets, but not a liquid FC sovereign debt market.

### **5.1.3 CIP Deviations for Supranationals**

The standard test of the CIP based on unsecured interbank rates or government bond yields in emerging markets and the United States is potentially invalid because of higher credit risk associated with emerging market interbank panels and sovereigns. Instead, we measure the CIP deviation as the difference between synthetic dollar yield of borrowing in the emerging market currency and the direct dollar borrowing cost in dollars for an AAA-rated supranational issuer. As in Section 1.3.4, we chose the Turkish lira and the Brazilian real because of frequent supranational issuance. However, we note that, as in our LC and FC bond comparison, the supranational bonds denominated in different currencies may have differential liquidity and clientele demand. During the crisis, we expect liquidity and clientele demand to become more favorable towards dollar-denominated bonds, so the CIP deviation for supranationals could potentially over-estimate no-arbitrage violations in the currency markets.

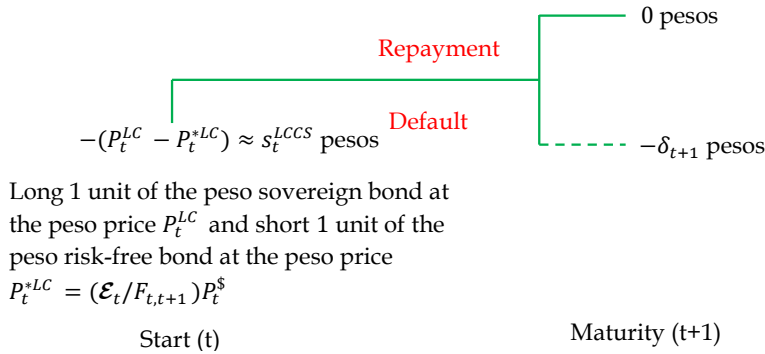
The left panel in Figure 28 plots LC credit spreads for Turkey and CIP deviations for the EIB to borrow in the lira and the dollar. The right panel in Figure 28 plots LC credit spreads for Brazil and CIP deviations for the KfW to borrow in the real and the dollar. We can see that the CIP does not hold exactly for KfW and EIB, but the deviations are smaller in size compared to the LC credit spreads. The mean CIP deviation for supranational yields is -10



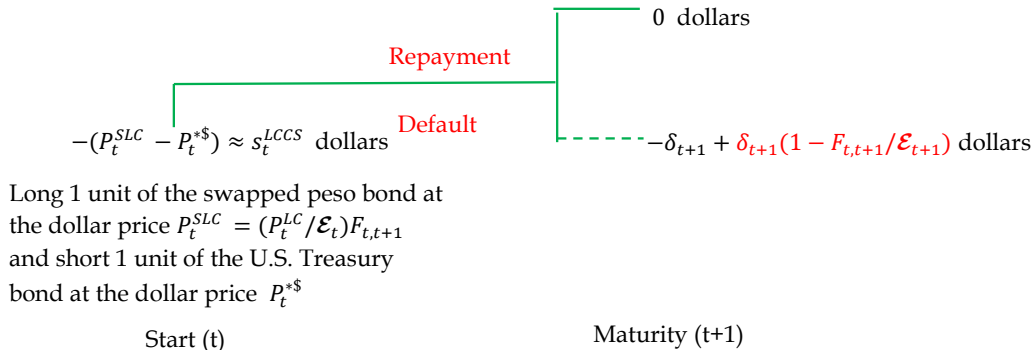
basis points for the lira and 25 basis points for the real. During the peak of the Lehman Brothers crisis and the European debt crisis, the CIP deviation for supranationals only accounts for less than 10 percent of the Turkish LC credit spread, but about 50 percent of the Brazilian LC credit spread. Therefore, violations of the long-term no-arbitrage conditions in the FX markets can be important for non-deliverable currencies, such as the Brazilian real, but cannot fully explain away the existence of a positive LC credit spread.

Figure 27: Cash Flow Illustration of the LC Credit Spread Under LC and Dollar Measures

(a) Net cash flows for trading  $s_t^{LCCS}$  under the LC measure

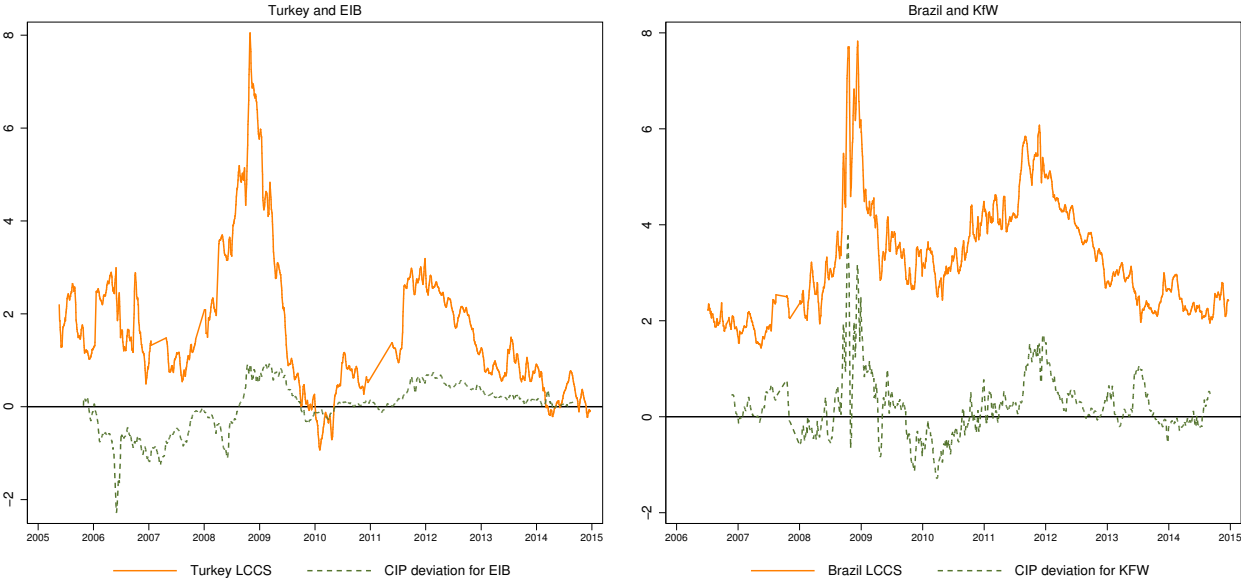


(b) Net cash flows for trading  $s_t^{LCCS}$  under the dollar measure



*Notes:* This figure summarizes the net cash flows on two trading strategies based on the LC credit spread. In Figure (a), under the LC measure, at time  $t$ , the investor goes long in one unit of the peso sovereign bond at the peso price  $P_t^{LC}$  and goes short in one unit of the peso risk-free bond at the peso price  $P_t^{*LC} = (\mathcal{E}_t/F_{t,t+1})P_t^{\$}$ . Thus, the investor receives  $s_t^{LCCS}$  pesos on net at time  $t$ . At time  $t + 1$ , if the Mexican government repays, there are zero net payments; if the Mexican government defaults, the investor suffers a default loss equal to  $\delta_{t+1}$  pesos. In Figure (b), under the dollar measure, at time  $t$ , the investor goes long in one unit of the swapped peso sovereign bond at the dollar price  $P_t^{SLC} = (P_t^{LC}/\mathcal{E}_t)F_{t,t+1}$  and goes short in one unit of the U.S. Treasury bond at the dollar price  $P_t^{*\$}$ . Thus, the investor receives  $s_t^{LCCS}$  dollars on net at time  $t$ . At time  $t + 1$ , if the Mexican government repays, there are zero net payments; if the Mexican government defaults, the investor suffers a default loss equal to  $\delta_{t+1}$  dollars and receives additional cash flows by unwinding the swap with unmatched LC cash flows,  $\delta_{t+1}(1 - F_{t,t+1}/\mathcal{E}_{t+1})$  dollars.

Figure 28: LC Credit Spreads and CIP Deviations for Supranationals (percentage points)



*Notes:* The left figure plots the 5-year zero-coupon LC credit spread for Turkey and the CIP deviation between lira- and dollar-denominated bonds issued by the EIB (the synthetic dollar yield of a lira-denominated bond minus the the yield on a dollar-denominated bond issued by the EIB). The right figure plots the 5-year zero-coupon LC credit spread for Brazil and the CIP deviation between real- and dollar-denominated bonds issued by the KfW (the synthetic dollar yield of a real-denominated bond minus the the yield on a dollar-denominated bond issued by the KfW). We use 10-day moving averages for all series.

Table 25: Liquidity Measures of Bond and Swap Markets

Country	(1) LC ba	(2) FC ba	(3) CCS ba	(4) LC Vol. (\$bln)	(5) FC Vol. (\$bln)	(6) CCS (\$bln)	(7) LC Turnover (%)	(8) FC Turnover (%)
Brazil*	0.10 (0.08)	0.15 (0.06)	0.69 (0.24)	146.45 (38.5)	104.31 (84.2)	4.66	15.53 (4.70)	188.35 (140.)
Colombia*	0.08 (0.07)	0.18 (0.07)	0.31 (0.13)	17.86 (8.91)	10.96 (3.42)	0.77	27.45 (12.4)	63.95 (21.8)
Hungary	0.12 (0.06)	0.20 (0.16)	0.32 (0.16)	18.14 (8.84)	7.36 (3.76)	10.38	33.01 (17.4)	33.51 (18.8)
Indonesia*	0.18 (0.07)	0.17 (0.17)	0.82 (0.57)	9.00 (4.50)	12.31 (6.31)	0.17	12.34 (7.01)	95.48 (66.0)
Israel*	0.04 (0.02)	0.10 (0.07)	0.24 (0.06)	9.71 (7.57)	3.49 (2.07)	1.18	10.46 (7.76)	35.20 (20.9)
Mexico	0.08 (0.07)	0.15 (0.06)	0.12 (0.07)	168.18 (98.0)	45.24 (18.8)	12.39	84.31 (74.5)	99.70 (44.1)
Peru*	0.12 (0.04)	0.17 (0.08)	0.36 (0.08)	1.98 (1.70)	6.19 (2.27)	0.32	23.94 (21.4)	62.08 (31.4)
Philippines*	0.20 (0.06)	0.13 (0.05)	0.58 (0.19)	2.75 (1.90)	15.69 (5.48)	0.04	4.64 (2.89)	64.10 (25.2)
Poland	0.07 (0.02)	0.10 (0.04)	0.21 (0.13)	56.67 (19.7)	13.02 (6.90)	4.18	41.34 (18.5)	29.13 (25.4)
Turkey	0.11 (0.06)	0.10 (0.01)	0.20 (0.11)	68.87 (23.8)	30.47 (13.4)	58.15	34.78 (12.8)	76.50 (47.4)
Mean	0.11 (0.07)	0.15 (0.10)	0.38 (0.32)	49.05 (66.4)	25.00 (40.5)	9.22	28.37 (33.2)	75.41 (71.9)

*Notes:* This table reports mean and standard deviation of various liquidity measures of bond and swap markets. Columns 1-3 report the mean bid-ask spread on LC bonds, FC bonds and currency swaps in the monthly sample. The bid-ask spreads for LC and FC bonds are computed as the mean of all daily bid-ask spreads on all LC and FC bonds with remaining maturity between 2 to 10 years in percentage points. Columns 4-5 summarize quarterly trading volume for LC and FC bonds provided in Debt Trading Volume Surveys conducted by Emerging Market Trading Association from 2005 to 2014. Column 6 reports average swap trading volume from aggregating individual transaction data posted on Bloomberg Swap Depository Reporting for 2013. Columns 7-8 divide the trading volume by the amount debt outstanding from the BIS data to compute the turnover ratios. The asterisk denotes that the country has non-deliverable swaps.

Table 26: Summary Statistics for Emerging Market Sovereign Debt Lending (2012-2014)

Country	(1)		(2)		(3)		(4)	
	Debt (\$b)		Inventory (\$b)		Lending (\$b)		Fee (bps)	
	LC	FC	LC	FC	LC	FC	LC	FC
Brazil	1330.75 (59.3)	55.93 (4.36)	9.71 (15.3)	5.11 (0.44)	0.098 (0.055)	0.786 (0.287)	50.2 (74.4)	18.3 (15.1)
Colombia	90.60 (4.96)	21.33 (1.47)	0.92 (0.14)	3.57 (0.48)	0.026 (0.019)	0.373 (0.106)	20.4 (11.1)	15.0 (9.23)
Hungary	58.97 (7.38)	26.21 (2.22)	1.66 (0.15)	2.19 (0.67)	0.315 (0.062)	0.473 (0.208)	18.7 (6.00)	25.7 (13.3)
Indonesia	97.66 (12.6)	31.35 (3.30)	0.24 (0.26)	4.69 (0.65)	0.000 (0)	0.623 (0.103)	N/A (N/A)	16.9 (11.1)
Israel	126.46 (13.2)	13.14 (1.10)	0.08 (0.04)	2.29 (0.19)	0.000 (0.000)	0.121 (0.035)	21.0 (N/A)	37.8 (54.1)
Mexico	359.95 (37.5)	52.07 (3.46)	3.24 (2.74)	6.32 (0.67)	0.000 (0.000)	0.687 (0.220)	26.3 (11.8)	21.0 (18.5)
Peru	12.63 (0.57)	14.40 (0.13)	0.33 (0.56)	2.54 (0.22)	0.002 (0.002)	0.244 (0.062)	51.5 (22.9)	12.0 (4.21)
Philippines	80.98 (5.34)	28.44 (0.62)	0.94 (0.40)	2.68 (0.28)	0.001 (0.001)	0.287 (0.070)	20.0 (21.8)	19.9 (16.2)
Poland	165.62 (13.3)	66.30 (2.82)	4.37 (1.97)	5.26 (0.59)	0.307 (0.109)	0.742 (0.216)	19.0 (27.3)	24.7 (16.5)
Turkey	204.27 (11.7)	55.86 (3.97)	1.58 (0.46)	5.26 (0.67)	0.002 (0.005)	0.391 (0.265)	48.3 (27.5)	19.3 (16.7)
Mean	251.93 (371.5)	36.50 (18.5)	2.31 (5.54)	3.99 (1.52)	0.075 (0.129)	0.472 (0.277)	30.6 (31.8)	21.0 (20.9)

*Notes:* This table reports mean and standard deviation for emerging market sovereign debt lending activities between 2012 and 2014. Column 1 reports average quarterly debt outstanding by currency based on BIS Debt Securities Statistics. Columns 2-4 use quarter-end data from Markit Securities Finance. Column 2 reports average daily inventory of total lendable sovereign debt securities in billions of dollars. Column 3 reports average amounts of loans outstanding in billions of dollars. Column 4 reports average lending fees across securities. For Indonesia, no actual loans are observed, so the fees cannot be calculated. For Israel, we only observe the fee for one security, so the standard deviation cannot be calculated.

Table 27: Data Sources and Variable Construction

<i>Country</i>	<i>Curve Currency</i>	<i>Zero-Coupon Curve Type</i>	<i>Yield Data Source</i>
Brazil	LC	Svensson	Brazilian Financial and Capital Market Associations (ANBIMA)
	FC	Nelson-Siegel	Bloomberg Fair Value par to zero
Colombia	LC and 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 and 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 PDEX
	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
<i>Variable</i>		<i>Data Source</i>	<i>Description</i>
<i>CDS</i>		Bloomberg	Sovereign credit default swaps at various tenors denominated in dollars.
<i>lc eq vol</i>		Datastream	Backward-looking local equity volatility (30 days)
<i>BBB/T</i>		Datastream	Merrill-Lynch BBB U.S. corporate bond spread over the 10-year U.S. Treasury yield
<i>CFNAI</i>		Chicago Fed	Chicago Fed National Activity Index
<i>VIX</i>		WRDS	Implied volatility on S&P index options.
$\Delta IP$		Haver	Year-over-year log changes in the industrial production index.
<i>LC and FC Debt/GDP</i>		BIS	LC and FC debt to GDP ratio
$\Delta CPI$		Haver	Year-over-year log changes in the consumer price index.
<i>ToT</i>		Global Financial Data	Log export over import price index
$\Delta Reserve$		International Financial Statistics	Monthly log change in foreign exchange reserves.

