Exchange Rate Risk and Foreign Discount in U.S. Dollar Bonds

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Abstract

This paper investigates the impact of exchange rate risk on pricing disparities, specifically the Foreign Discount, in U.S. dollar bonds issued by non-U.S. firms versus U.S. firms. Integrating theoretical insights with empirical analysis, I identify balance sheet and dollar home bias channels as key contributors to these disparities. The former channel links bond-level to firm-level exchange rate risk exposure, while the latter channel demonstrates the transmission of investor-level exchange rate risk exposure to U.S. dollar bonds issued by their local firms. The findings highlight the significance of exchange rate risk, especially U.S. dollar fluctuations, in asset pricing.

Keywords: USD bonds, Exchange Rate Risk, Bond Pricing, Balance Sheet Effect, Dollar Funding Cost, Home Bias

JEL Classifications: F30, F31, F34, G11, G12, G15

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1 Introduction

U.S. dollar (USD) bonds stand as highly sought-after assets in the global financial landscape. Since the 2008 global financial crisis, international investors have increasingly preferred USD bonds, resulting in a significant pricing differential between USD and non-USD bonds.[1] Within the realm of USD bonds, the proportion of outstanding USD bonds issued by non-U.S. firms in the corporate bond market has increased from 20% in 2004 to 40% in 2021, driven by factors such as access to a large, liquid international market, international trade, and arbitrage price differentials (Bruno and Shin 2017; Maggiori, Neiman, and Schreger 2019; Liao 2020). Recent research by Geng (2022) reveals that when controlling for various factors, USD bonds issued by non-U.S. firms (referred to as non-U.S. USD bonds) consistently exhibit larger credit spreads than those issued by U.S. firms (referred to as U.S. USD bonds), a phenomenon termed the Foreign Discount.

The existence of the Foreign Discount is surprising. In a frictionless financial market, there should be no pricing difference between USD-denominated bonds issued by two firms if the bonds share the same characteristics and the firms have identical fundamentals, regardless of their nationalities. This aligns with the standard no-arbitrage condition. Therefore, the Foreign Discount underscores the significance of the nationality effect in driving bond pricing differentials. This paper links the nationality effect to exchange rate risk, providing a risk-based explanation for the Foreign Discount. I focus on the financial channel of exchange rates, wherein fluctuations of the USD significantly influence cross-border capital flows, the risk-taking capabilities of global investors, and the net worth of non-U.S. firms (Bruno and Shin 2015; Avdjiev, Du, et al. 2019; Du and Schreger 2022).

I demonstrate that non-U.S. USD bonds have additional exposure to exchange rate risk compared to U.S. USD bonds, thereby contributing to the persistent pricing difference. Ex ante, one might expect a degree of exposure, yet the magnitude of exchange rate risk exposure is surprisingly high. My analysis reveals that, on average, exchange rate risk exposure accounts for approximately 56% of the Foreign Discount from January 2004 to March 2021. This finding sheds light on the significant role of exchange rate risk in driving the price difference within USD bonds. More importantly, this paper not only documents this novel link but also elucidates the sources of this additional exchange rate risk exposure.

I begin with a parsimonious static model that features two types of investors and firms: those from the U.S. and those from non-U.S. regions. Both groups of investors hold USD

1. See, for example, the Treasury premium (Du, Im, and Schreger 2018; Jiang, Krishnamurthy, and Lustig 2021) and the corporate basis (Liao 2020; Hu et al. 2023).

bonds issued by these firms. These investors are characterized by risk-averse behavior and mean-variance preferences, exhibiting a home bias toward USD bonds issued by their local firms. The model posits that the non-U.S. firm faces a currency mismatch issue on its balance sheet, as it incurs debts in USD while operating in a local currency market. Additionally, the model incorporates friction costs in an incomplete FX market, aligning with the empirical evidence of deviations in covered interest rate parity (CIP) (Du, Tepper, and Verdelhan 2018). The non-U.S. investor faces additional costs when converting local currency into USD.

In this framework, I denote the additional risk premium y_x of non-U.S. USD bonds over U.S. USD bonds as the Foreign Discount. The model leads to two key propositions. First, an exchange rate shock, such as an appreciation of the USD, diminishes the net worth of currency mismatched non-U.S. firms and undermines the fundamentals of these firms, as the depreciation of the local currency exerts a contractionary effect (Du and Schreger 2022). This adverse impact on non-U.S. firms escalates the risk associated with its USD bonds, leading investors to demand additional risk compensation. Consequently, this widens the y_x, exemplifying the balance sheet channel. Second, an appreciation of the USD also escalates the dollar funding costs for non-U.S. investors, subsequently constraining their risk-taking capacity (Avdjiev, Du, et al. 2019). As a result, they exert selling pressure on their USD asset holdings, predominantly impacting non-U.S. USD bonds. This predominance arises because non-U.S. investors primarily hold USD bonds issued by their local firms (Du and Huber 2023) due to their pre-existing home bias, leading to a greater effect on these bonds. This mechanism is referred to as the dollar home bias channel.

I present robust empirical evidence supporting the model using an extensive dataset spanning from January 2004 to March 2021 and comprising 15,375 USD bonds issued by 1,264 U.S. firms and 968 non-U.S. firms with a total notional amount of $11.88 trillion. To establish the nontrivial role of exchange rate risk within the Foreign Discount, I employ panel data regression with the strictest fixed effect sets: time, firm-year, and bond-level fixed effects to control for most of the possible factors that affect bond pricing. I then demonstrate that a one standard deviation appreciation in the USD leads to a 3.5 basis point increase in the Foreign Discount, equivalent to 8.5% of the Foreign Discount. Notably, this exchange rate risk aligns more closely with bilateral exchange rates rather than the broad USD index, as bilateral rates more effectively capture cross-sectional differences across non-U.S. countries. Furthermore, the impact of exchange rate risk on the Foreign Discount remains unchanged, both statistically and economically, after controlling for differential risk loadings of bonds to common bond-level characteristics, and with or without incorporating crisis periods. The influence of exchange rate risk is more pronounced during times of market turmoil and is observable in USD bonds issued by firms from both Emerging Market Economies (EME) and non-U.S. Advanced Economies (AE).[2] Notably, a more substantial impact is observed in EME USD bonds, while it is smaller for USD bonds issued by financial firms in G10 countries.[3]

Next, I present empirical evidence supporting the propositions of the model, beginning with an investigation of the balance sheet channel. The currency mismatch level in the balance sheets of non-U.S. firms is approximated by the proportion of outstanding USD bonds relative to the firms' total bonds. This measure is effective since firms generally operate in local markets but finance globally. Firm bond outstanding data are inferred from bond issuance information obtained from the SDC database. Approximately 52% of the total outstanding bond notional amount for non-U.S. firms consists of USD bonds. Specifically, for EME firms, USD bonds constitute a significant portion, ranging from 60% to 70%.

Importantly, I look at the endogenous choice of USD bond issuance by non-U.S. firms. Non-U.S. firms issue more USD bonds when they have more USD cash flows; however, a significant portion of USD bonds issued by non-U.S. firms do not match their USD cash flows, leaving them with considerable exchange rate risk exposure. I demonstrate that USD bonds issued by non-U.S. firms with a higher proportion of outstanding USD bonds exhibit greater exposure to exchange rate risk. Typically, for a USD bond issued by a non-U.S. firm with 52% of its total bonds outstanding in USD, a one standard deviation appreciation shock in the USD results in a 3.35 basis point increase in the Foreign Discount, which is about 8.1% of the Foreign Discount.

The balance sheet channel hypothesis remains robust across various specifications of currency mismatch levels for non-U.S. firms. Utilizing firm-level debt capital structure data from Capital IQ, I find that firms with more long-term USD liabilities are more exposed to exchange rate risk. Additionally, employing total asset data from the Compustat Fundamentals database, I construct a ratio of total USD bond outstanding to total assets. The results utilizing the USD bond to total asset ratio are consistent with the balance sheet channel.

I also consider the hedging capabilities of non-U.S. firms using financial and operating hedging. I find that both types of hedging work to mitigate exchange rate risk arising

2. The classification of EME and AE adheres to the guidelines established by the IMF World Economic Outlook.

3. Following Du, Tepper, and Verdelhan (2018), the G10 countries include Australia, Canada, Denmark, the Euro Area, Japan, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the United States. These countries are referred to as G10 because they use the G10 currencies.

from firms' USD liabilities. However, for financial hedging, only financial firms with a liquid local currency to USD pair in the FX market can effectively hedge their exchange rate risk exposures. For operating hedging, non-U.S. firms with more USD cash flow have less exchange rate risk exposure. Nonetheless, given the significantly higher proportion of USD liabilities over USD cash flows, non-U.S. firms still face considerable exchange rate risk exposure.

To examine the dollar home bias channel, I measure the ex ante home bias of non-U.S. USD bonds using the proportion of holdings by non-U.S. investors relative to the total bond outstanding at time $t-1$. These bond-level holdings data are sourced from the eMaxx database. In alignment with the dollar home bias channel, non-U.S. USD bonds with a greater proportion of non-U.S. investor holdings exhibit increased exchange rate risk exposures. For a typical USD bond, where approximately 73% of the total notional outstanding is held by non-U.S. investors, a one standard deviation appreciation in the USD increases the Foreign Discount by about 2.6 basis points, equivalent to a 6.3% increase. The influence of the dollar home bias channel is more significant for EME USD bonds and during periods of high VIX.

To further evidence the dollar home bias channel, I conduct a difference-in-differences (DiD) analysis centered on the reactivation of the standing central bank swap line policy during the Covid-19 period. This policy reduced dollar funding costs for non-U.S. investors who had access to it, thereby increasing their risk-taking capacities compared to other non-U.S. investors. Consistent with the dollar home bias channel, non-U.S. USD bonds issued by firms in countries where local investors had access to the swap line faced less selling pressure and exhibited a lower Foreign Discount compared to other non-U.S. USD bonds following the policy shock.

Lastly, I demonstrate that the balance sheet channel and the dollar home bias channel not only coexist but also mutually amplify each other's effects. Both channels exhibit dynamic significance throughout the sample period.

Related Literature. This paper contributes to the literature on the international role of the USD in asset pricing. A significant body of research focuses on the USD as a risk factor. Lustig, Roussanov, and Verdelhan (2014) document a USD factor based on the dollar carry trade strategy, offering a risk-based interpretation linked to global macroeconomic-level risks (Verdelhan 2018). Studies by Brusa, Ramadorai, and Verdelhan (2014), Nucera, Sarno, and Zinna (2024), and others highlight the importance of the USD factor in the pricing kernel of currency and international equity risk premiums.

Another strand of literature focuses on the fluctuation of the USD and its manifestation in the financial channel of exchange rates. A seminal paper by Bruno and Shin (2015) explains the impact of USD fluctuations on global liquidity through the banking risk-taking channel. They focus on the broad USD index and its link to the supply component of the financial channel of exchange rates. This component emphasizes how a stronger USD affects banks' credit portfolio tail risks, tightening their value-at-risk and economic capital constraints, thereby influencing the financial market and macroeconomy. Subsequent studies explore the significance of the financial channel in affecting cross-border bank lending (Avdjiev, Du, et al. 2019), sovereign spreads (Hofmann, Shim, and Shin 2022), global value chains (Bruno, Kim, and Shin 2018), and real economic activity (Avdjiev, Bruno, et al. 2019; Erik et al. 2019).

Focusing on bilateral exchange rates to the USD, another line of literature underscores the demand component of the financial channel of exchange rates. This body of work examines how USD appreciation decreases the net worth of non-U.S. firms with significant USD liabilities but whose assets are denominated in local currencies. The decline in net worth of non-U.S. firms leads to a contractionary effect on these firms, subsequently impacting the broader economy.[4] In this paper, I emphasize the significance of the demand component in affecting USD bond pricing and demonstrate how the financial channel of exchange rates affects USD bonds issued by non-US and US firms differently.

Additionally, this paper contributes to the corporate bond pricing literature, an area of extensive research with a focus on bond pricing determinants (e.g., Collin-Dufresne, Goldstein, and Martin 2001; Eom, Helwege, and Huang 2004; Huang and Huang 2012; Huang, Nozawa, and Shi 2023). Huang and Shi (2021) provide a systematic review of literature on corporate bond returns. Recent studies, such as those by Liao (2020), Cesa-Bianchi, Czech, and Eguren-Martin (2023), and Hu et al. (2023), focus on the currency effect in corporate bond pricing differentials, specifically the disparities between USD and non-USD bonds. This paper closely aligns with the work of Geng (2022), who documents a Foreign Discount in the USD bond market and attributes it to the uncertainty aversion of U.S. investors toward assets issued by non-U.S. firms, an aversion arising from difficulties in estimating the asset return distributions of these firms. Going beyond the uncertainty aversion hypothesis, in this paper, I offer an exchange rate risk-based explanation for the Foreign Discouns; further, I investigate the origins of bond-level exchange rate risk based on risk transmission from non-U.S. firm- and investor-level exchange rate risks.

4. Local currency depreciation results in balance sheet contraction (Korinek 2010; Kohn, Leibovici, and Szkup 2020; Caballero 2021), deteriorates firms' investment and net worth (Kim, Tesar, and Zhang 2015), increases default and bankruptcy risk (Dell'Ariccia, Laeven, and Marquez 2011; Niepmann and Schmidt-Eisenlohr 2022), affects stock prices (Bruno and Shin 2020), causes currency risks (Aghion, Bacchetta, and Banerjee 2001, 2004), magnifies monetary policy spillover (Akinci and Queralto 2018), widens sovereign risk premium (Hofmann, Shim, and Shin 2020; Wu 2020; Du and Schreger 2022), and lowers foreign currency borrowing (Hardy 2018).

This paper is also related to the literature on investors' home bias in portfolio composition. For example, Ahearne, Griever, and Warnock (2004) and Chan, Covrig, and Ng (2005) demonstrate international investors' home bias in asset allocations. Coeurdacier and Rey (2013) review various explanations of the home bias and present new portfolio facts for equities, bonds, and bank lending. Recently, Maggiori, Neiman, and Schreger (2020) document a strong home-currency bias in mutual funds' bond portfolios, along with a dominant USD bond demand for all investors beyond the home-currency bias, particularly noting a surge in USD-denominated cross-border holdings in corporate bonds after 2008 (Maggiori, Neiman, and Schreger 2019). In this paper, I shed light on how the ex ante home bias of non-U.S. investors transmits exchange rate risk exposure differently to USD bonds, resulting in a persistent pricing difference within the USD bond market.

The remainder of this paper is organized as follows. Section 2 introduces a parsimonious static model that outlines the balance sheet and dollar home bias channels. Section 3 describes the data sources. Section 4 establishes the connection between exchange rate risk and the Foreign Discount. Section 5 empirically tests these two channels, and Section 6 concludes the paper.

2 Model

In this section, I develop a parsimonious static model to establish the link between exchange rate risk and the Foreign Discount in USD bonds. The Foreign Discount of USD bonds reveals that non-U.S. USD bonds have a higher credit spread than U.S. USD bonds. This model provides a risk-based explanation for the Foreign Discount, suggesting that non-U.S. USD bonds have a higher credit spread because they have more exposure to exchange rate risk. The additional exchange rate risk exposures of non-U.S. USD bonds are sourced from two channels, which connect to differences in firm-level and investor-level exchange rate risks.

2.1 Model Setup

2.1.1 Firms

There are two representative price-taking firms in the model: a U.S. firm and a non-U.S. firm. Both operate in the domestic market and finance their business activities through the USD bond market. While these firms share many similarities, they differ in one key aspect: the non-U.S. firm experiences a currency mismatch, with its assets denominated in local currency and its liabilities in USD. The U.S. and non-U.S. firms issue USD bonds i and j in fixed amounts D_i and D_j, with observed bond yields y and $y + y_x$, respectively. The term y_x represents the additional risk premium, also termed the Foreign Discount, associated with non-U.S. USD bonds as compared to U.S. USD bonds. The payoff variances for bonds i and j are denoted as V and $V + v(\epsilon_{fx})$, respectively. ϵ_{fx} represents the exchange rate shock, which is defined in section 2.1.3.

2.1.2 Investors

In this setup, there are two representative investors: a U.S. investor and a non-U.S. investor. Both investors have mean-variance preferences and exhibit the same level of risk aversion, denoted by γ. Additionally, each investor exhibits a home bias toward USD bonds issued by domestic issuers, which indicates a preference for investing in bonds from firms within their own countries. This home bias influences their investment decisions and contributes to the observed differences in bond yields and risk exposures.

U.S. Investor. The U.S. investor invests n_i and n_j in USD bonds i and j, respectively, funding these investments with the domestic risk-free rate y^{rf}, where $y > y^{rf}$, in order to maximize utility:

$$max_{n_i,n_j} \underbrace{n_i y + n_j(y + y_x) - (n_i + n_j)y^{rf} - \frac{1}{2}\gamma V_n}_{\text{Mean-variance Preference}} + \underbrace{\mu_i}_{\text{Home Bias}} \tag{1}$$

where $V_n = [n_i^2 V + n_j^2(V + v(\epsilon_{fx})) + 2n_i n_j Cov(i,j)]$, and $Cov(i,j)$ is the covariance of returns for bond i and j.

