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

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Abstract

This paper investigates a persistent pricing disparity in the U.S. dollar (USD) bond market, where USD bonds issued by non-U.S. firms exhibit credit spreads 48 basis points higher than comparable bonds from U.S. firms, referred to as the Foreign Discount. Through theoretical and empirical analysis, I attribute this disparity to exchange rate risk, identifying two key channels. First, currency-mismatched non-U.S. firms borrowing in USD while operating in local currency transmit exchange rate risk to their USD bonds through the *balance sheet channel*. Second, non-U.S. investors face additional foreign exchange costs in obtaining USD funding, transferring this risk to USD bonds of non-U.S. firms due to investors' home bias in portfolio allocation, referred to as the *dollar home bias channel*. I show that exchange rate risk accounts for 54% of the Foreign Discount from 2004 to 2021. These findings underscore the significance of exchange rate risk 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 are highly sought-after assets in the global financial markets. Since the 2008 global financial crisis, international investors have increasingly preferred USD bonds, leading to a significant pricing differential between USD and non-USD bonds.[1] In the corporate bond market, the proportion of USD bonds issued by non-U.S. firms has risen from 20% in 2004 to 40% in 2021, driven by factors such as access to large, liquid markets, international trade, and arbitrage opportunities (Bruno and Shin 2017; Maggiori, Neiman, and Schreger 2019; Liao 2020). Recent research by Geng (2022) shows that, on average, USD bonds issued by non-U.S. firms (referred to as non-U.S. USD bonds) have persistently higher credit spreads than those issued by U.S. firms (U.S. USD bonds), a phenomenon known as the Foreign Discount.

The existence of the Foreign Discount is both unexpected and significant, with a monthly average of 48 basis points from 2004 to 2021. In a frictionless financial market, there should be no pricing difference between USD bonds issued by two firms if the bonds share identical characteristics and the firms have the same fundamentals, regardless of their nationality. This observation aligns with the standard no-arbitrage condition. As such, the Foreign Discount underscores the significance of nationality in driving bond pricing differentials. This paper connects the nationality effect to exchange rate risk, offering a risk-based explanation for the Foreign Discount. Specifically, I focus on the financial channel of exchange rates, where fluctuations in the USD significantly influence cross-border capital flows, the risk-taking capacity 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 greater exposure to exchange rate risk than U.S. USD bonds, which contributes to the persistent pricing disparity. While some degree of exposure was expected, the magnitude is surprisingly high. My analysis reveals that, on average, exchange rate risk accounts for 26 basis points, or 56% of the Foreign Discount, from January 2004 to March 2021. This highlights the substantial role exchange rate risk plays in driving price differences within USD bonds. More importantly, this paper not only establishes this novel link but also explains the underlying sources of the additional exchange rate risk exposure.

I begin with a parsimonious static model featuring two types of investors and firms: U.S.-based and non-U.S.-based. Both groups of investors hold USD bonds issued by these firms and are characterized by risk aversion and mean-variance preferences, with a home

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).

bias toward bonds from their respective regions. The model posits that non-U.S. firms face a currency mismatch on their balance sheets, borrowing in USD while operating in local currency markets. Additionally, the model incorporates frictional costs in an incomplete foreign exchange (FX) market, consistent with empirical evidence on deviations from covered interest rate parity (CIP) (Du, Tepper, and Verdelhan 2018). Non-U.S. investors incur 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 a USD appreciation, reduces the net worth of currency-mismatched non-U.S. firms and weakens their fundamentals, as the depreciation of the local currency has a contractionary effect (Du and Schreger 2022). This adverse impact raises the risk of these firms' USD bonds, prompting investors to demand additional risk compensation, thereby widening y_x, which exemplifies the balance sheet channel. Second, USD appreciation also increases funding costs for non-U.S. investors, limiting their risk-taking capacity (Avdjiev, Du, et al. 2019). As a result, they sell off USD assets, particularly non-U.S. USD bonds, due to their pre-existing home bias (Du and Huber 2023). Since non-U.S. investors predominantly hold USD bonds issued by local firms, the selling pressure disproportionately affects these bonds, a mechanism 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, which includes 15,375 USD bonds issued by 1,264 U.S. firms and 968 non-U.S. firms, with a total notional value of $11.88 trillion. On average, I find that non-U.S. USD bonds have credit spreads that are 41.6 basis points higher than U.S. USD bonds.[2] To isolate the effect of exchange rate risk on the Foreign Discount, I employ a panel data regression that controls for bonds' default and liquidity risks, incorporating stringent fixed-effect controls—time, firm-year, and bond-level fixed effects. This setup ensures comparisons between bonds with the same characteristics, issued at the same point in time by firms subject to identical shocks within the same year, where one issuer is a non-U.S. firm and the other is a U.S. firm. I demonstrate that a one standard deviation appreciation of the USD leads to a 3.54 basis points increase in the Foreign Discount, representing 8.5% of the total Foreign Discount. Notably, this exchange rate effect aligns more closely with bilateral exchange rates than with the broad USD index, as bilateral rates better capture cross-sectional differences across non-U.S.

2. The 41.6 basis points differ slightly from the previously mentioned 48 basis points, as they are estimated from panel data regression, whereas the 48 basis points represent monthly cross-sectional averages. The two estimates are closely aligned, and I use the 41.6 basis points in the subsequent analysis to evaluate the effect of exchange rate risk on the Foreign Discount, as it is derived from panel data regression.

countries. Lastly, the exchange rate risk exposure hypothesis remains robust after a series of robustness checks.

Next, I present empirical evidence supporting the model's propositions, beginning with an analysis of the balance sheet channel. The level of currency mismatch in the balance sheets of non-U.S. firms is approximated by the proportion of outstanding USD bonds relative to total bonds. This measure captures the extent of firms' global financing, as they typically operate in local markets while securing funds internationally. Firm bond data are inferred from bond issuance information provided by the SDC database. On average, USD bonds account for approximately 52% of the total outstanding bond notional amount for non-U.S. firms. For firms in Emerging Market Economies (EME), USD bonds constitute a larger share, ranging from 60% to 70%.[3]

Importantly, I examine the endogenous choice of USD bond issuance by non-U.S. firms. While non-U.S. firms issue more USD bonds when they have greater USD cash flows, a substantial portion of these bonds do not match their USD cash flows, leaving firms exposed to significant exchange rate risk. I demonstrate that USD bonds issued by non-U.S. firms with a higher proportion of USD bonds outstanding exhibit greater sensitivity to exchange rate risk. For example, a non-U.S. firm with 52% of its total bonds in USD experiences a 3.35 basis points increase in the Foreign Discount, or about 8.1% of the total, following a one standard deviation appreciation of the USD. The balance sheet channel hypothesis remains robust across various specifications of currency mismatch levels for non-U.S. firms. Using 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, I construct a ratio of USD bonds to total assets using data from the Compustat Fundamentals database. The results based on this USD bond-to-asset ratio are consistent with the balance sheet channel.

I also examine the hedging capabilities of non-U.S. firms, focusing on both financial and operational hedging strategies. My findings indicate that both approaches help mitigate exchange rate risk from USD liabilities. However, for financial hedging, only firms with access to a liquid local currency-to-USD pair in the FX market, particularly financial firms, can effectively hedge their exposures. In terms of operational hedging, non-U.S. firms with higher USD cash flows are less exposed to exchange rate risk. Nevertheless, due to the significantly higher proportion of USD liabilities relative to 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.

3. The classification of Emerging Market Economies and Advanced Economies follows the IMF World Economic Outlook guidelines.

USD bonds by calculating the proportion of holdings by non-U.S. investors relative to the total bond outstanding at time $t-1$. These bond-level holdings are sourced from the eMaxx database. Consistent with the dollar home bias channel, non-U.S. USD bonds with a higher proportion of non-U.S. investor holdings exhibit greater exchange rate risk exposure. 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 2.62 basis points, equivalent to a 6.3% increase. The effect of the dollar home bias channel is particularly pronounced for USD bonds issued by EME firms and during periods of elevated market volatility, as indicated by a high VIX.

To further support the dollar home bias channel, I conduct a Difference-in-Differences (DiD) analysis focused on the reactivation of the central bank swap line policy during the COVID-19 period. This policy reduced USD funding costs for non-U.S. investors with access, enhancing their capacity for risk-taking relative to other non-U.S. investors. As predicted by the dollar home bias channel, USD bonds issued by firms in countries where local investors had access to the swap line experienced less selling pressure and 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 reinforce each other, amplifying their combined impact. Both channels show dynamic significance throughout the sample period.

Related Literature. This paper contributes to the growing body of research on the international role of the USD in asset pricing. A significant strand of literature focuses on the USD as a risk factor. Lustig, Roussanov, and Verdelhan (2014) document a USD factor based on the dollar carry trade strategy, providing a risk-based interpretation linked to global macroeconomic risks (Verdelhan 2018). Other studies, such as those by Brusa, Ramadorai, and Verdelhan (2014) and Nucera, Sarno, and Zinna (2024), emphasize the role of the USD factor in pricing currency and international equity risk premiums.

Another important line of research explores USD fluctuations and their impact on the financial channel of exchange rates. A seminal paper by Bruno and Shin (2015) demonstrate how USD appreciation affects global liquidity through the banking risk-taking channel. A stronger USD tightens banks' credit portfolios by constraining value-at-risk and economic capital, which in turn influences financial markets and the broader macroeconomy. Subsequent research has further examined the significance of this financial channel in 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, another line of literature underscores the demand

component of the financial channel of exchange rates. This research shows how USD appreciation reduces the net worth of non-U.S. firms with significant USD liabilities but local currency assets, leading to a contractionary effect. The resulting decline in the net worth of these firms adversely impacts the broader economy.[4] This paper highlights the demand component's role in USD bond pricing and shows how the financial channel of exchange rates affects USD bonds issued by U.S. and non-U.S. firms differently.

This paper also contributes to the corporate bond pricing literature, which focuses extensively 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 corporate bond returns, while recent studies by Liao (2020), Cesa-Bianchi, Czech, and Eguren-Martin (2023), and Hu et al. (2023) investigate the currency effect in corporate bond pricing differentials, specifically between USD and non-USD bonds. This paper aligns closely with the work of Geng (2022), who documents a Foreign Discount in the USD bond market, attributing it to the uncertainty aversion of U.S. investors toward non-U.S. firms due to difficulties in estimating their asset return distributions. In contrast, this paper provides evidence that exchange rate risk is a critical driver of the Foreign Discount, even after accounting for the uncertainty aversion hypothesis. Additionally, I investigate the transmission of bond-level exchange rate risk, focusing on non-U.S. firms and investors as key sources of this risk.