## 5.2 Appendix: Sovereign Risk, Currency Risk, and Corporate Balance Sheets

### 5.2.1 LC Sovereign Risk

Table 28: Credit and Currency Risk in LC Sovereign Debt, 5-year bonds, 2005-2012

Country	Start	$s^{LC/US}$	$s^{LCCS}$	$\rho$
Brazil	Feb 2007	10.36	3.57	6.79
Colombia	Jun 2005	6.23	1.49	4.74
Hungary	Oct 2006	5.97	2.43	3.53
Indonesia	Jan 2005	7.10	1.30	5.80
Israel	Feb 2006	2.38	0.99	1.39
Korea	Jan 2005	2.06	1.65	0.42
Malaysia	May 2005	1.26	1.12	0.15
Mexico	Jan 2005	4.89	0.64	4.24
Peru	Jul 2006	3.83	0.91	2.92
Poland	Nov 2006	3.73	1.33	2.40
South Africa	Jan 2005	5.53	0.52	5.01
Thailand	Jan 2005	1.50	0.69	0.81
Turkey	May 2005	10.14	1.84	8.30

*Notes:* This table reports the country average nominal spread,  $s^{LC/US}$ , LC credit spread  $s^{LCCS}$ , and cross currency swap rate  $\rho$  for 13 emerging markets from 2005-2012. Start indicates the first month for which we were able to estimate a local currency sovereign yield curve and data on cross-currency swaps were available. Yield curve and cross currency swap data from Bloomberg.

### 5.2.2 Currency Composition of External Portfolios

**International Debt Securities** We obtain country-level data on international sovereign debt outstanding from the BIS debt securities statistics. The BIS defines international debt as debt issued outside the market where the borrower resides (Table 11) or the nationality of the borrower (Table 12). For sovereigns, there is no difference between the residence and nationality definitions. Source: BIS. As discussed in the text, we collect data on international LC sovereign bonds from Bloomberg and international LC bonds from Thomson.

**Domestic Sovereign Debt** In this section, we describe the data sources for foreign ownership of domestic sovereign debt.

- **Brazil:** Source: Brazilian Central Bank (direct contact). Ownership data are available at the security type level. Data on domestic debt outstanding by instruments are available. Includes foreign ownership of LFT (Financial Treasury Bills), LTN (National Treasury Bills), NTN (National Treasury Notes)
- **Colombia:** Source: Colombia Ministry of Finance (in Spanish). Only contains data only on Treasury Bonds. Ownership data are available at the security type level (i.e. fixed rate local currency and inflation-indexed). Data on domestic debt outstanding by instruments are available. Link to raw data: Source: Colombian Ministry of Finance (in Spanish)(last access: March 3, 2014).
- **Hungary:** Source: AKK – Hungarian Government Debt Management Agency. Quarterly data distinguishes between Treasury Bonds and Treasury Bills but the daily non-resident ownership data does not. Ownership data by interest rate types (i.e. fixed, floating, indexed) are not available. Links: to raw data: Data on domestic debt outstanding by instrument (last access: March 3, 2014). Non-resident ownership data (last access: March 3, 2014).
- **Indonesia:** Source: Asian Development Bank and Indonesian Central Bank. Treasury bills are not included. Ownership data by interest rate types are not available. Links to raw data: Ownership data source: Asian Development Bank Asian Bond Online (last access: March 3, 2014). Domestic debt outstanding by interest rate type from Bank of Indonesia (last access: March 3, 2014).
- **Israel:** Ownership data: Bank of Israel. Data prior to 2011 are obtained directly from central bank officials. Treasury bills are included. Ownership data by interest rate type are not available. Link to data after 2011: Bank of Israel (last access: March 3, 2014). Link to domestic debt outstanding by coupon type (excel files): 2007 data, 2008 data, 2009 data, 2010 data, 2011 data, 2012 data, 2013 data



- **Korea:** Source: Asian Development Bank. Treasury bills are not included. Domestic debt is close to 100 percent fixed coupon nominal debt but ownership data by interest rate types are not available. Link to raw data: Ownership data source: Asian Development Bank Asian Bond Online (last access: March 3, 2014).
- **Malaysia:** Source: Asian Development Bank. Treasury bills are not included. Only 3-20 year Malaysian bonds are included. Domestic debt is close to 100 percent fixed coupon nominal debt but ownership data by interest rate types are not available. Link to raw data: Ownership data source: Asian Development Bank Asian Bond Online (last access: March 3, 2014).
- **Mexico:** Source: Central Bank of Mexico. Treasury bills are included. Ownership data by interest rate types are available. Link to raw data: Central Bank of Mexico (last access: March 3, 2014).
- **Peru:** Source: Peruvian Ministry of Finance. Treasury Bonds only. Ownership data at the level of individual bond are available. Dataset created by digitizing the pie charts in the PDFs in link “Tenencia de Bonos Soberanos” (in Spanish)
- **Poland:** Source: Polish Ministry of Finance. Includes both Treasury Bonds and Treasury Bills, and foreign ownership data of bonds by interest rate type . Link to raw data: Polish Ministry of Finance( last access: March 3, 2014).
- **Russia:** Source: Russian Central Bank and Ministry of Finance. Treasury bills are included. Ownership data by interest rate types are not available. Debt outstanding by interest rate type are not available. Links to raw data: External debt of Russian Federation and Government debt outstanding from the Ministry of Finance (last access: March 3, 2014).

- **South Africa:** Source: South African Central Bank. The annual data are directly obtained from central bank officials. Ownership data by interest rate type are not available. Debt outstanding data by interest rate type are not available.
- **Thailand:** Source: Asian Development Bank. Treasury bills are included. Domestic debt is close to 100 percent fixed coupon nominal debt but ownership data by interest rate types are not available. Link to raw data: Ownership data source: Asian Development Bank Asian Bond Online (last access: March 3, 2014).
- **Turkey:** Source: Ministry of Finance. Treasury bills are included. Link to raw data: Ownership data and debt outstanding by interest rate types (last access: March 3, 2014).

### **Estimation of Non-resident Holdings of LC Corporate Debt Securities using TIC**

**Data** The Treasury International Capital (TIC) data publishes U.S. portfolio holdings of foreign securities at the annual frequency. Table A13 of the TIC data publishes the market value of U.S. holdings of foreign debt securities with maturities longer than one year, by country, sector of issuance and currency denomination. We use the updated Table 13 recently compiled by Carol Bertaut and Alexandra Tabova at the Federal Reserve Board. The updated dataset extended Table 13 back to 2003 and corrected a few errors in the public data published on the Treasury website (<http://www.treasury.gov/resource-center/data-chart-center/tic/Pages/windex.aspx>).

Given the total non-resident holdings of LC government securities  $A_{TOT}^G$  and the U.S. holdings of LC government securities in TIC  $A_{US}^G$ , we can estimate the share of the U.S. holdings in total non-resident holdings of government securities as

$$S_{US/TOT}^G = A_{US}^G / A_{TOT}^G.$$

We estimate a time-invariant  $S_{US/TOT}^G$  using the 10-year full sample. Alternatively, we can also use a time-varying share each year, which yields similar final results for the currency composition of corporate external portfolios.

To estimate the U.S. holdings of LC corporate debt securities, we assume that the share of the U.S. holdings in total non-resident holdings of EM corporate debt securities ( $S_{US/TOT}^C$ ) is the same as the share of the U.S. holdings in total non-resident holdings of EM sovereign debt securities ( $S_{US/TOT}^G$ ). Given the level of U.S. holdings of corporate LC debt securities  $A_{US,t}^C$ , we estimate the total non-resident holdings of LC EM corporate securities as

$$\hat{A}_{TOT}^{LC} = \frac{A_{US}^C}{S_{US/TOT}^C} = \frac{A_{US}^C}{(A_{US}^G/A_{TOT}^G)}.$$

### **Estimation of the Currency Composition of Cross-Border Loans using BIS LHS**

**Data** The BIS Locational Banking Statistics (LBS) provides quarterly data on cross-border financial claims and liabilities of banks resident in the BIS reporting countries. There are currently 22 BIS reporting countries for LBS, including all the major countries and offshore financial centers, such as Bermuda and Cayman Islands. Total cross-border claims of BIS reporting countries vis-a-vis an emerging market  $i$  represents the bulk of country  $i$ 's external liabilities from foreign banks.

The level of cross-border loans and deposits vis-a-vis individual emerging markets are available in Table 7A published on the BIS website<sup>128</sup>. In terms of the currency composition of the loans and deposits, the publicly available data publishes the currency breakdown of reporting banks at the aggregate level. We use the restricted version the BIS LBS, which contains more detailed data of the currency breakdown of BIS reporting banks' claims for individual counterparty location country. In particular, the BIS LBS reports cross-border loans and deposits originated by BIS reporting country banks vis-a-vis an emerging market  $i$  in five major currencies (the dollar, euro, yen, British pound, and Swiss franc) and a residual

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<sup>128</sup><http://www.bis.org/statistics/bankstats.htm>

currency category. We treat the residual currency as the LC of the emerging market, and all the major currencies as FC.

Figure 29: Currency Compositions of External Debt by Country, percentage

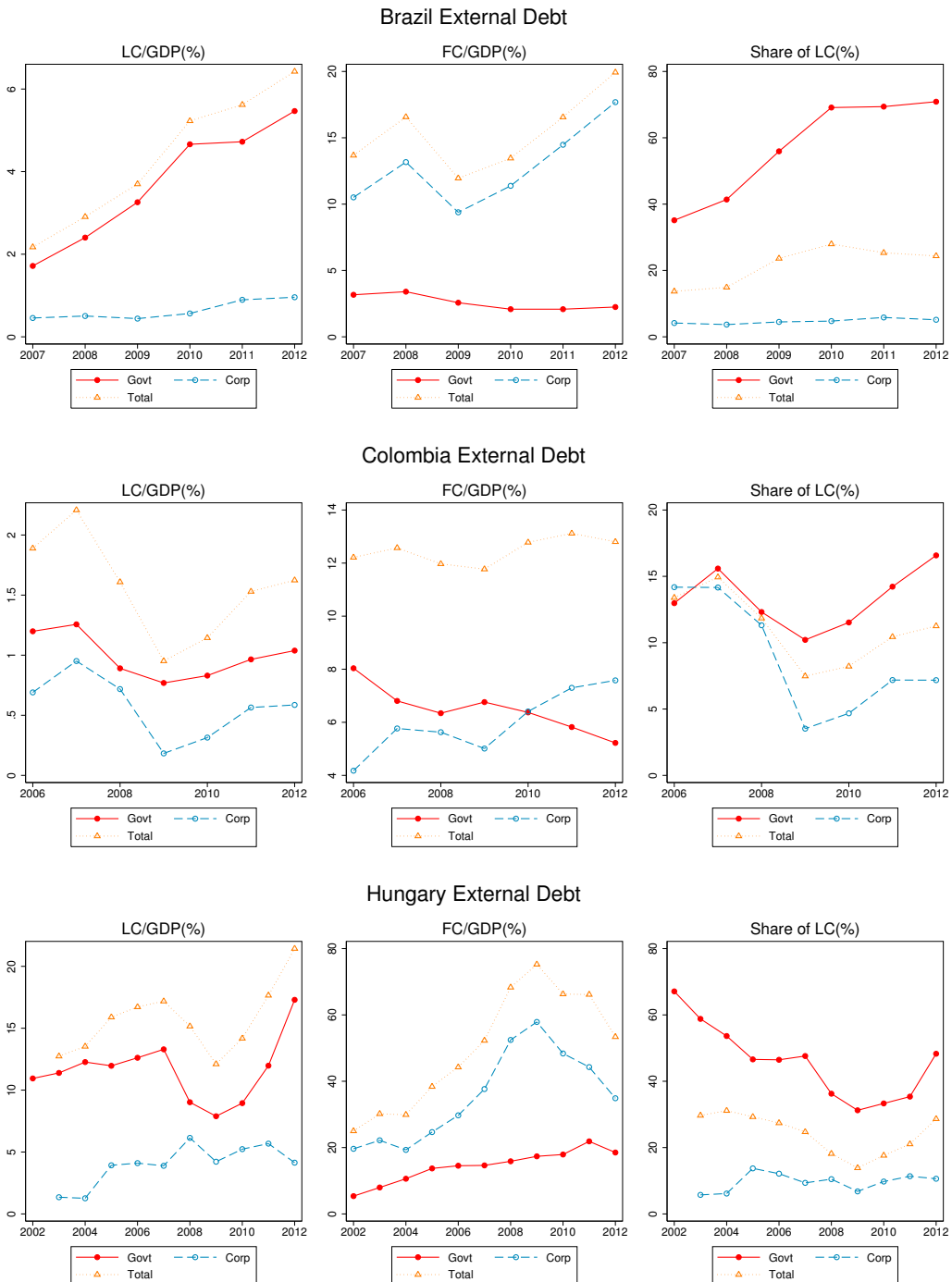
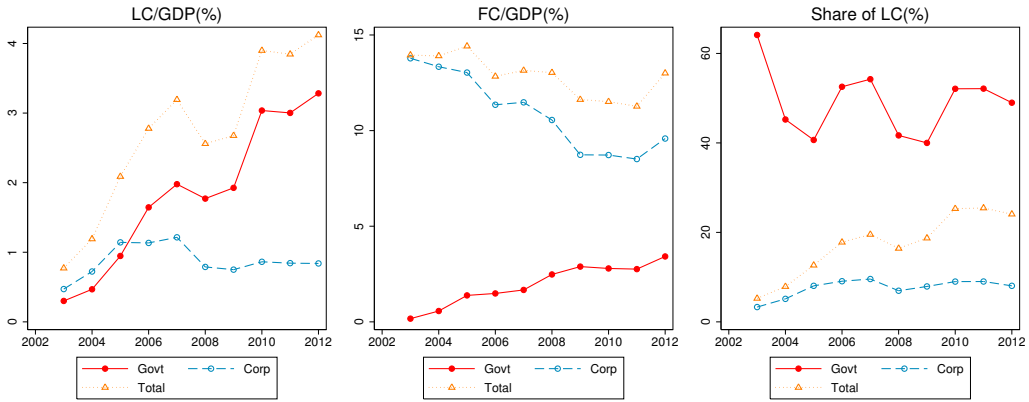
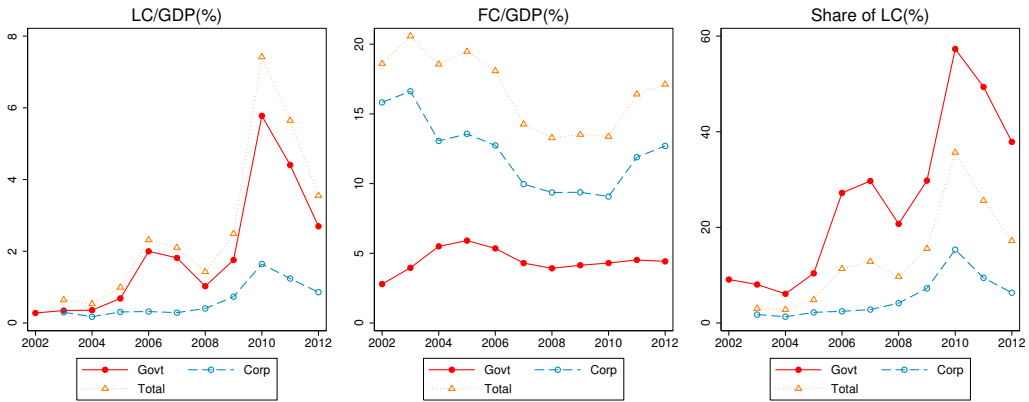


Figure 29: Sovereign debt structure by Country, percentage (continued)

