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

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Abstract

This paper examines the influence of differential exchange rate risk on the pricing disparities in U.S. dollar (USD) bonds, specifically focusing on the Foreign Discount observed in USD bonds issued by non-U.S. firms compared to those by U.S. firms. I combine theoretical insights and empirical analysis to investigate the underlying causes of these differential exchange rate risks. I show the balance sheet and dollar home bias channels as the primary contributors. The former channel links bond-level exchange rate risk exposure to firm-level exchange rate risk exposure, while the latter channel illustrates the transmission of investor-level exchange rate risk exposure to USD bonds issued by their local firms. The findings underscore the significant role of exchange rate risk in the pricing of USD bonds and provide insights into the transmission mechanisms of these risks in the USD bond market.

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

USD bonds are particularly sought-after assets in the global financial landscape. Since the 2008 global financial crisis, international investors have shown a marked preference for USD bonds (see, e.g., Krishnamurthy and Vissing-Jorgensen 2012; Maggiori, Neiman, and Schreger 2020), leading to a notable pricing differential between USD and non-USD bonds.[1] Within the realm of USD bonds, the proportion of outstanding USD bonds issued by non-U.S. firms in the corporate bond market has increased from 21% in 2004 to 42% in 2021, driven by factors such as access to a large, liquid international market, international trade, and arbitrage price differentials (Black and Munro 2010; Bruno and Shin 2017; Maggiori, Neiman, and Schreger 2019; Liao 2020). Recent research by Geng (2022) reveals that when controlling for various factors, USD bonds issued by non-U.S. firms (referred to as non-U.S. USD bonds) consistently exhibit larger credit spreads than those issued by U.S. firms (referred to as U.S. USD bonds), a phenomenon termed the Foreign Discount.

The existence of the Foreign Discount is intriguing for several reasons. First, it highlights that non-U.S. firms heavily rely on issuing USD bonds in the international market for financing, yet they incur higher issuance costs compared to U.S. firms, even after controlling for numerous factors. Second, the pricing discrepancy between USD bonds remains puzzling, particularly given the non-arbitrage condition. While Geng (2022) suggests an uncertainty aversion hypothesis from the perspective of U.S. investors to explain the Foreign Discount, this paper aims to further complement the current understanding by offering risk-based explanations linked to exchange rate risk. Exchange rate risk, especially fluctuations in the value of the U.S. dollar, is a critical aspect of international asset pricing, affecting cross-border capital flows and associated with macroeconomic-level risks (Lustig, Roussanov, and Verdelhan 2014; Avdjiev, Du, et al. 2019; Lilley et al. 2022; Bertaut, Bruno, and Shin 2021). This paper posits that non-U.S. USD bonds have additional exposure to exchange rate risk compared to U.S. USD bonds, thereby contributing to the persistent pricing difference. Initially, the idea of varying exchange rate risk exposure within USD bonds may not appear unexpected. However, my analysis reveals that, on average, exchange rate risk exposures account for approximately 56% of the Foreign Discount from January 2004 to March 2021. This finding is rather surprising and sheds light on the significant role of exchange rate risk in driving the price difference within USD bonds. More importantly, this paper not only documents this novel link but also elucidates the sources of this additional exchange rate risk exposure. Therefore, by addressing this question, I contribute to the literature by unraveling how international risk transmission via exchange rate risk ultimately results in a persistent price disparity

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).

within USD bonds.

I begin with a parsimonious static model featuring two types of investors: one from the U.S. and one from a non-U.S. region. Both investors are engaged in the USD bond market, involving issues from both U.S. and non-U.S. firms. These investors are characterized by risk-averse, mean-variance preferences and exhibit a home bias towards USD bonds issued by their local firms. The model posits that the non-U.S. firm faces a currency mismatch issue on its balance sheet, as it incurs debts in U.S. dollars while operating in a local currency market. Additionally, this model incorporates friction costs in an incomplete FX market, aligning with the empirical evidence of deviations in covered interest rate parity (Du, Tepper, and Verdelhan 2018). The non-U.S. investor faces additional costs when converting local currency into U.S. dollars.

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

Using an extensive dataset comprising 15,411 USD bonds issued by 1,265 U.S. firms and 971 non-U.S. firms, with a total notional value of $11.92 trillion spanning from January 2004 to March 2021, I present robust empirical evidence supporting my model. The initial focus is on delineating the impact of varying exchange rate risk exposures on the Foreign Discount. Employing panel data regression, I observe that a one standard deviation appreciation in the U.S. dollar leads to a 3.9 basis point increase in the Foreign Discount, equivalent to 9% of its value. Notably, this exchange rate risk is more closely aligned with bilateral exchange rates rather than the broad dollar index, as bilateral rates more effectively capture the cross-sectional differences across non-U.S. countries.