μ_i represents the total home bias utility of a U.S. investor for holding USD bonds issued by a U.S. firm. As the holding of home assets increases, the total home bias utility (μ_i) also increases, but the marginal home bias utility (μ_i') decreases. This assumption is consistent with the standard concave utility function, where there are diminishing returns to input factors such as wealth. Therefore, μ_i is concave, as expressed by the following conditions:

$$\mu_i' = \frac{\partial \mu_i}{\partial n_i} > 0 \text{ and } \mu_i'' = \frac{\partial^2 \mu_i}{\partial n_i^2} < 0 \tag{2}$$

From the first-order conditions of the U.S. investor's utility function, the optimal n_i^* and n_j^* are:

$$n_i^* = \frac{1}{\gamma[V(V+v(\epsilon_{fx})) - Cov(i,j)^2]}\left[(V+v(\epsilon_{fx}))[(y-y^{rf}) + \frac{\partial \mu_i}{\partial n_i}] - Cov(i,j)[(y-y^{rf}) + y_x]\right] \tag{3}$$

$$n_j^* = \frac{1}{\gamma[V(V+v(\epsilon_{fx})) - Cov(i,j)^2]}\left[V[(y-y^{rf}) + y_x] - Cov(i,j)[(y-y^{rf}) + \frac{\partial \mu_i}{\partial n_i}]\right] \tag{4}$$

Non-U.S. Investor. The non-U.S. investor allocates investments in USD bonds i and j, denoted as m_i and m_j, respectively. These investments are funded with the domestic risk-free rate y^{rf}, plus an additional (non-negative) FX cost for converting from the domestic currency to the USD in the FX market, represented as $f(\epsilon_{fx})$. This additional FX cost represents the frictional cost arising from imperfections in the international FX market, a typical example being CIP deviations. To simplify the model, the domestic risk-free rates for both U.S. and non-U.S. investors are identical. I define:

$$f(\epsilon_{fx}) = \frac{1}{2}(m_i + m_j)(c + \epsilon_{fx}) \tag{5}$$

where c is a constant cost. The additional FX cost faced by non-U.S. investors is dependent on the amount of USD demanded and the magnitude of the exchange rate shock. Therefore, the total funding cost for a non-U.S. investor is given by $y^{rf} + \frac{1}{2}(m_i + m_j)(c + \epsilon_{fx})$.

The non-U.S. investor aims to maximize their utility, which can be formulated as:

$$max_{m_i,m_j} \underbrace{m_i y + m_j(y+y_x) - (m_i+m_j)[y^{rf} + \frac{1}{2}(m_i+m_j)(c+\epsilon_{fx})] - \frac{1}{2}\gamma V_m}_{\text{Mean-variance Preference}} + \underbrace{\mu_j}_{\text{Home Bias}} \tag{6}$$

where $V_m = m_i^2 V + m_j^2(V + v(\epsilon_{fx})) + 2m_i m_j Cov(i,j)$. The assumption of non-U.S. investors' home bias utility μ_j is consistent with that of U.S. investors, where $\mu_j' = \frac{\partial \mu_j}{\partial m_j} > 0$ and $\mu_j'' = \frac{\partial^2 \mu_j}{\partial m_j^2} < 0$.

From the first-order conditions of the non-U.S. investor's utility function, the optimal m_i^* and m_j^* are:

$$m_i^* = \frac{1}{\gamma(c+\epsilon_{fx})V_{y_x} + \gamma^2[V(V+v(\epsilon_{fx})) - Cov(i,j)^2]} \left[[(c+\epsilon_{fx}) + \gamma(V+v(\epsilon_{fx}))](y-y^{rf}) - [(c+\epsilon_{fx}) + \gamma Cov(i,j)][(y-y^{rf}) + y_x + \frac{\partial \mu_j}{\partial m_j}]\right] \tag{7}$$

$$m_j^* = \frac{1}{\gamma(c+\epsilon_{fx})V_{y_x} + \gamma^2[V(V+v(\epsilon_{fx})) - Cov(i,j)^2]}$$
$$\left[[(c+\epsilon_{fx}) + \gamma V][(y - y^{rf}) + y_x + \frac{\partial \mu_j}{\partial m_j}] - [(c+\epsilon_{fx}) + \gamma Cov(i,j)](y - y^{rf})\right] \tag{8}$$

where $V_{y_x} = V + (V + v(\epsilon_{fx})) - 2Cov(i,j)$.

2.1.3 Exogenous Shock

In this model, I account for exogenous exchange rate shock in the FX market, represented by ϵ_{fx}. A positive value of ϵ_{fx} indicates an appreciation of the USD, whereas a negative value signifies a depreciation.

Notably, the bond j, issued by a non-U.S. firm, carries an additional risk, $v(\epsilon_{fx})$, compared to bond i, which is issued by a U.S. firm. The first-order derivative of $v(\epsilon_{fx})$ with respect to ϵ_{fx} is positive, as:

$$\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} > 0 \tag{9}$$

According to the balance sheet channel literature (e.g., Hardy 2018; Bruno and Shin 2020; Du and Schreger 2022), an appreciation of the USD weakens the fundamentals of non-U.S. firm j. This impact is transmitted to non-U.S. USD bonds, leading to an increase in the variance of payoffs. Such a scenario highlights the vulnerability of the non-U.S. firm to exchange rate fluctuations, as the value of its USD-denominated liabilities escalates with the appreciation of the USD.

The covariance of returns for bonds i and j, denoted as $Cov(i,j)$, is also a function of ϵ_{fx}, and the first order derivative of $Cov(i,j)$ on ϵ_{fx} is negative

$$\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} < 0 \tag{10}$$

The intuition behind the first-order derivative is rooted in the currency mismatch on the balance sheet of non-U.S. firm j. When an exchange rate shock occurs, the payoff correlation ($\rho_{i,j}$) between bonds i and j declines significantly. Consequently, the covariance of returns between these bonds also decreases.

Subsequently,

$$\frac{\partial [v(\epsilon_{fx}) + \mathrm{Cov}(i,j)]}{\partial \epsilon_{fx}} > 0 \tag{11}$$

as the exchange rate shock primarily affects the risk associated with bond j, which in turn indirectly impacts the covariance of returns between bonds i and j.

2.2 Market-clearing and Equilibrium

All markets are in net-zero supply. The market-clearing conditions are:

$$\begin{cases} n_i^* + m_i^* = D_i \\ n_j^* + m_j^* = D_j \end{cases} \tag{12}$$

Combining these two conditions, I get $n_i^* - n_j^* + m_i^* - m_j^* = D_i - D_j$

$$\begin{aligned} n_i^* - n_j^* + m_i^* - m_j^* & \\ &= D_i - D_j \\ &= \frac{1}{\gamma\alpha}\left[v(\epsilon_{fx})(y - y^{rf}) + [V + v(\epsilon_{fx}) + Cov(i,j)]\frac{\partial\mu_i}{\partial n_i} - [Cov(i,j) + V]y_x\right] \\ &+ \frac{1}{\gamma(c+\epsilon_{fx})V_{y_x} + \gamma^2\alpha}\left[\gamma v(\epsilon_{fx})(y - y^{rf}) - [2(c+\epsilon_{fx}) + \gamma Cov(i,j) + \gamma V](\frac{\partial\mu_j}{\partial m_j} + y_x)\right] \end{aligned} \tag{13}$$

where $\alpha = [V(V+v(\epsilon_{fx})) - Cov(i,j)^2] = [V(V+v(\epsilon_{fx})) - \rho_{i,j}^2 V(V+v(\epsilon_{fx}))] > 0$ because the correlation between USD bonds issued by U.S. and non-U.S. firms is imperfect ($|\rho_{i,j}| < 1$).

I can endogenize y_x

$$\begin{aligned} y_x = \frac{1}{\beta}\Bigg\{&\gamma\alpha\Bigg[2v(\epsilon_{fx})\underbrace{(y - y^{rf})}_{\text{common risk premium}} + [V + v(\epsilon_{fx}) + Cov(i,j)]\underbrace{\frac{\partial\mu_i}{\partial n_i}}_{\text{U.S. investor's marginal home bias utility}} - (Cov(i,j) + V)\overbrace{\frac{\partial\mu_j}{\partial m_j}}^{\text{non-U.S. investor's marginal home bias utility}} - \gamma\alpha\underbrace{(D_i - D_j)}_{\text{relative issuance}}\Bigg] \\ &+ \underbrace{(c+\epsilon_{fx})}_{\text{average FX cost}}\left[V_{y_x}v(\epsilon_{fx})(y - y^{rf}) + V_{y_x}[V + v(\epsilon_{fx}) + Cov(i,j)]\frac{\partial\mu_i}{\partial n_i} - 2\alpha\frac{\partial\mu_j}{\partial m_j} - V_{y_x}\gamma\alpha(D_i - D_j)\right]\Bigg\} \end{aligned} \tag{14}$$

where $\beta = (c+\epsilon_{fx})[V_{y_x}(Cov(i,j) + V) + 2\alpha] + 2\gamma\alpha(Cov(i,j) + V)$.

In addition, $V + Cov(i,j) = V + \rho_{i,j}\sqrt{V(V + v(\epsilon_{fx}))} > V + \rho_{i,j}\sqrt{V^2} = (1 + \rho_{i,j})V > 0$. Therefore, all coefficients (without considering the plus or minus sign) of $y - y^{rf}$, $\frac{\partial\mu_i}{\partial n_i}$, $\frac{\partial\mu_j}{\partial m_j}$ and $D_i - D_j$ are positive.

Definition [Equilibrium]: Holding other factors constant, y_x:

1. Increases with a higher common bond risk premium ($y - y^{rf} \uparrow$), as investors demand

a higher return for taking on more risk.

2. Increases with a higher marginal home bias utility for U.S. investors ($\frac{\partial \mu_i}{\partial n_i} \uparrow$), leading to lower demand for non-U.S. USD bonds. Conversely, y_x decreases with a higher marginal home bias utility for non-U.S. investors ($\frac{\partial \mu_j}{\partial m_j} \uparrow$), resulting in higher demand for non-U.S. USD bonds.

3. Decreases with a greater relative supply of U.S. USD bonds compared to non-U.S. USD bonds ($D_i - D_j \downarrow$), as the relative scarcity of non-U.S. USD bonds increases.

These factors explain the equilibrium level of the Foreign Discount in the USD bond market.

2.3 Proposition

Utilizing the equilibrium equation (Equation (14)), I examine the impact of exchange rate shock (ϵ_{fx}) on the Foreign Discount (y_x), focusing on the effects of demand-side factors on the Foreign Discount and controlling for the influence of supply-side factors, such as relative bond issuance.

2.3.1 Without FX Cost

First, I look at only the balance sheet channel by muting the average FX cost as $c + \epsilon_{fx} = 0$. The equilibrium of y_x becomes:

$$\begin{aligned} y_x &= \frac{1}{2(Cov(i,j)+V)} \\ &\left[2v(\epsilon_{fx})(y - y^{rf}) + [V + v(\epsilon_{fx}) + Cov(i,j)]\frac{\partial \mu_i}{\partial n_i} - (Cov(i,j)+V)\frac{\partial \mu_j}{\partial m_j} - \gamma\alpha(D_i - D_j)\right] \end{aligned} \tag{15}$$

The equilibrium of y_x is influenced by the level of $v(\epsilon_{fx})$. Given $\frac{\partial \mathrm{Cov}(i,j)}{\partial \epsilon_{fx}} < 0$ and $\frac{\partial[v(\epsilon_{fx})+\mathrm{Cov}(i,j)]}{\partial \epsilon_{fx}} > 0$, it follows that $\frac{\partial \alpha}{\partial \epsilon_{fx}} > 0$ (*Proof: See Appendix A.1*). Furthermore, the relative bond issuance difference, $D_i - D_j$, does not exert a marginal effect on y_x, given that I mute the supply-side factor.

Proposition 1 [Balance Sheet Channel]: *An appreciation exchange rate shock (an appreciation of the USD) has the following effects:*

1. *Increasing the riskiness of non-U.S. USD bonds ($\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} > 0$),*

2. *Decreasing the covariance of returns between non-U.S. USD bonds and U.S. USD bonds* ($\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} < 0$).

This shock intensifies the upward pressure on the Foreign Discount (y_x), exerted by the common risk premium ($y - y^{rf}$) and the marginal utility of home bias among U.S. investors ($\frac{\partial \mu_i}{\partial n_i}$). Simultaneously, the shock reduces the downward pressure on the Foreign Discount caused by the marginal utility of home bias among non-U.S. investors ($\frac{\partial \mu_j}{\partial m_j}$). As a result, the exchange rate shock leads to a higher risk premium for non-U.S. USD bonds compared to U.S. USD bonds ($\frac{\partial y_x}{\partial \epsilon_{fx}} > 0$). (*Proof: See Appendix A.2*)

Proposition 1 clearly demonstrates that, via the balance sheet channel, an exchange rate shock increases the risk associated with non-U.S. USD bonds, leading to a larger Foreign Discount (y_x). Consequently, the currency mismatch in a non-U.S. firm's balance sheet exposes its USD bonds to heightened exchange rate risk.

2.3.2 With FX Cost

Next, I examine the equilibrium of y_x in the context of a positive average FX cost ($c + \epsilon_{fx} > 0$).

$$
\begin{aligned}
y_x = \frac{1}{\beta} \\
& \Big\{ \underbrace{\gamma\alpha \left[2v(\epsilon_{fx})(y - y^{rf}) + [V + v(\epsilon_{fx}) + Cov(i,j)] \frac{\partial \mu_i}{\partial n_i} - (Cov(i,j) + V) \frac{\partial \mu_j}{\partial m_j} - \gamma\alpha(D_i - D_j) \right]}_{\text{Component 1: links with the balance sheet channel}} + \\
& \underbrace{(c + \epsilon_{fx}) \left[V_{y_x} v(\epsilon_{fx})(y - y^{rf}) + V_{y_x}[V + v(\epsilon_{fx}) + Cov(i,j)] \frac{\partial \mu_i}{\partial n_i} - 2\alpha \frac{\partial \mu_j}{\partial m_j} - V_{y_x}\gamma\alpha(D_i - D_j) \right]}_{\text{Component 2: links with the dollar home bias channel}} \Big\}
\end{aligned} \tag{16}
$$

where V_{y_x} increases with the exchange rate shock.[5]

I subdivide y_x into two components. *Component 1* links with the balance sheet channel, and *component 2* links with the dollar home bias channel. β is the coefficient of these two components. $\frac{\partial \beta}{\partial \epsilon_{fx}}$ is negative while there is a large exchange rate shock. (*Proof: See Appendix A.3*).[6]

5. $V_{y_x} = V + (V + v(\epsilon_{fx})) - 2Cov(i,j)$. Since the exchange rate shock primarily affects the risk associated with non-U.S. USD bond j, it results in a side effect on the covariance of returns between the two bonds, denoted as Cov(i,j). Therefore, $\frac{\partial V_{y_x}}{\partial \epsilon_{fx}} > 0$

6. $\frac{\partial \beta}{\partial \epsilon_{fx}}$ would not materially affect the sign of $\frac{\partial y_x}{\partial \epsilon_{fx}}$ because the first order derivative of the numerator on ϵ_{fx} is positive such as $\frac{\partial \gamma\alpha}{\partial \epsilon_{fx}} > 0$ and $\frac{\partial (c+\epsilon_{fx})}{\partial \epsilon_{fx}} > 0$.

I prove the impact of *component 1* in Proposition 1. In Proposition 2, I focus on *component 2*.

$$y_x \sim \underbrace{(c+\epsilon_{fx})}_{\text{average FX cost}} \left[\overbrace{V_{y_x} v(\epsilon_{fx})(y - y^{rf}) + V_{y_x}[V + v(\epsilon_{fx}) + Cov(i,j)] \frac{\partial \mu_i}{\partial n_i} - 2\alpha \frac{\partial \mu_j}{\partial m_j} - V_{y_x} \gamma \alpha (D_i - D_j)}^{\text{the standard factor term}} \right] \tag{17}$$

Component 2 is an interaction term between average FX costs and *the standard factor term* (as discussed in Section 2.2). An appreciation in the exchange rate shock increases the average FX cost for non-U.S. investors, which in turn diminishes their risk-taking capacity and lowers their demand for USD bonds. Consequently, the increased FX cost leads to an amplification of *the standard factor term* on the Foreign Discount. Particularly, this amplification effect is more pronounced when non-U.S. investors exhibit a lower marginal home bias utility ($\frac{\partial \mu_j}{\partial m_j}$).

Proposition 2 [Dollar Home Bias Channel]: *Given that* $\frac{\partial \mu_j}{\partial m_j} < 0$*, an increased FX cost positively impacts* y_x *under a strong ex ante home bias among non-U.S. investors. This positive effect arises because a high proportion of USD bonds held by non-U.S. investors leads to a lower ex post marginal home bias utility (*$\frac{\partial \mu_j}{\partial m_j}$*), thereby diminishing their incentive to retain these bonds in the face of rising funding costs. Consequently, the overall effect of the FX cost on component 2 is positive (*$\frac{\partial \text{Component 2}}{\partial \epsilon_{fx}} > 0$*), particularly for a large ex ante holding of non-U.S. USD bonds by non-U.S. investors (*m_j*) .*

(*Proof: See Appendix A.4*)

Proposition 2 underscores the interaction between home bias and FX costs for non-U.S. investors. Specifically, a pronounced ex ante home bias among these investors, coupled with an exchange rate shock impacting their FX costs, leads to substantial ex post selling pressure on non-U.S. USD bonds.

By synthesizing Propositions 1 and 2, I find that the outcome $\frac{\partial y_x}{\partial \epsilon_{fx}} > 0$ emerges from the contributions of both $\frac{\partial \text{Component 1}}{\partial \epsilon_{fx}} > 0$ and $\frac{\partial \text{Component 2}}{\partial \epsilon_{fx}} > 0$. Consequently, an exchange rate shock amplifies the Foreign Discount (y_x) through both the balance sheet and the dollar home bias channels.

2.4 Model Extension

This parsimonious model provides an essential theoretical foundation and guidance for my empirical analysis. I will then discuss two extensions that can enrich the model and their impact on its propositions.

FX Returns. My baseline model assumes non-US investors are fully hedged, so there are no FX returns for non-US investors when the USD appreciates. The assumption, though imperfect, simplifies the model, allowing me to focus on the key parameters of interest. The model can incorporate FX returns r into the non-US investors' utility function, making the total FX return $(m_i + m_j)r$.

The first question is whether the FX return affects the choice of non-U.S. investors between non-U.S. and U.S. USD bonds. The answer is no because FX returns depend on the amount of USD invested rather than the choice within USD bonds. Instead, the additional FX return incentivizes non-U.S. investors to hold USD bonds, as USD bonds provide an additional insurance return (or hedging property) because the USD generally appreciates in bad times. Therefore, FX returns are important to consider when studying the portfolio allocation choice of non-U.S. investors between USD bonds and non-USD bonds. This is beyond the scope of this paper.

Next, can FX returns affect the model's proposition? The answer is yes. When the USD appreciates, especially during a crisis period, non-U.S. investors face increased USD funding costs but also hold USD assets with significant unrealized FX returns. Therefore, non-U.S. investors can "realize" the FX return by selling USD bonds to get USD cash. A typical example is the "Dash for Dollars" phenomenon during the Covid period (Cesa-Bianchi, Czech, and Eguren-Martin 2023). Therefore, the additional benefits of selling USD assets during USD appreciation would further amplify the dollar home bias channel, as non-U.S. investors put more significant selling pressure on non-U.S. USD bonds due to ex ante home bias.