Indonesia External Debt



Israel External Debt



Korea External Debt

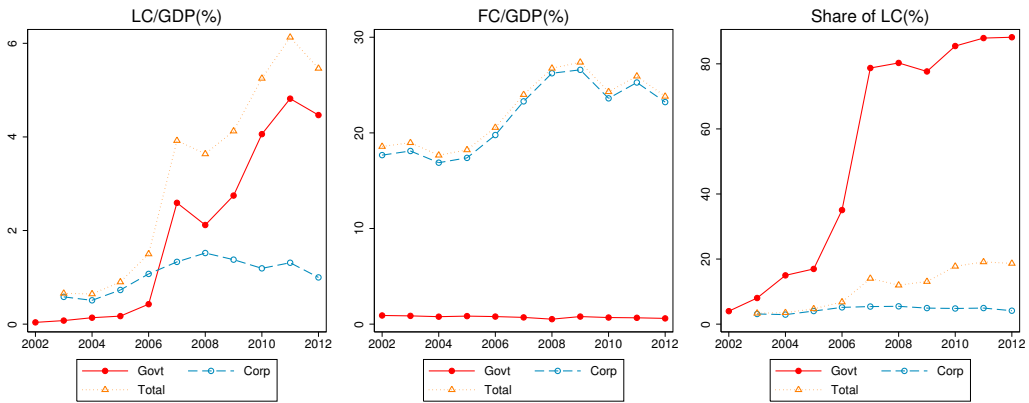
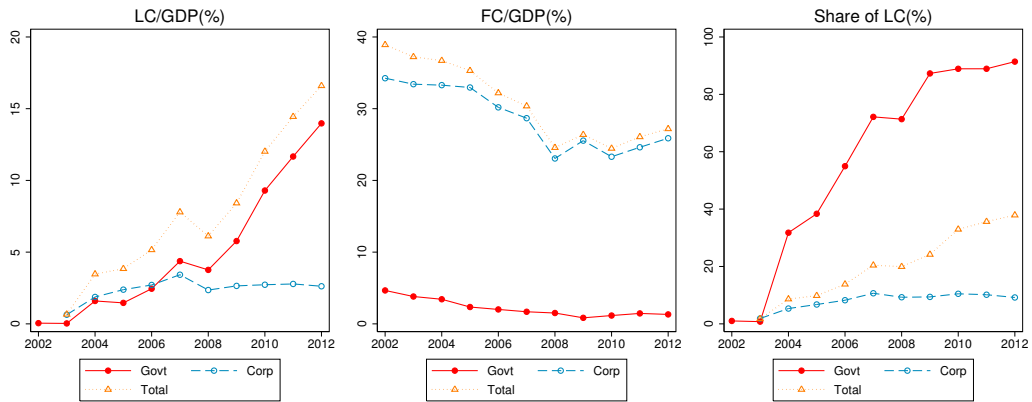
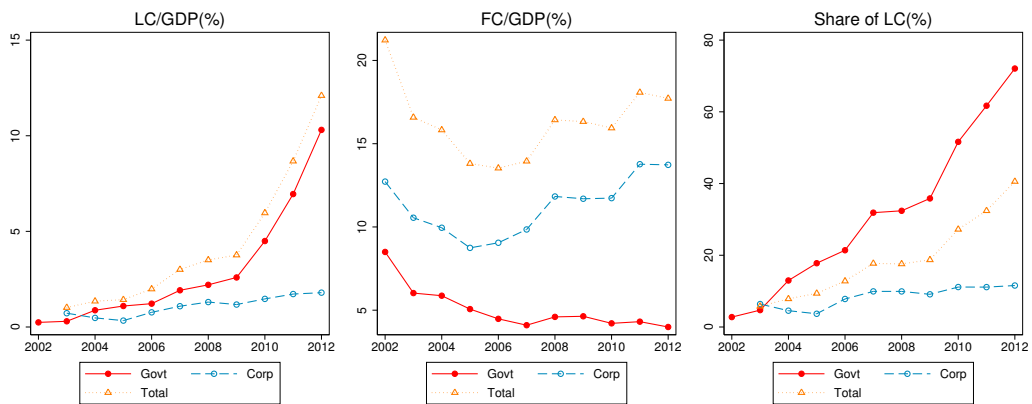


Figure 29: Sovereign debt structure by Country, percentage (continued)

Malaysia External Debt



Mexico External Debt



Peru External Debt

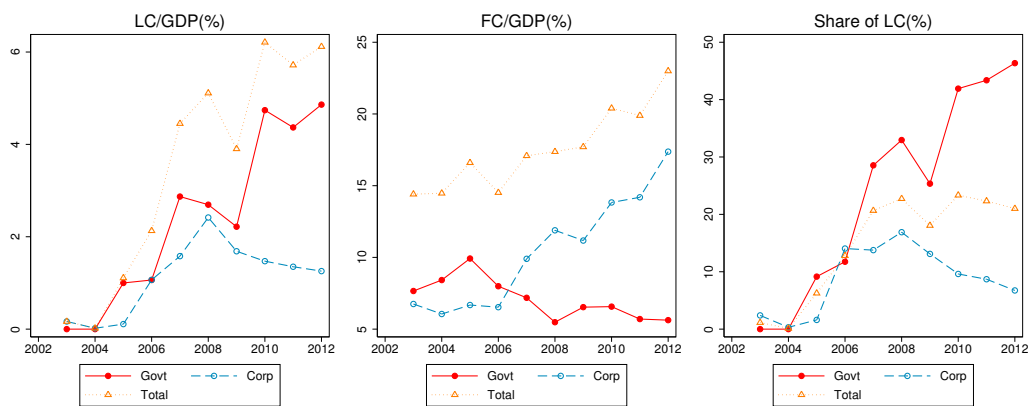


Figure 29: Sovereign debt structure by Country, percentage (continued)

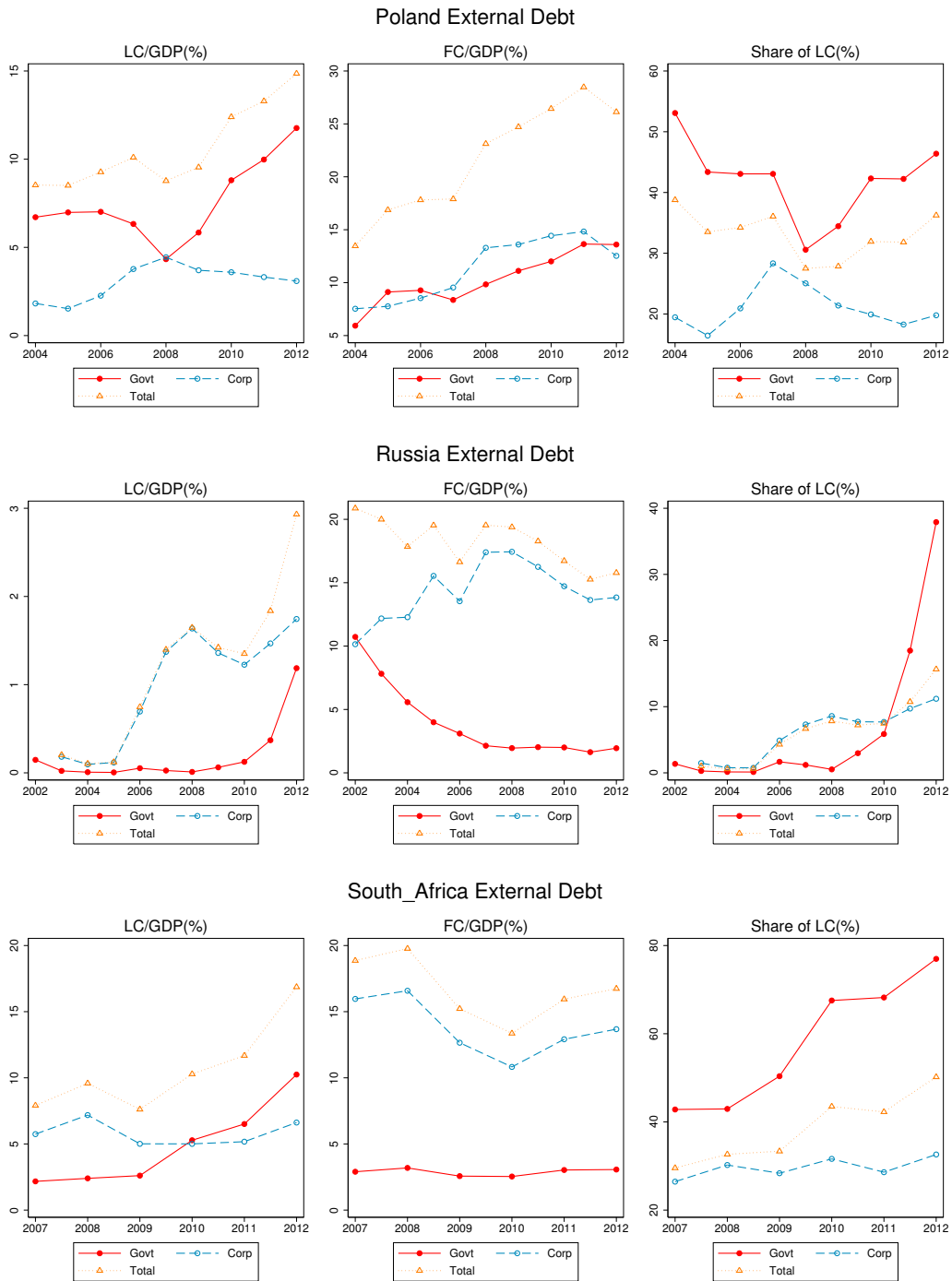
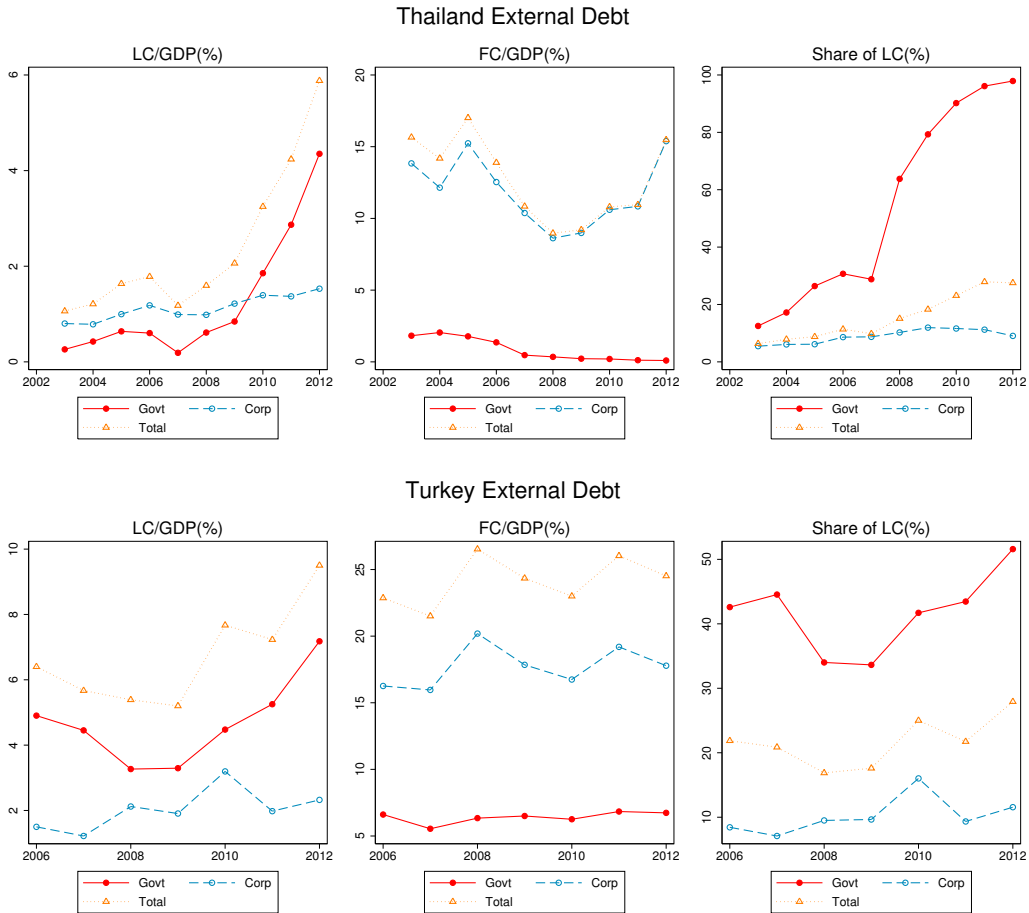


Figure 29: Sovereign debt structure by Country, percentage (continued)



*Notes:* The first panel plots the amount of local currency external debt held by non-official lenders. The middle panel, FC/GDP (%) is defined equivalently. The dotted orange line (Total) is the sum of corporate (Corp) and government (Govt) debt-to-GDP. Finally, the third panel is the share of each type of debt that is in local currency. The dotted orange line (Total) is the average of the share of corporate (Corp) and government (Govt) external debt in LC, weighted by the amount of each type of debt outstanding.

## Country-Level Currency Composition of External Debt

### 5.2.3 Mexican and Brazilian Data

The data on the currency composition of balance sheet data for Mexican firms come from Bloomberg. We began by running an equity search of all firms that list the country of risk as Brazil or Mexico. We then downloaded the balance sheet data for the every firm with an equity ticker. In particular, the key variables downloaded were “Debt in Foreign Currency” (Bloomberg Field BS\_DEBT\_INFOREIGN\_CURR), “Total Liabilities” (Bloomberg Field



BS\_TOT\_LIAB2”) and “Total Assets” (Bloomberg Field BS\_TOT\_ASSET). Our key variable of interest, the Foreign Currency Liability Ratio (“FCLR”) is then defined as the ratio of “Debt in Foreign Currency” to “Total Liabilities” or “Total Assets.” Data for Brazil is consolidated but data for Mexico is unconsolidated.

For equity returns, we used the Bloomberg field “Total Return Index Gross of Dividends” (TOT\_RETURN\_INDEX\_GROSS\_DVDS). We then compute quarterly returns by computing the change in the log of the total return index. We use the same definition for calculating the returns on the Brazilian and Mexican Equity Indices. Data on deposits rates are from Global Financial Data.

In order to look at changes in credit spreads, we have to go about matching firms to the debt that they issued. We begin by running a fixed income search (SRCH <GO>) and find fixed coupon dollar denominated bonds issued by Brazilian and Mexican firms in Bloomberg. We can then download all available historical secondary market prices and yields for every bond. We use the mid yield to maturity on the bond for our analysis. Using Bloomberg’s Excel Add-in, we can use the field BOND\_TO\_EQY\_TICKER that provides the Bloomberg equity ticker for the firm that issued the fixed income instrument. This will be the firm identifier we use to match the bond prices to the balance sheet information of the issuing firm.

To compute the credit spread, we compute the remaining maturity on the bond at each point in time. We then use the Gurkaynak et al. (2007) coefficients to compute the yield to maturity on a US Treasury bond of the same maturity and define the spread as the difference between the two yields. We drop all bonds where the yield to maturity is negative, the spread is less than negative 50 basis points, the yield to maturity is over 1,000%, or there is less than one quarter remaining until the bond matures.

We use the log of market capitalization for our measure of firm size (Bloomberg field HISTORICAL\_MARKET\_CAP). For the market to book ratio, we used the market to value to book value ratio per share (Bloomberg field PX\_TO\_BOOK\_RATIO).

Figure 30: CCS and FC Debt Outstanding in 2012 (\$ billions)

	(1)	(2)	(3)
Currency	CCS Notional	Corp FC	Govt FC
Reporting Currencies			
TRY	320	136	58
RUB	83	288	41
KRW	76	272	10
ZAR	67	51	11
MXN	67	161	49
HUF	53	44	23
PLN	53	64	70
Non-Reporting Currencies			
BRL	<25	370	58
COP	<25	26	21
IDR	<25	78	32
ILS	<25	34	11
MYR	<25	78	5
PEN	<25	35	12
THB	<25	57	0.3

*Notes:* CCS notional outstanding from Table 3 in the DTCC Trade Information Warehouse: Link. Corporate FC and Government FC data from the dataset constructed in Section 2.3.