Lastly, this paper relates to the literature on investors' home bias in portfolio composition. Ahearne, Griever, and Warnock (2004) and Chan, Covrig, and Ng (2005) document the home bias of international investors in asset allocations, while Coeurdacier and Rey (2013) review explanations for the home bias and present new portfolio facts across asset classes. More recently, Maggiori, Neiman, and Schreger (2020) show a strong home-currency bias in mutual fund bond portfolios, alongside increasing demand for USD bonds across international investors. This paper sheds light on how the ex ante home bias of non-U.S. investors transmits exchange rate risk exposure differently across USD bonds, contributing to persistent pricing differentials in 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

4. Local currency depreciation leads to balance sheet contraction (Korinek 2010; Kohn, Leibovici, and Szkup 2020; Caballero 2021), worsens firm investment and net worth (Kim, Tesar, and Zhang 2015), increases bankruptcy risk (Dell'Ariccia, Laeven, and Marquez 2011; Niepmann and Schmidt-Eisenlohr 2022), impacts stock prices (Bruno and Shin 2020), raises currency risks (Aghion, Bacchetta, and Banerjee 2001, 2004), amplifies monetary policy spillover (Akinci and Queralto 2018), widens sovereign risk premiums (Hofmann, Shim, and Shin 2020; Wu 2020; Du and Schreger 2022), and decreases foreign currency borrowing (Hardy 2018).

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 connection between exchange rate risk and the Foreign Discount in USD bonds. The Foreign Discount reflects the higher credit spreads of non-U.S. USD bonds compared to their U.S. counterparts. This model offers a risk-based explanation, attributing the higher credit spreads of non-U.S. USD bonds to their greater exposure to exchange rate fluctuations. These additional exposures arise from two distinct channels, which capture differences in both firm-level and investor-level exchange rate risks.

2.1 Model Setup

2.1.1 Firms

The model features two representative, price-taking firms: one U.S.-based and one non-U.S.-based. Both firms operate in their respective domestic markets and finance their operations through the issuance of USD bonds. While the firms are similar in many respects, they differ in a critical way: the non-U.S. firm faces a currency mismatch, with its assets denominated in local currency and its liabilities in USD.

The U.S. and non-U.S. firms issue fixed amounts of USD bonds, D_i and D_j, respectively, with observed bond yields y for the U.S. firm and $y + y_x$ for the non-U.S. firm. The term y_x denotes the additional risk premium, referred to as the Foreign Discount, associated with non-U.S. USD bonds relative to U.S. USD bonds. The payoff variances for the bonds are denoted as V for the U.S. bond and $V + v(\epsilon_{fx})$ for the non-U.S. bond, where ϵ_{fx} represents the exchange rate shock, further defined in Section 2.1.3.

2.1.2 Investors

The model includes two representative investors: one U.S.-based and one non-U.S.-based. Both investors are characterized by mean-variance preferences and share the same level of risk aversion, denoted by γ. In addition, each investor displays a home bias toward USD bonds issued by domestic firms, preferring to invest in bonds from firms within their own country. This home bias plays a crucial role in shaping their investment decisions and contributes to the differences in bond yields and risk exposures observed in the market.

U.S. Investor. The U.S. investor allocates n_i and n_j to USD bonds i and j, respectively, and funds these investments at the domestic risk-free rate y^{rf}, where $y > y^{rf}$. The investor's objective is to maximize utility, which incorporates both mean-variance preferences and home bias:

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

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 home bias utility derived from holding USD bonds issued by a U.S. firm. As the holdings of domestic assets (n_i) increase, the total home bias utility μ_i also increases, though at a diminishing rate, consistent with a standard concave utility function. Thus, μ_i satisfies 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 for utility maximization, the optimal holdings n_i^* and n_j^* are derived as:

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

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

Non-U.S. Investor. The non-U.S. investor allocates funds to USD bonds i and j, denoted by m_i and m_j, respectively. These investments are financed at the domestic risk-free rate y^{rf}, plus an additional FX cost for converting from the domestic currency to USD. This FX cost, represented as $f(\epsilon_{fx})$, captures the frictional costs arising from imperfections in the international FX market, such as CIP deviations. For simplicity, the domestic risk-free rates are assumed to be identical for both U.S. and non-U.S. investors. The FX cost is defined as:

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

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 maximizes utility as follows:

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

where $V_m = m_i^2 V + m_j^2(V + v(\epsilon_{fx})) + 2m_i m_j Cov(i, j)$. The home bias utility function for the non-U.S. investor, μ_j, is analogous to that of the U.S. investor, and satisfies the following concavity conditions: $\mu_j' = \frac{\partial \mu_j}{\partial m_j} > 0$ and $\mu_j'' = \frac{\partial^2 \mu_j}{\partial m_j^2} < 0$.

The first-order conditions yield the optimal investments m_i^* and m_j^*:

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

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

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

2.1.3 Exogenous Shock

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

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

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

meaning that an appreciation of the USD increases the variance of bond j's payoffs. 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, as its USD liabilities increase in value. This results in heightened risk for non-U.S. USD bonds, reflected by an increase in $v(\epsilon_{fx})$.

Additionally, the covariance of returns between bonds i and j, denoted by $\text{Cov}(i, j)$, is also influenced by ϵ_{fx}. The first-order derivative of $\text{Cov}(i, j)$ with respect to ϵ_{fx} is negative:

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

The intuition behind this result lies in the currency mismatch on the balance sheet of non-U.S. firm j. As the USD appreciates, the correlation between the payoffs of bonds i and j ($\rho_{i,j}$) declines due to the extra exposure of bond j to exchange rate fluctuations. Consequently, the covariance of returns between bonds i and j decreases.

Thus, the combined effect of the exchange rate shock on the variance of bond j and the covariance between bonds i and j can be expressed as:

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

illustrating how the exchange rate shock primarily increases the risk associated with bond j, which in turn indirectly affects 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 $n_i^* - n_j^* + m_i^* - m_j^* = D_i - D_j$

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

where $\alpha = [V(V + v(\epsilon_{fx})) - Cov(i,j)^2] = [V(V + v(\epsilon_{fx})) - \rho_{i,j}^2 V(V + v(\epsilon_{fx}))] > 0$, since the correlation between U.S. and non-U.S. USD bonds 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, since $V + Cov(i,j) = V + \rho_{i,j}\sqrt{V(V + v(\epsilon_{fx}))} > V + \rho_{i,j}\sqrt{V^2} = (1 + \rho_{i,j})V > 0$, all coefficients (disregarding signs) 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, the Foreign Discount y_x:

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

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

Using the equilibrium condition derived in Equation (14), I investigate the impact of exchange rate shocks (ϵ_{fx}) on the Foreign Discount (y_x). This analysis focuses on the influence of demand-side factors while holding supply-side factors, such as relative bond issuance, constant.

2.3.1 Without FX Cost

First, I focus on the balance sheet channel by setting the average FX cost to zero ($c+\epsilon_{fx}=0$). Under this condition, the equilibrium expression for y_x simplifies to:

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

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

Proposition 1 [Balance Sheet Channel]: *An appreciation of the USD has the following effects:*

1. *It increases the riskiness of non-U.S. USD bonds ($\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} > 0$),*
2. *It decreases 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 exchange rate 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 exerted by the marginal utility of home bias among non-U.S. investors ($\frac{\partial \mu_j}{\partial m_j}$). As a result, the appreciation shock leads to a higher risk premium for non-U.S. USD bonds relative to U.S. USD bonds ($\frac{\partial y_x}{\partial \epsilon_{fx}} > 0$).
(*Proof: See Appendix A.2*)

Proposition 1 demonstrates that, through 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). This outcome highlights how the currency mismatch on the balance sheet of non-U.S. firms exposes their USD bonds to heightened exchange rate risk.

2.3.2 With FX Cost

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

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

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

I decompose y_x into two main components. *Component 1* is associated with the balance sheet channel, while *Component 2* is linked to the dollar home bias channel. The coefficient β aggregates the effects of these two components, and $\frac{\partial \beta}{\partial \epsilon_{fx}}$ is negative when the exchange rate shock is large (see *Proof: Appendix A.3*).[6]

The impact of *Component 1* was demonstrated in Proposition 1. Now, I focus on *Component 2* in Proposition 2.

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 indirectly influences the covariance of returns between bonds i and j. Therefore, $\frac{\partial V_{yx}}{\partial \epsilon_{fx}} > 0$.

6. $\frac{\partial \beta}{\partial \epsilon_{fx}}$ does not significantly affect the sign of $\frac{\partial y_x}{\partial \epsilon_{fx}}$ because the first-order derivatives of the numerator with respect to ϵ_{fx} are positive, such as $\frac{\partial \gamma\alpha}{\partial \epsilon_{fx}} > 0$ and $\frac{\partial (c+\epsilon_{fx})}{\partial \epsilon_{fx}} > 0$.

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

Component 2 represents an interaction between the average FX cost and the *standard factor term* (as defined in Section 2.2). An appreciation in the exchange rate shock increases the average FX cost for non-U.S. investors, reducing their risk-taking capacity and lowering their demand for USD bonds. This increased FX cost amplifies the effect of the *standard factor term* on the Foreign Discount. This amplification is particularly pronounced when non-U.S. investors exhibit 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 increase in FX costs positively impacts* y_x *under conditions of strong ex ante home bias among non-U.S. investors. This effect arises because a high proportion of USD bonds held by non-U.S. investors results in a lower ex post marginal home bias utility* ($\frac{\partial \mu_j}{\partial m_j}$)*, reducing their incentive to retain these bonds when facing rising FX costs. As a result, the overall effect of the FX cost on Component 2 is positive* ($\frac{\partial Component\ 2}{\partial \epsilon_{fx}} > 0$)*, especially when there is 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 highlights the interaction between home bias and FX costs for non-U.S. investors. Specifically, a strong ex ante home bias among these investors, combined with an exchange rate shock that raises 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 overall outcome, $\frac{\partial y_x}{\partial \epsilon_{fx}} > 0$, emerges from the combined effects of both $\frac{\partial \text{Component 1}}{\partial \epsilon_{fx}} > 0$ and $\frac{\partial \text{Component 2}}{\partial \epsilon_{fx}} > 0$. Thus, an exchange rate shock amplifies the Foreign Discount (y_x) through both the balance sheet and dollar home bias channels.

2.4 Model Extension

This parsimonious model provides the theoretical foundation for my empirical analysis. In this section, I discuss two potential extensions that can enrich the model and assess their impact on the model's key propositions.

FX Returns. The baseline model assumes that non-U.S. investors are fully hedged, mean-

ing they do not experience FX returns when the USD appreciates. While this assumption simplifies the model and allows the focus to remain on key parameters, it can be relaxed to incorporate FX returns. Specifically, FX returns r can be introduced into the non-U.S. investors' utility function, resulting in a total FX return of $(m_i + m_j)r$.