Firm Hedging. My model also assumes that non-U.S. firms do not hedge the exchange rate risk of their USD liabilities. In theory, there are two types of hedging that firms can use. First, firms can conduct financial hedging through FX derivatives. However, not all firms can do that. A general firm is not sophisticated enough to hedge its dynamic FX exposures (Du and Schreger 2022). In section 5.1.3, I show that only financial firms with a liquid local currency to USD pair in the FX market can effectively hedge their exchange rate risk exposures.

Second, non-U.S. firms have non-U.S. assets and cash flows, which serve as a natural operating hedge for their USD liabilities. This is linked with the endogenous choice of USD bond issuance by non-U.S. firms, which I will also discuss later in my empirical section 5.1.1. In short, I show that part of the USD bonds issued by non-U.S. firms matches their USD assets and cash flows. However, there is still a significant portion of USD bonds issued by non-U.S. firms that is not due to the endogenous choice of their USD assets and cash flows but other factors such as pricing arbitrage, access to large liquid markets, or international currency bias. Therefore, all other endogenous preferences of non-U.S. firms, aside from asset and cash flow matching, result in additional *unhedged* exchange rate risk exposures for these firms when issuing USD bonds.

Overall, non-U.S. firms do not fully hedge the exchange rate risk exposures on their balance sheets, resulting in additional exchange rate risk, which plays a key role in my model.

3 Data and Definitions

3.1 Corporate Bond Data

I construct the corporate bond dataset using bond issuance information from the SDC Platinum Global New Issues database. This database includes various characteristics of each issue, such as notional principal, maturity date, coupon structure, denomination currency, issuer's nation, issuer's ultimate parent, and option-like feature indicators. I focus on USD-denominated bonds. Following Liao (2020) and Hu et al. (2023), I further filter the bonds based on three criteria: (1) the bond is unsecured, non-putable, non-convertible, and non-perpetual and has fixed-rate coupons; (2) the issuer is not in a government-related industry, such as city government, national government, or city agency; and (3) the bond has an initial maturity of at least one year and a notional principal of at least $50 million. A significant number of USD bonds issued by non-U.S. firms, especially emerging market firms, are intermediated through offshore subsidiaries (Maggiori, Neiman, and Schreger 2020; Coppola et al. 2021; Du and Schreger 2022). Therefore, nationality-based data better measure the issuer's country of origin. Specifically, I trace each bond back to its ultimate parent's nationality by linking it to the issuer's CUSIP, issuer's nation, and ultimate parent's CUSIP from the SDC database. I match around 97% of bonds with their ultimate parent's nationality. Approximately 37% of non-U.S. USD bonds are issued by non-U.S. firms through their offshore subsidiaries.

I merge the filtered bond data with month-end price quotes (bid-, mid-, and ask-yield to maturity) from Bloomberg based on ISIN. This is a widely used data source for studies on international corporate bond markets (Valenzuela 2016; Geng 2022). The sample period is from January 2004 to March 2021. For each bond-month observation, I assign a credit rating following Dick-Nielsen, Feldhütter, and Lando (2012): I first look up bond's credit rating in the Standard & Poor's Global Ratings database; if its rating in that month is missing, I turn to the Moody's Default & Recovery Database. If the rating information is still unavailable, I use the rating from other agencies as displayed in Bloomberg (e.g., Fitch). Finally, I winsorize the yield-to-maturity and bid-ask spread at the 1% level on a monthly basis to remove outliers.[7]

The final dataset consists of 15,375 bonds issued by 1,264 U.S. firms and 968 non-U.S. firms with a total notional amount of $11.88 trillion. Figure 1 displays the dynamics of USD bonds outstanding notional amount from January 2004 to March 2021. I disaggregate USD bonds based on the issuer's country of origin into U.S. and non-U.S. I further classify non-U.S. into non-U.S. AE and EME. Figure 1a and 1b report the time-series outstanding notional amount in $ billions and the percentage of total USD bond outstanding notional amount, respectively. The total USD bond outstanding notional amount exhibits a clear upward trend, peaking at around $6 trillion. The outstanding notional of non-U.S. USD bonds has sharply increased since the 2008 global financial crisis, and the share of non-U.S. USD bonds outstanding notional amount over the total USD bond outstanding notional amount has doubled from 20% to 40%. Non-U.S. AE USD bonds account for a significant portion of non-U.S. USD bonds. Figure 1 highlights the importance of non-U.S. issuers in the USD bond issuance market.

Table 1 presents the monthly average of the number of bonds, the notional amount in $ billions, and the number of corresponding firms by rating and maturity categories. On average, there are approximately 3,523 bonds with notional amount of $2,782 billion issued by 1,213 firms each month. The A&BBB rating classes and the maturity group of 3-7 years hold the largest share in terms of both issuance and outstanding notional amount. With respect to the market size of each issuer, U.S. USD bonds comprise around 68% (2,382) of bonds, 64% ($1,771 billion) of notional amount, and 60% (730) of issuers in the sample. Within the non-U.S. USD bonds, non-U.S. AE USD bonds account for approximately 74% (840) of bonds, 77% ($782 billion) of notional amount, and 63% (304) of issuers in the sample.

Table 2 provides the summary statistics of USD bond characteristics, including credit spread, rating, remaining maturity, age, issuance size, and coupon rate. I employ a numerical translation of credit rating by assigning 1 to AAA and 2 to AA+ and progressively increase the numerical value until assigning 21 to C. The mean level of a USD bond features a 1.89% credit spread with a rating of 7.70, remaining maturities of 7.98 years, an age of 4.57 years, an issuance size of $790 million, a 4.87% coupon rate, and a 0.15% bid-ask spread. On average, non-U.S. USD bonds exhibit slightly lower credit spreads, bid-ask

7. I primarily use bid-ask spreads from Bloomberg and fill bid-ask spread data for a small portion of bonds using the WRDS Bond Returns database.

spreads, and ratings compared to U.S. USD bonds. Among the non-U.S. USD bonds, EME USD bonds have a significantly larger credit spread (2.92%), larger bid-ask spreads (0.18%), and a worse rating (9.07).

3.2 Institutional Investor Holdings Data

I acquire data on U.S. institutional investor holdings from Thomson Reuters Lipper eMaxx. This dataset is free from survivorship bias and is widely employed in the literature (e.g. Becker and Ivashina 2015; Jiang et al. 2022). The data include security-level fixed income holdings at quarter-ends from 2003Q4 to 2021Q1. I match the holdings data with the SDC Platinum Global New Issues database based on bonds' ISIN. Figure 2a presents the covered U.S. institutional investors in the dataset, and I classify U.S. institutional investors into Mutual Funds, Property/Casualty Insurance Companies, Life Insurance Companies, and Others. Notably, mutual funds have doubled from 1,000 to around 2,000. Figure 2b plots the average shares of USD bonds held by U.S. institutional investors from 2004Q1 to 2021Q1. The share is measured by the percentage of U.S. institutional investor holdings over the bond total issuance size. I categorize USD bonds based on the issuer's country of origin into U.S., non-U.S., EME, and G10 (non-U.S.). Approximately 46% of U.S. USD bonds outstanding notional amount are held by U.S. institutional investors. However, only 27% (10%) of non-U.S. (EME) USD bonds outstanding notional amount (EME firms) are held by U.S. institutional investors.

3.3 Other Data

U.S. Treasury yields with maturities of 1, 2, 5, 7, 10, 12, 15, 20, and 30 years are obtained from Bloomberg. I download the nominal broad USD index from Federal Reserve Economic Data. I primarily use the Nominal Broad USD Index (DTWEXBGS), which began in 2006. I fill in the nominal USD index from 2004 to 2006 using the Nominal Broad USD Index (Goods Only) (DISCONTINUED). I normalize the two indices to have the same value on the 2nd of January 2006. I also obtain the bilateral exchange rate from Bloomberg. The VIX data are from Federal Reserve Economic Data. All data are monthly.

I construct the firm-level debt capital structure using data from Capital IQ and total asset data from Compustat Fundamentals. I also access foreign sales, income, and asset data at the firm level from Worldscope Segments. I then match the firm-level fundamental data with the bond-level data based on the firm-level ID. Details on the matching steps are available in Appendix B.

4 Empirical Evidence: Exchange Rate Risk

My theoretical model highlights the significant role of exchange rate risk in influencing the Foreign Discount. In this section, I establish a robust link between bond-level exchange rate risk exposures and the Foreign Discount. I then present empirical evidence supporting Propositions 1 and 2 in the model in Section 5.

4.1 Exchange Rate Risk Exposure

Starting with anecdotal evidence, a model-free estimation of the Foreign Discount can be obtained by comparing two similar bonds issued by comparable firms within the same industry and with the same credit rating, one based in the U.S. and the other outside the U.S. Notably, Airbus and Boeing are dominant players in the commercial aircraft market, characterized as a duopoly. Airbus is located in France, while Boeing is based in the U.S. These companies, although fierce competitors, share many similarities in terms of market dominance, product families, global presence, and technological advancements. Therefore, I construct a model-free estimation of the Foreign Discount by comparing similar USD bonds issued by Airbus (ISIN: US26824KAA25) and Boeing (ISIN: US097023BG91).[8]

Figure 3 presents the time series of the model-free Foreign Discount as a blue bar, the USD/EUR exchange rate as a green line, and the scaled broad USD index as an orange line. The USD experienced significant depreciation in 2017, attributable to pronounced political risks and uncertainty surrounding the U.S. economy.[9] Interestingly, this marked depreciation of the USD coincided with a considerable contraction of the Foreign Discount, highlighting potential linkages between exchange rate risk and the Foreign Discount.

I formally examine the effect of exchange rate risk exposure on the Foreign Discount through a panel specification in Equation (18):

$$\text{CreditSpread}_{i,t} = \alpha + \beta\text{Foreign}_i + \lambda\Delta\text{Dollar}_t + \theta\text{Foreign}_i \times \Delta\text{Dollar}_t + \text{controls}_{i,t} + \epsilon_{i,t} \tag{18}$$

where $\text{CreditSpread}_{i,t}$ is the credit spread for corporate USD bond i at time t, and Foreign_i is a dummy variable that takes a value of 1 for issues from non-U.S. firms. Dollar_t is the log of the USD value at time t. An increase in Dollar_t represents an appreciation of the

8. In April 2013, Airbus issued a ten-year tenor USD bond (ISIN: US26824KAA25) with a fixed coupon rate of 2.7%, maturing in April 2023. Meanwhile, in October 2014, Boeing issued a seven-year tenor USD bond (ISIN: US097023BG91) with a fixed coupon rate of 2.35%, maturing in October 2021. The credit spreads of these two bonds exhibit a high correlation of 0.72 at the level.

9. For instance, the administration of former President Trump failed to enact the healthcare and tax-cut reforms it had initially promised.

USD. Other control variables include bond characteristics such as rating, bid-ask spreads, remaining maturity, age, issuance size, and coupon rate.

Table 3 presents the results. Column (1) replicates the findings of Geng (2022) with time (year-month) and industry fixed effects but includes an additional interaction term between Foreign_i and ΔDollar. The coefficient of Foreign_i, β, is 0.416 at a 1% significance level. I demonstrate that, without the exchange rate shock, the average credit spread of non-U.S. USD bonds is 41.6 basis points higher than that of U.S. USD bonds, highlighting the Foreign Discount. Importantly, the coefficient of the interaction term, θ, is positive at a 1% significance level. Therefore, non-U.S. USD bonds have a larger exposure to exchange rate risk than U.S. USD bonds.

Given the large cross-country bond panel dataset, there are noticeable differences among countries, firms, and bonds. To establish robust results, I leverage the advantage of fixed effects to control for all possible factors. Appendix C.1 presents the results with an exhaustive combination of fixed effects. In the following analysis, I employ the strictest fixed effect sets: time, firm-year, and bond-level fixed effects to control for various factors that could affect bond pricing. These factors include fundamental differences between countries and bonds, time-varying shocks to each country and firm, such as sovereign risk and economic policy uncertainty, as well as firm fundamentals and credit risk. As a result, Foreign_i would be absorbed by the firm fixed effect. Columns (2) and (3) of Table 3 present the results using the broad USD index and bilateral exchange rate, respectively. After incorporating the strictest fixed effect sets, the R^2 increases from 0.48 to 0.83, indicating the effectiveness of my model specification in controlling for all possible factors. The coefficient of the interaction term, θ, remains highly positive and significant at the 1% significance level. For example, in column (3), a θ value of 0.022 indicates that a one standard deviation appreciation shock to the bilateral exchange rate (1.61) increases the Foreign Discount by 3.5 basis points, which is about 8.5% of the Foreign Discount.

To visually represent the relationship between the Foreign Discount and heterogeneous exchange rate exposure, I estimate a cross-sectional regression of Equation (18) each month and display the results in Figure 4. Figure 4a shows the time series of the Foreign Discount, while Figure 4b highlights the contribution of heterogeneous exchange rate exposure, accounting for 26 basis points and 54% of the Foreign Discount, on average, from January 2004 to March 2021.[10 11]

10. From July 2008 to December 2008, the Foreign Discount experienced a sharp increase from -32 basis points to 210 basis points, closely related to a significant appreciation of the USD during the same period. For example, the U.S. broad USD index rose by approximately 10% in that time.

11. The Foreign Discount exhibits a pattern similar to the CIP deviations documented by Du, Tepper, and Verdelhan (2018). In Appendix C.2, I investigate the extent to which CIP deviations can fully account for

A natural follow-up question to the exchange rate risk analysis is which exchange rate matters. In column (4) of Table 3, I include interaction terms of the Foreign dummy with both the broad USD index and the bilateral exchange rate. Only the coefficient of the interaction term using the bilateral exchange rate remains highly significant. Furthermore, following Avdjiev, Bruno, et al. (2019), I construct orthogonalized components of the two exchange rates relative to each other. Column (5) includes both interaction terms using the broad USD and the orthogonalized component of the bilateral exchange rate relative to the broad USD. Since the broad USD acts *de facto* as a global factor, the orthogonalized component of the bilateral exchange rate captures the country-specific shock. Column (6) includes both interaction terms using the bilateral exchange rate and the orthogonalized component of the broad USD relative to the bilateral exchange rate.[12] For example, the orthogonalized component of the broad USD relative to the EUR/USD bilateral exchange rate captures exogenous shocks affecting the USD but unrelated to any shocks affecting the relative valuation of EUR/USD. Only the coefficient of the interaction term using the orthogonalized component of the bilateral exchange rate remains highly significant, while the coefficient of the interaction term using the orthogonalized component of the broad USD is statistically insignificant.

Overall, the impact of exchange rate risk on the Foreign Discount is primarily attributable to shocks affecting the bilateral exchange rate, rather than the broad USD. This result aligns with my prior assumption, as bilateral rates can more accurately capture the cross-sectional differences for each country. Therefore, in subsequent empirical analyses, I focus on the bilateral exchange rate.

4.2 Robustness Checks

I conduct a series of robustness checks presented in Table 4. First, the exposure of corporate bonds, issued by both US and non-US firms, to conventional bond characteristics may vary. Consequently, a prevalent question arises: Is the impact of exchange rate risk on the Foreign Discount unique, or does it merely reflect conventional bond risk? To investigate this query, interaction terms between the Foreign dummy and a series of bond-level characteristics are added in column (1). The coefficient (θ) of the interaction between the Foreign dummy and exchange rate risk is 0.021, and it is highly significant at the 1% level. Additionally, the magnitude of 0.021 aligns closely with the previous finding of

the Foreign Discount. The findings suggest that exchange rate risk more effectively explains the Foreign Discount.

12. I construct the orthogonalized component of the broad USD for each bilateral exchange rate separately, instead of regressing the broad USD on all bilateral exchange rates at once.

0.022 in column (3) of Table 3. This outcome indicates that the effects of exchange rate risk exposure are independent of the differential risk loadings of bonds to common bond-level characteristics. In column (2), I address the non-stationarity problem by adding the lag of the credit spread into the control variables. In column (3), I include only the sample from 2010 to 2019 to eliminate the effects of the global financial crisis and the Covid-19 period. θ remains positive and highly significant in columns (2) and (3).

In column (4), I introduce a three-way interaction term among Foreign_i, $\Delta\text{Dollar}_t^{Bilateral}$, and VIX_t^{High}. VIX_t^{High} is a dummy variable indicating periods of heightened market volatility, taking a value of 1 when the VIX is higher than 30.[13] Excluding the global financial crisis period, I show that the effect of exchange rate risk is more pronounced during market turmoil, given the significant and positive coefficient of this three-way interaction term. Quantitatively, the additional exchange rate risk exposure during high-VIX periods is nearly four times greater. In unreported results, I find that the findings are robust when using the continuous VIX variable or alternative measures of market stress, such as the BEX uncertainty index (Bekaert, Engstrom, and Xu 2022). In column (5), I introduce a three-way interaction term: $\text{Foreign}_i \times \Delta\text{Dollar}_{i,t}^{Bilateral} \times \text{EME}_i$. EME_i is a dummy variable that takes a value of 1 for issuers from emerging market economies. The positive coefficient of this three-way interaction term indicates that USD bonds issued by EME firms have more exposure to exchange rate risk than those issued by non-U.S. AE firms. Lastly, in column (6), I introduce a four-way interaction term: $\text{Foreign}_i \times \Delta\text{Dollar}_{i,t}^{Bilateral} \times \text{Fin}_i \times \text{G10}_i$. Fin_i is a dummy variable that takes a value of 1 for financial firm issuers. G10_i is a dummy variable that takes a value of 1 for issuers from G10 countries. The coefficient of this four-way interaction term is significantly negative, at -0.023, while the corresponding three-way interaction term ($\text{Foreign}_i \times \Delta\text{Dollar}_{i,t}^{Bilateral} \times \text{Fin}_i$) has a significantly positive coefficient, at 0.027. Therefore, non-U.S. USD bonds issued by G10 financial firms exhibit lower exchange rate risk exposures compared to other non-U.S. USD bonds.

5 Empirical Evidence: Balance Sheet and Dollar Home Bias Channels

In this section, I transition Propositions 1 and 2 (as discussed in Section 2) into empirical testing, specifically focusing on the balance sheet and dollar home bias channels.