#### 5.2.4 Possibility of FX Derivative Hedging

Comprehensive data on corporate FX derivative usage rarely exist, even for developed countries.<sup>129</sup> It is even more challenging to estimate the degree of FX derivative hedging used by emerging market firms. We examine aggregate statistics on FX derivative and FC debt outstanding at the country level, and argue that the size of the derivative market in emerging markets is significantly smaller than total FC debt for most emerging markets. Therefore, firms do not fully hedge their FC liabilities using FX derivatives.

Cross currency swaps (CCS) provide a natural way for firms to hedge against FC fixed income liabilities. Depository Trust & Clearing Corporation (DTCC) started publishing global CCS derivative outstanding amounts by currency for the top 20 currencies very recently. Table 30 compares total CCS outstanding reported by DTCC and FC debt outstanding based on our estimation in 2012. Among 14 sample countries, 7 currencies are ranked as top 20

<sup>129</sup>Australia is the single exception, where comprehensive surveys are conducted regarding FX derivatives used by firms.

currencies in terms of CCS outstanding, so exact amounts are reported. The remaining 7 currencies by definition have a lower amount outstanding than the top 20 currencies, and so we can infer that they have CCS outstanding less than \$25 billion, the lowest reporting amount for the 20th ranked currency. We compare CCS outstanding amounts with FC liabilities by country. With exceptions of Turkey and South Africa, all the other 12 sample countries have total FC debt outstanding greater than total CCS outstanding.

Furthermore, we know that not all the CCS outstanding is used for corporate FX derivative hedging. According to the BIS Semiannual OTC Derivative Survey, about half of the currency swap outstanding is inter-dealer in nature.<sup>130</sup> This inter-dealer exposure likely represents market making and proprietary trading related activities in LC rates markets. In addition, portfolio investors also use CCS to hedge their long-term currency exposure on LC denominated assets. Therefore, it is very plausible that total CCS outstanding amounts vastly overestimate the actual amount of FX hedging of FC corporate debt.

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<sup>130</sup>BIS surveys do not report FX derivative outstanding for individual emerging market currencies.

## 5.2.5 Miscellaneous Empirics

Table 29: LC Debt Duration

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Brazil	1.95	2.17	2.01	2.02	2.23	2.69	2.80	2.85	2.85	2.96	3.13
Colombia		3.42	3.47	3.25	3.25	3.54	3.63	4.41	4.44	4.49	4.60
Hungary	3.25	3.53	3.65	3.69	3.62	3.61	3.19	2.42	2.54	3.06	2.88
Indonesia		5.03	5.85	4.95	5.35	5.86	5.59	5.45	6.25	7.11	7.56
Malaysia	3.79	4.58	4.59	4.62	4.78	4.89	4.90	4.83	4.15	4.75	5.04
Mexico	2.15	2.27	2.50	2.97	3.75	4.53	5.13	5.11	5.82	5.99	6.14
Peru					7.87	10.41	9.78	10.78	10.14	9.81	9.46
Poland	2.49	2.46	2.97	3.29	3.49	3.85	3.83	3.75	3.89	3.89	4.03
Russia				5.96	6.60	6.82	6.46	5.74	4.66	5.07	5.26
South Africa	6.24	6.11	6.31	6.38	6.33	6.19	7.46	7.06	7.30	7.74	8.19
Thailand		5.43	5.15	4.84	4.72	5.03	5.33	5.16	5.29	5.94	6.81
Turkey			1.37	1.57	1.51	1.05	1.54	1.70	2.27	2.22	2.38
Median	3.25	4.05	3.65	4.15	4.72	4.96	5.02	5.14	4.98	5.51	5.69

Approximation of Macaulay duration of outstanding debt. Average maturity of the debt from BIS Securities Statistics and maturity weighted yield from JP Morgan EMBI. Assumption that coupons are paid annually.

Table 30: Sovereign Credit Spreads and External Debt

VARIABLES	(1) Quarter, LC	(2) Quarter, LC	(3) Quarter, FC	(4) Quarter, FC	(5) Annual, LC	(6) Annual, LC	(7) Annual, FC	(8) Annual, FC
$\frac{FC\ Gov}{GDP}$	12.83*** (4.100)	12.21*** (3.393)	15.87** (6.951)	16.65** (6.225)	5.742 (8.180)	5.232 (7.550)	13.83 (8.142)	15.34* (7.417)
$\frac{LC\ Gov}{GDP}$	6.648** (2.529)	7.746*** (2.012)	4.210 (3.212)	0.408 (3.411)	6.165** (2.713)	4.672* (2.263)	-0.337 (7.048)	1.587 (5.591)
$\frac{FC\ Private}{GDP}$	2.297* (1.324)	2.564** (1.242)	3.207*** (0.656)	2.040** (0.756)	3.878** (1.592)	3.633** (1.307)	3.745* (1.773)	3.423* (1.539)
$\Delta Reserves$	-4.001 14.59	-77.57 116.1	-258.3*** -85.00	-298.4*** -77.52	-52.08 -6.327	-51.25 1.527	-213.5** 34.19	-198.4** 21.65
$Vol(ToT)$	318.5*** 280.7***	164.2*** 218.7***	-130.6 67.18**	-74.10 -39.53	-86.19 252.8***	-153.7 293.1***	-87.91 76.13	-219.2 -4.286
Observations	357	350	427	427	94	93	111	111
R-squared	0.717	0.664	0.784	0.736	0.765	0.754	0.755	0.776
Countries	12	12	13	13	13	13	14	14
Global Controls	No	Yes	No	Yes	No	Yes	No	Yes
Time FE	Yes	No	Yes	No	Yes	No	Yes	No

Notes: The table reports panel regression results of the level of the LC and FC credit spread on country level and global variables. All specifications contain country fixed effects. Heteroskedasticity autocorrelation spatial correlation robust Driscoll and Kraay (1998) standard errors with a 4 quarter lag. Standard errors follow Vogelsang (2012) when time fixed effects are used.  $\left(\frac{FC\ Gov}{GDP}\right)$ ,  $\left(\frac{LC\ Gov}{GDP}\right)$  and  $\left(\frac{FC\ Private}{GDP}\right)$  are the FC sovereign debt/GDP ratio, the LC sovereign debt/GDP ratio, and the FC private debt/GDP ratio.  $\Delta Reserves$  is the log change in foreign exchange reserves,  $\Delta ToT$  is the log change in the terms of trade, and  $Vol(ToT)$  is the volatility of the terms of trade over the previous 12 months. “Global Controls” refers to the VIX, Fed Funds Rate, BBB-Treasury Spread, 10-Year Treasury Spread, and Ted Spread. These variables are all from FRED of the Federal Reserve Bank of St. Louis. VIX is the 30 day implied volatility of the S&P, the Fed Funds Rate is the effective overnight Federal Funds Rate, the BBB-Treasury Spread is the option-adjusted spread of the Bank of America Merrill Lynch US Corporate BBB Index over US Treasuries, the 10-Year Treasury Spread is the 10-Year Treasury Constant Maturity Rate, and the Ted Spread is the spread between 3-month dollar Libor and the 3-Month Treasury Bill. South Africa only included in annual regressions because of data availability. Russia only included in CDS regressions because LC debt not investable during much of sample. Global controls coefficients omitted for space. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Standard errors for some variables suppressed for space.

### 5.2.6 Model Setup and Extensions

In this appendix, we will consider extensions to the model. First we will add two new elements to the static version: FC sovereign debt and domestic sales of the entrepreneurial output. We will use the parameter  $\alpha_G$  to denote the share of sovereign debt in LC. When we move to the dynamic model, we will set  $\alpha_G = 1$ , meaning all sovereign debt is in LC. The second extension we consider is domestic sales of the entrepreneurial endowment. While the baseline case where entrepreneurs sell their endowment externally and earn profits is slightly more tractable, it makes the counterfactual assumption that emerging market exports are sticky in local currency. As shown in and Goldberg and Tille (2008) and Gopinath et al. (2010) most EM exports to the US are priced in dollars. The complication is that domestic sales lead to gains for the agent purchasing the good, as it is being purchased for a real price of  $(1 - \zeta)$  and has a real international price of 1. We assume that competitive firms purchase the good from entrepreneurs and resell the good to foreigners at a real price of 1. Therefore, on each unit purchased, firms will earn a profit of  $\zeta$ . We assume that households own an equal share of these competitive firms, and so aggregate profits are shared equally across agents. Aggregate profits will be given by  $\zeta\gamma\nu\mu\omega$ , as  $\zeta$  gives the profit per unit,  $\gamma$  the measure of entrepreneurs,  $\nu$  a new parameter indexing the share of LC goods sold domestically,  $\mu$  the share of sticky price goods in entrepreneur production and  $\omega$  the amount produced per entrepreneur. To simplify notation, we will write denote  $\omega_{LC} = \gamma\nu\mu\omega$ .

In this case, consumption in repayment states is given by:

$$C^R = \underbrace{AX(\zeta)^\gamma}_{\text{Production}} + \underbrace{\zeta\omega_{LC}}_{\text{Profits}} - \underbrace{(1 - \alpha_G\zeta)b}_{\text{Debt Repayments}}$$

we can revisit the condition for inflation optimality in Equation 25.

$$\zeta = \max \left\{ \frac{\omega - Z}{(\mu\omega - \alpha_P Z)} - \left( \frac{\gamma A (\xi\gamma)^\gamma}{\alpha_G b + \omega_{LC}} \right)^{1/(1-\gamma)} (\mu\omega - \alpha_P Z)^{\gamma/(1-\gamma)}, 0 \right\} \quad (43)$$

By adding domestic sales of the LC good, we can see there is some incentive to inflate even when there is no LC sovereign debt. The reason why the inflation policy is the max of the inflation rule and 0 is that the sovereign has no incentive to deflate. Because the sticky price good is the tradable good, in the event of appreciation/deflation, the real price of the good would be greater than 1 and demand for it would drop to zero. Because a hyperinflation where the value of LC goes to zero is given by the point where  $\zeta = 1$ , the highest level the inflation tax can be is 1. We can solve for the threshold in terms of aggregate productivity levels above which inflation is 0 and below which inflation is 1, denoting these thresholds as  $A_0$  and  $A_1$ , respectively.

$$A_0 = \frac{(\omega - Z)^{1-\gamma} (\alpha_G b + \omega_{LC})}{\gamma (\xi \gamma)^\gamma (\mu \omega - \alpha_P Z)}$$

$$A_1 = \frac{((1 - \mu) \omega - (1 - \alpha_P) Z)^{1-\gamma} (\alpha_G b + \omega_{LC})}{(\mu \omega - \alpha_P Z) \gamma (\xi \gamma)^\gamma}$$

This allows us to rewrite the inflation policy function as

$$\zeta = \begin{cases} 1 & A < A_1 \\ \frac{1}{(\mu \omega - \alpha_P Z)} \left( \omega - Z - \left( \frac{\gamma A (\xi \gamma)^\gamma (\mu \omega - \alpha_P Z)}{\alpha_G b + \omega_{LC}} \right)^{\frac{1}{1-\gamma}} \right) & A \in [A_1, A_0] \\ 0 & A > A_0 \end{cases} \quad (44)$$

Plugging the optimal inflation rate in to the consumption function and rearranging, we can write consumption in repayment as

$$C^R = A \frac{1}{1-\gamma} (\xi\gamma)^{\frac{\gamma}{1-\gamma}} (\mu\omega - \alpha_P Z)^{\frac{\gamma}{1-\gamma}} (LC + \omega_{LC})^{\frac{-\gamma}{1-\gamma}} \Gamma - \left( \frac{(1-\alpha_P)Z - (1-\mu)\omega}{(\mu\omega - \alpha_P Z)} \right) LC - FC + \left( \frac{\omega - Z}{(\mu\omega - \alpha_P Z)} \right) \omega_{LC}$$

where  $LC = \alpha_G b$ ,  $FC = (1 - \alpha_G) b$  and  $\Gamma = \gamma \frac{1}{1-\gamma} - \gamma \frac{1}{1-\gamma}$ . Consumption in default is calculated by setting  $\zeta = 0$  and assessing the sovereign default cost

$$C^D = A_D(A) (\xi\gamma)^\gamma (\omega - Z)^\gamma$$

The default threshold  $A_{crit}$  is pinned down by solving for the productivity level such that  $C_R(A) = C_D(A)$ , or the fixed point such that:

$$A_{Crit} = \left( \frac{A_D(A) (\xi\gamma)^\gamma (\omega - Z)^\gamma + \left( \frac{(1-\alpha_P)Z - (1-\mu)\omega}{(\mu\omega - \alpha_P Z)} \right) LC + FC - \left( \frac{\omega - Z}{(\mu\omega - \alpha_P Z)} \right) \omega_{LC}}{(\xi\gamma)^{\frac{\gamma}{1-\gamma}} (\mu\omega - \alpha_P Z)^{\frac{\gamma}{1-\gamma}} (LC + \omega_{LC})^{\frac{-\gamma}{1-\gamma}} \Gamma} \right)^{1-\gamma} + \frac{FC - \left( \frac{\omega - Z}{(\mu\omega - \alpha_P Z)} \right) \omega_{LC}}{(\xi\gamma)^{\frac{\gamma}{1-\gamma}} (\mu\omega - \alpha_P Z)^{\frac{\gamma}{1-\gamma}} (LC + \omega_{LC})^{\frac{-\gamma}{1-\gamma}} \Gamma} \right)^{1-\gamma} \quad (45)$$

To recover the results in the static example in the text, we can set  $\xi = 1/\gamma$ ,  $\mu = 1$ ,  $\omega_{LC} = 0$ , and  $\alpha_G = 1$ :



$$C_R = A^{\frac{1}{1-\gamma}} (\omega - \alpha_P Z)^{\frac{\gamma}{1-\gamma}} b^{\frac{-\gamma}{1-\gamma}} \Gamma - \left( \frac{(1-\alpha_P)Z}{\omega - \alpha_P Z} \right) b$$

$$A_{Crit} = \left( \frac{A_D(A) (\omega - Z)^\gamma + \left( \frac{(1-\alpha_P)Z}{\omega - \alpha_P Z} \right) b}{(\omega - \alpha_P Z)^{\frac{\gamma}{1-\gamma}} b^{\frac{-\gamma}{1-\gamma}} \Gamma} \right)^{1-\gamma}$$

**Domestic sales in dynamic model** Including sticky price domestic sales in the dynamic model is straightforward. The only parts of equation block 26 that change are consumption in repayment and the inflation policy function. With domestic sales  $\omega_{LC}$  and  $\alpha_G = 1$ , these are now given by:

$$C_R(A, b, b') = AX (\zeta(\cdot))^\gamma - \kappa b (1 - \zeta(\cdot)) + q^{LC}(A, b') [b' - (1 - \zeta(\cdot)) \delta b] + \zeta \omega_{LC}$$

$$\zeta(A, b, b') = \frac{\omega - Z - \left( \gamma (\mu \omega - \alpha_P Z) \left( \frac{A (\xi \gamma)^\gamma}{b (\kappa + \delta q^{LC}(A, b')) + \omega_{LC}} \right) \right)^{1/(1-\gamma)}}{(\mu \omega - \alpha_P Z)}$$

In both cases, domestic sales  $\omega_{LC}$  enter in the same way as outstanding LC sovereign debt, meaning that domestic sales reduce the cost of inflation. While a full calibration would require data well beyond the scope of this paper, here we consider the simplest case where  $\nu = 1$ , so that we assume all sticky price sales are domestic. Because this provides an additional incentive to inflate, we double  $\xi$  from our baseline calibration. In Table 31, we compute the model implied moments and see that as we increase  $\alpha_P$ , the LC credit spread falls and currency risk becomes the dominant risk on sovereign debt.