A critical question is whether FX returns influence the choice between non-U.S. and U.S. USD bonds. The answer is no, because FX returns depend on the total amount of USD invested, rather than the choice within USD bonds. However, FX returns provide an additional incentive for non-U.S. investors to hold USD assets. This is because USD bonds offer a hedge, generating positive returns during periods of USD appreciation, which typically coincide with adverse economic conditions. Thus, while FX returns are important when examining portfolio allocation decisions between USD and non-USD bonds, this analysis lies beyond the scope of this paper.

Do FX returns affect the model's propositions? Yes. During USD appreciation, particularly in times of crisis, non-U.S. investors face rising USD funding costs but hold USD assets with significant unrealized FX gains. These investors can "realize" these FX gains by selling USD bonds to obtain USD liquidity, as seen during the "Dash for Dollars" phenomenon in the COVID-19 crisis (Cesa-Bianchi, Czech, and Eguren-Martin 2023). The opportunity to sell USD assets during periods of USD appreciation can amplify the dollar home bias channel, as non-U.S. investors apply greater selling pressure on non-U.S. USD bonds due to their pre-existing home bias.

Firm Hedging. The model also assumes that non-U.S. firms do not hedge the exchange rate risk on their USD liabilities. In practice, firms employ two primary strategies for hedging. First, firms can engage in financial hedging through FX derivatives. However, not all firms possess the sophistication necessary to effectively hedge dynamic FX exposures (Du and Schreger 2022). In section 5.1.3, I show that only financial firms with access to highly liquid FX markets can efficiently hedge their exchange rate risk.

Second, non-U.S. firms may rely on natural operational hedges. Firms with non-U.S. assets and cash flows can partially offset the exchange rate risk associated with their USD liabilities. This natural hedge is closely tied to the endogenous decision of non-U.S. firms to issue USD bonds, a topic I will explore further in section 5.1.1. In short, some USD bonds issued by non-U.S. firms are matched with their USD assets and cash flows. However, a significant portion of these bonds are issued for other reasons, such as pricing arbitrage, access to liquid markets, or international currency bias. These cases result in additional *unhedged* exchange rate risk exposure when firms issue USD bonds.

In sum, non-U.S. firms do not fully hedge the exchange rate risk on their balance sheets,

leading to additional risk exposure. This unhedged risk plays a crucial 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 dataset includes various characteristics of each bond, such as notional principal, maturity date, coupon structure, denomination currency, issuer's nationality, ultimate parent company, and option-like feature indicators. I focus exclusively on USD bonds. Following the filtering approach of Liao (2020) and Hu et al. (2023), I apply the following criteria to select bonds: (1) the bond must be unsecured, non-putable, non-convertible, non-perpetual, and have a fixed-rate coupon; (2) the issuer must not belong to a government-related industry, such as city government, national government, or city agency; and (3) the bond must have an initial maturity of at least one year and a notional principal of at least $50 million.

A substantial portion of USD bonds issued by non-U.S. firms, particularly EME firms, are intermediated through offshore subsidiaries (Maggiori, Neiman, and Schreger 2020; Coppola et al. 2021; Du and Schreger 2022). To accurately capture the issuer's country of origin, I trace each bond to its ultimate parent company's nationality. This process is done by linking each bond to the issuer's CUSIP, the issuer's country, and the ultimate parent company's CUSIP in the SDC database. I successfully match approximately 97% of bonds with their ultimate parent's nationality, with around 37% of non-U.S. USD bonds being issued through offshore subsidiaries of non-U.S. firms.

I merge the filtered bond data with month-end price quotes (bid-, mid-, and ask-yields to maturity) sourced from Bloomberg, using ISIN identifiers. Bloomberg is a widely recognized data source for studies on international corporate bond markets (Valenzuela 2016; Geng 2022). The sample period spans from January 2004 to March 2021. For each bond-month observation, I assign a credit rating by first referencing the bond's credit rating from the Standard & Poor's Global Ratings database. If this rating is unavailable, I turn to the Moody's Default & Recovery Database. If the bond's rating is still missing, I use ratings from other agencies available on Bloomberg (e.g., Fitch). To account for outliers, I winsorize the yield-to-maturity and bid-ask spread at the 1% level on a monthly basis.[7]

The final dataset consists of 15,375 bonds issued by 1,264 U.S. firms and 968 non-U.S.

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

firms, with a total notional amount of $11.88 trillion. Figure 1 displays the evolution of the outstanding notional amount of USD bonds from January 2004 to March 2021. I disaggregate the bonds based on the issuer's country of origin into U.S. and non-U.S. categories, with the latter further divided into non-U.S. Advanced Economies (AE) and EME. Figures 1a and 1b show the time-series of the outstanding notional amount in billions of USD and as a percentage of the total USD bond market, respectively.

The total notional amount of outstanding USD bonds exhibits a clear upward trend, peaking at approximately $6 trillion. Since the 2008 global financial crisis, the notional amount of non-U.S. USD bonds has increased significantly, with the share of non-U.S. USD bonds doubling from 20% to 40% of the total USD bond market. Notably, non-U.S. AE bonds represent a substantial portion of non-U.S. USD bonds. Figure 1 underscores the growing role of non-U.S. issuers in the USD bond market.

Table 1 provides the monthly average of bonds, notional amounts (in $ billions), and the number of firms, disaggregated by rating and maturity categories. On average, the dataset includes approximately 3,523 bonds with a notional value of $2,782 billion issued by 1,213 firms each month. The A&BBB rating classes and the 3-7 year maturity group represent the largest shares of both issuance volume and outstanding notional amounts. U.S. USD bonds comprise about 68% (2,382 bonds) of the sample, accounting for 64% ($1,771 billion) of the notional amount and 60% (730 firms) of issuers. Within the non-U.S. USD bond category, non-U.S. AE bonds account for 74% (840 bonds) of the total, 77% ($782 billion) of the notional value, and 63% (304 firms) of the issuers.

Table 2 presents summary statistics of USD bond characteristics, including credit spreads, ratings, remaining maturities, bond age, issuance size, and coupon rates. Credit ratings are numerically translated, with AAA assigned a value of 1, AA+ a value of 2, and progressively increasing to 21 for C-rated bonds. On average, a USD bond in the sample has a credit spread of 1.89%, a rating of 7.70, a remaining maturity of 7.98 years, an age of 4.57 years, an issuance size of $790 million, a coupon rate of 4.87%, and a bid-ask spread of 0.15%. Non-U.S. USD bonds tend to have slightly lower credit spreads, bid-ask spreads, and ratings compared to U.S. USD bonds. Among non-U.S. USD bonds, EME bonds display significantly larger credit spreads (2.92%), wider bid-ask spreads (0.18%), and lower credit ratings (9.07).

3.2 Institutional Investor Holdings Data

I acquire data on U.S. institutional investor holdings from Thomson Reuters Lipper eMaxx. This dataset, which is free from survivorship bias, 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 using the bonds' ISIN identifiers.

Figure 2a presents the number of U.S. institutional investors covered in the dataset, classified into four categories: Mutual Funds, Property/Casualty Insurance Companies, Life Insurance Companies, and Others. Notably, the number of mutual funds has doubled from approximately 1,000 to around 2,000 over the sample period. Figure 2b illustrates the average share of USD bonds held by U.S. institutional investors between 2004Q1 and 2021Q1. The share is measured as the percentage of U.S. institutional investor holdings relative to the total issuance size of each bond. I categorize USD bonds based on the issuer's country of origin into U.S., non-U.S., EME, and G10 (non-U.S.).[8] Approximately 46% of the outstanding notional amount of U.S. USD bonds is held by U.S. institutional investors. In contrast, only 27% of the outstanding notional amount of non-U.S. USD bonds, and just 10% of EME USD bonds, are held by U.S. institutional investors.

3.3 Other Data

I obtain U.S. Treasury yields for maturities of 1, 2, 5, 7, 10, 12, 15, 20, and 30 years from Bloomberg. The Nominal Broad USD Index is sourced from Federal Reserve Economic Data, primarily using the DTWEXBGS index, which begins in 2006. For the period between 2004 and 2006, I supplement the data with the discontinued Nominal Broad USD Index (Goods Only) and normalize both indices to have the same value as of January 2, 2006. I also retrieve bilateral exchange rate data from Bloomberg and VIX data from Federal Reserve Economic Data. The Economic Policy Uncertainty index is obtained from Baker, Bloom, and Davis (2016). All data are recorded at a monthly frequency.

I construct firm-level debt capital structures using data from Capital IQ, while total asset data is sourced from Compustat Fundamentals. Additionally, I access firm-level foreign sales, income, and asset data from Worldscope Segments. The firm-level fundamental data are matched with bond-level data using firm-level identifiers. Further details on the data matching process can be found in Appendix B.

8. Following Du, Tepper, and Verdelhan (2018), 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 G10 currencies.

4 Empirical Evidence: Exchange Rate Risk

My theoretical model underscores the pivotal role of exchange rate risk in driving the Foreign Discount. In this section, I establish a robust relationship between bond-level exchange rate risk exposures and the Foreign Discount. Following this, I present empirical evidence supporting Propositions 1 and 2 from the model, as detailed in Section 5.

4.1 Exchange Rate Risk Exposure

To begin 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 holding identical credit ratings, one based in the U.S. and the other outside the U.S. Airbus and Boeing, the dominant players in the commercial aircraft market, offer a prime example of such a comparison. Both companies operate within a duopoly, with Airbus headquartered in France and Boeing in the U.S. Despite their fierce competition, these firms share notable similarities in terms of market dominance, product families, global presence, and technological capabilities. Using this comparison, I construct a model-free estimation of the Foreign Discount by comparing USD bonds issued by Airbus (ISIN: US26824KAA25) and Boeing (ISIN: US097023BG91).[9]

Figure 3 shows the time series of the model-free Foreign Discount (blue bars), the USD/EUR exchange rate (green line), and the scaled broad USD index (orange line). Notably, the USD experienced significant depreciation in 2017 due to heightened political risks and uncertainty surrounding the U.S. economy.[10] This depreciation coincided with a marked contraction in the Foreign Discount, suggesting a potential link between exchange rate risk and the Foreign Discount.

I formally examine the effect of exchange rate risk exposure on the Foreign Discount using the 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 USD.

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

10. For example, the administration of former President Trump faced challenges in passing promised healthcare and tax reform legislation.