13. This threshold is based on a rule of thumb. For more information, visit https://www.fidelity.com.sg/beginners/what-is-volatility/volatility-index.

5.1 Balance Sheet Channel

In Proposition 1 of the model, I propose a balance sheet channel wherein an appreciation of the USD leads to a decline in the net worth of currency-mismatched non-U.S. firms. This results in a contraction of their balance sheets, which negatively affects their bond prices. According to this balance sheet channel, I hypothesize that USD bonds issued by non-U.S. firms with significant currency mismatches, particularly those with substantial USD liabilities, are more exposed to exchange rate risk

5.1.1 Endogenous Choice

I use the ratio of outstanding USD bonds to the total amount of bonds issued by the firm as a measure of the level of USD liabilities on the firm's balance sheet. The ratio of outstanding USD bonds to total bonds outstanding is a practical and informative measure of a firm's USD liabilities. Since USD bonds are commonly used by both U.S. and non-U.S. firms to access the large and liquid international bond market, this ratio can provide valuable insights into a firm's exposure to exchange rate risk and its overall level of USD-denominated debt.

The bond's outstanding notional data are inferred from the international bond issuance data in the SDC database. In detail, I follow the same data filtering process as in Section 3 but retain bonds of all currency denominations. Since the remaining bonds are non-putable and non-convertible, I estimate an approximate bond outstanding notional amount based on the issue date and maturity date and aggregate this to the firm level. I then calculate the proportion of USD-denominated bonds to the total bonds' outstanding notional amount and aggregate this at the firm level to the U.S., non-U.S., G10 (non-U.S.), and EME levels by taking the average value for each month. Figure 5 presents the dynamic proportion of USD bonds in the total bonds' outstanding notional amount. USD bonds account for around 52% of the total bonds' outstanding notional amount for non-U.S. firms; firms from EME have a significantly higher USD bond proportion (60% - 70%) than firms from non-U.S. G10 countries (40% - 45%). Unsurprisingly, U.S. firms have only a small proportion of bonds denominated in non-USD.

One important concern is the endogenous choice of USD bond issuance by non-U.S. firms. If non-U.S. firms issue USD bonds exclusively to match their USD assets or cash flows, their exchange rate risk exposure would be fully hedged. However, USD bond issuance by non-U.S. firms might also be motivated by other factors, such as accessing larger capital markets and exploiting interest rate differentials. These choices can introduce additional exchange rate risk exposure for non-U.S. firms.

Based on the Worldscope Segment data, I directly test the endogenous choice of USD bond issuance by non-U.S. firms.The availability of Worldscope Segment data varies across different variables, allowing me to match up to 71.2% of non-U.S. firms, providing a good understanding of firms' endogenous choices regarding USD bond issuance. Additionally, I use foreign assets, sales, and income of non-U.S. firms to proxy their USD assets, sales, and income based on the USD dominant role in international trade. For example, Gopinath et al. (2020) and Gopinath and Stein (2021) show that for non-U.S. countries, firms set export prices in a dominant currency, most often USD. Therefore, although not all foreign-related assets, sales, and incomes are directly denominated in USD, the ultimate cash flows often settle in USD. Furthermore, I resample the yearly-level data to monthly-level data using the last available value.

Specifically, following Colacito, Qian, and Stathopoulos (2023), who also study the endogenous choice of USD bond issuance by non-U.S. firms, I regress the share of USD bonds to the total bond's outstanding notional amount for firm f at time t ($\text{USDShare}_{f,t}$) on the share of foreign assets to total assets ($\text{ForeignAssetShare}_{f,t}$), foreign sales to total sales ($\text{ForeignSaleShare}_{f,t}$), and foreign income to total income ($\text{ForeignIncomeShare}_{f,t}$), while controlling for country-time fixed effects, as specified in the following equation.

$$\text{USDShare}_{f,t} = \alpha + \beta_1 \text{ForeignAssetShare}_{f,t} + \beta_2 \text{ForeignSaleShare}_{f,t} + \beta_3 \text{ForeignIncomeShare}_{f,t} + \epsilon_{f,t} \quad (19)$$

Table 5 presents the results. The coefficients of $\text{ForeignAssetShare}_{f,t}$ and $\text{ForeignSaleShare}_{f,t}$ are highly significant in the univariate regression. However, when all variables are included in the same regression, consistent with Colacito, Qian, and Stathopoulos (2023), the outstanding notional amount of USD bonds is only significantly connected to foreign sales (USD cash flows). More interestingly, the intercepts of all regressions are highly significant both economically and statistically. For example, in column (2), after controlling for $\text{ForeignSaleShare}_{f,t}$, α is 0.476, indicating that, on average, 47.6% of the USD bond share for non-U.S. firms is driven by other factors beyond USD asset and cash flow matching. Overall, non-U.S. firms issue a significant amount of USD bonds not only to match USD assets and cash flows but also for other reasons, exposing these firms to significant exchange rate risk. The results also support the effectiveness of using $\text{USDShare}_{f,t}$ to proxy the currency mismatch level of non-U.S. firm balance sheets.

5.1.2 USD Liabilities

I test the balance sheet channel to add a tripe interaction term $\text{Foreign}_i \times \Delta\text{Dollar}_t \times \text{USDShare}_{f,t}$ in Equation (20). Its coefficient, γ reflects the significance of the balance sheet channel.

$$\text{CreditSpread}_{i,t} = \alpha + \theta\text{Foreign}_i \times \Delta\text{Dollar}_t + \gamma\text{Foreign}_i \times \Delta\text{Dollar}_t \times \text{USDShare}_{f,t} + \text{controls}_{i,t} + \epsilon_{i,t} \quad (20)$$

Table 6 provides evidence for the balance sheet channel. Column (1) shows that USD bonds issued by non-U.S. firms with larger USD liabilities have higher exposure to exchange rate risk. The coefficient of the triple interaction term, γ, is 0.04 and significant at the 1% level. Therefore, for a USD bond issued by a non-U.S. firm with an average $\text{USDShare}_{f,t}$ of 0.52, a one standard deviation appreciation shock to the bilateral exchange rate (1.61) increases the Foreign Discount by 3.35 basis points.[14] This is approximately 8.1% of the Foreign Discount.

The measure of $\text{USDShare}_{f,t}$ is not perfect but can cover the full sample of my data. I further construct alternative measures of USD liabilities using the firm-level debt capital structure from Capital IQ. The Capital IQ data provide detailed information on the currency composition of outstanding debt for individual firms.[15] I match around 84% of my sample to the Capital IQ database, and I resample the yearly-level debt capital structure to monthly-level data using the last available data. Specifically, I construct two variables: $\text{USDLiabShare}_{f,t}$ and $\text{USDLiabShare}_{f,t}^{Long-term}$. $\text{USDLiabShare}_{f,t}$ is the proportion of USD liabilities to total liabilities, and $\text{USDLiabShare}_{f,t}^{Long-term}$ is the proportion of long-term USD liabilities to total long-term liabilities. For long-term liabilities, I identify those with a remaining maturity of more than 3 years. Columns (2) and (3) replace $\text{USDShare}_{f,t}$ with $\text{USDLiabShare}_{f,t}$ and $\text{USDLiabShare}_{f,t}^{Long-term}$, respectively. I find that γ is significant only when using $\text{USDLiabShare}_{f,t}^{Long-term}$. One possible explanation is that non-U.S. firms borrow more in USD for long-term funding. For example, the median level of $\text{USDLiabShare}_{f,t}$ for non-U.S. firms is 0.24, compared to 0.42 for $\text{USDLiabShare}_{f,t}^{Long-term}$. This finding confirms the significant role of long-term USD liabilities in influencing the exchange rate risk exposures of non-U.S. firms. Additionally, it validates the use of $\text{USDShare}_{f,t}$, which reflects the proportion of long-term USD bonds relative to total long-term bonds.

14. The value of 0.52 indicates that, for non-U.S. firms, approximately 52% of the bond's outstanding notional amount is denominated in USD.

15. For more data information, see Kim, Mano, and Mrkaic (2020).

Another challenge of using $\text{USDShare}_{f,t}$ is that this measure only considers the liability side and cannot fully reflect the magnitude of currency mismatch. Thus, I construct an alternative measure of currency mismatch, $\text{USDBond2TA}_{f,t}$, which represents the ratio of the outstanding USD bonds' notional amount ($\text{USDShare}_{f,t}$) to a firm's total assets for firm f at time t. The firm's total assets are sourced from the Compustat Fundamentals database and resampled to the monthly level using the last available data. I match around 78% of my sample. $\text{USDBond2TA}_{f,t}$ is winsorized at the 1% level. Column (4), which uses $\text{USDBond2TA}_{f,t}$, shows results that are consistent with those obtained from using $\text{USDShare}_{f,t}$. Therefore, the balance sheet channel hypothesis is robust across different specifications of currency mismatch levels for non-U.S. firms.

5.1.3 Financial and Operating Hedging

Non-U.S. firms have two primary ways to hedge their exchange rate risk exposures arising from their USD liabilities. First, firms can use FX derivatives for financial hedging. However, most firms cannot effectively hedge their balance sheet's exchange rate risk exposure due to the high costs and complexities associated with dynamic financial hedging (Du and Schreger 2022). Therefore, I focus on how financial firms use financial instruments to reduce their exchange rate risk exposures. Specifically, I examine financial firms from Australia, Canada, the Euro Area, Japan, and the United Kingdom, as their local currencies versus USD have the highest FX turnover.[16] This implies that their local financial firms have liquid markets for financial hedging. I construct a dummy variable Top5_f, which is equal to one if firms are from Australia, Canada, the Euro Area, Japan, the United Kingdom, or the United States. Column (5) of Table 6 shows that the coefficient of the five-way interaction term ($\text{Foreign}_i \times \Delta\text{Dollar}_t \times \text{USDShare}_{f,t} \times \text{Fin}_i \times \text{Top5}_i$) is negative and significant, while the coefficient of the four-way interaction term ($\text{Foreign}_i \times \Delta\text{Dollar}_t \times \text{USDShare}_{f,t} \times \text{Fin}_i$) is insignificant. Therefore, only financial firms with a liquid local currency to USD pair in the FX market can effectively hedge their exchange rate risk exposures.

Second, as discussed in section 5.1.1, firms can use their foreign cash flows to hedge their exchange rate risk exposures on the liabilities side through operating hedging. I test whether firms with more foreign cash flows have less exchange rate risk exposure. The results, presented in column (6) of Table 6, show a negative and significant coefficient of the new interaction term ($\text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} \times \text{USDShare}_{f,t} \times \text{ForeignSaleShare}_{f,t}$), indicating the effectiveness of operating hedging. However, as shown in 5.1.1, non-U.S.

16. The BIS 2022 Triennial Central Bank Survey shows that the top five advanced economy FX market turnover pairs are USD/EUR, USD/JPY, USD/GBP, USD/CAD, and USD/AUD.

firms still have a considerable amount of USD liabilities that do not match their foreign cash flows, leaving them with significant exchange rate risk exposures.

5.2 Dollar Home Bias Channel

I propose the dollar home bias channel in Proposition 2 of my model. This channel connects bond-level exchange rate risk exposures to investor-level exchange rate risk exposures and comprises two main elements.

First, there is a home bias in investing in USD bonds. As shown in Figure 2b, investors exhibit a home bias towards USD bonds issued by their own local firms. More formally, I construct a new variable $\text{NonUSHolding}_{i,t}$, which represents the proportion of bond i's outstanding notional amount held by non-U.S. investors at time t.[17] Following Maggiori, Neiman, and Schreger (2020), I run the following regression:

$$\text{NonUSHolding}_{i,t-1} = \alpha + \lambda_1 D_{i,\text{AE (non-G10)}} + \lambda_2 D_{i,\text{G10 (non-US)}} + \lambda_3 D_{i,\text{EME}} + \text{controls}_{i,t} + \epsilon_{i,t} \quad (21)$$

where $D_{i,\text{AE (non-G10)}}$, $D_{i,\text{G10 (non-US)}}$, and $D_{i,\text{EME}}$ are equal to one if the bond is issued by firms from AE (non-G10), G10 (non-US), and EME, respectively, and their coefficients indicate the level of home bias of local investors. $\text{controls}_{i,t}$ includes bond-level characteristics. The coefficients λ_1, λ_2, and λ_3 are 0.33, 0.08, and 0.30, respectively, and are significant at the 1% level. Therefore, there is a strong home bias for USD bonds issued by firms from AE (non-G10) and EME, but it is less prominent for USD bonds issued by firms from G10 (non-US). For example, USD bonds issued by EME firms have 30% more non-U.S. investors holding them.

Second, an appreciation of the USD is associated with stress on cross-border USD liquidity and higher indirect dollar funding costs for non-U.S. investors (Avdjiev, Du, et al. 2019), leading to a decrease in the risk-taking ability of these investors.

Combining these two elements, due to ex ante home bias, non-U.S. investors predominantly hold non-U.S. USD bonds in their portfolios. Consequently, an appreciation of the USD reduces the risk-taking capabilities of non-U.S. investors, exerting selling pressure on their holdings, mainly affecting non-U.S. USD bonds. I hypothesize that non-U.S. USD bonds with a higher proportion of non-U.S. investors have more significant exposure to exchange rate risk.

17. The eMaxx database provides only quarterly-level holdings data, so I resample it to monthly using the last available holdings data. I winsorize $\text{NonUSHolding}_{i,t}$ at the 1% level to mitigate the impact of outliers. The holdings data at the non-U.S. level is not perfect but can offer clear indications of the home bias of both U.S. and non-U.S. investors.

5.2.1 Non-U.S. Investor Holdings

I test the dollar home bias channel through a panel specification in Equation (22).

$$\begin{aligned}\text{CreditSpread}_{i,t} =&\alpha + \theta\text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} \\ &+ \omega\text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} \times \text{NonUSHolding}_{i,t-1} + \text{controls}_{i,t} + \epsilon_{i,t}\end{aligned} \tag{22}$$

I add $\text{NonUSHolding}_{i,t-1}$ to measure the level of ex ante investors' home bias. This lag variable also helps to avoid any contemporaneous impact on USD and investor holdings. Consequently, ω reflects the significance of the dollar home bias channel.

Table 7 supports the existence of the dollar home bias channel. Column (1) indicates that for USD bonds issued by non-U.S. firms, an (ex ante) average $\text{NonUSHolding}_{i,t-1}$ of 0.73, combined with a one standard deviation appreciation shock to the bilateral exchange rate (1.61), leads to an increase in the Foreign Discount. This increase is approximately 2.6 basis points, equivalent to a 6.3% increase. Additionally, the dollar home bias channel appears to similarly affect USD bonds issued by both financial and non-financial firms, as shown in column (2). Column (3) demonstrates that this channel is more pronounced for EME USD bonds, showing that their local investors are less resilient to funding cost shocks. Column (4) indicates that the dollar home bias channel is especially pronounced during periods of market turmoil, reflecting a joint effect of market uncertainty and heightened funding costs.

5.2.2 Central Bank Swap Line

In addition to standard panel data regression, I conduct a DiD analysis to assess the effectiveness of the dollar home bias channel. This analysis specifically examines how exogenous policy shocks affect non-U.S. investors, leading to varied outcomes for non-U.S. bonds as a consequence of the dollar home bias channel. A prime example is the reactivation of the central bank swap line policy during the Covid-19 crisis.

First, the international fallout from Covid-19 in March 2020 led to an unexpected shortage of cross-border USD liquidity. Cesa-Bianchi, Czech, and Eguren-Martin (2023) document a "Dash for Dollars" phenomenon, where investors, especially those from non-U.S. countries, liquidated their USD assets to meet USD-denominated obligations. This action significantly widened the credit spreads of USD bonds compared to non-USD bonds. Based on the dollar home bias channel, non-U.S. USD bonds likely experienced more severe impacts due to this liquidity shortage. Subsequently, the central bank swap line was reactivated to distribute low-cost USD liquidity to dealers at the counterparty central banks.[18] Investors with access to the swap line were therefore less affected by the scarcity of cross-border USD. Hence, within non-U.S. USD bonds, I differentiate between a treatment group of "Swap" USD bonds and a control group of "Other" USD bonds. The "Swap" USD bonds include those issued by firms in countries linked to central banks with swap line access, providing local investors with cheaper USD liquidity.

My analysis primarily focuses on the standing swap line agreement between the Federal Reserve and the central banks of England, Canada, the European Union, Japan, and Switzerland.[19] I designate March 15, 2020, as "Event Day Zero," and compare the Foreign Discount between "Swap" and "Other" USD bonds. Specifically, I examine the Foreign Discount for the five trading days before (March 9 to March 13) and three trading days after (March 16 to March 18) the reactivation of the standing swap line. Importantly, the Federal Reserve expanded the temporary swap lines on March 19, 2020. Therefore, my analysis is confined to the period when only the standing swap line policy was operational.

Figure 6 presents the Foreign Discount for both "Swap" and "Other" bonds around the reactivation of the Federal Reserve's standing swap lines on March 15, 2020. This analysis uses daily bond yield data. Before Event Day Zero, there is a noticeable parallel trend in the Foreign Discount between "Swap" and "Other" bonds. However, following the reactivation, the Foreign Discount for "Swap" bonds began to decrease, in contrast to an increase in "Other" bonds.

$$\Delta \text{CreditSpread}_{i,t} = \alpha + \lambda \text{Foreign} \times \text{D}_{Covid} \times \text{D}_{Swap} + \eta \text{Foreign} \times \text{D}_{Covid} + \phi \text{D}_{Covid} + \text{controls}_{i,t} + \epsilon_{i,t} \quad (23)$$

I formally test the effect of standing swap lines using a triple difference specification in Equation (23). The first difference in credit spread serves as the dependent variable to control for the non-stationary problem of daily bond yield. D_{Covid} is a dummy variable, assigned a value of 1 after the reactivation of standing swap lines on March 15, 2020. D_{Swap} is another dummy variable, given a value of 1 for "Swap" USD bonds. The sample period includes daily data from March 9, 2020, to March 18, 2020. Table 8 presents the results. The coefficient of the triple DiD interaction term is negative and significant, with values of -0.043 in both columns (1) and (2), which use firm fixed effects and firm and day

18. A central bank swap line is an agreement between central banks to exchange their respective currencies. The effectiveness of the standing swap line in alleviating dollar liquidity shortages has been examined by Bahaj and Reis (2020, 2022) and Ferrara et al. (2022).