Table 31: Key Moments, Domestic Sales

	Share LC Debt $\alpha_P$	Mean LCCS $s^{LCCS}$	Mean Nom. Spread $s^{LC/US}$	Credit Share $s^{LC/US}/s^{LCCS}$	Sov. Debt/GDP $B/Y$
Model	0%	2.00	2.00	100%	9.1%
Model	10%	0.76	0.95	80.1%	9.9%
Model	20%	0.09	2.21	4.1%	10.2%

### 5.2.7 Proof and Discussion of Proposition 1

**Proposition 1:** For sufficiently convex default costs, the LC credit spread is falling and currency risk is rising with the share of LC private and sovereign debt.

To prove this, we first need to prove two lemmas. First, we need to prove that there exists a unique productivity level,  $A_{Crit}$ , such that when productivity  $A$  is below the threshold the sovereign finds it optimal to default and when  $A$  is above the threshold the sovereign repays. Then we need to demonstrate that this threshold is falling with the share of LC debt, and therefore a higher share of LC debt shrinks the region where the sovereign default. To keep notation compact, we will set  $\mu = 1$ ,  $\xi = 1/\gamma$ , and  $\omega_{LC} = 0$ .

**Lemma 2.** *As long as the costs of default are sufficiently convex, there exists a unique productivity level,  $A_{Crit}$ , such that when productivity  $A$  is below the threshold the sovereign finds it optimal to default and when  $A$  is above the threshold the sovereign repays. The convexity of default cost condition is  $\frac{\partial A_D}{\partial A} \frac{A}{A_D} < \frac{1}{1-\gamma}$ . All commonly used default costs in the literature satisfy this condition.*

Proof: There are two cases to consider: first,  $A_{Crit}$  occurs in the region below  $A_0$  where inflation is positive. In this case we can write consumption in repayment and default as:

$$C_R = A^{\frac{1}{1-\gamma}} (\omega - \alpha_P Z)^{\frac{\gamma}{1-\gamma}} LC^{\frac{-\gamma}{1-\gamma}} \Gamma - \left( \frac{(1 - \alpha_P) Z}{(\omega - \alpha_P Z)} \right) \alpha_G b - (1 - \alpha_G) b$$

$$C_D = A_D(A) (\omega - Z)^\gamma$$

We can then differentiate both consumption in repayment and default with respect to productivity

$$\begin{aligned}\frac{\partial C_R}{\partial A} &= \frac{1}{1-\gamma} \frac{C_R}{A} \\ \frac{\partial C_D}{\partial A} &= \frac{\partial A_D}{\partial A} \frac{C_D}{A_D(A)}\end{aligned}$$

At  $A_{Crit}$ , we know  $C_R = C_D$ , a level we can denote as  $C_{Crit}$

$$\begin{aligned}\frac{\partial C_R}{\partial A} &= \frac{1}{1-\gamma} \frac{C_{Crit}}{A} \\ \frac{\partial C_D}{\partial A} &= \frac{\partial A_D}{\partial A} \frac{C_{Crit}}{A_D(A)} \\ \frac{\partial C_R}{\partial A_{Crit}} / \frac{\partial C_D}{\partial A_{Crit}} &= \frac{1}{1-\gamma} \frac{A_D(A_{crit})}{A} \left( \frac{\partial A_D}{\partial A} \right)^{-1}\end{aligned}$$

Therefore,  $\frac{\partial C_R}{\partial A_{Crit}} / \frac{\partial C_D}{\partial A_{Crit}} > 1$  as long as we have

$$\begin{aligned}\frac{1}{1-\gamma} \frac{A_D(A_{crit})}{A} \left( \frac{\partial A_D}{\partial A} \right)^{-1} &> 1 \\ \frac{A_D}{A} &> (1-\gamma) \frac{\partial A_D}{\partial A}\end{aligned}$$

Or,

$$\frac{\partial A_D}{\partial A} \frac{A}{A_D} < \frac{1}{1-\gamma}$$

Therefore, if the elasticity of productivity in default with respect to underlying productivity is less than  $\frac{1}{1-\gamma}$ , we can be assured of having a unique default threshold as the slope of consumption in repayment with respect to productivity is always higher than consumption

in default. The standard default costs (proportional costs, kinked cost, and hybrid default costs) all satisfy this condition.

1. Proportional Costs (Aguiar and Gopinath (2006)).  $A_D = (1 - \theta) A$ ,  $\theta \in (0, 1)$

$$1 < \frac{1}{1 - \gamma}$$

2. Kinked default costs (Arellano (2008)).  $A_D = \hat{A}$

$$0 < \frac{1}{1 - \gamma}$$

3. Hybrid default costs ((Chatterjee and Eyigungor (2012))).  $A_D = A(1 - d_0) - d_1 A^2$

$$\frac{\partial A_D}{\partial A} = (1 - d_0) - 2d_1 A$$

$$\frac{(1 - d_0) - 2d_1 A}{(1 - d_0) - d_1 A} < \frac{1}{1 - \gamma}$$

because the quadratic term  $d_1 \geq 0$ . If we are in the case where there is no inflation prior to default, we can write consumption in repayment and default as

$$C_R = A(\omega - Z)^\gamma - b$$

$$C_D = A_D(A)(\omega - Z)^\gamma$$

Once again,  $A_{crit}$  is defined as the productivity level where consumption in repayment equals consumption default  $C_R = C_D$ . Differentiating  $C_R$  and  $C_D$  with respect to underlying productivity, we have

$$\begin{aligned}\frac{\partial C_R}{\partial A} &= (\omega - Z)^\gamma \\ \frac{\partial C_D}{\partial A} &= \frac{\partial A_D}{\partial A_{crit}} (\omega - Z)^\gamma\end{aligned}$$

Therefore, the slope of consumption in repayment with respect to productivity as long as we have

$$\frac{\partial A_D}{\partial A} < 1$$

Once again, this condition is satisfied by the standard default costs.

**Lemma 3.** *The sovereign default threshold is falling with the share of private debt in local currency as long as the sovereign finds it optimal to choose a strictly positive amount of inflation before defaulting.*

**Proof:**

Suppose  $A_{crit}$  is in the region where the sovereign chooses some positive inflation

$$\begin{aligned}C_R^{CRIT} &= A_{crit}(\alpha_P) ((1 - \zeta(A_{crit}, \alpha_P)) (\omega - \alpha_P Z) - (1 - \alpha_P) Z)^\gamma - (1 - \alpha_G \zeta(A_{crit}, \alpha_P)) B \\ &= C_R(A_{crit}(\alpha_P), \zeta(A_{crit}(\alpha_P), \alpha_P), \alpha_P) \\ C_D^{CRIT} &= A_D(A_{crit}(\alpha_P)) (\omega - Z)^\gamma \\ &= C_D(A_D(A_{crit}(\alpha_P)))\end{aligned}$$

Definition of  $A_{crit}$  is the value of  $A$  such that

$$C_R(A) = C_D(A)$$

We can then totally differentiate both sides. We differentiate the left hand side first:

$$\frac{dC_R^{CRIT}}{d\alpha_P} = \frac{\partial C_R}{\partial A_{Crit}} \frac{\partial A_{Crit}}{\partial \alpha_P} + \frac{\partial C_R}{\partial \zeta} \left( \frac{\partial \zeta}{\partial A_{crit}} \frac{\partial A_{crit}}{\partial \alpha_P} + \frac{\partial \zeta}{\partial \alpha_P} \right) + \frac{\partial C_R}{\partial \alpha_P}$$

The sovereign FOC gives  $\frac{\partial C_R}{\partial \zeta} = 0$  (envelope theorem). Therefore, the change in consumption in repayment with respect to  $\alpha_P$  is given by the direct increase in consumption in repayment, and the increase in consumption in repayment coming from shifting the default threshold.

$$\frac{dC_R^{CRIT}}{d\alpha_P} = \frac{\partial C_R}{\partial A_{Crit}} \frac{\partial A_{Crit}}{\partial \alpha_P} + \frac{\partial C_R}{\partial \alpha_P}$$

$$\frac{dC_D^{CRIT}}{d\alpha_P} = \frac{\partial C_D}{\partial A_D} \frac{\partial A_D}{\partial A_{Crit}} \frac{\partial A_{Crit}}{\partial \alpha_P}$$

Therefore, we have

$$\frac{\partial A_{Crit}}{\partial \alpha_P} = \frac{-\frac{\partial C_R}{\partial \alpha_P}}{\frac{\partial C_R}{\partial A_{Crit}} - \frac{\partial C_D}{\partial A_D} \frac{\partial A_D}{\partial A_{Crit}}}$$

The condition for the denominator to be positive is that there exists a default threshold, Lemma 1. Therefore we can focus only on the numerator.

$$\begin{aligned} C_R &= A_{Crit} ((1 - \zeta) (\omega - \alpha_P Z) - (1 - \alpha_P) Z)^\gamma - (1 - \alpha_G \zeta) b \\ \frac{\partial C_R}{\partial \alpha} &= \gamma A_{Crit} X^{\gamma-1} (Z - (1 - \zeta (A_{crit})) Z) \\ \frac{\partial C_R}{\partial \alpha} &= \gamma A_{Crit} X^{\gamma-1} (\zeta (A_{crit}) Z) \end{aligned}$$

This equation is strictly positive when  $\zeta (A_{crit})$  is positive and is zero otherwise. Therefore, Because  $\frac{\partial A_{Crit}}{\partial \alpha_P}$  is proportional to  $-\frac{\partial C_R}{\partial \alpha_P}$ , we have shown the default threshold is falling with

the share of LC corporate debt when the inflation rate at the threshold is positive and zero otherwise. We can use the exact same steps to show this condition is equivalent for  $\alpha_G$ , the share of LC sovereign debt. Following the same steps, we see that

$$\frac{\partial A_{Crit}}{\partial \alpha_G} = \frac{-\frac{\partial C_R}{\partial \alpha_G}}{\frac{\partial C_R}{\partial A_{Crit}} - \frac{\partial C_D}{\partial A_D} \frac{\partial A_D}{\partial A_{Crit}}}$$

Because we can write

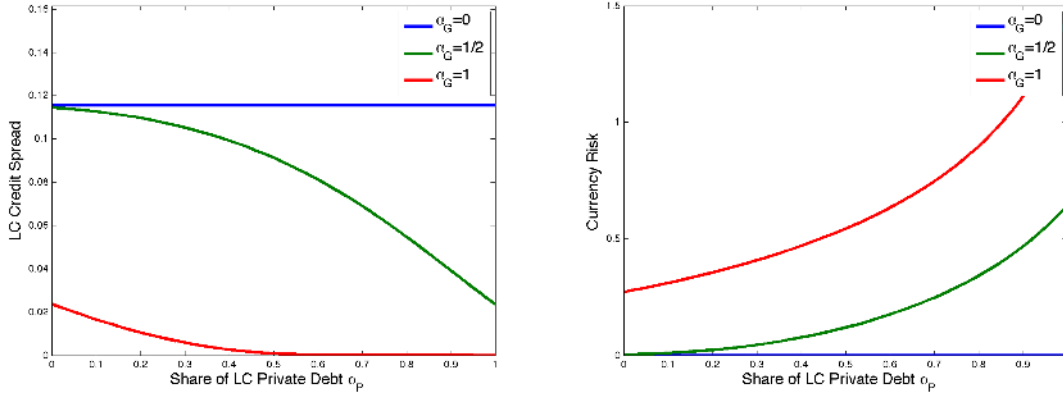
$$\begin{aligned} C_R &= A_{Crit} ((1 - \zeta) (\omega - \alpha_P Z) - (1 - \alpha_P) Z)^\gamma - (1 - \alpha_G \zeta) b \\ \frac{\partial C_R}{\partial \alpha_G} &= \zeta (A_{Crit}) b \end{aligned}$$

Therefore, as long as  $\zeta (A_{Crit}) > 0$ , consumption is increasing with the share of LC sovereign debt. As in the case for corporate debt, when  $\zeta (A_{Crit})$  is 0, changing the debt denomination has no effect on consumption, and therefore no effect on the default threshold.

Finally, differentiating the inflation policy function, we see that it is increasing in both  $\alpha_G$  and  $\alpha_P$ . Because the LC credit spread is an increasing function of  $A_{Crit}$ , we know that shifting  $A_{Crit}$  down lowers default risk. Therefore, a higher LC share reduces default risk. Because inflation directly increases with  $\alpha_P$  and  $\alpha_G$ , and also increases with falls in  $A_{Crit}$ , we know that currency risk is rising with  $\alpha_P$  and  $\alpha_G$ .

In Figure 31, we plot how the LC credit spread and currency risk change with the share of LC private debt for three levels of sovereign LC shares, 0, 1/2 and 1. We assume that  $A$  is distributed log-normally. The figure should only be interpreted qualitatively. When all sovereign debt is in FC ( $\alpha_G = 0$ ), the sovereign is never tempted to inflate because it cannot reduce its debt burden. Because of this, changes in the currency composition of private debt have no effect at all on any of the spreads. The green line in the left panel is the case when half of the sovereign debt is in local currency and half is in FC. In this calibration, when all private debt is in FC and half of sovereign debt is in FC, we see that as more of the private

Figure 31: Currency and Credit Risk



*Notes:* The left panel plots the LC credit spread as a function of the share of LC in private debt  $\alpha_p$  for three levels of sovereign LC shares,  $\alpha_G$ . The right panel plots currency risk  $\rho$  as a function of the share of LC in private debt  $\alpha_p$  for three levels of sovereign LC shares,  $\alpha_G$ .

debt is in LC, the credit spread declines monotonically. In the right panel, we see that this fall in the credit spread is associated with a rise in the spread on a default-free LC bond as inflation is increasing with the share of LC private debt. In this case, even when all private debt is in FC, there is both currency and credit risk on the defaultable LC bond. As  $\alpha_p$  increases, we see credit risk disappears on sovereign debt but currency risk increases.

### 5.2.8 Bond Pricing

In this section, we present the steps to price defaultable FC debt, as in section 2.5.1, defaultable LC debt as in section 2.5.2, and default-free LC debt as in section 2.5.3. With a promised FC coupon structure of

$$\kappa [1, \delta, \delta^2, \delta^3]$$

a risk-free investor needs to calculate the present value of the expected cash flows:



$$\begin{aligned}
q_t^{FC} &= E_t \left[ \frac{\kappa \cdot (1 - D_{t+1})}{1 + r^*} + \frac{\delta \kappa \cdot (1 - D_{t+1})(1 - D_{t+2})}{(1 + r^*)^2} + \dots \right] \\
&= E_t \left[ \frac{\kappa \cdot (1 - D_{t+1})}{1 + r^*} + \frac{\delta \kappa \cdot \prod_{j=1}^2 (1 - D_{t+j})}{(1 + r^*)^2} + \frac{\delta^2 \kappa \cdot \prod_{j=1}^3 (1 - D_{t+j})}{(1 + r^*)^3} \dots \right] \\
&= E_t \left[ \sum_{s=0}^{\infty} \left( \prod_{j=1}^{s+1} (1 - D_{t+j}) \right) \frac{\kappa \delta^s}{(1 + r^*)^{1+s}} \right] \\
&= E_t \left[ (1 - D_{t+1}) \frac{\kappa}{1 + r^*} + (1 - D_{t+1}) \sum_{s=1}^{\infty} \left( \prod_{j=2}^{s+1} (1 - D_{t+j}) \right) \frac{\kappa \delta^s}{(1 + r^*)^{1+s}} \right] \\
&= E_t \left[ \frac{(1 - D_{t+1})}{1 + r} \left( \kappa + \delta \left( \sum_{s=0}^{\infty} \left( \prod_{j=1}^{s+1} (1 - D_{t+1+j}) \right) \frac{\kappa \delta^s}{(1 + r^*)^{1+s}} \right) \right) \right] \\
&= \frac{E_t [(1 - D_{t+1}) (\kappa + \delta q_{t+1}^{FC})]}{1 + r^*}
\end{aligned}$$

where the last step uses the initial definition of  $q_t^{FC}$ . Note that when  $\delta = 0$  we have one period debt and  $q_t^{FC} = \kappa \frac{E_t [1 - D_{t+1}]}{1 + r^*}$ , as in Aguiar and Gopinath (2006) and Arellano (2008), when  $\kappa = 1$ .