Control variables include bond-specific 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), incorporating time (year-month) and industry fixed effects, while also adding the interaction term between Foreign_i and ΔDollar. The coefficient on Foreign_i, β, is 0.416 and significant at the 1% level. This indicates that, in the absence of exchange rate shocks, the average credit spread for non-U.S. USD bonds is 41.6 basis points higher than for U.S. USD bonds, underscoring the existence of the Foreign Discount. More importantly, the coefficient on the interaction term, θ, is positive and significant at the 1% level, demonstrating that non-U.S. USD bonds exhibit greater exposure to exchange rate risk compared to U.S. USD bonds.

Given the extensive cross-country bond panel dataset, noticeable differences exist across countries, firms, and bonds. To ensure robust results, I leverage fixed effects to control for potential confounding factors. Appendix C.1 presents the results with an exhaustive combination of fixed effects. In the following analysis, I employ the strictest set of fixed effects—time, firm-year, and bond-level—which control for a range of factors influencing bond pricing, including fundamental differences between countries and bonds, time-varying shocks (e.g., sovereign risk, economic uncertainty), and firm-specific fundamentals and credit risk. This setup allows for comparisons between bonds with identical characteristics, issued at the same point in time by firms experiencing identical shocks within the same year, where one issuer is a non-U.S. firm and the other is a U.S. firm. Consequently, the Foreign_i dummy variable is absorbed by the firm-year fixed effect.

Columns (2) and (3) of Table 3 present results using the broad USD index and bilateral exchange rates, respectively. After incorporating the strictest fixed effects, the R^2 increases from 0.48 to 0.83, indicating the effectiveness of this model specification in controlling for relevant factors. The coefficient on the interaction term, θ, remains highly positive and significant at the 1% level. For instance, in column (3), a θ value of 0.022 implies that a one standard deviation appreciation in the bilateral exchange rate (1.61) increases the Foreign Discount by 3.54 basis points, accounting for approximately 8.5% of the total Foreign Discount.

To further illustrate the relationship between the Foreign Discount and heterogeneous exchange rate exposure, I estimate a cross-sectional regression of Equation (18) for each month and present 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, which accounts for 26 basis points, or 54% of the Foreign Discount on average,

from January 2004 to March 2021.[11][12]

A natural follow-up question to the exchange rate risk analysis is which exchange rate matters most. In column (4) of Table 3, I include interaction terms between the Foreign dummy and both the broad USD index and the bilateral exchange rate. Only the coefficient on the interaction term involving the bilateral exchange rate remains highly significant.

Following Avdjiev, Bruno, et al. (2019), I then construct orthogonalized components of the two exchange rates relative to each other. In column (5), I include interaction terms for both the broad USD and the orthogonalized component of the bilateral exchange rate relative to the broad USD. Since the broad USD serves as a *de facto* global factor, the orthogonalized component of the bilateral exchange rate captures country-specific shocks. In column (6), I include interaction terms for the bilateral exchange rate and the orthogonalized component of the broad USD relative to the bilateral exchange rate.[13] For instance, 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 EUR/USD-specific shocks. The results indicate that only the coefficient on the interaction term involving the orthogonalized component of the bilateral exchange rate remains highly significant, whereas the coefficient on the orthogonalized component of the broad USD is statistically insignificant.

Overall, the impact of exchange rate risk on the Foreign Discount is driven primarily by shocks to the bilateral exchange rate rather than the broad USD. This finding is consistent with my prior assumption that bilateral rates better capture cross-sectional differences across countries. Consequently, in the subsequent empirical analyses, I focus on the bilateral exchange rate.

4.2 Robustness Checks

I conduct several robustness tests to validate the exchange rate risk exposure hypothesis, with detailed results presented in Appendix C.2. Below is a summary of these tests.

First, an important question arises: Is the impact of exchange rate risk on the Foreign Discount unique, or does it simply reflect conventional bond risk? To address this, I include

11. From July to December 2008, the Foreign Discount surged from -32 basis points to 190 basis points, coinciding with a significant appreciation of the USD. During this period, the broad USD index rose by approximately 10%.

12. The pattern of the Foreign Discount closely resembles the CIP deviations documented by Du, Tepper, and Verdelhan (2018). In Appendix C.2, I explore the extent to which CIP deviations can account for the Foreign Discount. The findings suggest that exchange rate risk is a more effective explanation.

13. I construct the orthogonalized component of the broad USD for each bilateral exchange rate individually, rather than regressing the broad USD on all bilateral exchange rates simultaneously.

interaction terms between the Foreign dummy and various bond-level characteristics in the original model specification, as shown in Equation (18). Second, I address potential non-stationarity by incorporating the lag of the credit spread among the control variables. Third, I restrict the sample period to 2010-2019, thereby excluding the effects of the global financial crisis and the COVID-19 pandemic. In all cases, the coefficient (θ) for the interaction between the Foreign dummy and exchange rate risk remains positive and highly significant at the 1% level.

Furthermore, I introduce an interaction term between the Foreign dummy and the country-level Economic Policy Uncertainty index to account for country-specific uncertainty. Geng (2022) use the Economic Policy Uncertainty index to test the uncertainty aversion hypothesis, which posits that U.S. investors assign a higher discount to non-U.S. USD bonds when the issuer's country faces greater uncertainty. After controlling for country-level uncertainty, the exchange rate risk hypothesis remains robust.

Additionally, I demonstrate that the effect of exchange rate risk is more pronounced during periods of market turmoil and for USD bonds issued by EME firms. In contrast, non-U.S. USD bonds issued by G10 financial firms exhibit lower exposure to exchange rate risk. More importantly, the impact of exchange rate risk is significantly smaller for USD bonds issued by non-U.S. firms with historically low FX rate volatility (local currency to USD), underscoring the critical role of exchange rate risk in this context.

5 Empirical Evidence: Balance Sheet and Dollar Home Bias Channels

In this section, I empirically test Propositions 1 and 2 (outlined in Section 2), focusing on the balance sheet channel and the dollar home bias channel.

5.1 Balance Sheet Channel

In Proposition 1, I propose a balance sheet channel where an appreciation of the USD reduces the net worth of currency-mismatched non-U.S. firms. This decline leads to a contraction in their balance sheets, negatively impacting the prices of their bonds. Under this balance sheet channel, I hypothesize that USD bonds issued by non-U.S. firms with significant currency mismatches, particularly those holding substantial USD liabilities, are more vulnerable to exchange rate risk.

5.1.1 Endogenous Choice

I measure the level of USD liabilities on a firm's balance sheet using the ratio of outstanding USD bonds to the total bonds issued by the firm. This ratio serves as a practical and informative measure of a firm's exposure to exchange rate risk and its level of USD debt. Given that both U.S. and non-U.S. firms commonly issue USD bonds to access the large and liquid international bond market, this ratio provides valuable insights into their USD liabilities.

The bond issuance data are inferred from the international bond issuance dataset in the SDC database. I follow the same data filtering process as outlined in Section 3, but I retain bonds denominated in all currencies. Since the bonds are non-putable and non-convertible, I estimate the outstanding notional amount based on the issue and maturity dates and aggregate this to the firm level. I then calculate the proportion of USD bonds relative to the total bonds' outstanding notional amount, aggregating this measure at the firm level. The data are further classified into U.S., non-U.S., G10 (non-U.S.), and EME firms by taking the average value for each month.

Figure 5 presents the dynamics of the proportion of USD bonds relative to the total bonds' outstanding notional amount. On average, USD bonds account for around 52% of the total bonds' outstanding notional amount for non-U.S. firms. Firms from EMEs exhibit a significantly higher proportion of USD bonds (60% - 70%) compared to non-U.S. G10 firms (40% - 45%). Unsurprisingly, U.S. firms issue only a small proportion of bonds denominated in non-USD currencies.

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

To directly test the endogenous choice of USD bond issuance by non-U.S. firms, I utilize Worldscope Segment data. The availability of this data varies across different variables, but I am able to match up to 71.2% of non-U.S. firms, providing a robust sample for analyzing firms' endogenous decisions regarding USD bond issuance. I use firms' foreign assets, sales, and income as proxies for their USD assets, sales, and income, based on the dominant role of the USD in international trade. As demonstrated by Gopinath et al. (2020) and Gopinath and Stein (2021), firms in non-U.S. countries frequently set export prices in a dominant currency, which is most often the USD. While not all foreign-related

assets, sales, and incomes are directly denominated in USD, the ultimate cash flows often settle in USD. To align with the monthly frequency of my bond-level data, I resample the yearly-level Worldscope data to a monthly frequency using the last available value.

Specifically, following Colacito, Qian, and Stathopoulos (2023), who also examine the endogenous choice of USD bond issuance by non-U.S. firms, I regress the share of USD bonds in a firm's total outstanding bond notional amount ($\text{USDShare}_{f,t}$) 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. The regression specification is as follows:

$$\begin{aligned}\text{USDShare}_{f,t} =&\alpha + \beta_1 \text{ForeignAssetShare}_{f,t} + \beta_2 \text{ForeignSaleShare}_{f,t} \\ &+ \beta_3 \text{ForeignIncomeShare}_{f,t} + \epsilon_{f,t}\end{aligned} \tag{19}$$

Table 4 presents the results. The coefficients on $\text{ForeignAssetShare}_{f,t}$ and $\text{ForeignSaleShare}_{f,t}$ are highly significant in the univariate regressions. 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 significantly linked only to foreign sales (USD cash flows). More interestingly, the intercepts of all regressions are both economically and statistically significant. For instance, in column (2), after controlling for $\text{ForeignSaleShare}_{f,t}$, the intercept α is 0.476, indicating that, on average, 47.6% of the USD bond share for non-U.S. firms is driven by factors beyond USD asset and cash flow matching.

Overall, these findings suggest that non-U.S. firms issue a substantial portion of USD bonds not only to hedge USD assets and cash flows but also for other reasons, thereby exposing themselves to significant exchange rate risk. The results also confirm the effectiveness of using $\text{USDShare}_{f,t}$ as a proxy for the currency mismatch level on non-U.S. firms' balance sheets.

5.1.2 USD Liabilities

To test the balance sheet channel, I introduce a triple interaction term, $\text{Foreign}_i \times \Delta\text{Dollar}_t \times \text{USDShare}_{f,t}$, in Equation (20). The coefficient γ captures the significance of the balance sheet channel:

$$\begin{aligned}\text{CreditSpread}_{i,t} =&\alpha + \theta \text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} \\ &+ \gamma \text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} \times \text{USDShare}_{f,t} + \text{controls}_{i,t} + \epsilon_{i,t}\end{aligned} \tag{20}$$

Table 5 presents the results, providing evidence for the balance sheet channel. Column (1) shows that USD bonds issued by non-U.S. firms with larger USD liabilities exhibit

higher exposure to exchange rate risk. The coefficient of the triple interaction term, γ, is 0.04 and significant at the 1% level. 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 accounts for approximately 8.1% of the Foreign Discount.