Furthermore, upon accounting for the differential risk loadings of bonds to common bond-level characteristics, the influence of exchange rate risk on the Foreign Discount remains unchanged, both statistically and economically. Additionally, the impact of exchange rate risk persists beyond crisis periods, becoming more pronounced during times of market turmoil. This effect is observable in USD bonds issued by both Emerging Market Economies (EME) and non-U.S. Advanced Economies (AE) firms. Notably, a more substantial impact is seen in EME USD bonds. The classification of EME and AE adheres to the guidelines established by the IMF World Economic Outlook. Moreover, USD bonds issued by financial firms in G10 countries[2] demonstrate a reduced exposure to exchange rate risk when compared to those issued by other non-U.S. firms.

Next, I present empirical evidence supporting the propositions of the model. I begin by investigating the balance sheet channel. The currency mismatch level in the balance sheets of non-U.S. firms is approximated by the proportion of outstanding USD bonds relative to the firms' total bonds. This measure is effective since firms generally operate in local markets but finance globally. Firm bond outstanding data is inferred from bond issuance information obtained from the SDC database. Approximately 52% of the total outstanding bond notional amount for non-U.S. firms consists of USD bonds. Specifically, for EME firms, USD bonds constitute a significant portion, ranging from 60% to 70%. Empirically, I demonstrate that USD bonds issued by non-U.S. firms with a higher proportion of outstanding USD bonds exhibit greater exposure to exchange rate risk. Typically, for a USD bond issued by a non-U.S. firm with 52% of its total bond outstanding in USD bonds, a one standard deviation appreciation shock in the U.S. dollar results in a 4.7 basis point increase in the Foreign Discount, corresponding to approximately 11.2% of its value. Alternative measures of currency mismatch levels are also constructed. Utilizing firm-level debt capital structure data from Capital IQ, firms with more long-term USD liabilities are more exposed to exchange rate risk. Additionally, employing total asset data from the Compustat Fundamentals database, I construct a ratio of total USD bond outstanding to total assets. The results utilizing the USD bond to total asset ratio are consistent with the balance sheet channel. Thus, the balance sheet channel hypothesis remains robust across various specifications of currency mismatch levels for non-U.S. firms.

Also, the hedging capabilities of non-U.S. firms using financial instruments and foreign currency revenues are considered. To assess the impact of hedging on the balance sheet channel, firms are disaggregated into financial and non-financial categories, and non-financial firms are further divided into tradable and non-tradable sectors. By definition, financial firms may have better capabilities to hedge exchange rate risk exposures using financial instruments, and tradable firms are more likely to offset their exchange rate risk exposures on liabilities with foreign currency income from overseas operations. However, I find that, under the same level of currency mismatch, there is no significant difference in exchange rate risk exposures for USD bonds issued by non-U.S. financial, non-financial tradable, and non-financial non-tradable firms.

2. G10 countries include Australia, Canada, Denmark, the Euro Area, Japan, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the United States, referring to those using G10 currencies.

I then examine the dollar home bias channel. The ex-ante home bias of non-U.S. USD bonds is gauged using the proportion of holdings by non-U.S. investors relative to the total bond outstanding at time $t-1$. This bond-level holding data is sourced from the eMaxx database. In alignment with the dollar home bias channel, non-U.S. USD bonds with a greater proportion of non-U.S. investor holdings exhibit increased exchange rate risk exposures. For an typical USD bond, where approximately 73% of the total outstanding notional is held by non-U.S. investors, a one standard deviation appreciation in the U.S. dollar results in an increase in the Foreign Discount by about 3.2 basis points, which equates to around 7.7% of its value. The influence of the dollar home bias channel is notably more significant for EME USD bonds and during periods of high VIX.

To further elucidate this channel, a difference-in-difference (DiD) analysis is conducted, centered around the reactivation of the standing central bank swap line policy during the Covid-19 period. The implementation of this policy provided lower dollar funding costs for those non-U.S. investors with access to it. In accordance with the dollar home bias channel, this policy differential impacts the risk-taking capacities of non-U.S. investors, thereby influencing the exchange rate risk exposures of USD bonds issued by their local firms and the Foreign Discount. Empirically, for non-U.S. USD bonds issued by firms from countries whose local investors had access to the swap line policies, there is a relative decrease in the Foreign Discount of these bonds by approximately 4.3 basis points compared to other non-U.S. USD bonds.