Next, we can turn to the price of a defaultable a defaultable LC bond. As discussed in the text, the bond promises LC cash flows of

$$P_t \kappa [1, \delta, \delta^2, \dots]$$

A foreign investor values these LC cash flows in FC by dividing through by the price level

$$\kappa \left[ \frac{P_t}{P_{t+1}}, \delta \frac{P_t}{P_{t+2}}, \delta^2 \frac{P_t}{P_{t+3}}, \dots \right].$$

To price the bond, the investors again calculates present value of the expectation of the cash flows

$$\begin{aligned}
q_t^{LC} &= E_t \left[ \frac{\kappa \cdot (1 - D_{t+1})(1 - \zeta_{t+1})}{1 + r^*} + \frac{\delta \kappa \cdot (1 - D_{t+1})(1 - D_{t+2})(1 - \zeta_{t+1})(1 - \zeta_{t+2})}{(1 + r^*)^2} + \dots \right] \\
&= E_t \left[ \frac{\kappa \cdot (1 - D_{t+1})(1 - \zeta_{t+1})}{1 + r^*} + \frac{\delta \kappa \cdot \prod_{j=1}^2 (1 - D_{t+j})(1 - \zeta_{t+j})}{(1 + r^*)^2} + \dots \right] \\
&= E_t \left[ \sum_{s=0}^{\infty} \left( \prod_{j=1}^{s+1} (1 - D_{t+j})(1 - \zeta_{t+j}) \right) \frac{\kappa \delta^s}{(1 + r^*)^{1+s}} \right] \\
&= E_t \left[ \frac{(1 - D_{t+1})(1 - \zeta_{t+1})}{1 + r} \left( \kappa + \delta \left( \sum_{s=0}^{\infty} \left( \prod_{j=1}^{s+1} (1 - D_{t+1+j})(1 - \zeta_{t+1+j}) \right) \frac{\kappa \delta^s}{(1 + r^*)^{1+s}} \right) \right) \right] \\
&= \frac{E_t [(1 - D_{t+1})(1 - \zeta_{t+1})(\kappa + \delta q_{t+1}^{LC})]}{1 + r^*}
\end{aligned}$$

where once again the last step uses the initial definition of  $q_t^{LC}$ . When we have  $\delta = 0$ , and so we have one period debt, this becomes  $q_t^{LC} = \kappa \frac{E_t [(1 - D_{t+1})(1 - \zeta_{t+1})]}{1 + r^*}$ .

Finally, we turn to pricing a default-free LC bond. While this bond has the same promised cash flows as the defaultable LC bond, the lender continues to receive the coupon payments in the event of a sovereign default. To price the bond, the lender calculates the discounted present value of the debt:

$$\begin{aligned}
q_t^{*LC} &= E_t \left[ \frac{\kappa \cdot (1 - \zeta_{t+1})}{1 + r^*} + \frac{\delta \kappa \cdot (1 - \zeta_{t+1})(1 - \zeta_{t+2})}{(1 + r^*)^2} + \dots \right] \\
q_t^{*LC} &= E_t \left[ \frac{\kappa \cdot (1 - \zeta_{t+1})}{1 + r^*} + \frac{\delta \kappa \cdot \prod_{j=1}^2 (1 - \zeta_{t+j})}{(1 + r^*)^2} + \frac{\delta^2 \kappa \cdot \prod_{j=1}^3 (1 - \zeta_{t+j})}{(1 + r^*)^3} \dots \right] \\
q_t^{*LC} &= E_t \left[ \sum_{s=0}^{\infty} \left( \prod_{j=1}^{s+1} (1 - \zeta_{t+j}) \right) \frac{\kappa \delta^s}{(1 + r^*)^{1+s}} \right] \\
q_t^{*LC} &= E_t \left[ (1 - \zeta_{t+1}) \frac{\kappa}{1 + r^*} + (1 - \zeta_{t+1}) \sum_{s=1}^{\infty} \left( \prod_{j=2}^{s+1} (1 - \zeta_{t+j}) \right) \frac{\kappa \delta^s}{(1 + r^*)^{1+s}} \right] \\
q_t^{*LC} &= E_t \left[ (1 - \zeta_{t+1}) \frac{\kappa}{1 + r^*} + \frac{\delta}{1 + r} (1 - \zeta_{t+1}) \left( \sum_{s=0}^{\infty} \left( \prod_{j=1}^{s+1} (1 - \zeta_{t+1+j}) \right) \frac{\kappa \delta^s}{(1 + r^*)^{1+s}} \right) \right] \\
q_t^{*LC} &= E_t \left[ \frac{(1 - \zeta_{t+1})}{1 + r} \left( \kappa + \delta \left( \sum_{s=0}^{\infty} \left( \prod_{j=1}^{s+1} (1 - \zeta_{t+1+j}) \right) \frac{\kappa \delta^s}{(1 + r^*)^{1+s}} \right) \right) \right] \\
q_t^{*LC} &= \frac{E_t [(1 - \zeta_{t+1}) (\kappa + \delta q_{t+1}^{*LC})]}{1 + r^*}
\end{aligned}$$

where once again the last step uses the initial definition of  $q_t^{*LC}$ . It is important to note that this bond price schedule does not affect the sovereign's decision in equilibrium and so, unlike the defaultable bond price schedule  $q^{LC}$ , this fixed point problem can be solved after the policy functions have been solved for. As discussed in the text, to calculate this expectation we need to price the default-free LC debt in states in which the sovereign has defaulted, accounting for stochastic re-entry into credit markets. Using the subscript  $D$  to indicate default and  $R$  to indicate repayment, we can write the expression for equation 27.

$$\begin{aligned}
q_R^{*LC}(A, b') &= \frac{E [(1 - \zeta(\cdot)) (\kappa + \delta ((1 - D(A', b')) (q_R^{*LC}(A', b''(A', b')))) + D(A', b') q_D^{*LC}(A')) \mid A, b']}{1 + r^*} \\
q_D^{*LC}(A) &= \frac{\kappa + \delta E [\lambda q_R^{*LC}(A', 0) + (1 - \lambda) q_D^{*LC}(A') \mid A, b']}{1 + r^*}
\end{aligned}$$

The expressions for the expectation of  $q_{t+1}^{*LC}$  beginning from good and bad credit standing can be found in the text.

### 5.2.9 Laffer Curves

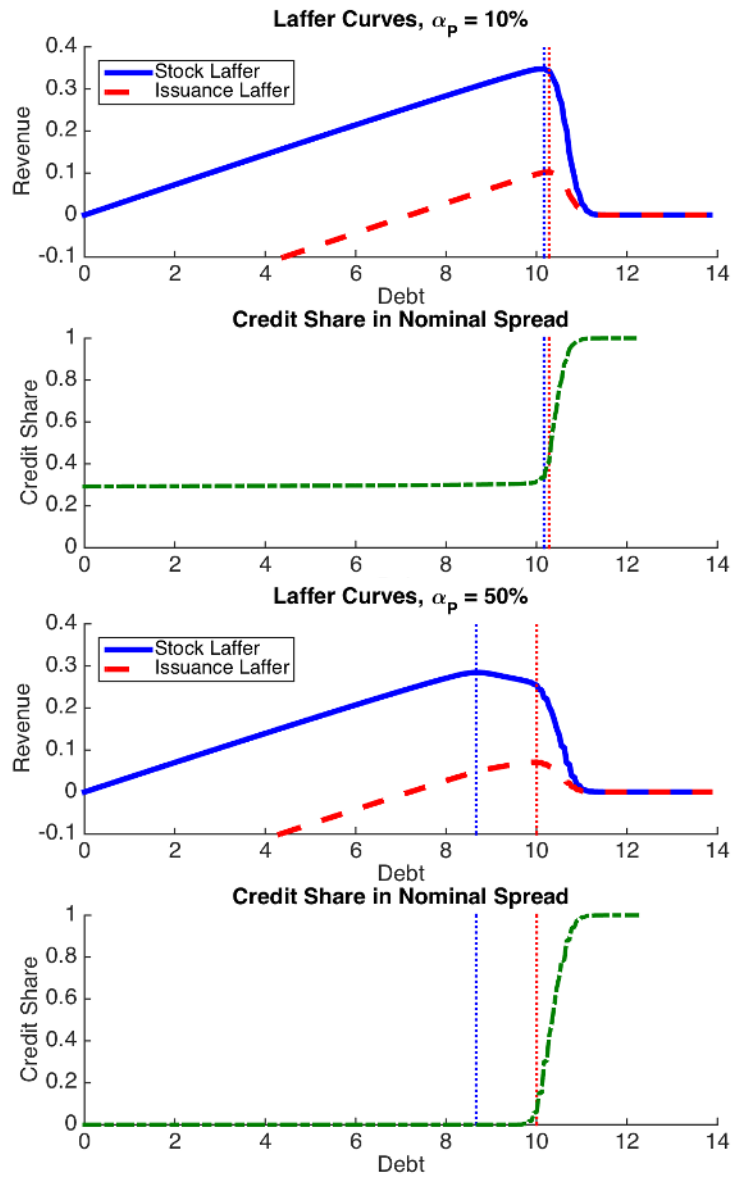
As discussed in the text, we focus our discussion on the stock Laffer curve,  $q \cdot b'$ , rather than the issuance Laffer curve  $q \cdot (b' - (1 - \zeta) \delta b)$ , for intuition. Here, we briefly discuss why this is sufficient in practice. While the sovereign could potentially find it optimal to issue debt past the peak of the stock Laffer curve and up the peak of the issuance Laffer curve, this is not the case for the policy functions from our calibration. In Figure 32, we plot the stock and issuance Laffer curves for the case that the sovereign issued 7.5% of debt-to-average-GDP last period, and productivity is at its mean level. Of course, the stock Laffer curve is independent of the amount of inherited debt. For the case when  $\alpha_P = 10\%$  (first figure, top panel), we see the peak of the stock and issuance Laffer curves are very close together. This is because the bond price schedule is sufficiently steep that additional bond issuance at the peak of the stock Laffer curve fails to raise additional revenue. In the second figure of the first panel, we see that the credit share at the peak of the issuance Laffer curve is slightly higher than at the peak of the stock Laffer curve.

In the second set of figures, where  $\alpha_P = 50\%$ , we see in the top figure that there is now a fairly significant difference between the peak of the stock and issuance Laffer curves, with the issuance Laffer curve peaking after nearly 1.5% of GDP of additional borrowing. This is because the bond price schedule is less steep when the primary risk is inflation rather than default, and so there is a wide region where the debt dilution effects overwhelm the price fall. In the second figure, we can even see there is a small amount of credit risk at the peak of the issuance Laffer curve that is not present in the share Laffer curve. While the difference between these two curves makes it is potentially important to look at the issuance Laffer curve, in Figure 33, we see this is not the case for our calibration.

The first two panels of this figure plot debt issuance at the debt level that would cause the stock and issuance debt Laffer curves to peak, along with the equilibrium bond issuance policy function  $\tilde{b}(\bar{A}, b)$  for average productivity. The 45 degree line is plotted to indicate when  $\tilde{b}(\bar{A}, b) > b$ . The left panel in the top row plots the case when  $\alpha_P = 10\%$  and the right

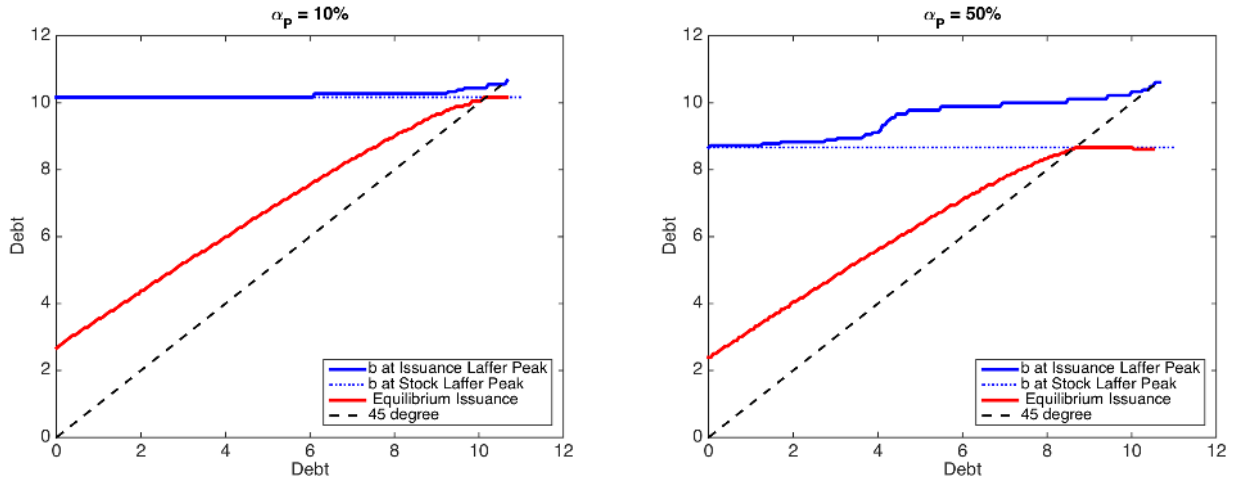
panel plots the case when  $\alpha_P = 50\%$ . The bond issuance that causes the stock Laffer curve to peak is the same regardless of  $b$  and is therefore a horizontal line. The key result from the figure is that the sovereign does not choose to borrow past the peak of the *stock* Laffer curve when it begins on the increasing side of the stock Laffer curve. When we look at the right panel with  $\alpha_P = 50\%$ , we see that in equilibrium, the government's optimal policy keeps it below the peak of the stock Laffer curve and never comes close to approaching the peak of the issuance Laffer curve. In other words, the steepness of the bond price schedule as the sovereign approaches the peak of the stock Laffer curve makes the sovereign find it optimal to curtail its borrowing.

Figure 32: Stock and Issuance Laffer Curves,  $b = 7.5\%/\bar{Y}$



*Notes:* In both sets of plots, we consider the case when  $A = \bar{A}$  and the sovereign issued 7.5% debt/GDP last period. The first pair of charts are for the case when  $\alpha_P = 10\%$  and the second when  $\alpha_P = 50\%$ . The top figure in each of the two sets plots the stock and issuance Laffer curve, with the dashed vertical lines indicating the borrowing level at the peak of the two debt Laffer curves. The bottom figure in each set plots the credit share  $s^{LCCS}/s^{LC/US}$  for each set level of debt issuance, with the vertical lines denoting the borrowing level at the peak of both types of debt Laffer curve.

Figure 33: Debt Levels and Credit Shares at Peak of Laffer Curve



Notes: The first 2 panels of this figure plot debt issuance at the debt level that would cause the stock and issuance debt Laffer curves to peak, along with the equilibrium bond issuance policy function  $\tilde{b}(\bar{A}, b)$  for average productivity. The 45 degree is plotted to indicate when  $\tilde{b}(\bar{A}, b) > b$ . The left panel in the top row plots the case when  $\alpha_P = 10\%$  and the right panel plots the case when  $\alpha_P = 50\%$ . The bond issuance that causes the stock Laffer curve to peak is the same regardless of  $b$  and is therefore a horizontal line.

## 5.3 Appendix: The Costs of Sovereign Default

### 5.3.1 GMM and Returns-IV

In this section, we present results for the GMM and Returns-IV estimators discussed in the text. Given the problematic behavior of these estimators under the null hypothesis that  $\alpha = 0$ , we cannot interpret our bootstrapped confidence intervals as providing correct coverage for the t-tests and J-tests conducted in this section. We therefore have removed all the of asterisks from the tables, although we list the standard errors and confidence intervals generated by our procedure.

For our GMM confidence intervals, we use the moment-recentering procedure discussed by Horowitz (2001). We also employ this bootstrap strategy to estimate the 95% confidence interval for the over-identification test (J statistic). The 95% confidence interval for the J-statistic is based on the 95th percentile of the sampling distribution, and the associated test is one-sided. Currently, we run our GMM procedure on abnormal returns/CDS changes, treating them as known. The GMM estimator is a two-step GMM estimator.