The measure of $\text{USDShare}_{f,t}$ is not perfect but covers the full sample of my data. To strengthen the analysis, I construct alternative measures of USD liabilities using firm-level debt capital structure data from Capital IQ. The Capital IQ database provides detailed information on the currency composition of outstanding debt for individual firms. I match approximately 84% of my sample to the Capital IQ data and resample the yearly-level debt structure to monthly-level data using the last available value. Specifically, I create two variables: $\text{USDLiabShare}_{f,t}$ and $\text{USDLiabShare}_{f,t}^{\text{Long-term}}$. $\text{USDLiabShare}_{f,t}$ represents the proportion of USD liabilities to total liabilities, while $\text{USDLiabShare}_{f,t}^{\text{Long-term}}$ reflects the proportion of long-term USD liabilities to total long-term liabilities. For long-term liabilities, I define those with a remaining maturity of more than 3 years.

In Columns (2) and (3) of Table 5, I replace $\text{USDShare}_{f,t}$ with $\text{USDLiabShare}_{f,t}$ and $\text{USDLiabShare}_{f,t}^{\text{Long-term}}$, respectively. I find that the coefficient γ is significant only when using $\text{USDLiabShare}_{f,t}^{\text{Long-term}}$. This suggests that non-U.S. firms primarily borrow in USD for long-term funding. For instance, the median $\text{USDLiabShare}_{f,t}$ for non-U.S. firms is 0.24, compared to 0.42 for $\text{USDLiabShare}_{f,t}^{\text{Long-term}}$. This result confirms the critical role of long-term USD liabilities in determining the exchange rate risk exposures of non-U.S. firms, and it also supports the use of $\text{USDShare}_{f,t}$, which captures the proportion of long-term USD bonds relative to total long-term bonds.

Another challenge with using $\text{USDShare}_{f,t}$ is that it only considers the liability side of the balance sheet, thus failing to fully capture the extent of currency mismatch. To address this, I construct an alternative measure, $\text{USDBond2TA}_{f,t}$, which represents the ratio of the outstanding USD bonds' notional amount ($\text{USDShare}_{f,t}$) to a firm's total assets at time t. The firm's total asset data are sourced from the Compustat Fundamentals database and resampled to monthly frequency using the last available value. I am able to match around 78% of my sample. $\text{USDBond2TA}_{f,t}$ is winsorized at the 1% level.

Column (4) uses $\text{USDBond2TA}_{f,t}$, and the results are consistent with those obtained using $\text{USDShare}_{f,t}$. Hence, the balance sheet channel hypothesis holds robustly across different specifications of currency mismatch levels for non-U.S. firms.

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.

5.1.3 Financial and Operational Hedging

Non-U.S. firms primarily hedge their exchange rate risk exposures arising from USD liabilities through two mechanisms. First, firms can engage in financial hedging using FX derivatives. However, most firms face significant challenges in effectively hedging their balance sheet exchange rate exposures due to the high costs and complexities involved in dynamic financial hedging (Du and Schreger 2022). Therefore, I focus on financial firms, which are more likely to utilize financial instruments to mitigate their exchange rate risk. Specifically, I examine financial firms from Australia, Canada, the Euro Area, Japan, and the United Kingdom, as their local currencies have the highest FX turnover against the USD.[15] This suggests that financial firms in these regions have more liquid markets for financial hedging. I construct a dummy variable Top5_f, equal to one for firms from Australia, Canada, the Euro Area, Japan, the United Kingdom, or the United States. Column (5) of Table 5 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, whereas the four-way interaction term ($\text{Foreign}_i \times \Delta\text{Dollar}_t \times \text{USDShare}_{f,t} \times \text{Fin}_i$) is insignificant. These results suggest 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, as discussed in Section 5.1.1, firms can utilize foreign cash flows to hedge their exchange rate risk exposures through operational hedging. I test whether firms with more foreign cash flows exhibit less exchange rate risk exposure. The results, presented in Column (6) of Table 5, show a negative and significant coefficient for the new interaction term ($\text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} \times \text{USDShare}_{f,t} \times \text{ForeignSaleShare}_{f,t}$), demonstrating the effectiveness of operational hedging. However, as shown in Section 5.1.1, many non-U.S. firms continue to have substantial USD liabilities that are not matched by foreign cash flows, leaving them with significant exchange rate risk exposure.

5.2 Dollar Home Bias Channel

In Proposition 2 of my model, I propose the dollar home bias channel, which links bond-level exchange rate risk exposures to investor-level risk exposures. This channel comprises two key elements.

First, there is a notable home bias among investors when allocating investments in USD bonds. As shown in Figure 2b, investors prefer USD bonds issued by domestic firms. To capture this, I construct the variable $\text{NonUSHolding}_{i,t}$, representing the proportion of

15. According to the BIS 2022 Triennial Central Bank Survey, the top five advanced economy FX market turnover pairs are USD/EUR, USD/JPY, USD/GBP, USD/CAD, and USD/AUD.

bond i's outstanding notional amount held by non-U.S. investors at time t.[16] Following Maggiori, Neiman, and Schreger (2020), I run the following regression to assess the extent of home bias[17]:

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

where $D_{i,\text{AE (non-G10)}}$, $D_{i,\text{G10 (non-US)}}$, and $D_{i,\text{EME}}$ are dummy variables indicating bonds issued by firms from AE (non-G10), G10 (non-U.S.), and EME, respectively. The coefficients λ_1, λ_2, and λ_3—0.30, 0.08, and 0.33, respectively—are significant at the 1% level, indicating strong home bias for USD bonds issued by firms from AE (non-G10) and EME, but less so for those from G10 (non-U.S.) countries. For example, USD bonds issued by EME firms have 33% higher holdings by non-U.S. investors compared to U.S. USD bonds.

Second, an appreciation of the USD exacerbates cross-border USD liquidity stress and increases indirect USD funding costs for non-U.S. investors (Avdjiev, Du, et al. 2019), thereby reducing their risk-taking capacity and leading to selling pressure on their portfolios.

Combining these two elements, due to ex ante home bias, non-U.S. investors disproportionately transmit selling pressure to non-U.S. USD bonds during periods of USD appreciation. Therefore, I hypothesize that non-U.S. USD bonds with a higher proportion of non-U.S. investors exhibit greater exposure to exchange rate risk.

5.2.1 Non-U.S. Investor Holdings

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

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

I add $\text{NonUSHolding}_{i,t-1}$ to measure the level of ex ante investors' home bias. By lagging this variable, I also mitigate concerns about contemporaneous impacts between USD fluctuations and investor holdings. Consequently, ω reflects the significance of the dollar home bias channel.

16. Since the eMaxx database provides quarterly holdings data, I resample it to a monthly frequency using the last available data. I winsorize $\text{NonUSHolding}_{i,t}$ at the 1% level to mitigate the impact of outliers. Although not perfect, the data offer clear insights into home bias among U.S. and non-U.S. investors.

17. The model includes standard bond-level characteristics, such as rating, maturity, age, coupon rate, and bid-ask spread, along with time and industry fixed effects to control for broader macroeconomic shocks and sector-specific risks.

Table 6 provides strong support for the dollar home bias channel. Column (1) shows that for USD bonds issued by non-U.S. firms, an average ex ante $\text{NonUSHolding}_{i,t-1}$ of 0.73, combined with a one standard deviation appreciation shock to the bilateral exchange rate (1.61), leads to a 2.62 basis points increase in the Foreign Discount, which is equivalent to a 6.3% rise.

The results in column (2) suggest that the dollar home bias channel similarly affects USD bonds issued by both financial and non-financial firms. However, column (3) shows that the effect is more pronounced for USD bonds issued by EME firms, reflecting that local investors in these markets are more vulnerable to funding cost shocks. Lastly, column (4) highlights that the dollar home bias channel is especially strong during periods of market turmoil, indicating that heightened market uncertainty amplifies the effect of funding cost shocks on non-U.S. USD bonds.

5.2.2 Central Bank Swap Line

In addition to standard panel data regression, I conduct a DiD analysis to evaluate the effectiveness of the dollar home bias channel. This analysis examines how exogenous policy shocks, such as the reactivation of central bank swap lines, affect funding costs differently for non-U.S. investors, resulting in divergent outcomes for non-U.S. bonds due to the dollar home bias channel.

In March 2020, the international fallout from COVID-19 led to an unexpected shortage of cross-border USD liquidity. Cesa-Bianchi, Czech, and Eguren-Martin (2023) document the "Dash for Dollars" phenomenon, wherein investors, particularly non-U.S. investors, liquidated their USD assets to meet USD obligations. This wave of selling pressure significantly widened the credit spreads of USD bonds relative to non-USD bonds. Based on the dollar home bias channel, non-U.S. USD bonds likely experienced more severe impacts from this liquidity crunch. Subsequently, the Federal Reserve reactivated the central bank swap line to provide low-cost USD liquidity to central bank counterparties.[18] Investors with access to the swap line faced less severe liquidity constraints. Therefore, I differentiate between a treatment group of "Swap" USD bonds, issued by firms in countries with central banks that had access to the swap lines, and a control group of "Other" USD bonds.

My analysis focuses primarily on the standing swap line agreement between the Federal Reserve and the central banks of the United Kingdom, Canada, the European Union,

18. A central bank swap line is an agreement between central banks to exchange currencies, facilitating liquidity access. The effectiveness of swap lines in mitigating USD liquidity shortages has been examined by Bahaj and Reis (2020, 2022) and Ferrara et al. (2022).

Japan, and Switzerland.[19] March 15, 2020, is designated as "Event Day Zero," and I compare the Foreign Discount for "Swap" and "Other" USD bonds before and after this event. Specifically, I examine the Foreign Discount 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, a period when only the standing swap line was operational.

Figure 6 illustrates the Foreign Discount for both "Swap" and "Other" bonds around the reactivation of the Federal Reserve's standing swap lines. Using daily bond yield data, I find a parallel trend in the Foreign Discount between "Swap" and "Other" bonds before Event Day Zero. However, after the reactivation, the Foreign Discount for "Swap" bonds declines, while it increases for "Other" bonds.

$$\begin{aligned}\Delta\text{CreditSpread}_{i,t} = \alpha + \lambda\text{Foreign} \times \text{D}_{Covid} \times \text{D}_{Swap} \\ + \eta\text{Foreign} \times \text{D}_{Covid} + \phi\text{D}_{Covid} + \text{controls}_{i,t} + \epsilon_{i,t}\end{aligned} \tag{23}$$

To formally test the effect of the standing swap line, I employ a triple difference specification in Equation (23). The first difference in credit spreads is used as the dependent variable to control for the non-stationarity of daily bond yields. The dummy variable D_{Covid} is set to 1 after March 15, 2020, when the standing swap lines were reactivated, and D_{Swap} is set to 1 for "Swap" USD bonds. The sample period covers daily data from March 9, 2020, to March 18, 2020. Table 7 presents the results. The coefficient of the triple DiD interaction term is negative and significant, with a value of -0.043 in both columns (1) and (2), where I use the firm fixed effect and the firm and day fixed effects, respectively. This result indicates that the Foreign Discount of "Swap" USD bonds decreased by 4.3 basis points more than that of "Other" USD bonds. This provides further evidence of the dollar home bias channel, as non-U.S. investors with access to swap lines exerted less selling pressure on USD bonds issued by their local firms, thereby mitigating the exchange rate risk exposure of those bonds during the liquidity crunch.