19. In addition to this agreement, the Federal Reserve implemented similar policies to address the cross-border USD liquidity crisis, with crucial timing differences. The reactivated standing swap line was established on March 15, 2020. Shortly afterward, on March 19, 2020, the Federal Reserve announced temporary swap lines with other central banks, including the Reserve Bank of Australia, Banco Central do Brasil, Danmarks Nationalbank, and others. This timing difference provides an excellent basis for a DiD analysis.

fixed effects, respectively. This result indicates that the Foreign Discount of "Swap" USD bonds decreased by 4.3 basis points more than "Other" USD bonds. This divergence is further evidence of the dollar home bias channel. During tight cross-border USD liquidity, non-U.S. investors with swap line access exerted less selling pressure on USD bonds issued by their local firms, thereby reducing the exchange rate risk exposures of those non-U.S. USD bonds.

5.3 Channel Comparison and Robustness Tests

Previous findings underscore the significance of firm-level (balance sheet channel) and investor-level (dollar home bias channel) exchange rate risk exposures in influencing bond-level exchange rate risk exposures, which in turn affect the Foreign Discount within USD bonds. Here, I compare these two channels.

$$\begin{aligned} \text{CreditSpread}_{i,t} =& \alpha + \theta \text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} + \gamma \text{Foreign}_i \times \Delta\text{Dollar}_t \times \text{USDShare}_{f,t} \\ &+ \omega \text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} \times \text{NonUSHolding}_{i,t-1} + \text{controls}_{i,t} + \epsilon_{i,t} \end{aligned} \tag{24}$$

Table 9 examines these two channels using Equation (24). In column (1), the coefficients of the two three-way interaction terms ($\text{Foreign}_i \times \Delta\text{Dollar}_{i,t}^{Bilateral} \times \text{USDShare}_{f,t}$ and $\text{Foreign}_i \times \Delta\text{Dollar}_{i,t}^{Bilateral} \times \text{NonUSHolding}_{i,t-1}$) are positive and significant at the 1% level. For a typical firm with an average $\text{USDShare}_{f,t}$ of 0.52 and $\text{NonUSHolding}_{i,t-1}$ of 0.73, a one standard deviation appreciation shock to the bilateral exchange rate (1.61) increases the Foreign Discount by 1.9 basis points, equivalent to a 4.6% increase. In column (2), after adding the interaction term between the two channels ($\text{Foreign}_i \times \Delta\text{Dollar}_{i,t}^{Bilateral} \times \text{USDShare}_{f,t} \times \text{NonUSHolding}_{i,t-1}$), the corresponding coefficient is positive and highly significant, suggesting these two channels amplify each other.

Finally, I explore the dynamic significance of the two channels by conducting a rolling regression of Equation (24) with a 36-month window from January 2004 to March 2021. Figure 7 displays the rolling effects of both channels with a 95% confidence interval in the shaded area. Both channels spiked during the global financial crisis, in 2015 when the Federal Reserve raised interest rates for the first time since 2006, and during the Covid-19 period. The significance of the balance sheet channel fluctuated throughout the sample period but became consistently significant in the later part. The dollar home bias channel has remained consistently significant since 2008 but has become less pronounced in recent periods.

6 Conclusion

This paper proposes an exchange rate risk-based explanation for the Foreign Discount within USD bonds. I demonstrate that non-U.S. USD bonds persistently exhibit higher credit spreads than their U.S. counterparts, primarily attributable to greater exposure to exchange rate risk. This price dispersion and differential exchange rate risk exposure, significant yet overlooked in previous research, become especially relevant considering that non-U.S. USD bonds accounted for 40% of the total USD bonds outstanding in 2021.

Integrating theoretical insights with empirical analysis, I identify two channels contributing to the differential exposure to exchange rate risk. First, the balance sheet channel reveals that non-U.S. firms with significant USD liabilities encountering currency mismatches are more susceptible to fluctuations in the USD. This susceptibility translates their firm-level exchange rate risks into bond-level risks. Second, the dollar home bias channel highlights that the appreciation of the USD diminishes the risk-taking capacity of non-U.S. investors, leading to an increase in the sale of their holdings. This selling pressure disproportionately affects USD bonds issued by non-U.S. firms, largely held due to a pre-existing home bias. The dollar home bias channel links investor and bond-level exchange rate risks.

This paper underscores the importance of exchange rate risk, particularly fluctuations in the USD, in asset pricing through the financial channel of exchange rates. This work also raises questions for future research. For instance, which type of non-U.S. investors primarily transmit exchange rate risk to their USD holdings? How effectively can firms use financial derivatives to hedge their exchange rate risk and, consequently, reduce their costs of issuing USD bonds? Further research employing granular firm-level and investor-level data could shed light on the heterogeneity in the transmission of exchange rate risk from firms and investors to USD bonds.

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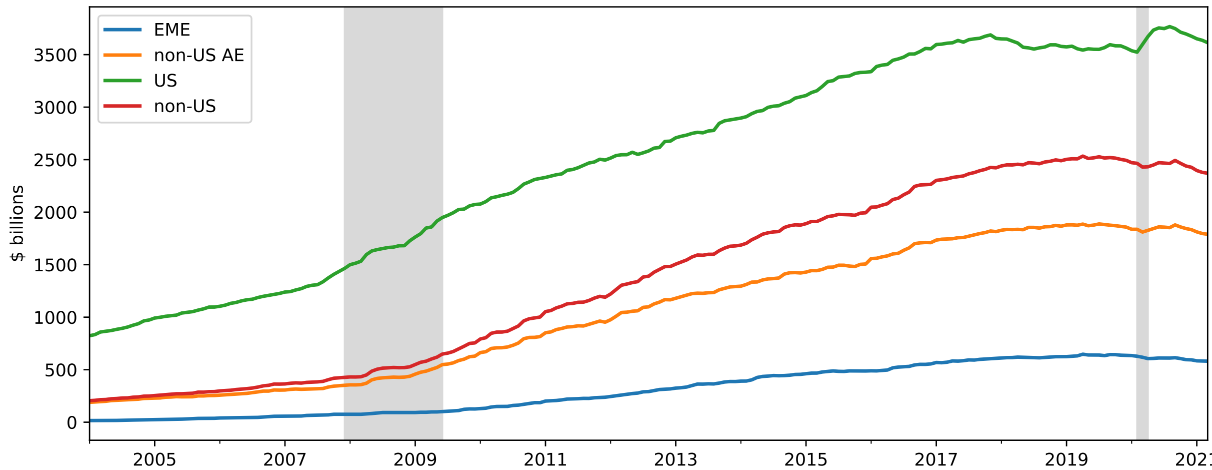
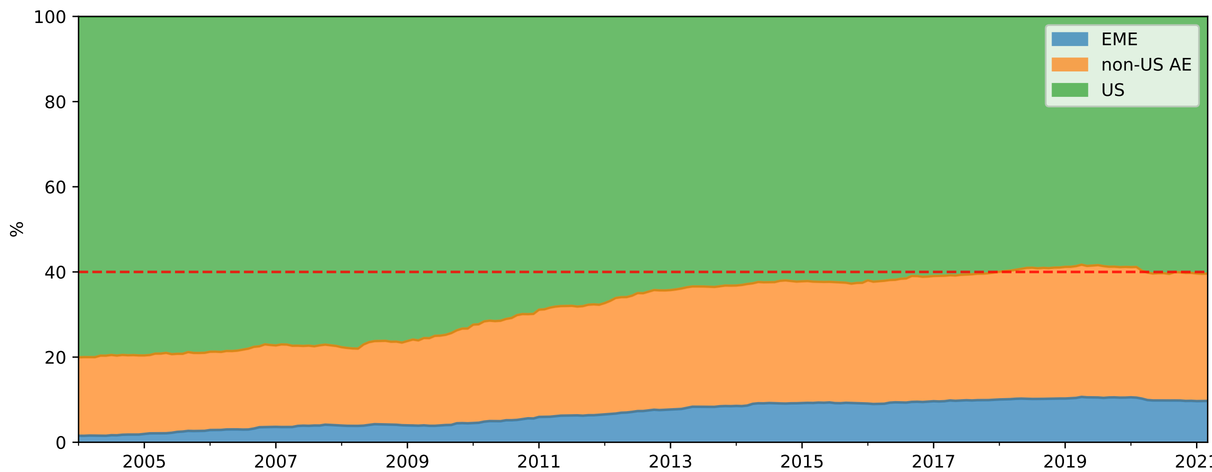
Figure 1: Outstanding Notional Amounts of USD Bonds

(a) Outstanding Notional Amounts in $ Billions



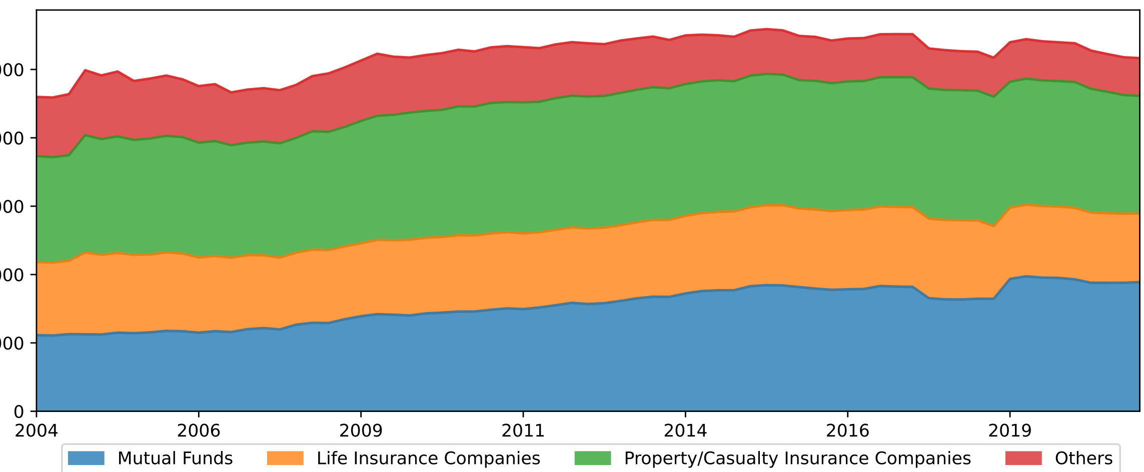
(b) Shares of Outstanding Notional Amounts



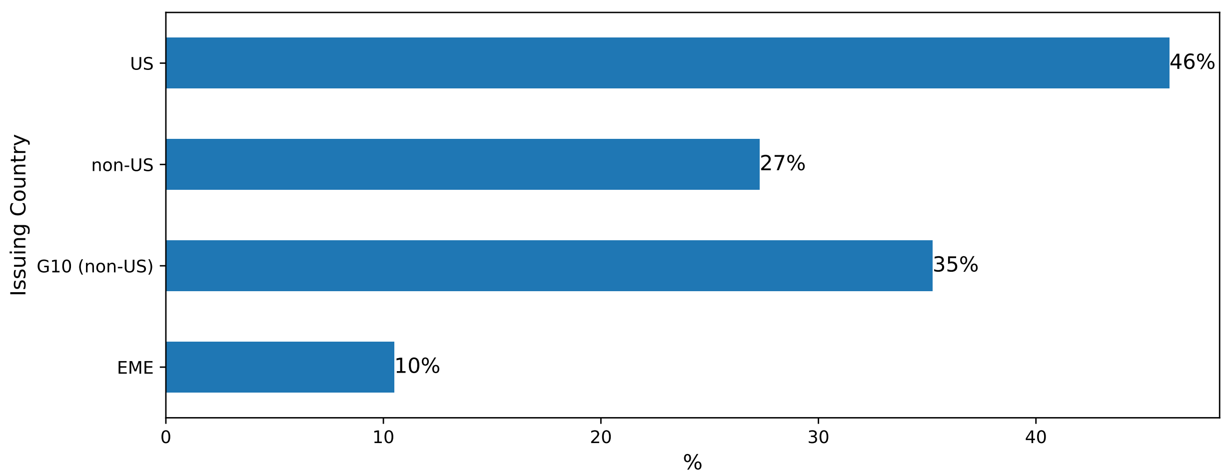
Note: This figure presents the outstanding notional amounts of USD bonds from January 2004 to March 2021. USD bonds are classified based on the issuer's country of origin into U.S. and non-U.S.. I further classify non-U.S. to non-U.S. AE and EME. Panel (a) illustrates the dynamics of total outstanding notional amounts of dollar bonds in billions of dollars, while panel (b) shows the shares of outstanding notional amounts based on the issuer's country of origin. The data source is the SDC Platinum Global New Issues database. Shaded bars denote months designated as recessions by the National Bureau of Economic Research.

Figure 2: U.S. Institutional Investor Holding Data

(a) Numbers of Covered U.S. Institutional Investors

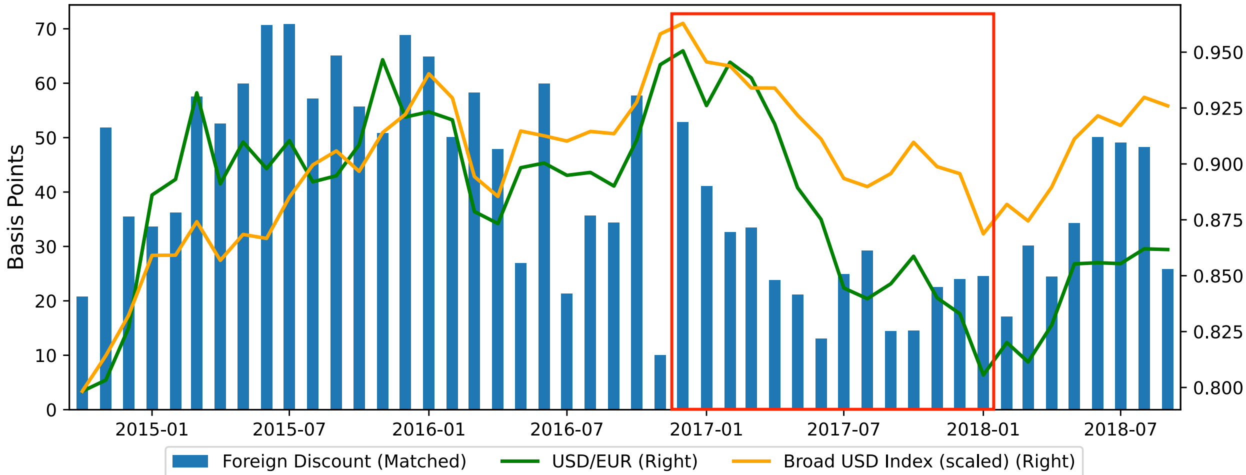


(b) Average Shares of USD Bonds Held by U.S. Institutional Investors



Note: This figure presents data on U.S. institutional investor holdings. Panel (a) shows the dynamics of covered U.S. institutional investors from 2004Q1 to 2021Q1. I classify U.S. institutional investors into Mutual Funds, Property/Casualty Insurance Companies, Life Insurance Companies, and Others. Panel (b) illustrates the average share of USD bonds held by U.S. institutional investors from 2004Q1 to 2021Q1. This share is measured as the percentage of the total issuance size of USD bonds held by U.S. institutional investors. I classify USD bonds based on the issuer's country of origin into U.S., non-U.S., EME and G10 (Non-U.S.). The data source is from Thomson Reuters Lipper eMaxx.

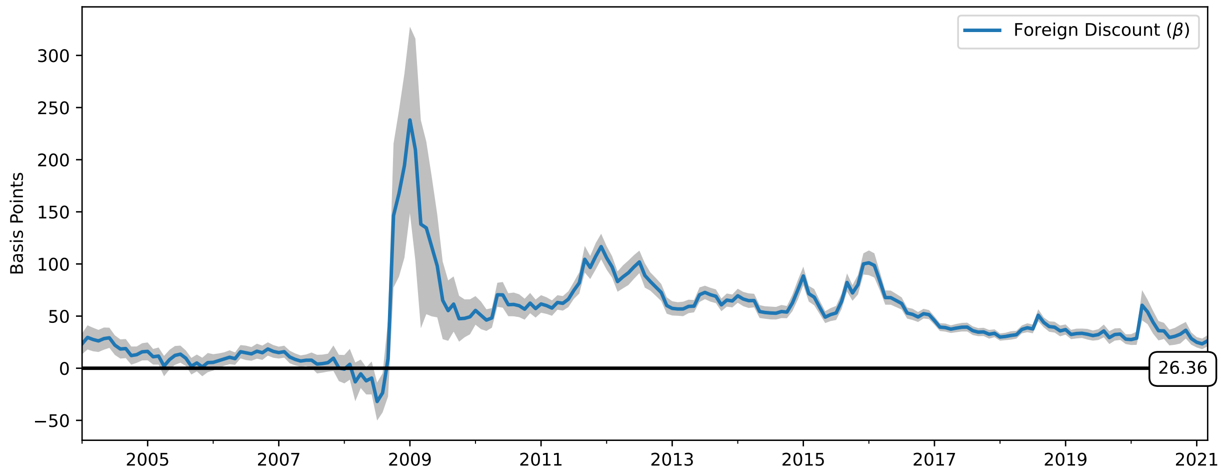
Figure 3: Anecdotal Evidence: Airbus and Boeing



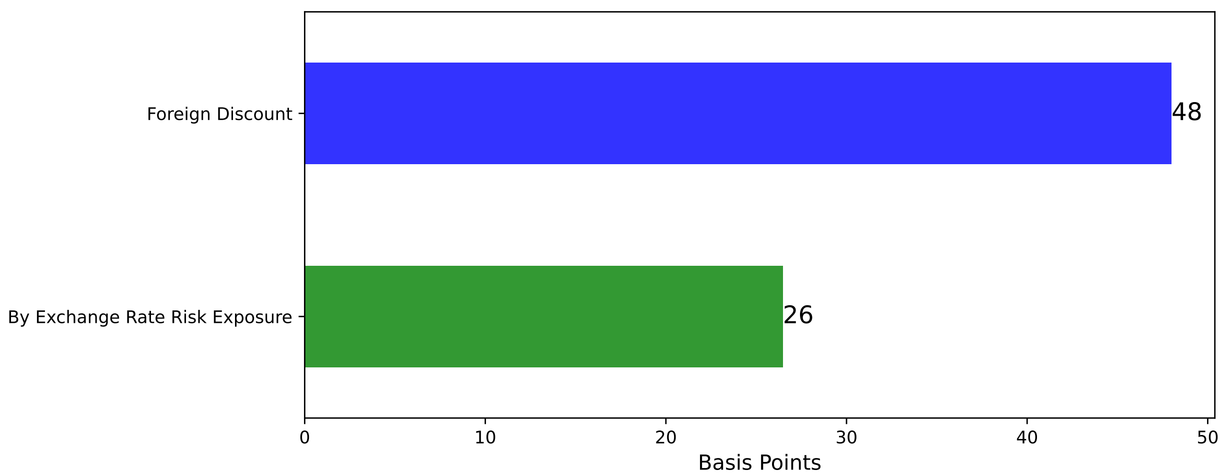
Note: The figure presents the Foreign Discount (Matched) as a blue bar, alongside the USD/EUR exchange rate and the broad USD index, depicted by green and orange lines, respectively. The Foreign Discount (Matched) is calculated as the difference in credit spreads between the USD bonds issued by Airbus (ISIN: US26824KAA25) and those issued by Boeing (ISIN: US097023BG91). The USD/EUR exchange rate represents the value of one USD in terms of euros. The broad USD index, measuring the value of one USD in terms of a basket of other world currencies, is scaled to have the same initial value as the USD/EUR exchange rate for comparative purposes.