Table 32: Returns-IV

	(1)	(2)	(3)	(4)
	Index	Banks	Non-Financial	Real Estate
$\Delta D$	-61.56***	-68.53***	-46.66*	176.7
Robust SE	(15.50)	(21.09)	(20.05)	(506.9)
95% CI	[-99.3,-13.5]	[-104.4,-29.5]	[-84.8,9.0]	[-3.5e+3,472.2]
Observations	413	413	413	413
1st Stage F-Stat	81.99	71.37	41.32	0.237

	(5)	(6)	(7)
	FX (ADR)	FX (On.)	FX (Official)
$\Delta D$	55.59***	-9.886	499.5
Robust SE	(12.23)	(11.61)	(1,058)
95% CI	[13.1,81.1]	[-43.8,34.9]	[-1.3e+5,721.9]
Observations	368	413	413
1st Stage F-Stat			

Notes: This table reports the results for the variance-based estimator estimated as the ratio of  $\lambda\alpha^2$  to  $\lambda\alpha$ . This estimator is called the “Returns-IV” estimator because it depends on the excess variance of the ADR return on event days. The column headings denote the outcome variable. Index is the MSCI Argentina Index, Banks is our equally weighted index of Argentine bank ADRs, Industrial is our equally weighted index of Argentine industrial ADRs, and REIT is our equally weighted index of Argentine real estate holding companies. FX (ADR) is the ARS/USD exchange rate derived from the ratio of ADR prices (in USD) to the price of the underlying equity (in ARS). FX (On.) is the ARS/USD exchange rate offered by onshore currency dealers. FX (Official) is the exchange rate set by the Argentine government. The coefficient on  $\Delta D$  is the effect on the percentage returns of an increase in the 5-year risk-neutral default probability from 0% to 100%, implied by the Argentine CDS curve. Standard errors and confidence intervals are computed using the stratified bootstrap procedure described in the text. The underlying data is based on the two-day event windows and non-events described in the text.

Table 33: GMM

	(1)	(2)	(3)	(4)
	Index	Banks	Non-Financial	Real Estate
$\alpha$ ( $\Delta D$ )	-54.45**	-60.09***	-30.95	-0.466
Robust SE	(14.05)	(14.16)	(16.67)	(14.58)
95% CI	[-99.4,-15.5]	[-99.1,-28.6]	[-79.0,33.9]	[-64.5,37.7]
$\lambda$	30.04	30.55	26.42	33.05
Robust SE	(13.21)	(13.64)	(12.54)	(13.02)
95% CI	[-143.8,57.4]	[-41.8,56.2]	[-264.1,56.7]	[-497.5,57.5]
Observations	413	413	413	413
J-Stat	0.180	0.280	0.596	0.0207
J-Stat-CI	[0,6.4]	[0,4.4]	[0,4.9]	[0,8.8]

	(5)	(6)	(7)
	FX (ADR)	FX (On.)	FX (Official)
$\alpha$ ( $\Delta D$ )	40.82	17.87**	-0.166
Robust SE	(21.24)	(4.218)	(0.851)
95% CI	[-80.6,129.4]	[0.9,29.1]	[-2.3,1.5]
$\lambda$	21.39	50.85**	33.60
Robust SE	(10.44)	(11.66)	(14.17)
95% CI	[-166.3,52.2]	[3.2,69.3]	[-4.4e+03,48.9]
Observations	368	413	413
J-Stat	1.160	5.521**	0.872
J-Stat-CI	[0,15.5]	[0,2.8]	[0,25.0]

Notes: The GMM estimates are based on a two-step estimator, run once for each outcome variable. The column headings denote the outcome variable. Index is the MSCI Argentina Index, Banks is our equally weighted index of Argentine bank ADRs, Non-Financial is our equally weighted index of Argentine non-financial ADRs, and Real Estate is our equally weighted index of Argentine real estate holding companies. FX (ADR) is the ARS/USD exchange rate derived from the ratio of ADR prices (in USD) to the price of the underlying equity (in ARS). FX (On.) is the ARS/USD exchange rate offered by onshore currency dealers. FX (Official) is the exchange rate set by the Argentine government. The parameter  $\alpha$  is the effect on the percentage returns of an increase in the probability of default, from 0% to 100%.  $\lambda$  is proportional to the difference in the variance of the default probability shocks during event and non-event windows. Standard errors and confidence intervals are computed using the stratified bootstrap procedure described in the text, with moment recentering. J-Stat is an overidentification test of the validity of the assumptions described in Rigobon and Sack (2004). The underlying data is based on the two-day event windows and non-events described in the text.

### 5.3.2 Mexico and Brazil

#### 5.3.3 Risk-Neutral Default Probabilities

We convert CDS spreads into risk-neutral default probabilities to provide a clearer sense of the magnitude of the estimated coefficients. We emphasize that we work with risk-neutral

Table 34: Regressions for Brazil and Mexico

	(1)	(2)	(3)	(4)
	Brazil CDS	Brazil Index	Mexico CDS	Mexico Index
OLS $\Delta D$	53.08***	-12.21***	42.75***	-5.978**
Robust SE	(8.632)	(3.823)	(7.861)	(3.150)
95% CI	[30.53,76.38]	[-18.40,-6.50]	[20.43,67.46]	[-11.18,-0.98]
Event IV $\Delta D$	23.16**	-3.035	6.330	0.634
Robust SE	(15.22)	(6.592)	(13.98)	(5.426)
95% CI	[1.14,53.00]	[-15.04,9.30]	[-25.62,48.25]	[-4.14,7.93]
CDS-IV $\Delta D$	20.68	-1.098	1.728	1.669
Robust SE	(16.44)	(7.075)	(15.09)	(5.812)
95% CI	[-4.28,54.10]	[-9.84,10.18]	[-33.83,48.53]	[-3.22,8.73]

Notes: This table reports the results for the OLS, IV-style event study, and CDS-IV estimators of the effect of changes in the risk-neutral default probability ( $\Delta D$ ) on the 5-year CDS spreads and stock market indices of Brazil and Mexico. The coefficient on  $\Delta D$  is the effect on the percentage returns (of stocks) and change in the 5-year CDS spread (in bps) of an increase in the 5-year risk-neutral default probability from 0% to 100%, implied by the Argentine CDS curve. Standard errors and confidence intervals are computed using the stratified bootstrap procedure described in the text. The underlying data is based on the two-day event windows and non-events described in the text. Significance levels: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

probabilities and do not attempt to convert them to physical probabilities. Pan and Singleton (2008b) and Longstaff et al. (2011a) impose additional structure to estimate the physical default probabilities.

We begin with data from Markit on CDS par spreads. The par spread is the coupon payment that a buyer of CDS protections pays to the seller of the contract such that the CDS contract has zero cost at initiation. Because the seller of a CDS insures the buyer of a CDS against credit losses throughout the duration of the contract, pricing the contract involves calculating the term structure of credit risk on the bond.

The market standard for pricing CDS is a reduced form model that models time-varying credit risk as a time-varying hazard rate of default.<sup>131</sup> The simplest version of such a model would be to assume that throughout the life of CDS contract there is a constant default hazard rate  $\lambda$ . In this simple case, we can convert the par spread  $S_T$  for a contract with maturity  $T$  to the hazard rate,

<sup>131</sup>White (2013) provides a very thorough discussion of the ISDA standard model.

$$\lambda = \frac{S_T}{1 - Recov.} \quad (46)$$

where *Recov.* is the recovery rate, which is assumed to be known and constant. Once this hazard rate  $\lambda$  is calculated, we can calculate the probability that a bond defaults before time  $t = T$  as

$$Pr(Def < T) = 1 - \exp(-\lambda T).$$

For example, a 1-year CDS with zero recovery and a par spread of 100% would imply a hazard rate of 1. This means that half the time the bond would fully default and the seller would fully compensate the buyer, and half the time the underlying bond would not default and the seller would earn an annual interest rate of 100%, breaking even on average.

If there were only one tenor of CDS observed in the market, this constant hazard rate calculation would be all that is feasible. However, with the multiple tenors we do not need to restrict the hazard function  $\lambda$  to be constant throughout the duration of the CDS. Our dataset includes quotes at the 6 month, 1 year, 2 year, 3 year, 4 year, 5 year, 7 year, 10 year, 15 year, 20 year and 30 year tenors. We follow the ISDA standard and construct the risk-free yield curve using the Libor deposit rate for the 6 month tenor and interest rate swap rate for all longer maturities. This data can be downloaded from FRED, the online database of the Federal Reserve Bank of St. Louis.

We implement the standard market model in Matlab using *cdsbootstrap*. The assumption of the standard model is that the time varying hazard rate  $\lambda(t)$  is constant between all of the nodes of the CDS curve. This mean that we begin by using 46 to calculate  $\lambda_{6m}$ , the hazard rate between the initiation of the contract and its expiration 6 months later. We use the recovery rate that Markit calculates by polling the reporting dealers as our assumed recovery upon default. This recovery rate is assumed to be the same for all tenors. Having calculated  $\lambda_{6M}$ , we can calculate  $\lambda_{1Y}$ , the hazard rate between 6 months and 1 year of the

contract consistent with the observed par spread, then  $\lambda_{2Y}$  between 1 and 2 years, and so on up the curve. Having calculated these hazard rates, we can then compute the probability of a default during the life of each contract as:

$$\begin{aligned}
 Pr(D \leq 6M) &= 1 - \exp\left(-\lambda_{6M} \cdot \left(\frac{1}{2}\right)\right) \\
 Pr(D \leq 1Y) &= 1 - \exp\left(-\lambda_{6M} \cdot \left(\frac{1}{2}\right) - \lambda_{1Y} \cdot \left(\frac{1}{2}\right)\right) \\
 &\vdots \\
 Pr(D \leq 5Y) &= 1 - \exp\left(-\lambda_{6M} \cdot \left(\frac{1}{2}\right) - \lambda_{1Y} \cdot \left(\frac{1}{2}\right) - \lambda_{2Y} - \lambda_{3Y} - \lambda_{4Y} - \lambda_{5Y}\right)
 \end{aligned}$$

We perform this bootstrapping for our 11 tenors for the full sample period (January 3, 2011 to July 30, 2014).

### 5.3.4 Econometric Model

The model we use is

$$\begin{aligned}
 \Delta D_t &= \mu_d + \omega_D^T X_t + \gamma^T r_t + \beta_D F_t + \epsilon_t \\
 r_t &= \mu + \Omega X_t + \alpha \Delta D_t + \beta F_t + \eta_t,
 \end{aligned}$$

where  $r_t$  is a vector of returns,  $\Delta D_t$  is the change in the default probability,  $X_t$  is a set of global factors (S&P 500, etc...),  $F_t$  is an unobserved factor, and  $\epsilon_t$  is the idiosyncratic default probability shock, and  $\eta_t$  is a vector of return shocks that do not directly affect the probability of default. Through some algebra, we show that this is equivalent to the systems described in equations 34 and 35, used in most of our analysis, and equations 41 and 42 used in the cross-sectional analysis.

We begin by separating the equation governing the vector of returns  $r_t$  into the return of asset  $i$ ,  $r_{i,t}$ , which is the asset of interest, and the returns of some other assets, denoted

$r_{-i,t}$ . We separate the various coefficient vectors and matrices,  $\mu, \Omega, \alpha, \beta, \gamma$ , and shocks  $\eta_t$ , into versions for asset  $i$ ,  $\mu_i, \omega_i^T$ , etc..., and versions for the other assets,  $\mu_{-i}, \Omega_{-i}$ , etc... This system can be written as

$$\begin{aligned}\Delta D_t &= \mu_d + \omega_D^T X_t + \gamma_i^T r_{i,t} + \gamma_{-i}^T r_{-i,t} + \beta_D F_t + \epsilon_t \\ r_{i,t} &= \mu_i + \omega_i^T X_t + \alpha_i \Delta D_t + \beta_i F_t + \eta_{i,t} \\ r_{-i,t} &= \mu_{-i} + \Omega_{-i} X_t + \alpha_{-i} \Delta D_t + \beta_{-i} F_t + \eta_{-i,t}.\end{aligned}$$

Most of our analysis considers only a single asset,  $r_{i,t}$ , and the default probably change  $\Delta D_t$ . Substituting the returns  $r_{-i,t}$  into the  $\Delta D_t$  equation,

$$\begin{aligned}\Delta D_t &= \frac{\mu_d + \gamma_{-i}^T \mu_{-i}}{1 - \gamma_{-i}^T \alpha_{-i}} + \frac{\omega_D^T + \beta_{-i}^T \Omega_{-i}}{1 - \gamma_{-i}^T \alpha_{-i}} X_t + \frac{\gamma_i^T r_{i,t}}{1 - \gamma_{-i}^T \alpha_{-i}} + \\ &\quad \frac{\beta_D + \gamma_{-i}^T \beta_{-i}}{1 - \gamma_{-i}^T \alpha_{-i}} F_t + \frac{1}{1 - \gamma_{-i}^T \alpha_{-i}} (\gamma_{-i}^T \eta_{-i,t} + \epsilon_t) \\ r_{i,t} &= \mu_i + \omega_i^T X_t + \alpha_i \Delta D_t + \beta_i F_t + \eta_{i,t}.\end{aligned}$$

This system, for the two assets, is equivalent to the one in equations 34 and 35, except that it has two shocks,  $\gamma_{-i}^T \eta_{-i,t}$  and  $\epsilon_t$ , that directly affect  $\Delta D_t$  without affecting  $r_{i,t}$ , and includes constants and observable controls  $X_t$ . Neither of these differences substantially alter the identification assumptions or analysis. The event study and Rigobon (2003) approach both identify the coefficient  $\alpha_i$ , under their identifying assumptions, which is the coefficient of interest.