5.3 Channel Comparison

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

19. In addition to the standing swap line, the Federal Reserve implemented temporary swap lines with other central banks, such as the Reserve Bank of Australia and Banco Central do Brasil. The standing swap line was reactivated on March 15, 2020, while temporary swap lines were announced on March 19, 2020, providing an ideal basis for a Difference-in-Differences analysis.

bonds. Here, I compare these two channels.

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

Table 8 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 and currency mismatches are particularly vulnerable to fluctuations in the USD, transmitting firm-level exchange rate

risks into bond-level pricing. Second, the dollar home bias channel demonstrates that USD appreciation reduces the risk-taking capacity of non-U.S. investors, leading to increased selling pressure on their USD bond holdings. This pressure disproportionately impacts USD bonds issued by non-U.S. firms, which are predominantly held due to home bias. Together, these channels explain how both firm- and investor-level exchange rate risks contribute to the Foreign Discount.

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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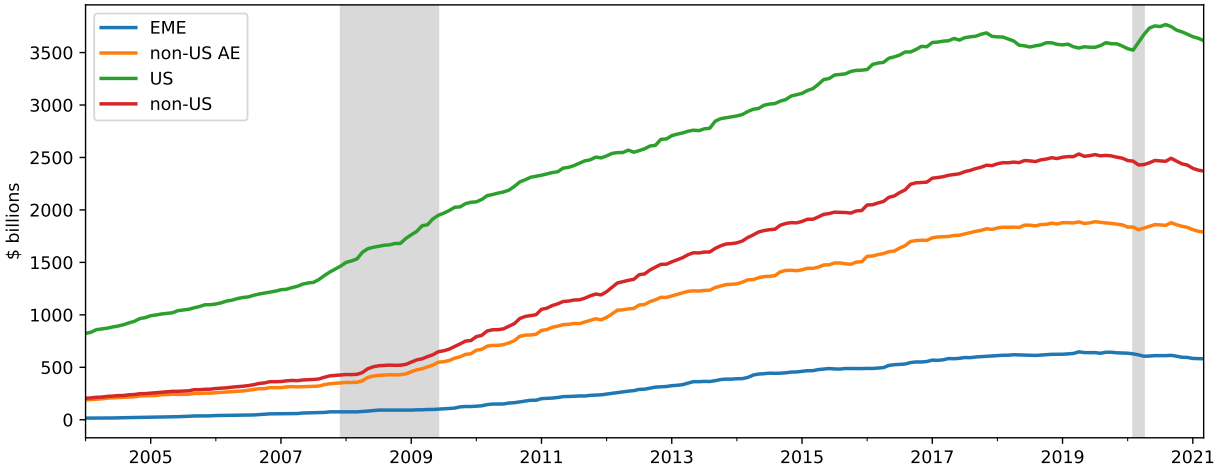
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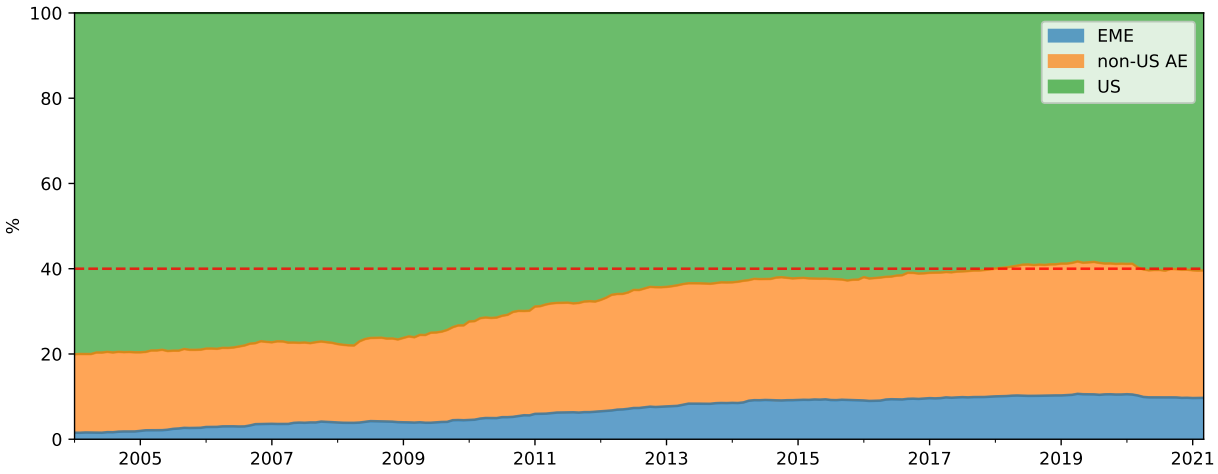
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Figure 1: Outstanding Notional Amounts of USD Bonds

(a) Outstanding Notional Amounts in $ Billion



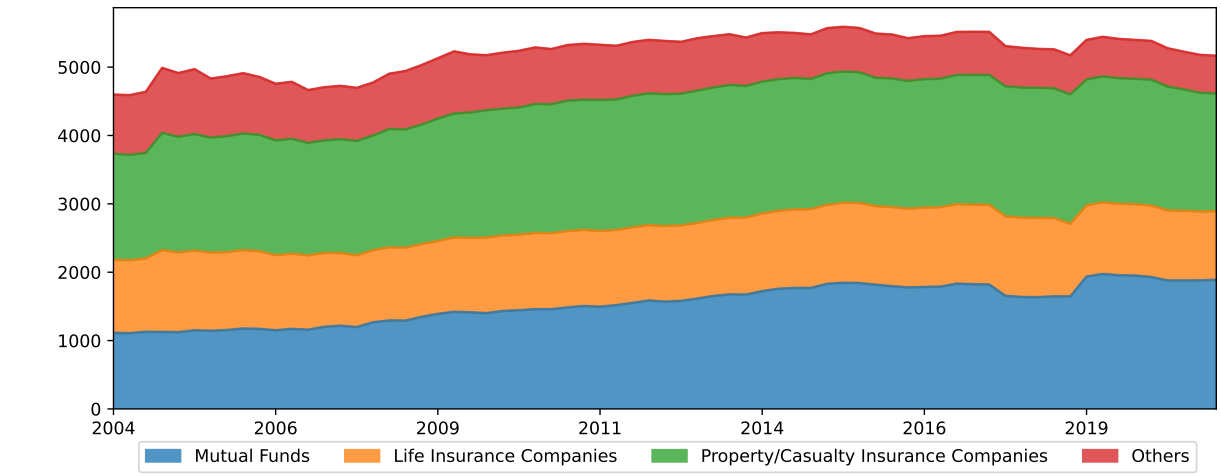
(b) Shares of Outstanding Notional Amounts



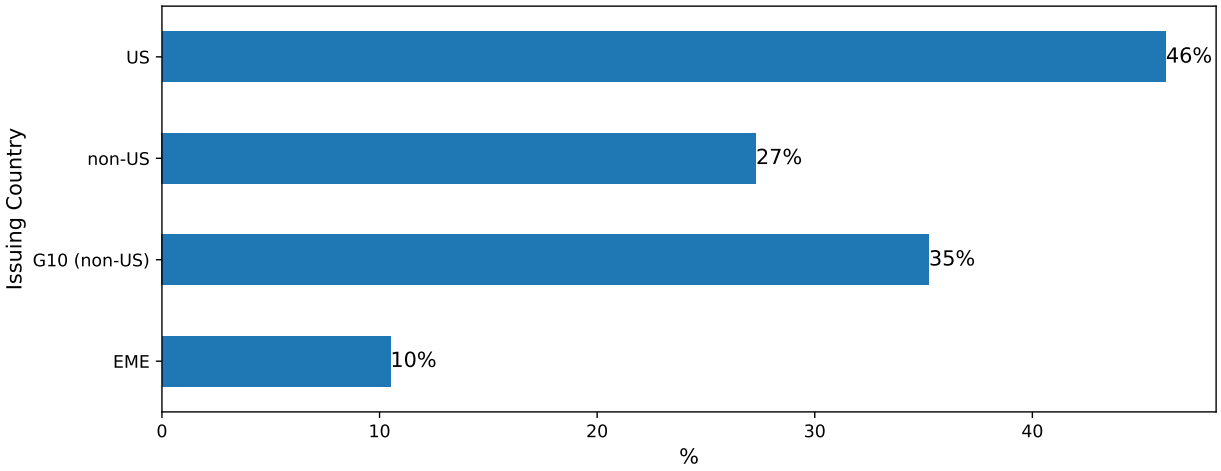
Note: This figure presents the outstanding notional amounts of USD bonds from January 2004 to March 2021. USD bonds are classified based on the issuer's country of origin into U.S. and non-U.S.. I further classify non-U.S. to non-U.S. AE and EME. Panel (a) illustrates the dynamics of total outstanding notional amounts of dollar bonds in $ billion, 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

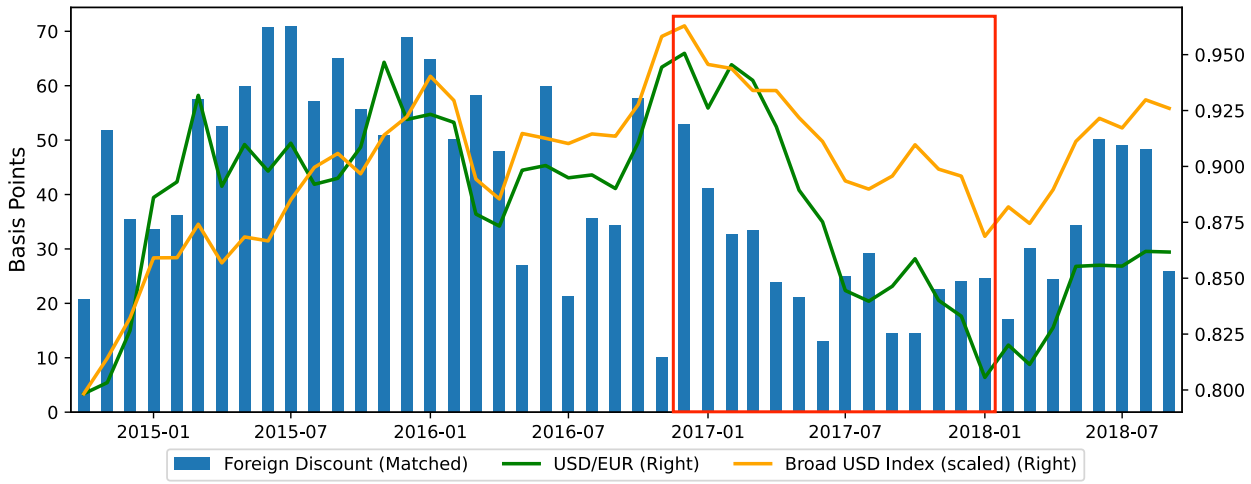


(b) Average Shares of USD Bonds Held by U.S. Institutional Investors



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.