Lastly, I demonstrate that the balance sheet channel and the dollar home bias channel not only coexist but also mutually amplify each other's effects. Both channels exhibit dynamic significance throughout the sample period, becoming increasingly persistent in recent times. Furthermore, I acknowledge the fundamental differences between countries, firms, and bonds in my extensive cross-country panel data. By leveraging the advantages of fixed effects, I construct a comprehensive set of fixed effect models to control for these fundamental differences, as well as time-varying shocks at both the country and firm levels. All my results remain robust after incorporating these fixed effect sets.

The remainder of this paper is organized as follows. Section 2 provides a review of relevant literature. Section 3 introduces a parsimonious static model that outlines the balance sheet and dollar home bias channels. Section 4 describes the data sources. Section 5 establishes the connection between exchange rate risk and the Foreign Discount. Section 6 then empirically tests these two channels, and Section 7 concludes the paper.

2 Related Literature

This paper contributes to the literature on the international role of the U.S. dollar in asset pricing. A significant body of research has focused on the dollar as a risk factor.

Lustig, Roussanov, and Verdelhan (2014) document a dollar factor based on the dollar carry trade strategy, offering a risk-based interpretation linked to global macroeconomic-level risks (Verdelhan 2018). Studies by Nucera, Sarno, and Zinna (2023) and others have highlighted the importance of the dollar factor in the pricing kernel of currency risk premiums. Further research by Brusa, Ramadorai, and Verdelhan (2014) and Andrew Karolyi and Wu (2021) demonstrates the pricing power of the dollar factor in the international equity market.

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

Focusing on the bilateral exchange rates to the U.S. dollar, another line of literature underscores the importance of the demand component of the financial channel of exchange rates. This aspect examines how U.S. dollar appreciation decreases the net worth of non-U.S. firms with significant USD liabilities but with assets denominated in local currencies. The decline in net worth of non-U.S. firms leads to a contractionary effect on those firms, subsequently impacting the broader economy.[3] My paper emphasizes the significance of demand component in affecting USD bond pricing, demonstrating how the financial channel of exchange rates affects USD bonds issued by non-US and US firms differently.

Additionally, this paper contributes to the corporate bond pricing literature, an area extensively researched with a focus on bond pricing determinants (e.g., Collin-Dufresne, Goldstein, and Martin 2001; Eom, Helwege, and Huang 2004; Huang and Huang 2012; Huang, Nozawa, and Shi 2019). Huang and Shi (2021) provide a systematic review of literature on corporate bond returns. Recent studies, such as those by Liao (2020), Hu et al. (2023), and Cesa-Bianchi, Czech, and Eguren-Martin (2023), have begun to focus on the currency effect, specifically the disparities between USD and non-USD bonds,

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

in corporate bond pricing differentials. This paper closely aligns with the work of Geng (2022), who document a Foreign Discount in the USD bond market and attribute it to the uncertainty aversion of U.S. investors towards assets issued by non-U.S. firms, arising from difficulties in estimating the asset return distributions of these firms. Going beyond the uncertainty aversion hypothesis, my paper offers risk-based explanations for the Foreign Discount linked to bond-level exchange rate risk and investigates the origins of bond-level exchange rate risk based on risk transmission from non-U.S. firm- and investor-level exchange rate risks.

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

3 Model

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

3.1 Model Setup

Firms

There are two representative price-taking firms in the model: a U.S. firm and a non-U.S. firm. Both operate in the domestic market and finance their business activities through the USD bond market. While these firms share many similarities, they differ in one key aspect: the non-U.S. firm experiences a currency mismatch, with its assets denominated in local currency and its liabilities in U.S. dollars. Consequently, the appreciation of the U.S. dollar leads to a decline in the net worth of currency-mismatched non-U.S. firms j, resulting in a contraction of its balance sheets. (Bruno and Shin 2020; Du and Schreger 2022). The U.S. and non-U.S. firms issue USD bonds i and j in fixed amounts D_i and D_j, with observed bond yields y and $y + y_x$, respectively. The term y_x represents the additional risk premium, also termed the Foreign Discount, associated with non-U.S. USD bonds as compared to U.S. USD bonds. The payoff variances for bonds i and j are denoted as V and $V + v(\epsilon_{fx})$, respectively.

In this context, ϵ_{fx} represents the exchange rate shock, with an appreciation shock equivalent to an appreciation of the U.S. dollar. The function $v(\epsilon_{fx})$ captures the additional risk of bond j's payoff due to the exchange rate shock, thereby reflecting the impact of ϵ_{fx} on the bond's risk profile. The first-order derivative of $v(\epsilon_{fx})$ with respect to ϵ_{fx} is positive, as:

$$\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} > 0 \tag{1}$$

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

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

$$\frac{\partial Cov(i, j)}{\partial \epsilon_{fx}} < 0 \tag{2}$$

The intuition behind this phenomenon lies in the currency mismatch present in non-U.S. firm j's balance sheet. When an exchange rate shock occurs, the payoff correlation ($\rho_{i,j}$) between bonds i and j declines significantly. Consequently, the covariance between these bonds, represented also decreases.