Next, we discuss a version of this system with the market return. Let the market return be a weighted version of the return vector,  $r_{m,t} = w^T r_t$ . Separating the vectorized version of

the system into four equations,

$$\begin{aligned}
\Delta D_t &= \mu_d + \omega_D^T X_t + \gamma_i^T r_{i,t} + \gamma_{-i}^T r_{-i,t} + \beta_D F_t + \epsilon_t \\
r_{i,t} &= \mu_i + \omega_i^T X_t + \alpha_i \Delta D_t + \beta_i F_t + \eta_{i,t} \\
r_{-i,t} &= \mu_{-i} + \Omega_{-i} X_t + \alpha_{-i} \Delta D_t + \beta_{-i} F_t + \eta_{-i,t} \\
r_{m,t} &= \mu_m + \omega_m^T X_t + \alpha_m \Delta D_t + F_t + w^T \eta_t,
\end{aligned}$$

where  $\mu_m = w^T \mu$ ,  $\omega_m^T = w^T \Omega$ , and so on. We have assumed that  $w^T \beta = 1$ , which is a normalization. Substituting out  $r_{-i,t}$ ,

$$\begin{aligned}
\Delta D_t &= \frac{\mu_d + \gamma_{-i}^T \mu_{-i}}{1 - \gamma_{-i}^T \alpha_{-i}} + \frac{\omega_D^T + \beta_{-i}^T \Omega_{-i}}{1 - \gamma_{-i}^T \alpha_{-i}} X_t + \frac{\gamma_i^T r_{i,t}}{1 - \gamma_{-i}^T \alpha_{-i}} + \\
&\quad \frac{\beta_D + \gamma_{-i}^T \beta_{-i}}{1 - \gamma_{-i}^T \alpha_{-i}} F_t + \frac{1}{1 - \gamma_{-i}^T \alpha_{-i}} (\gamma_{-i}^T \eta_{-i,t} + \epsilon_t) \\
r_{i,t} &= \mu_i + \omega_i^T X_t + \alpha_i \Delta D_t + \beta_i F_t + \eta_{i,t} \\
r_{m,t} &= \mu_m + \omega_m^T X_t + \alpha_m \Delta D_t + F_t + w^T \eta_t,
\end{aligned}$$

as above. Next, we solve for  $F_t$  using the market return equation:

$$F_t = r_{m,t} - \mu_m - \omega_m^T X_t - \alpha_m \Delta D_t - w^T \eta_t.$$

Plugging this into our system of equations,

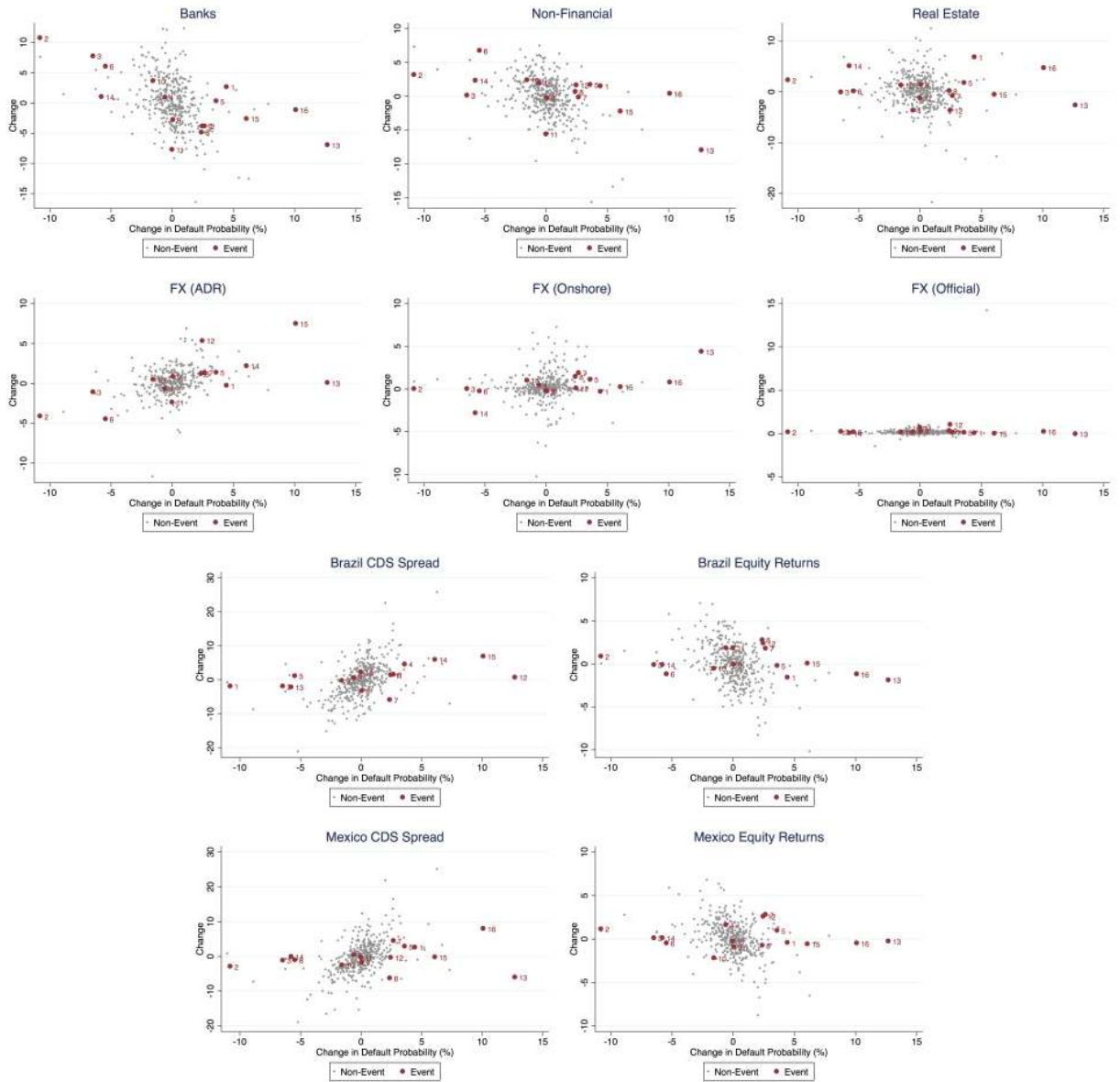
$$\begin{aligned}
(1 + \alpha_m \frac{\beta_D + \gamma_{-i}^T \beta_{-i}}{1 - \gamma_{-i}^T \alpha_{-i}}) \Delta D_t &= \left( \frac{\mu_d + \gamma_{-i}^T \mu_{-i}}{1 - \gamma_{-i}^T \alpha_{-i}} - \frac{\beta_D + \gamma_{-i}^T \beta_{-i}}{1 - \gamma_{-i}^T \alpha_{-i}} \mu_m \right) \\
&+ \left( \frac{\omega_D^T + \beta_{-i}^T \Omega_{-i}}{1 - \gamma_{-i}^T \alpha_{-i}} - \frac{\beta_D + \gamma_{-i}^T \beta_{-i}}{1 - \gamma_{-i}^T \alpha_{-i}} \omega_m^T \right) X_t + \\
&\frac{\gamma_i^T r_{i,t}}{1 - \gamma_{-i}^T \alpha_{-i}} + \frac{\beta_D + \gamma_{-i}^T \beta_{-i}}{1 - \gamma_{-i}^T \alpha_{-i}} r_{m,t} + \\
&\left( \frac{\gamma_{-i}^T}{1 - \gamma_{-i}^T \alpha_{-i}} - \frac{\beta_D + \gamma_{-i}^T \beta_{-i}}{1 - \gamma_{-i}^T \alpha_{-i}} w_{-i}^T \right) \eta_{-i,t} + \\
&\frac{\beta_D + \gamma_{-i}^T \beta_{-i}}{1 - \gamma_{-i}^T \alpha_{-i}} w_i \eta_{i,t} + \frac{1}{1 - \gamma_{-i}^T \alpha_{-i}} \epsilon_t \\
r_{i,t} &= (\mu_i - \beta_i \mu_m) + (\omega_i^T - \beta_i \omega_m^T) X_t + (\alpha_i - \beta_i \alpha_m) \Delta D_t \\
&+ \beta_i r_{m,t} + (1 - w_i \beta_i) \eta_{i,t} + w_{-i}^T \eta_{-i,t}.
\end{aligned}$$

This system is equivalent to the one presented in equations 41 and 42, except that there are multiple common factors ( $\eta_{i,t}$  and  $\eta_{-i,t}$ ) and no idiosyncratic return shocks. The event study and Rigobon (2003) approach both identify the coefficient  $(\alpha_i - \beta_i \alpha_m)$ , under their identifying assumptions, which is the coefficient of interest.

### 5.3.5 Figures and Tables



Figure 34: Change in Default Probability and other Financial Variables on Event and Non-Event Days



Notes: This figure plots the change in the risk-neutral probability of default and returns on all indices and exchange rates, as well as Mexican and Brazilian equities and CDS, on event and non-event days. Each event and non-event day is a two-day event or non-event as described in the text. The numbers next to each maroon dot references each event-day in the table below Figure 22. The procedure for classifying events and non-events is described in the text.

Table 35: Events and Non-Events

Two-Day Window End	Event Type	Description	PDF Time (EST) and Link	News Time (EST) and Link	Comments
7Dec11	Excluded	Original ruling by Judge Griesa with regards to Pari Passu clause.	7Dec11, 12:55pm Decision	Missing	There was very little contemporaneous news coverage, and we are unable to determine when the ruling became public. The first story we found about the ruling is based on an article in “La Nacion” published on 5Mar12.
23Feb12	Excluded	Order by Judge Griesa requiring “ratable payment.”	Missing Order	Missing	See above.
05Mar12	Excluded	Stay granted by Judge Griesa, pending appeal.	Missing Stay	05Mar12, 7:11am Bloomberg	See above.
26Oct12	Excluded	Appeals court upholds Judge Griesa’s ruling that the Pari Passu clause requires equal treatment of restructured bondholders and holdouts.	25Oct12, 12:43pm Decision	26Oct12, 2:14pm Bloomberg	The appeals court releases opinions during the middle of the day. Unfortunately, the closing marks on this day are questionable, given the impending impact of “Superstorm Sandy.”

Table 35: Events and Non-Events (Continued)

Two-Day Window End	Event Type	Description	PDF Time (EST) and Link	News Time (EST) and Link	Comments
23Nov12	Excluded	Judge Griesa removes the stay on his order that Argentina immediately pay the holdouts, if they also pay the exchange bondholders.	Missing Order	22Nov12, 5:33am. Business News Americas	Nov 22 was Thanksgiving in the United States, and all CDS marks on that date and the morning of the 23rd appear to be the same as on the 21st. The opinion was filed by Judge Griesa on the night of the 21st, but was embargoed until the 23rd. On the 22nd, the Argentine market fell a lot, but bounced back on the 23rd. We cannot observe this in the ADR data, so we exclude this event.
27Nov12	Open-to-Open, 26Nov12 to 27Nov12	Judge Griesa denies the exchange bondholders request for a stay. The bondholders immediately appealed.	26Nov12, 3:43pm Denial	27Nov12, 5:00am. New York Post	The denial occurred on the 26th, and both the government of Argentina and the exchange bondholders immediately appealed. We compare the open on the 27th to the open on the 26th. The 26th is an Argentine holiday, so the ADR Blue Rate is missing (for the open-to-open, but not the two day window).
29Nov12	Close-to-Open, 28Nov12 to 29Nov12	Appeals court grants emergency stay of Judge Griesa's order.	28Nov12, 5:04pm Stay	29Nov12, 8:24am. Bloomberg	
05Dec12	Open-to-Close, 04Dec12	Appeals court denies request of holdouts to force Argentina to post security against the payments owed.	04Dec12, 1:15pm. Denial	04Dec12, 1:46pm. Bloomberg	

Table 35: Events and Non-Events (Continued)

Two-Day Window End	Event Type	Description	PDF Time (EST) and Link	News Time (EST) and Link	Comments
07Dec12	Close-to-Close, 05Dec12 to 06Dec12	Appeals court allows the Bank of New York (custodian of the exchange bonds) and the Euro bondholders to appear as interested parties.	05Dec12, 10:13pm. Order	06Dec12, 11:47am Bloomberg	
11Jan13	Close-to-Open, 10Jan13 to 11Jan13	Appeals court denies certification for exchange bondholders to appeal to NY state court for interpretation on Pari Passu clause.	10Jan13, 4:10pm Order	11Jan13, 12:01am Bloomberg	The ruling was written immediately after the closes on the 10th.
28Feb13	Excluded	Appeals court denies request for en-banc hearing of appeal.	28Feb13, 3:27pm. Decision	Missing Shearman	The denial occurred at the beginning of a hearing, during which lawyers for both sides argued various issues. Lawyers from Argentina may have changed their arguments in response to expectations about the Argentine economy, violating the exclusion restriction.
04Mar13	Open-to-Open, 01Mar13 to 04Mar13	Appeals court asked Argentina for a payment formula.	01Mar13, 11:49am. Order	01Mar13, 4:46pm Financial Times	The FT story is the earliest we could find. Most other coverage is from the following day (a Saturday).

Table 35: Events and Non-Events (Continued)

Two-Day Window End	Event Type	Description	PDF Time (EST) and Link	News Time (EST) and Link	Comments
04Mar13	Open-to-Open, 01Mar13 to 04Mar13	Appeals court asked Argentina for a payment formula.	01Mar13, 11:49am. Order	01Mar13, 4:46pm Financial Times	The FT story is the earliest we could find. Most other coverage is from the following day (a Saturday).
27Mar13	Open-to-Open, 27Mar13 to 26Mar13	Appeals court denies Argentina's request for en-banc rehearing.	26Mar13, 11:58am Order	26Mar13, 2:35pm Bloomberg	The Bloomberg story specifically mentions a 374bp increase in the 5yr CDS spread, which does not appear in our data until after the NY close at 3:30pm. We use the one day window to ensure we are capturing the event.
01Apr13	Non-Event (neither event or excluded)	Argentina files payment plan. Offer roughly 1/6 of Judge Griesa ordered.	N/A	30Mar13, 12:05pm Bloomberg	Argentina filed just before midnight on 28Mar13. Actions by Argentina are endogenous. This neither an event nor excluded.
22Apr13	Non-Event (neither event or excluded)	Holdouts reject Argentina's payment plan.	19Apr13, 5:20pm Reply	20Apr13, 12:01am Bloomberg	Holdouts reject Argentina's payment plan. Also conceivably endogenous. The rejection was filed after business hours on Friday, 19Apr13. This is also neither an event nor excluded.
26Aug13	Close-to-Close, 22Aug13 to 23Aug13	Appeals court upholds Griesa's decision.	22Aug13, 4:21pm Decision	23Aug13, 4:02pm Bloomberg	The appeals court announces decisions during the business day. The modification date of the PDF is 10:17am. However, because the

Table 35: Events and Non-Events (Continued)

Two-Day Window End	Event Type	Description	PDF Time (EST) and Link	News Time (EST) and Link	Comments
11Sep13	Non-Event	Supreme court schedules hearing to consider Argentina's appeal.	Missing Docket Info.	Bloomberg	The supreme court distributed case materials related to Argentina's petition. We were advised that this is routine and not "news," so we do not count it as a ruling.
26Sep13	Excluded	Holdouts had petitioned Griesa to consider the Argentine central bank liable for the defaulted debt. Argentina motioned to dismiss, and Griesa rejected Argentina's motion.	Missing		We were not able to find Griesa's ruling, so we exclude this event.
04Oct13	Open-to-Open, 03Oct12 to 04Oct13	Griesa bars Argentina from swapping the exchange bonds into Argentine-law bonds.	03Oct13, 2:43pm. Order	03Oct13, 6:27pm. Bloomberg	
08Oct13	Open-to-Close, 07Oct13	Supreme court denies Argentina's first petition.	N/A Order	07Oct13, 11:45am SCOTUS Blog	The stock market opens (9:30am EST) before the Supreme court issues decisions (9:30am or 10:00am EST).
19Nov13	Open-to-Open, 18Nov13 to 19Nov13	Appeals court denies Argentina's request for an en-banc hearing.	18Nov13, 11:04am Denial	19Nov13, 12:01am Bloomberg	The modification time of the orders is 4:53pm.

Table 35: Events and Non-Events (Continued)

Two-Day Window End	Event Type	Description	PDF Time (EST) and Link	News Time (EST) and Link	Comments
13Jan14	Open-to-Close, 10Jan14	Supreme court agrees to hear Argentina case.	10Jan14, 2:42pm Order	10Jan14, 2:48pm SCOTUS Blog	The supreme court usually announces orders at 10am. The document was likely posted afterwards.
17Jun14	Open-to-Close, 16Jun14	Supreme court denies Argentina's second petition.	See Text. Denial	See Text. SCOTUS Blog	The text discusses this event in detail.
23Jun14	Open-to-Open, 20Jun14 to 23Jun14	Griesa prohibits debt swap of exchange bonds to Argentine law bonds.	20Jun14, 2:17pm Order		20Jun14 is an Argentine holiday, so the local stocks are missing. This event is excluded from our ADR analysis because of the two-day windows (it overlaps with the event below).
24Jun14	Open-to-Open, 23Jun14 to 24Jun14	Griesa appoints special master to oversee negotiations.	23Jun14, 12:36pm Order	23Jun14, 7:35pm Bloomberg	The modification date for the order is 1:05pm. This event is excluded from our local stock analysis because of the two-day event windows (see the event above).
27Jun14	Open-to-Close, 26Jun14	Griesa rejects Argentina's application for a stay, pending negotiations.	26Jun14, 11:40am Order	26Jun14, 2:05pm Bloomberg	
30Jun14	Non-Event	Argentina misses a coupon payment			
29Jul14	Open-to-Open, 28Jul14 to 29Jul14	Griesa allows Citi to pay Repsol bonds for one month.	28Jul14, 3:51pm Order	28Jul14, 12:01am Bloomberg	The modification time on the order is 5:07. This event almost certainly occurred post-close, but we use the one day window to be safe.
30Jul14		The 30-day grace period for the missed payment expires.		Bloomberg	We end our dataset on 29Jul14.