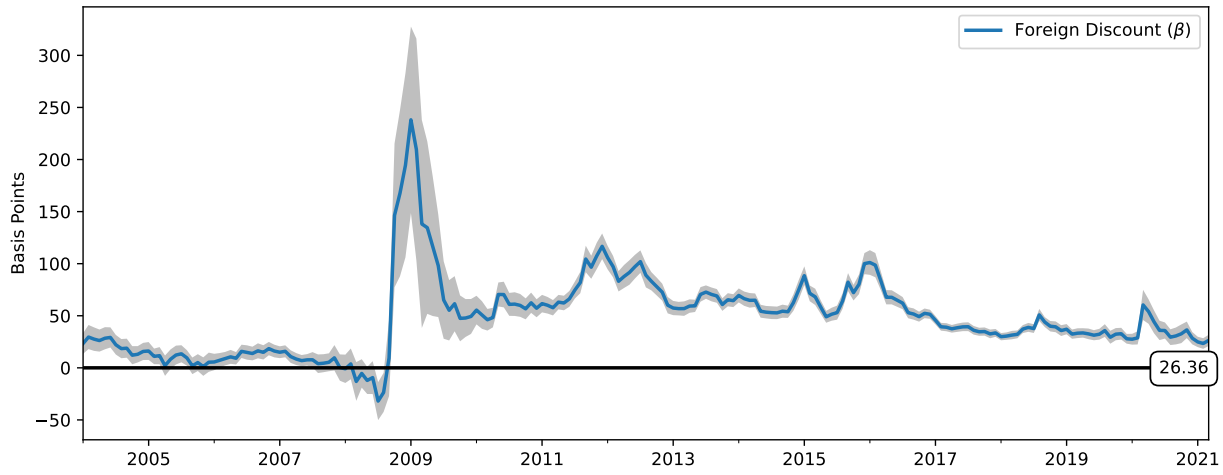
Figure 3: Anecdotal Evidence: Airbus and Boeing



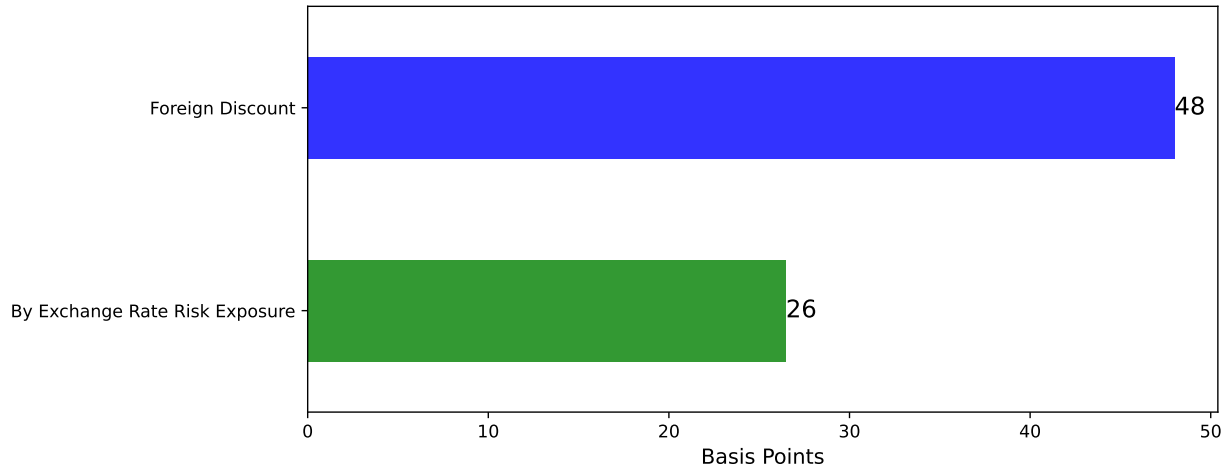
Note: The figure presents the Foreign Discount (Matched) as a blue bar, alongside the USD/EUR exchange rate and the broad USD index, depicted by green and orange lines, respectively. The Foreign Discount (Matched) is calculated as the difference in credit spreads between the USD bonds issued by Airbus (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:

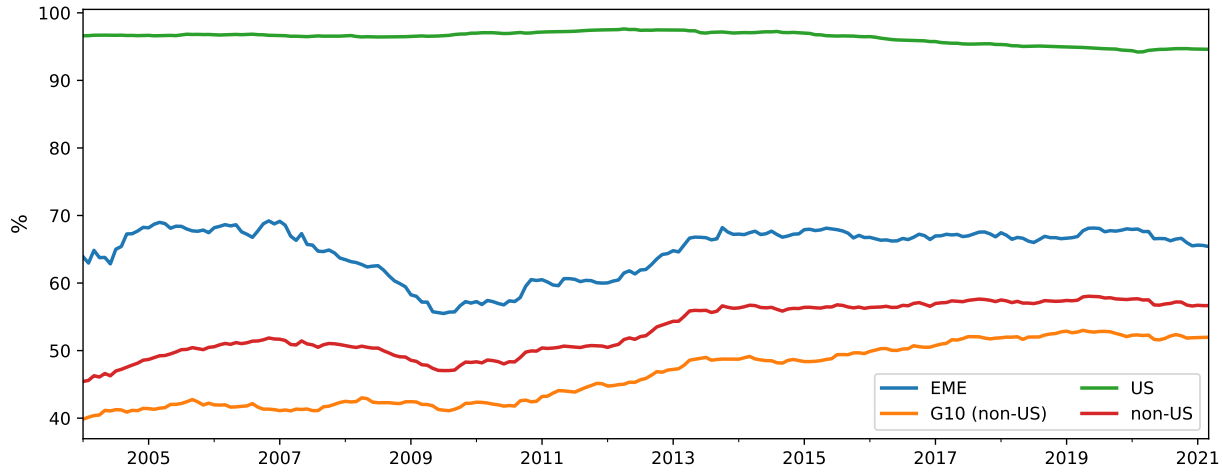
$$\text{CreditSpread}_{i,t} = \alpha + \beta \text{Foreign}_i + \text{controls}_{i,t} + \epsilon_{i,t}$$

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:

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

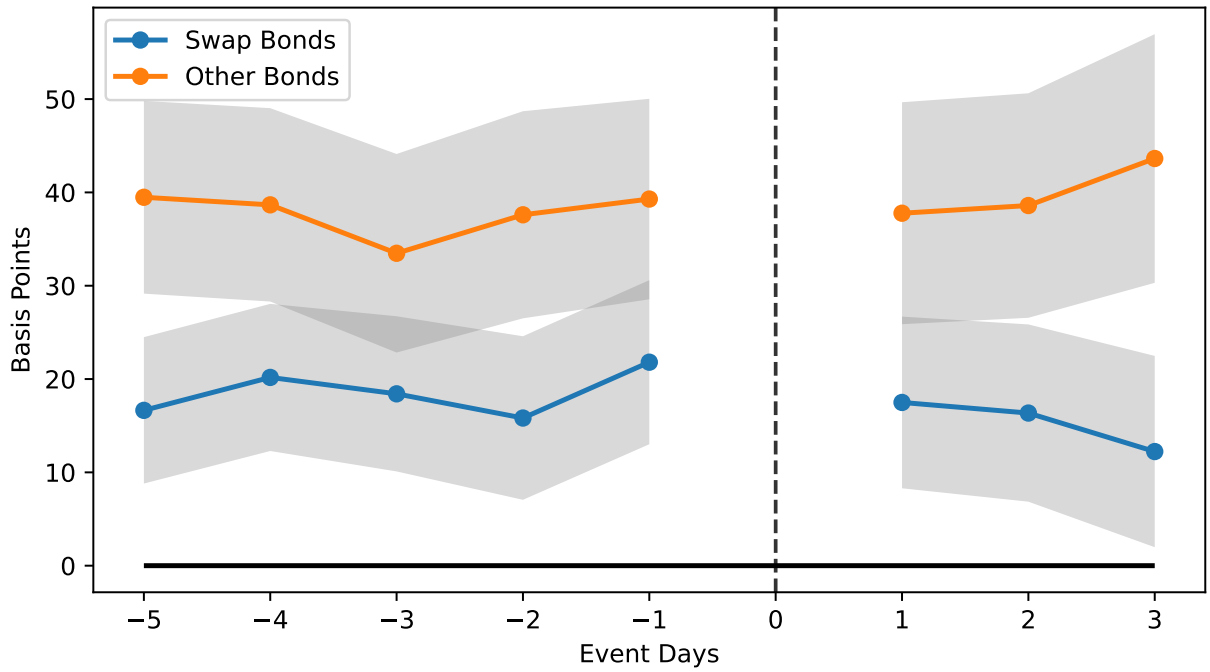
Then, I get the average of Foreign Discount as the mean of $\beta_2 \text{Foreign}_i + \theta \text{Foreign}_i \times \Delta\text{Dollar}_t$ and the average of contribution by the exchange rate exposure as the mean of $\theta \text{Foreign}_i \times \Delta\text{Dollar}_t$. The sample period is monthly 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 around the Policy Shock