Figure 4: Foreign Discount and the Contribution of Exchange Rate Risk Exposure

(a) Time Series of the Foreign Discount



(b) Mean of the Foreign Discount and Contribution by Exchange Rate Risk Exposure



Note: The top figure presents the time series of the Foreign Discount (represented by the blue line) for USD bonds, along with a 95% confidence interval depicted in the shaded area. I estimate the time-series variables by running the cross-section regression each month:

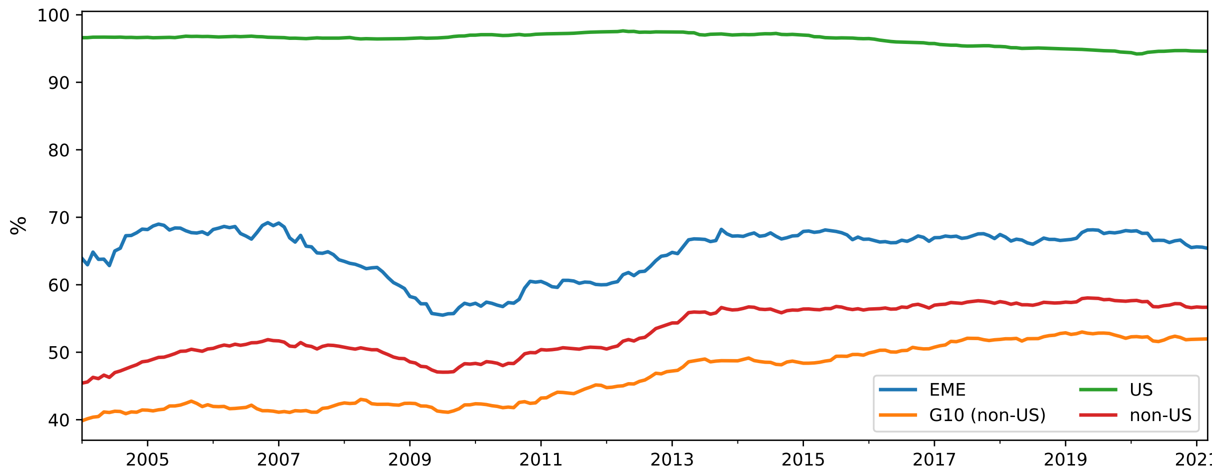
$$\text{CreditSpread}_{i,t} = \alpha + \beta \text{Foreign}_i + \text{controls}_{i,t} + \epsilon_{i,t}$$

The blue line is the β. The bottom figure illustrates the mean of the Foreign Discount and the contribution of exchange rate exposure. To obtain the mean value, I first estimate the cross-section regression for each month:

$$\text{CreditSpread}_{i,t} = \alpha + \beta_2 \text{Foreign}_i + \gamma \Delta \text{Dollar}_t + \theta \text{Foreign}_i \times \Delta \text{Dollar}_t + \text{controls}_{i,t} + \epsilon_{i,t}$$

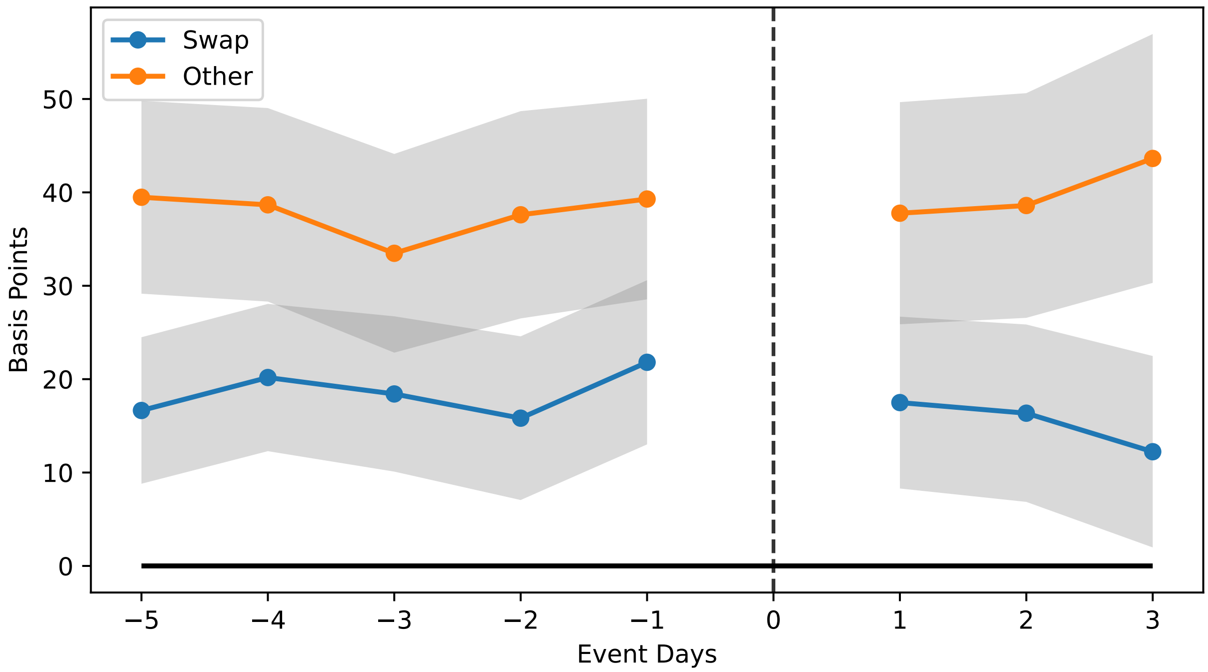
Then, I get the average of Foreign Discount as the mean of $\beta_2 \text{Foreign}_i + \theta \text{Foreign}_i \times \Delta \text{Dollar}_t$ and the average of contribution by the exchange rate exposure as the mean of $\theta \text{Foreign}_i \times \Delta \text{Dollar}_t$. The sample period is monthly from January 2004 to March 2021. Foreign_i is a dummy variable that takes a value of 1 for issues that are non-U.S. firms. ΔDollar_t is the log change in the broad USD index at time t. Control variables include bond characteristics such as rating, bid-ask spreads, remaining maturity, age, issuance size, and coupon rate.

Figure 5: The Share of USD Bonds in Total Outstanding Bond Notional Amount



Note: This figure presents the share of USD bonds in the total outstanding bond notional amount. I classify firms based on the issuer's country of origin into U.S., non-U.S., EME and G10 (Non-U.S.). I infer the bond outstanding amount using the SDC Platinum Global New Issues database.

Figure 6: Foreign Discount in the COVID-19 Pandemic

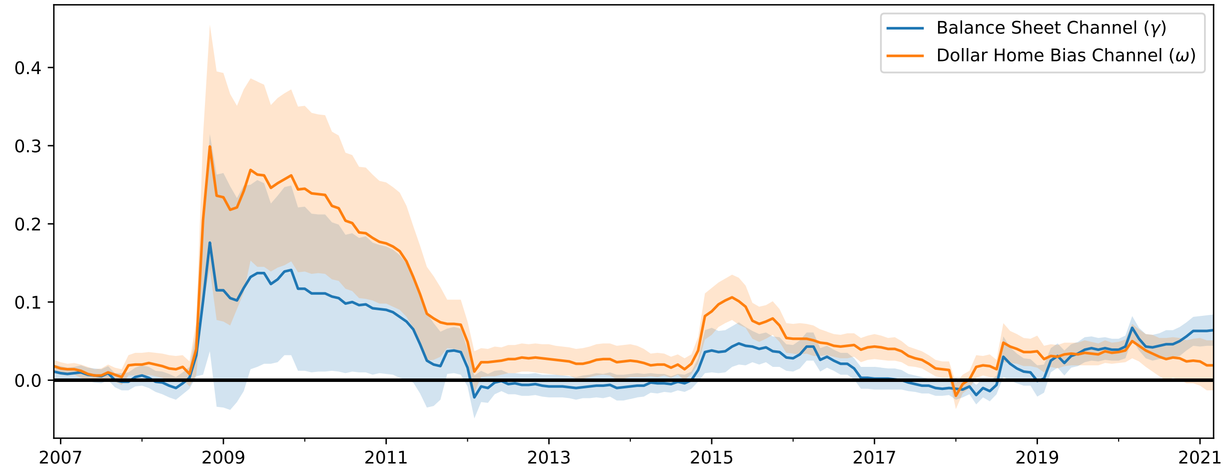


Note: The figure presents the Foreign Discounts for USD bonds issued by non-U.S. firms from "Swap" countries and "Other" countries, respectively. The "Swap" countries refer to countries of the five other Central Banks (the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank, and the Swiss National Bank). The "Other" countries are the rest of the non-U.S. countries. The figure presents Foreign Discounts for five days before and three days after the event day. The event day refers to the day when the Federal Reserve reactivated the standing swap lines with the five other central banks on March 15, 2020. The estimation of the Foreign Discount is based on the cross-section regression:

$$\text{CreditSpread}_{i,t} = \alpha + \beta_1 \text{Swap}_i + \beta_2 \text{Other}_i + \text{controls}_{i,t} + \epsilon_{i,t}$$

where Swap_i (Other_i) takes a value of 1 for firms from Swap (Other) countries, respectively. The blue line represents β_1, and the orange line represents β_2, with their respective 95% confidence intervals depicted in shaded areas around each line. The sample period covers daily data from March 09, 2020, to March 18, 2020.

Figure 7: Channel Comparison: Rolling Windows Analysis



Note: This figure presents the rolling effect of the balance sheet channel and the dollar home bias channel with a window of 36 months from January 2004 to March 2021. The rolling regression is:

$$\begin{aligned}\text{CreditSpread}_{i,t} =& \alpha + \theta \text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} + \gamma \text{Foreign}_i \times \Delta\text{Dollar}_t \times \text{USDShare}_{f,t} \\ &+ \omega \text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} \times \text{NonUSHolding}_{i,t-1} + \text{controls}_{i,t} + \epsilon_{i,t}\end{aligned}$$

The blue (orange) line presents the rolling effect of the balance sheet channel (dollar home bias) with a 95% confidence interval in the shaded area. Control variables include bond characteristics such as rating, and bid-ask spreads, as well as all corresponding two-way interaction terms of the three-way interaction terms. The regression also controls for time and firm-fixed effects.

Table 1: Corporate Bond Information - Issuer Level

	No.	Notl. $bil	No. Firms
All			
Total	3,523.20	2,782.31	1,212.64
Rating			
AAA&AA	477.98	499.07	131.31
A	1,252.10	1,046.57	353.62
BBB	1,311.37	929.66	496.96
HY (BB and below)	481.75	307.02	254.35
Maturity			
1-3 yrs	869.83	708.09	519.38
3-7 yrs	1,330.18	1,060.73	737.25
7-10 yrs	647.69	517.57	438.50
10+ yrs	675.50	495.92	324.53

	No.	Notl. $bil	No. Firms		No.	Notl. $bil	No. Firms
US				**non-US**			
Total	2,381.94	1,771.06	730.27	Total	1,141.26	1,011.25	483.77
Rating				**Rating**			
AAA&AA	247.68	275.96	56.80	AAA&AA	230.30	223.11	74.66
A	827.60	645.17	201.74	A	424.50	401.40	152.02
BBB	976.94	655.33	331.63	BBB	334.43	274.33	165.84
HY (BB and below)	329.72	194.60	155.98	HY (BB and below)	152.02	112.41	98.59
Maturity				**Maturity**			
1-3 yrs	516.28	396.67	297.66	1-3 yrs	353.55	311.42	221.85
3-7 yrs	870.87	647.28	447.12	3-7 yrs	459.31	413.44	290.43
7-10 yrs	460.00	344.17	301.54	7-10 yrs	187.68	173.40	137.04
10+ yrs	534.79	382.93	241.91	10+ yrs	140.71	112.99	82.77
non-US AE				**non-US EME**			
Total	840.11	781.96	304.05	Total	301.14	229.29	180.28
Rating				**Rating**			
AAA&AA	213.33	208.15	65.52	AAA&AA	16.97	14.95	9.14
A	348.04	340.75	113.24	A	76.45	60.65	38.78
BBB	210.44	180.91	90.73	BBB	124.00	93.42	75.27
HY (BB and below)	68.29	52.14	39.98	HY (BB and below)	83.73	60.27	58.84
Maturity				**Maturity**			
1-3 yrs	263.49	252.06	144.87	1-3 yrs	90.06	59.36	77.03
3-7 yrs	326.71	312.61	186.81	3-7 yrs	132.60	100.84	103.78
7-10 yrs	138.15	129.62	96.03	7-10 yrs	49.53	43.78	41.01
10+ yrs	111.76	87.68	62.79	10+ yrs	28.96	25.31	19.99

Note: This table reports summary statistics for corporate USD bond data in the full sample. I classify USD bonds based on the issuer's country of origin into U.S. and non-U.S. I further classify non-U.S. to non-U.S. AE and EME. I report the monthly average of the number of bonds (No.), the notional amount in $ billions (Notl. $ bil) and the number of corresponding firms (No. Firms) at the total level, rating level and maturity level. The sample is monthly from January 2004 to March 2021.

Table 2: Summary Statistics

	N	Mean	STD	Min	25%	50%	75%	Max
All								
CreditSpread	729,302	1.89	2.62	0.00	0.75	1.25	2.15	94.48
Rating	729,302	7.70	3.16	1	6	8	9	21
Maturity	729,302	7.98	7.71	1.00	3.02	5.28	9.01	99.41
Age	729,302	4.57	4.55	0.00	1.49	3.27	6.16	34.21
IssueSize	729,302	790	694	50	350	575	1,000	15,000
Coupon	729,302	4.87	1.87	0.00	3.50	4.88	6.12	15.50
BidAskSpread	729,302	0.15	0.19	0.00	0.06	0.10	0.17	4.03
US								
CreditSpread	493,062	1.90	2.75	0.00	0.75	1.26	2.11	94.48
Rating	493,062	7.93	3.09	1	6	8	9	21
Maturity	493,062	8.66	8.08	1.0	3.3	5.9	9.6	99.4
Age	493,062	5.08	4.88	0.00	1.70	3.67	6.82	30.93
IssueSize	493,062	744	706	50	300	500	1,000	15,000
Coupon	493,062	5.07	1.81	0.00	3.75	5.12	6.25	15.50
BidAskSpread	493,062	0.16	0.20	0.00	0.06	0.11	0.18	4.03
Non-US								
CreditSpread	236,240	1.88	2.30	0.00	0.75	1.25	2.24	94.40
Rating	236,240	7.23	3.23	1	5	7	9	21
Maturity	236,240	6.58	6.66	1.0	2.6	4.4	7.7	96.7
Age	236,240	3.52	3.52	0.00	1.20	2.59	4.64	34.21
IssueSize	236,240	886	658	50	500	750	1,000	11,000
Coupon	236,240	4.47	1.94	0.00	2.95	4.30	5.75	15.00
BidAskSpread	236,240	0.14	0.17	0.00	0.06	0.10	0.15	4.03
Non-US AE								
CreditSpread	173,903	1.51	1.91	0.00	0.64	1.01	1.76	94.40
Rating	173,903	6.56	2.98	1	4	6	8	21
Maturity	173,903	6.70	6.73	1.00	2.62	4.44	7.84	96.68
Age	173,903	3.58	3.77	0.00	1.16	2.53	4.62	34.21
IssueSize	173,903	931	673	50	500	750	1,250	11,000
Coupon	173,903	4.18	1.87	0.00	2.70	3.95	5.50	13.00
BidAskSpread	173,903	0.12	0.15	0.00	0.06	0.09	0.14	4.03
EME								
CreditSpread	62,337	2.92	2.91	0.00	1.37	2.13	3.49	70.42
Rating	62,337	9.07	3.20	1	7	9	11	21
Maturity	62,337	6.23	6.43	1.00	2.70	4.40	7.17	96.41
Age	62,337	3.34	2.69	0.00	1.30	2.74	4.70	23.05
IssueSize	62,337	761	596	50	500	600	1,000	6,750
Coupon	62,337	5.29	1.91	0.00	3.88	5.12	6.45	15.00
BidAskSpread	62,337	0.18	0.20	0.00	0.07	0.12	0.22	4.03

Note: This table reports summary statistics for corporate USD bond data in the full sample. I classify USD bonds based on the issuer's country of origin into U.S. and non-U.S.. I further classify non-U.S. to non-U.S. AE and EME. *CreditSpread* is measured as the difference between the corporate bond yield and Treasury yield with the same maturity in percent. *Rating* is a numerical translation of rating: 1 = AAA, 2 = AA+ and so on. *Maturity* is the bond's remaining maturity in years. *Age* is the time since issuance in years. *IssueSize* is the bond issuance size in $ million. *Coupon* is the bond's coupon payment in percent. *BidAskSpread* is the bond's bid-ask spread in percent. The sample is monthly from January 2004 to March 2021.

Table 3: Foreign Discount and Exchange Rate Risk Exposure

	(1)	(2)	(3)	(4)	(5)	(6)
	Full	Full	Full	Full	Full	Full
Foreign	0.416***					
	(0.047)					
Foreign× ΔDollar	0.030***	0.018***		-0.008		0.019***
	(0.005)	(0.005)		(0.005)		(0.005)
Foreign× $\Delta\text{Dollar}^{Bilateral}$			0.022***	0.024***	0.074***	
			(0.003)	(0.003)	(0.011)	
Foreign× $\Delta\text{Dollar}^{Orth}$					0.007	
					(0.005)	
Foreign× $\Delta\text{Dollar}^{Bilateral,Ortho}$						0.024***
						(0.003)
$\Delta\text{Dollar}^{Ortho}$					0.141***	
					(0.024)	
BidAskSpread	2.088***	1.425***	1.423***	1.423***	1.421***	1.423***
	(0.215)	(0.104)	(0.104)	(0.104)	(0.104)	(0.104)
Rating	0.369***	0.375***	0.375***	0.375***	0.375***	0.375***
	(0.023)	(0.050)	(0.050)	(0.050)	(0.050)	(0.050)
Maturity	0.039***					
	(0.002)					
Age	0.008					
	(0.008)					
log(IssueSize)	0.017					
	(0.033)					
Coupon	0.112***					
	(0.026)					
Constant	-2.407***	-1.214***	-1.216***	-1.216***	-1.230***	-1.215***
	(0.276)	(0.385)	(0.385)	(0.385)	(0.385)	(0.385)
R^2	0.48	0.83	0.83	0.83	0.83	0.83
N	729,302	728,595	728,595	728,595	728,595	728,595
Time-FE	✓	✓	✓	✓	✓	✓
Industry-FE	✓					
Firm-Year & Bond-FE		✓	✓	✓	✓	✓

Note: This table estimates a panel data model in which the dependent variable is the Credit Spread of corporate USD bonds. Foreign_i is a dummy variable that takes a value of 1 for non-U.S. firm issuers. ΔDollar_t and $\Delta\text{Dollar}^{Bilateral}_{i,t}$ represent the log change in the nominal broad USD index and the bilateral exchange rate of the USD to the issuers' local currency, respectively. $\Delta\text{Dollar}^{Ortho}$ is the orthogonal component of ΔDollar relative to $\Delta\text{Dollar}^{Bilateral}_{i,t}$, and $\Delta\text{Dollar}^{Bilateral,Ortho}$ is the orthogonal component of $\Delta\text{Dollar}^{Bilateral}$ relative to ΔDollar. The sample covers monthly data from January 2004 to March 2021. Standard errors are clustered at the firm level and are shown in parentheses. *** denotes significance at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 4: Foreign Discount and Exchange Rate Risk Exposure: Further Tests

	(1)	(2)	(3)	(4)	(5)	(6)
	Full	Full	2010 to 2019	Excluding GFC	Full	Full
Foreign× ΔDollar^{Bilateral}	0.021***	0.024***	0.012***	0.011***	0.006**	0.033***
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.005)
Foreign× Rating	-0.052					
	(0.096)					
Foreign× Maturity	0.046**					
	(0.019)					
Foreign× BidAskSpread	0.649***					
	(0.211)					
CreditSpread$_{t-1}$		0.820***				
		(0.024)				
Foreign× ΔDollar^{Bilateral}×VIX^{High}				0.043***		
				(0.008)		
Foreign× VIX^{High}				0.012		
				(0.027)		
Foreign× ΔDollar^{Bilateral}×EME					0.041***	
					(0.006)	
Foreign× ΔDollar^{Bilateral}× Fin						0.027**
						(0.012)
Foreign× ΔDollar^{Bilateral}× Fin × G10						-0.023*
						(0.012)
ΔDollar^{Bilateral} × G10						-0.031***
						(0.005)
BidAskSpread	1.281***	0.862***	1.668***	1.395***	1.422***	1.421***
	(0.121)	(0.057)	(0.140)	(0.099)	(0.104)	(0.104)
Rating	0.388***	0.079***	0.208***	0.225***	0.376***	0.375***
	(0.061)	(0.020)	(0.031)	(0.027)	(0.050)	(0.050)
Constant	-1.296***	-0.400***	-0.185	-0.284	-1.219***	-1.217***
	(0.377)	(0.151)	(0.248)	(0.212)	(0.385)	(0.385)
R^2	0.83	0.92	0.90	0.89	0.83	0.83
N	728,595	693,936	506,821	677,650	728,595	728,595
Time-FE & Firm-Year & Bond-FE	✓	✓	✓	✓	✓	✓

Note: This table estimates a panel data model in which the dependent variable is the Credit Spread of corporate USD bonds. Foreign$_i$ is a dummy variable that takes the value of 1 for non-U.S. firm issuers. ΔDollar$_{i,t}^{Bilateral}$ represents the log change in the bilateral exchange rate of the USD to the issuers' local currency. VIX$_t^{High}$ is a dummy variable that is set to 1 when the VIX is higher than 30. Fin$_i$ is a dummy variable that takes a value of 1 for issuers that are financial firms. EME$_i$ is a dummy variable for issuers from emerging market economies, taking the value of 1. G10$_i$ is a dummy variable that is set to 1 for issuers from G10 countries. The sample covers monthly data from January 2004 to March 2021. Standard errors are clustered at the firm level and are shown in parentheses. *** denotes significance at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 5: Endogenous Choice of USD Bond Issuance

	(1)	(2)	(3)	(4)
	Full	Full	Full	Full
ForeignAssetShare	0.137***			-0.042
	(0.049)			(0.066)
ForeignSalesShare		0.246***		0.234***
		(0.033)		(0.048)
ForeignIncomeShare			0.033	-0.009
			(0.027)	(0.028)
Constant	0.545***	0.476***	0.574***	0.503***
	(0.019)	(0.018)	(0.014)	(0.024)
R^2	0.39	0.43	0.35	0.39
N	37,007	45,894	30,043	27,244
Country-Time FE	✓	✓	✓	✓

Note: This table estimates a panel data model in which the dependent variable is $\text{USDShare}_{f,t}$, representing the proportion of USD bonds to the total outstanding bond notional amount for firm f at time t. $\text{ForeignAssetShare}_{f,t}$, $\text{ForeignSalesShare}_{f,t}$, and $\text{ForeignIncomeShare}_{f,t}$ are the proportions of foreign assets, sales, and income to total assets, sales, and income for firm f at time t, respectively. The outstanding USD bonds are inferred from the SDC new issuance data. The foreign assets, sales, and income are sourced from Worldscope Segment. The sample covers monthly data of non-U.S. firms from January 2004 to March 2021. Standard errors are clustered at the firm level and are shown in parentheses. *** denotes significance at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 6: Balance Sheet Channel

	(1)	(2)	(3)	(4)	(5)	(6)
	Full	Full	Full	Full	Full	Full
Foreign× $\Delta\text{Dollar}^{Bilateral}$	-0.002	0.017***	0.009***	0.014***	-0.005	-0.003
	(0.004)	(0.003)	(0.003)	(0.002)	(0.008)	(0.007)
Foreign× $\Delta\text{Dollar}^{Bilateral}$ × USDShare	0.040***				0.046***	0.039***
	(0.009)				(0.012)	(0.012)
Foreign× $\Delta\text{Dollar}^{Bilateral}$ × USDLiabilitiesShare		-0.000				
		(0.006)				
Foreign× $\Delta\text{Dollar}^{Bilateral}$ × $\text{USDLiabilitiesShare}^{LongTerm}$			0.016***			
			(0.006)			
Foreign× $\Delta\text{Dollar}^{Bilateral}$ ×Bond2TA				0.002***		
				(0.000)		
Foreign× $\Delta\text{Dollar}^{Bilateral}$ × USDShare × Fin					0.033	
					(0.029)	
Foreign× $\Delta\text{Dollar}^{Bilateral}$ × USDShare × Fin × Top5					-0.076*	
					(0.042)	
Foreign× $\Delta\text{Dollar}^{Bilateral}$ × ForeignSalesShare						0.008
						(0.012)
Foreign× $\Delta\text{Dollar}^{Bilateral}$ × USDShare × ForeignSalesShare						-0.038**
						(0.019)
Controls	✓	✓	✓	✓	✓	✓
R^2	0.83	0.83	0.83	0.82	0.83	0.83
N	728,595	632,852	632,852	611,727	728,595	547,385
Time-FE & Firm-Year & Bond-FE	✓	✓	✓	✓	✓	✓

Note: This table estimates a panel data model in which the dependent variable is the Credit Spread of corporate USD bonds. $\text{USDShare}_{f,t}$ represents the proportion of USD bonds to the total outstanding bond notional amount for firm f at time t. $\text{USDLiabShare}_{f,t}$ is the proportion of USD liabilities to total liabilities for firm f at time t. $\text{USDLiabShare}_{f,t}^{Long-term}$ indicates the proportion of long-term USD liabilities to total long-term liabilities for firm f at time t. $\text{USDBond2TA}_{f,t}$ is the ratio of the outstanding USD bonds' notional amount to a firm's total assets for firm f at time t. $\text{ForeignSalesShare}_{f,t}$,is the proportions of foreign sales to sales for firm f at time t. Other bond characteristics controlled for include rating and bid-ask spreads, all of which are included in $\text{Controls}_{i,t}$. $\text{Controls}_{i,t}$ encompasses both the two-way interaction terms associated with the three-way interactions and the three-way interaction terms associated with the four-way interactions. The liabilities and total assets of firms are sourced from Capital IQ Capital Structure Debt and Compustat Fundamentals. The sample covers monthly data from January 2004 to March 2021. Standard errors are clustered at the firm level and are shown in parentheses. *** denotes significance at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 7: Dollar Home Bias Channel: Non-U.S. Investors Holding

	(1)	(2)	(3)	(4)
	Full	Full	Full	Full
Foreign× ΔDollar^{Bilateral}	-0.029***	-0.031***	-0.010*	-0.012***
	(0.005)	(0.006)	(0.005)	(0.004)
Foreign× ForeignHolding$_{t-1}$	-0.082	-0.204	-0.055	0.060
	(0.180)	(0.231)	(0.190)	(0.194)
Foreign× ΔDollar^{Bilateral} × ForeignHolding$_{t-1}$	0.062***	0.065***	0.019**	0.030***
	(0.008)	(0.009)	(0.008)	(0.005)
Foreign× ΔDollar^{Bilateral} × ForeignHolding$_{t-1}$×Fin		-0.008		
		(0.019)		
Foreign× ΔDollar^{Bilateral} × ForeignHolding$_{t-1}$×EME			0.070***	
			(0.019)	
Foreign× ΔDollar^{Bilateral} × ForeignHolding$_{t-1}$×VIX^{High}				0.127***
				(0.035)
ForeignHolding$_{t-1}$	-0.214*	-0.156	-0.214*	-0.432***
	(0.119)	(0.151)	(0.119)	(0.147)
Controls	✓	✓	✓	✓
R^2	0.83	0.83	0.83	0.83
N	672,107	672,107	672,107	672,107
Time-FE & Firm-Year & Bond-FE	✓	✓	✓	✓

Note: This table estimates a panel data model where the dependent variable is the Credit Spread of corporate USD bonds. NonUSHolding$_{i,t-1}$ represents the proportion of outstanding USD bond i held by non-U.S. investors at time $t-1$. Other bond characteristics controlled for include rating and bid-ask spreads, all of which are included in Controls$_{i,t}$. Controls$_{i,t}$ encompasses both the two-way interaction terms associated with the three-way interactions and the three-way interaction terms associated with the four-way interactions. The sample spans monthly data from January 2004 to March 2021. Standard errors are clustered at the firm level and are shown in parentheses. *** denotes significance at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 8: Dollar Home Bias Channel: Central Bank Swap Line

	(1)	(2)
	Full	Full
Foreign$\times$ D_{Covid} $\times$ D_{Swap}	-0.043*	-0.043*
	(0.022)	(0.022)
Foreign$\times$ D_{Covid}	0.013	0.013
	(0.021)	(0.021)
D_{Covid}	-0.077***	
	(0.010)	
Rating	-0.002	-0.002
	(0.003)	(0.003)
Maturity	-0.000*	-0.000
	(0.000)	(0.000)
Age	-0.004***	-0.004***
	(0.001)	(0.001)
log(IssueSize)	0.017***	0.017***
	(0.004)	(0.004)
Coupon	0.019***	0.019***
	(0.003)	(0.003)
VIX	0.007***	
	(0.000)	
BidAskSpread	0.106***	0.115***
	(0.011)	(0.011)
Constant	-0.432***	-0.037
	(0.044)	(0.038)
R^2	0.12	0.17
N	42,872	42,872
Firm FE	✓	✓
Date FE		✓

Note: This table estimates the panel data model in which the dependent variable is the first difference in the Credit Spread of corporate USD bonds. D_{Covid} is a dummy variable, taking values of 1 after March 15th, 2002. D_{Swap} is a dummy variable, taking values of 1 for USD bonds issued by non-U.S. firms from countries that accessed the standing swap line, which include Canada, Euro Area, Japan, Switzerland, United Kingdom. The sample period covers daily data from March 09, 2020, to March 19, 2020. Standard errors are clustered at the firm level and in parentheses. *** denotes significance at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 9: Channel Comparison

	(1)	(2)
	Full	Full
Foreign× ΔDollar^{Bilateral}	-0.048***	0.014
	(0.008)	(0.011)
Foreign× ΔDollar^{Bilateral} × USDShare	0.031***	-0.065***
	(0.007)	(0.017)
Foreign× ΔDollar^{Bilateral} × ForeignHolding$_{t-1}$	0.060***	-0.019
	(0.008)	(0.015)
Foreign× ΔDollar^{Bilateral} × USDShare × ForeignHolding$_{t-1}$		0.121***
		(0.025)
USDShare	-0.545**	-1.114**
	(0.220)	(0.464)
Foreign× USDShare	0.726**	1.799***
	(0.287)	(0.584)
ForeignHolding$_{t-1}$	-0.213*	-1.151*
	(0.119)	(0.695)
Foreign× ForeignHolding$_{t-1}$	-0.086	1.266*
	(0.180)	(0.721)
Controls	✓	✓
R^2	0.83	0.83
N	672,107	672,107
Time-FE & Firm-Year & Bond-FE	✓	✓

Note: This table estimates a panel data model where the dependent variable is the Credit Spread of corporate USD bonds. USDShare$_{f,t}$ represents the proportion of USD bonds to the total outstanding bonds for firm f at time t. NonUSHolding$_{i,t-1}$ is the proportion of USD bond i outstanding held by non-U.S. investors at time $t-1$. Other bond characteristics controlled for include rating and bid-ask spreads, all of which are included in Controls$_{i,t}$. Controls$_{i,t}$ encompasses both the two-way interaction terms associated with the three-way interactions and the three-way interaction terms associated with the four-way interactions. The sample spans monthly data from January 2004 to March 2021. Standard errors are clustered at the firm level and are shown in parentheses. *** denotes significance at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Online Appendix to

"Exchange Rate Risk and Foreign Discount in U.S. Dollar Bonds"

(Not for publication)

Appendix A Model

Appendix A.1 Proof 1

I already define that $\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} < 0$ and $\frac{\partial[v(\epsilon_{fx})+\text{Cov}(i,j)]}{\partial \epsilon_{fx}} > 0$. Then,

$$\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} = \frac{\partial[\rho_{i,j}\sqrt{V(V+v(\epsilon_{fx}))}]}{\partial \epsilon_{fx}} = \frac{\partial \rho_{i,j}}{\partial \epsilon_{fx}}\sqrt{V(V+v(\epsilon_{fx}))} + \frac{V\rho_{i,j}}{2\sqrt{V(V+v(\epsilon_{fx}))}}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} < 0 \quad (1)$$

$$\frac{\partial \rho_{i,j}}{\partial \epsilon_{fx}} < -\frac{\rho_{i,j}}{2(V+v(\epsilon_{fx}))}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} \quad (2)$$

In addition,

$$\begin{aligned}\frac{\partial[v(\epsilon_{fx})+Cov(i,j)]}{\partial \epsilon_{fx}} &= \frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} + \frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} = \frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} + \frac{\partial \rho_{i,j}}{\partial \epsilon_{fx}}\sqrt{V(V+v(\epsilon_{fx}))} + \frac{V\rho_{i,j}}{2\sqrt{V(V+v(\epsilon_{fx}))}}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} \\ &= \frac{2\sqrt{V(V+v(\epsilon_{fx}))}+V\rho_{i,j}}{2\sqrt{V(V+v(\epsilon_{fx}))}}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} + \sqrt{V(V+v(\epsilon_{fx}))}\frac{\partial \rho_{i,j}}{\partial \epsilon_{fx}}\end{aligned} \quad (3)$$

Then $\frac{\partial[v(\epsilon_{fx})+Cov(i,j)]}{\partial \epsilon_{fx}} = \frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} + \frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} > 0$ if $\frac{\partial \rho_{i,j}}{\partial \epsilon_{fx}} > -\frac{2\sqrt{V(V+v(\epsilon_{fx}))}+V\rho_{i,j}}{2V(V+v(\epsilon_{fx}))}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}}$.
Overall, when $\frac{\partial \rho_{i,j}}{\partial \epsilon_{fx}} \in \left(-\frac{2\sqrt{V(V+v(\epsilon_{fx}))}+V\rho_{i,j}}{2V(V+v(\epsilon_{fx}))}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}}, -\frac{\rho_{i,j}}{2(V+v(\epsilon_{fx}))}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}}\right)$, then

$$\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} < 0 \text{ and } \frac{\partial[v(\epsilon_{fx})+Cov(i,j)]}{\partial \epsilon_{fx}} > 0 \quad (4)$$

I can decompose $\frac{\partial \alpha}{\partial \epsilon_{fx}}$ as:

$$\frac{\partial \alpha}{\partial \epsilon_{fx}} = \frac{\partial[(1-\rho_{i,j}^2)V(V+v(\epsilon_{fx}))]}{\partial \epsilon_{fx}} = -2\rho_{i,j}\frac{\partial \rho_{i,j}}{\partial \epsilon_{fx}}V(V+v(\epsilon_{fx})) + (1-\rho_{i,j}^2)V\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} \quad (5)$$