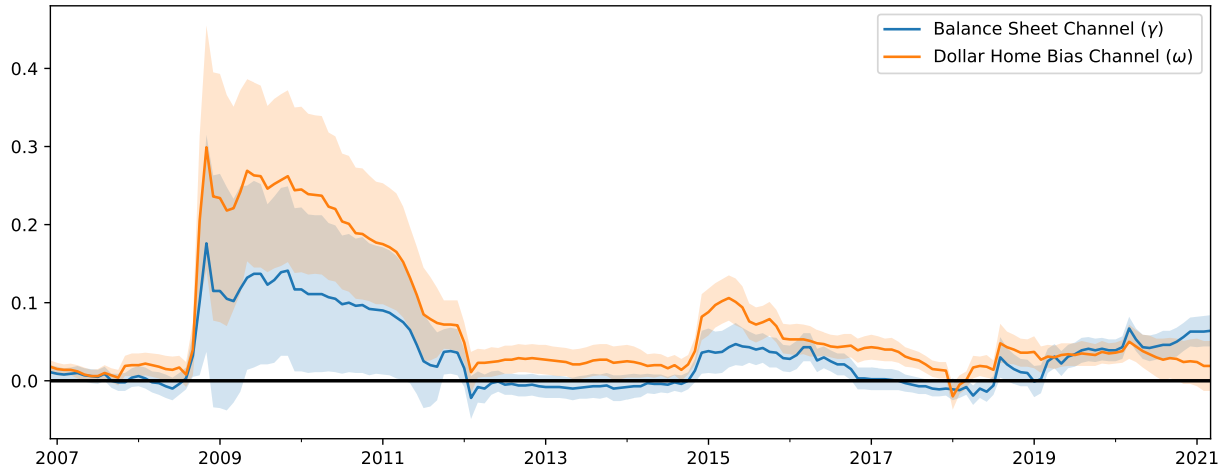


Note: The figure presents the Foreign Discounts for USD bonds issued by non-U.S. firms from "Swap" countries and "Other" countries, respectively. The "Swap" countries refer to countries of the five other Central Banks (the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank, 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:

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

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, firm-year, and bond-level 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 $\Delta\text{Dollar}_{i,t}^{Bilateral}$ 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 $\Delta\text{Dollar}_{i,t}^{Bilateral}$, 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: 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 5: Balance Sheet Channel

	(1)	(2)	(3)	(4)	(5)	(6)
	Full	Full	Full	Full	Full	Full
Foreign× ΔDollar^{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× ΔDollar^{Bilateral} × USDShare	0.040***				0.046***	0.039***
	(0.009)				(0.012)	(0.012)
Foreign× ΔDollar^{Bilateral} × USDLiabilitiesShare		-0.000				
		(0.006)				
Foreign× ΔDollar^{Bilateral} × USDLiabilitiesShare^{LongTerm}			0.016***			
			(0.006)			
Foreign× ΔDollar^{Bilateral} ×Bond2TA				0.002***		
				(0.000)		
Foreign× ΔDollar^{Bilateral} × USDShare × Fin					0.033	
					(0.029)	
Foreign× ΔDollar^{Bilateral} × USDShare × Fin × Top5					-0.076*	
					(0.042)	
Foreign× ΔDollar^{Bilateral} × ForeignSalesShare						0.008
						(0.012)
Foreign× ΔDollar^{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. USDShare$_{f,t}$ represents the proportion of USD bonds to the total outstanding bond notional amount for firm f at time t. USDLiabShare$_{f,t}$ is the proportion of USD liabilities to total liabilities for firm f at time t. USDLiabShare$^{Long-term}_{f,t}$ indicates the proportion of long-term USD liabilities to total long-term liabilities for firm f at time t. 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. 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 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 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 6: 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 7: Dollar Home Bias Channel: Central Bank Swap Line

	(1)	(2)
	Full	Full
Foreign× $D_{Covid} \times D_{Swap}$	-0.043*	-0.043*
	(0.022)	(0.022)
Foreign× 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 8: 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:

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

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 $\frac{\partial \beta}{\partial \epsilon_{fx}}$

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

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

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:

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

Then,

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

$\frac{\partial \beta}{\partial \epsilon_{fx}}$ 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 $\frac{\partial V_{yx}}{\partial \epsilon_{fx}} > 0$, $\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}}$, $\frac{\partial V+v(\epsilon_{fx})+Cov(i,j)}{\partial \epsilon_{fx}} > 0$, $\frac{\partial \mu_i}{\partial n_i} > 0$ 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

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 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	729,300	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× ΔDollar^{Bilateral}	0.005**	0.004*
	(0.002)	(0.002)
Foreign× ΔCIP^{1m,Libor}	0.021	
	(0.027)	
Foreign× 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$^{Bilateral}_{i,t}$ represents the log change in the bilateral exchange rate of the USD to the issuers' local currency. ΔCIP$^{1m}_{i,t}$ and ΔCIP$^{3m}_{i,t}$ 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.

Appendix C.3 Robustness Tests

I conduct a series of robustness tests to examine whether non-U.S. USD bonds have greater exposure to exchange rate risk than U.S. USD bonds, as shown in Tables C3 and C4.

First, the exposure of corporate bonds, issued by both U.S. and non-U.S. firms, to conventional bond characteristics may vary. Consequently, a key 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, I introduce interaction terms between the Foreign dummy and several bond-level characteristics in column (1) of Table C3. The coefficient (θ) of the interaction between the Foreign dummy and exchange rate risk is 0.021 and is highly significant at the 1% level. Additionally, the magnitude of 0.021 is closely aligned with the previous result of 0.022 in column (3) of Table 3. This finding suggests that the effect of exchange rate risk exposure is independent of the differential risk loadings associated with common bond-level characteristics. In column (2) of Table C3, I address the potential non-stationarity issue by including the lagged credit spread among the control variables. In column (3) of Table C3, I restrict the sample to the 2010-2019 period to exclude the impacts of the global financial crisis and the COVID-19 pandemic. In both columns (2) and (3), θ remains positive and highly significant.

Additionally, Geng (2022) utilize the country-level Economic Policy Uncertainty index as a proxy for country-level uncertainty, finding that it explains a substantial portion of the Foreign Discount. Their findings support the uncertainty aversion hypothesis, which posits that U.S. investors apply a higher discount to non-U.S. USD bonds when the issuer's country faces greater uncertainty. I test whether including the country-level Economic Policy Uncertainty index eliminates the effects of exchange rate risk exposure. Columns (4) and (5) of Table C3 present the results of the interaction terms between the Foreign dummy and the level of, as well as the change in, the Economic Policy Uncertainty index, respectively. Both columns demonstrate that the exchange rate risk hypothesis remains robust after controlling for country-level uncertainty.

In column (1) of Table C4, I introduce a three-way interaction term: $\text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} \times \text{VIX}_t^{High}$. VIX_t^{High} is a dummy variable indicating periods of heightened market volatility, taking a value of 1 when the VIX exceeds 30.[20] Excluding the global financial crisis period, I find that the effect of exchange rate risk is more pronounced during market turmoil, evidenced by the significant and positive coefficient of the three-way interaction term. Quantitatively, the additional exchange rate

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

risk exposure during high-VIX periods is nearly four times greater. In unreported results, I find that these 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 (2), I introduce a three-way interaction term: Foreign$i \times \Delta\text{Dollar}_{i,t}^{Bilateral} \times \text{EME}_i$, where EME_i is a dummy variable indicating issuers from emerging market economies. The positive coefficient of this interaction term suggests that USD bonds issued by EME firms have greater exposure to exchange rate risk than those issued by non-U.S. advanced economy firms. In column (3), I introduce a four-way interaction term: Foreign$i \times \Delta\text{Dollar}_{i,t}^{Bilateral} \times \text{Fin}_i \times \text{G10}_i$. Here, Fin_i is a dummy variable indicating financial firm issuers, and G10_i indicates issuers from G10 countries. The coefficient of this four-way interaction term is significantly negative (-0.023), while the corresponding three-way interaction term (Foreign$i \times \Delta\text{Dollar}_{i,t}^{Bilateral} \times \text{Fin}_i$) is significantly positive (0.027). These results indicate that non-U.S. USD bonds issued by G10 financial firms exhibit lower exposure to exchange rate risk compared to other non-U.S. USD bonds.

Lastly, in column (4) of Table C4, I introduce a three-way interaction term: $\text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} \times \text{Vol}_i^{Low}$. Vol_i^{Low} is a dummy variable equal to 1 for issuers with low FX rate volatility of the local currency against the USD. Low volatility is defined as currency pairs in the lower quartile based on the coefficient of variation, calculated as the ratio of the standard deviation to the mean of their monthly exchange rate. The coefficient of this three-way interaction term is significantly negative (-0.01), indicating that the impact of exchange rate risk is substantially smaller for USD bonds issued by non-U.S. firms with historically low FX rate volatility. This result highlights the importance of exchange rate risk in bond pricing and reinforces the validity of the exchange rate risk hypothesis.

Table C3: Foreign Discount and Exchange Rate Risk Exposure: Further Tests I

	(1)	(2)	(3)	(4)	(5)
	Full	Full	2010 to 2019	Full	Full
Foreign× ΔDollar^{Bilateral}	0.021***	0.024***	0.012***	0.017***	0.017***
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
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× EPU				0.025	
				(0.030)	
Foreign× ΔEPU					0.013
					(0.013)
EPU				0.004	
				(0.027)	
ΔEPU					-0.015
					(0.011)
BidAskSpread	1.281***	0.862***	1.668***	1.387***	1.387***
	(0.121)	(0.057)	(0.140)	(0.107)	(0.107)
Rating	0.388***	0.079***	0.208***	0.363***	0.363***
	(0.061)	(0.020)	(0.031)	(0.052)	(0.052)
Constant	-1.296***	-0.400***	-0.185	-1.166***	-1.146***
	(0.377)	(0.151)	(0.248)	(0.404)	(0.398)
R^2	0.83	0.92	0.90	0.82	0.82
N	728,595	693,936	506,821	689,759	689,758
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$^{Bilateral}_{i,t}$ represents the log change in the bilateral exchange rate of the USD to the issuers' local currency. ΔEPU$_{i,t}$ represents the change in the Economic Policy Uncertainty index for the issuer's country. 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 C4: Foreign Discount and Exchange Rate Risk Exposure: Further Tests II

	(1)	(2)	(3)	(4)
	Excluding GFC	Full	Full	Full
Foreign× ΔDollar^{Bilateral}	0.011***	0.006**	0.033***	0.023***
	(0.002)	(0.002)	(0.005)	(0.003)
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)	
Foreign× ΔDollar^{Bilateral}×Vol^{Low}				-0.010***
				(0.003)
BidAskSpread	1.395***	1.422***	1.421***	1.423***
	(0.099)	(0.104)	(0.104)	(0.104)
Rating	0.225***	0.376***	0.375***	0.375***
	(0.027)	(0.050)	(0.050)	(0.050)
Constant	-0.284	-1.219***	-1.217***	-1.216***
	(0.212)	(0.385)	(0.385)	(0.385)
R^2	0.89	0.83	0.83	0.83
N	677,650	728,595	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. Vol$_i^{Low}$ is a dummy variable equal to 1 for issuers with low foreign exchange rate volatility of the local currency against the USD. Low volatility is defined for currency pairs in the lower quartile based on the coefficient of variation, calculated as the ratio of the standard deviation to the mean of their monthly exchange rate. 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.