Then, the smallest $\frac{\partial \alpha}{\partial \epsilon_{fx}}$ is when $\frac{\partial \rho_{i,j}}{\partial \epsilon_{fx}} = -\frac{\rho_{i,j}}{2(V+v(\epsilon_{fx}))}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}}$. I can get

$$\begin{aligned}\frac{\partial \alpha}{\partial \epsilon_{fx}} &= \left[-2\rho_{i,j}V(V+v(\epsilon_{fx}))\right]\left[-\frac{\rho_{i,j}}{2(V+v(\epsilon_{fx}))}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}}\right] + (1-\rho_{i,j}^2)V\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} \\ &= \rho_{i,j}^2 V\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} + (1-\rho_{i,j}^2)V\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} = \frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} > 0\end{aligned} \quad (6)$$

Appendix A.2 Proof of Proposition 1

By muting the FX cost, the equilibrium of y_x is:

$$y_x = \frac{1}{2(Cov(i,j)+V)} \left[2v(\epsilon_{fx})(y-y^{rf}) + [V + v(\epsilon_{fx}) + Cov(i,j)]\frac{\partial \mu_i}{\partial n_i} - (Cov(i,j)+V)\frac{\partial \mu_j}{\partial m_j} - \gamma\alpha(D_i - D_j)\right] \tag{7}$$

Then, taking the first-order derivatives:

$$\begin{aligned}\frac{\partial y_x}{\partial \epsilon_{fx}} =& \underbrace{\frac{\partial[(2Cov(i,j)+V)^{-1}]}{\partial \epsilon_{fx}}}_{>0} \\ & \underbrace{\left[2v(\epsilon_{fx})(y-y^{rf}) + [V + v(\epsilon_{fx}) + Cov(i,j)]\frac{\partial \mu_i}{\partial n_i} - (Cov(i,j)+V)\frac{\partial \mu_j}{\partial m_j} - \gamma\alpha(D_i - D_j)\right]}_{\text{term 1}>0} \\ & + \underbrace{\frac{1}{2(Cov(i,j)+V)}}_{>0} \\ & \left[\underbrace{2\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}}(y-y^{rf})}_{>0} + \underbrace{\frac{\partial[v(\epsilon_{fx}) + Cov(i,j)]}{\partial \epsilon_{fx}}\frac{\partial \mu_i}{\partial n_i}}_{>0} \underbrace{-\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}\frac{\partial \mu_j}{\partial m_j}}_{>0} \underbrace{-\gamma\frac{\partial \alpha}{\partial \epsilon_{fx}}(D_i - D_j)}_{?}\right]\end{aligned} \tag{8}$$

The *term 1* is greater than 0, as it is based on the empirical fact of the Foreign Discount in the USD bond market. Consequently, every term in Equation (8) is positive except for $-\gamma\frac{\partial \alpha}{\partial \epsilon_{fx}}(D_i - D_j)$, which depends on the relative outstanding notional of USD bonds issued by U.S. and non-U.S. firms. This paper focuses on the demand-side effect, so I mute the supply-side effect. As a result, there is no marginal effect of relative bond issuance $D_i - D_j$ on y_x. Ultimately, $\frac{\partial y_x}{\partial \epsilon_{fx}} > 0$.

Appendix A.3 Proof of $\frac{\partial \beta}{\partial \epsilon_{fx}}$

$\beta = (c + \epsilon_{fx})[V_{y_x}(Cov(i,j) + V) + 2\alpha] + 2\gamma\alpha(Cov(i,j) + V)$.

$$
\begin{aligned}
\frac{\partial \beta}{\partial \epsilon_{fx}} &= V_{y_x}(Cov(i,j)+V) + 2\alpha + (c+\epsilon_{fx})\left[\frac{\partial V_{y_x}}{\partial \epsilon_{fx}}(Cov(i,j)+V) + V_{y_x}\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} + 2\frac{\partial \alpha}{\partial \epsilon_{fx}}\right] \\
&+ \left[2\gamma\frac{\partial \alpha}{\partial \epsilon_{fx}}(Cov(i,j)+V) + 2\gamma\alpha\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}\right] \\
&= [V + (V + v(\epsilon_{fx})) - 2Cov(i,j)][Cov(i,j)+V] + 2[V(V+v(\epsilon_{fx})) - Cov(i,j)^2] \\
&+ (c+\epsilon_{fx})\Bigg[[\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} - 2\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}](Cov(i,j)+V) + [V + (V+v(\epsilon_{fx})) - 2Cov(i,j)]\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} \\
&+ 2[V\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} - 2Cov(i,j)\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}]\Bigg] \\
&+ \left[2\gamma\frac{\partial \alpha}{\partial \epsilon_{fx}}(Cov(i,j)+V) + 2\gamma\alpha\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}\right]
\end{aligned} \tag{9}
$$

The first part:

$$
\begin{aligned}
&[V + (V + v(\epsilon_{fx})) - 2Cov(i,j)][Cov(i,j)+V] + 2[V(V+v(\epsilon_{fx})) - Cov(i,j)^2] \\
&= Cov(i,j)[v(\epsilon_{fx}) - V] + V^2[4 - 3\rho_{i,j}^2] + 3v(\epsilon_{fx})V(1-\rho_{i,j}^2) \\
&> Cov(i,j)[v(\epsilon_{fx}) - V] + V^2 = \rho_{i,j}\sqrt{V(V+v(\epsilon_{fx}))}v(\epsilon_{fx}) + V(V - \rho_{i,j}\sqrt{V(V+v(\epsilon_{fx}))}) \\
&\geq \rho_{i,j}V(v(\epsilon_{fx})) + V(V - \rho_{i,j}(V+v(\epsilon_{fx}))) = V^2 - \rho_{i,j}V^2 > 0
\end{aligned} \tag{10}
$$

The second part:

$$
\begin{aligned}
&[\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} - 2\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}](Cov(i,j)+V) + [V + (V+v(\epsilon_{fx})) - 2Cov(i,j)]\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} \\
&+ 2[V\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} - 2Cov(i,j)\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}] \\
&= \left[v(\epsilon_{fx}) - 8Cov(i,j)\right]\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} + [Cov(i,j) + 3V]\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}}
\end{aligned} \tag{11}
$$

Then,

$$
\begin{aligned}
\frac{\partial \beta}{\partial \epsilon_{fx}} &= V_{y_x}(Cov(i,j)+V) + 2\alpha + (c+\epsilon_{fx})\left[\frac{\partial V_{y_x}}{\partial \epsilon_{fx}}(Cov(i,j)+V) + V_{y_x}\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} + 2\frac{\partial \alpha}{\partial \epsilon_{fx}}\right] \\
&+ \left[2\gamma\frac{\partial \alpha}{\partial \epsilon_{fx}}(Cov(i,j)+V) + 2\gamma\alpha\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}\right] \\
&= \underbrace{Cov(i,j)[v(\epsilon_{fx}) - V] + V^2[4-3\rho_{i,j}^2] + 3v(\epsilon_{fx})V(1-\rho_{i,j}^2)}_{>0} \\
&+ (c+\epsilon_{fx})\left[[v(\epsilon_{fx}) - 8Cov(i,j)]\underbrace{\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}}_{<0} + \underbrace{[Cov(i,j)+3V]\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}}}_{>0}\right] \\
&+ \left[\underbrace{2\gamma\frac{\partial \alpha}{\partial \epsilon_{fx}}(Cov(i,j)+V)}_{>0} + \underbrace{2\gamma\alpha\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}}_{<0}\right]
\end{aligned} \tag{12}
$$

$\frac{\partial \beta}{\partial \epsilon_{fx}}$ is negative for a large $(c+\epsilon_{fx})v(\epsilon_{fx})\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}$. In other words, the term is negative while there is a large exchange rate shock, increasing the average FX cost $(c+\epsilon_{fx})$, risk $(v(\epsilon_{fx}))$ of USD bonds issued by non-U.S firms and hedging abilities $(\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}})$ of USD bonds issued by U.S. firms.

Appendix A.4 Proof of Proposition 2

Component 2 is:

$$
(c+\epsilon_{fx})\left[V_{y_x}v(\epsilon_{fx})(y-y^{rf}) + V_{y_x}[V+v(\epsilon_{fx})+Cov(i,j)]\frac{\partial \mu_i}{\partial n_i} - 2\alpha\frac{\partial \mu_j}{\partial m_j} - V_{y_x}\gamma\alpha(D_i - D_j)\right] \tag{13}
$$

where $\frac{\partial V_{y_x}}{\partial \epsilon_{fx}} > 0$, $\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}}$, $\frac{\partial V+v(\epsilon_{fx})+Cov(i,j)}{\partial \epsilon_{fx}} > 0$, $\frac{\partial \mu_i}{\partial n_i} > 0$ and $\frac{\partial \mu_j}{\partial m_j} > 0$. Also, there is no marginal effect of relative bond issuance $D_i - D_j$ on y_x as I mute the supply-side factor.

Then, the $\frac{\partial \text{Component 2}}{\partial \epsilon_{fx}} > 0$ when non-U.S. investors ex ante hold a substantial amount of USD bonds issued by non-U.S. firms, as represented by a large m_j. Consequently, the expost marginal home bias $(\frac{\partial \mu_j}{\partial m_j})$ approaches zero. The intuition behind this is that the average home bias utility μ_j decreases when non-U.S. investors already have a significant amount of USD bonds issued by domestic firms.

Appendix B Data Set Construction and Details

Appendix B.1 Capital IQ - Capital Structure Debt

I obtain detailed corporate debt structure information from Capital IQ, accessed through WRDS. A significant advantage of the Capital IQ dataset is its provision of the currency composition of outstanding debt for individual firms, which is crucial for constructing the ratio of USD debt to total debt in this paper. Capital IQ assigns a unique *CompanyID* to each firm. However, the SDC Platinum Global New Issues database provides only the CUSIP identifier for firms. Therefore, I match CUSIP with *CompanyID* from Capital IQ through the following steps. First, the Identifiers database in Capital IQ provides a historical match between CUSIP and *CompanyID*. The CUSIP in Capital IQ is 9 digits, whereas the CUSIP in SDC is 6 digits. Thus, matching is initially based on the first 6 digits, as these identify the firm. Second, for the CUSIPs from SDC that cannot be matched with Capital IQ, I employ a fuzzy matching function (rapidfuzz) in Python to align the company names provided in SDC and Capital IQ, subsequently verifying each match manually. Third, for firms that remain unmatched after the fuzzy matching process, I manually match CUSIP with *CompanyID* based on company names.

Capital IQ classifies liabilities as follows: *Bank Loans*, *Bank Overdraft*, *Bills Payable*, *Bonds and Notes*, *Capital Leases*, *Commercial Paper*, *Debentures*, *Federal Reserve Bank Borrowings*, *FHLB Borrowings*, *Federal Funds Purchased*, *General Borrowings*, *Letter of Credit Outstanding*, *Mortgage Bonds*, *Mortgage Loans*, *Mortgage Notes*, *Notes Payable*, *Other Borrowings*, *Revolving Credit*, *Securities Loaned*, *Securities Sold Under Agreement to Repurchase*, *Securitization Facility*, *Term Loan*, and *Trust Preferred Securities*.

Appendix B.2 Compustat Fundamentals

I obtain detailed data on total assets from Compustat Fundamentals via WRDS. Compustat Fundamentals provides standardized financial statements for publicly held companies in North America and globally, assigning a unique six-digit Global Company Key (GVKEY) to each company. To integrate this data with the SDC Platinum Global New Issues database, I follow several steps for matching firm-level CUSIP to GVKEY. Initially, I acquire a historical match between the *CompanyID* (from Capital IQ) and the GVKEY using the Identifiers database in Capital IQ. Building on my previously established database of matched CUSIP and *CompanyID*, I further align CUSIP with GVKEY. I utilize annual total assets data from Compustat Fundamentals and resample it to monthly. Subsequently, I convert the total assets to USD values using the end-of-month bilateral exchange rates obtained from Bloomberg.

Appendix B.3 Worldscope Segments

I obtain the percentage of foreign assets, sales, and income data for each firm from Worldscope Segments via WRDS. The Worldscope Database contains detailed financial statement and profile data on public companies globally, assigning a unique Worldscope *PermanentID* to each company. To integrate this data with the SDC Platinum Global New Issues database, I follow several steps to match CUSIP to *PermanentID*. First, I match the six-digit CUSIP with the *PermanentID*. Second, using Capital IQ's Identifiers, I match the firm-level CUSIP from SDC Platinum Global New Issues to the firm-level ISIN. Then, I match the ISIN to the *PermanentID* from Worldscope. Third, for the remaining unmatched firms, I manually match the CUSIP with the *PermanentID* based on company names.

Appendix C Empirical Evidence: Robustness Tests

Appendix C.1 Fixed Effects

I present the results with an exhaustive combination of fixed effects to control for all possible factors in Table C1. All regressions control for the time fixed effect. Columns (1) and (2) add the country and bond fixed effects to control for fundamental differences between each country and bond, respectively. Column (3), in addition to the standard time and firm fixed effects, adds the country-year fixed effect to account for the time-varying shocks in each country, such as sovereign risk, economic policy uncertainty, capital controls, and the macroprudential index. The country-year fixed effect also controls for the uncertainty aversion hypothesis, which is an alternative explanation of the Foreign Discount proposed by Geng (2022), linked with non-U.S. country-level risk. Column (4) adds the firm-year fixed effect to control for dynamic changes in firm fundamentals, such as firm financial health and default risk. Column (5) uses a combination of time, bond, and firm-year fixed effects to control for exhaustible factors that could affect bond pricing. θ is positive and significant at the 1% level in all columns. Overall, exchange rate risk significantly affects the Foreign Discount within USD bonds, as non-U.S. USD bonds have a larger exchange rate risk exposure than U.S. USD bonds.

Table C1: Foreign Discount and Exchange Rate Risk Exposure: Fixed Effects

	(1)	(2)	(3)	(4)	(5)
	Full	Full	Full	Full	Full
Foreign× ΔDollar^{Bilateral}	0.029***	0.027***	0.022***	0.022***	0.022***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
BidAskSpread	2.214***	1.703***	1.469***	1.040***	1.423***
	(0.239)	(0.147)	(0.146)	(0.097)	(0.104)
Rating	0.341***	0.537***	0.410***	0.312***	0.375***
	(0.023)	(0.050)	(0.032)	(0.032)	(0.050)
Maturity	0.035***		0.039***	0.033***	
	(0.002)		(0.002)	(0.001)	
Age	0.008		0.019***	-0.005	
	(0.008)		(0.006)	(0.004)	
log(IssueSize)	0.087**		-0.052***	-0.057***	
	(0.036)		(0.019)	(0.013)	
Coupon	0.109***		0.066***	0.122***	
	(0.025)		(0.017)	(0.012)	
Constant	-2.480***	-2.502***	-1.875***	-1.138***	-1.216***
	(0.305)	(0.378)	(0.262)	(0.258)	(0.385)
R^2	0.47	0.65	0.60	0.80	0.83
N	729300	729,135	729,275	728,736	728,595
Time-FE	✓	✓	✓	✓	✓
Country-FE	✓				
Bond-FE		✓			✓
Firm-FE			✓		
Country-Year FE			✓		
Firm-Year				✓	✓

Note: This table examines the robustness of the exchange rate risk effect on the Foreign Discount using various sets of fixed effects controls. The dependent variable is the Credit Spread of corporate USD bonds. Other bond characteristics controlled for include rating, bid-ask spreads, remaining maturity, age, issuance size, and coupon rate, all of which are included in Controls$_{i,t}$. The sample spans monthly data from January 2004 to March 2021. Standard errors are clustered at the firm level and are shown in parentheses. *** denotes significance at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Appendix C.2 Cross-border U.S. Dollar Liquidity

The Foreign Discount within USD bonds spiked during the global financial crisis and has remained persistent since then. This pattern mirrors the trend in covered interest parity (CIP) deviations documented by Du, Tepper, and Verdelhan (2018). CIP deviations, representing the difference between synthetic USD funding costs and direct USD funding costs, reflect the stress in cross-border USD liquidity (Bahaj and Reis 2020). Thus, a pertinent question arises: can the exchange rate risk hypothesis be fully accounted for by changes in cross-border USD liquidity, as measured by CIP deviation? To explore this question, I follow the methodology of Du, Tepper, and Verdelhan (2018) and construct one-month and three-month LIBOR-based CIP deviations for G10 currency pairs. An increase in CIP deviation signals a growing scarcity of cross-border USD liquidity, as the cost of synthetic USD funding rises relative to that of direct USD funding. Subsequently, I revise Equation (18) to include the interaction between the Foreign dummy and CIP deviation. The results, presented in Table C2, indicate that only the coefficient for the interaction with the Foreign dummy is significant and positive, aligning with the baseline result. Hence, although the Foreign Discount and CIP deviation exhibit similar trends, the exchange rate risk more effectively explains the Foreign Discount.

Table C2: Foreign Discount and CIP Deviations

	(1)	(2)
	Full	Full
Foreign$\times$ ΔDollar^{Bilateral}	0.005**	0.004*
	(0.002)	(0.002)
Foreign$\times$ ΔCIP^{1m,Libor}	0.021	
	(0.027)	
Foreign$\times$ ΔCIP^{3m,Libor}		0.101
		(0.079)
BidAskSpread	1.313***	1.313***
	(0.109)	(0.109)
Rating	0.377***	0.376***
	(0.057)	(0.057)
Constant	-1.275***	-1.274***
	(0.441)	(0.441)
R^2	0.82	0.82
N	598,768	598,768
Time-FE & Firm-Year & Bond-FE	✓	✓

Note: This table estimates a panel data model in which the dependent variable is the Credit Spread of corporate USD bonds. Foreign$_i$ is a dummy variable that takes the value of 1 for non-U.S. firm issuers. ΔDollar$_{i,t}^{Bilateral}$ represents the log change in the bilateral exchange rate of the USD to the issuers' local currency. ΔCIP$_{i,t}^{1m}$ and ΔCIP$_{i,t}^{3m}$ represent the change in one-month and three-month covered interest parity (CIP) deviations of the USD to the issuers' local currency. Other bond characteristics controlled for include rating, bid-ask spreads, remaining maturity, age, issuance size, and coupon rate, all of which are included in Controls$_{i,t}$. The sample covers monthly data from January 2004 to March 2021. Standard errors are clustered at the firm level and are shown in parentheses. *** denotes significance at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.