Investors

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

U.S. Investor

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

$$max_{n_i,n_j} \underbrace{n_i y + n_j(y + y_x) - (n_i + n_j)y^{rf} - \frac{1}{2}\gamma V_n +}_{\text{Mean-variance Preference}} \underbrace{n_i \mu_i}_{\text{Home Bias}} \tag{3}$$

where $V_n = [n_i^2 V + n_j^2(V + v(\epsilon_{fx})) + 2n_i n_j Cov(i,j)]$.

μ_i represents the average utility of the U.S. investor for holding each unit of USD bonds issued by U.S. firms, while the total additional utility due to home bias is given by $n_i\mu_i$. As the holding of home assets increases, the total home bias utility ($n_i\mu_i$) also increases, but the average home bias utility (μ_i) decreases. This assumption is consistent with the standard concave utility assumptions, where there are diminishing returns to input factors such as wealth. Furthermore, there is a non-negative restriction on μ_i, which is represented by a convex function:

$$\mu_i' = \frac{\partial \mu_i}{\partial n_i} < 0 \quad \text{and} \quad \mu_i'' = \frac{\partial^2 \mu_i}{\partial n_i^2} > 0 \tag{4}$$

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

$$n_i^* = \frac{1}{\gamma[V(V + v(\epsilon_{fx})) - Cov(i,j)^2]}\left[(V + v(\epsilon_{fx}))[(y - y^{rf}) + (\mu_i + \frac{\partial \mu_i}{\partial n_i})] - Cov(i,j)[(y - y^{rf}) + y_x]\right] \tag{5}$$

$$n_j^* = \frac{1}{\gamma[V(V + v(\epsilon_{fx})) - Cov(i,j)^2]}\left[V[(y - y^{rf}) + y_x] - Cov(i,j)[(y - y^{rf}) + (\mu_i + \frac{\partial \mu_i}{\partial n_i})]\right] \tag{6}$$

Non-U.S. Investor

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

$$f(\epsilon_{fx}) = \frac{1}{2}(m_i + m_j)(c + \epsilon_{fx}) \tag{7}$$

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

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

$$max_{m_i,m_j} \underbrace{m_i y + m_j(y + y_x) - (m_i + m_j)[y^{rf} + \frac{1}{2}(m_i + m_j)(c + \epsilon_{fx})] - \frac{1}{2}\gamma V_m}_{\text{Mean-variance Preference}} + \underbrace{m_j \mu_j}_{\text{Home Bias}} \quad (8)$$

where $V_m = m_i^2 V + m_j^2(V + v(\epsilon_{fx})) + 2m_i m_j Cov(i,j)$. The assumption of non-U.S. investors home bias utility $m_i \mu_j$ is consistent with the U.S. investors, where $\mu_j > 0$, $\mu_j' = \frac{\partial \mu_j}{\partial m_j} < 0$ and $\mu_j'' = \frac{\partial^2 \mu_j}{\partial m_j^2} > 0$.
From the first-order conditions of the non-U.S. investor's utility function, the optimal m_i^* and m_j^* are:

$$\begin{aligned} m_i^* = & \frac{1}{\gamma(c + \epsilon_{fx})V_{y_x} + \gamma^2[V(V + v(\epsilon_{fx})) - Cov(i,j)^2]} \\ & \left[[(c + \epsilon_{fx}) + \gamma(V + v(\epsilon_{fx}))](y - y^{rf}) - [(c + \epsilon_{fx}) + \gamma Cov(i,j)][(y - y^{rf}) + y_x + (\mu_j + \frac{\partial \mu_j}{\partial m_j})] \right] \end{aligned} \quad (9)$$

$$\begin{aligned} m_j^* = & \frac{1}{\gamma(c + \epsilon_{fx})V_{y_x} + \gamma^2[V(V + v(\epsilon_{fx})) - Cov(i,j)^2]} \\ & \left[[(c + \epsilon_{fx}) + \gamma V][(y - y^{rf}) + y_x + (\mu_j + \frac{\partial \mu_j}{\partial m_j})] - [(c + \epsilon_{fx}) + \gamma Cov(i,j)](y - y^{rf}) \right] \end{aligned} \quad (10)$$

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

Exogenous Shock

In this model, I account for exogenous foreign exchange rate shocks in the FX market, represented by ϵ_{fx}. A positive value of ϵ_{fx} indicates an appreciation of the U.S. dollar, whereas a negative value signifies a depreciation. Such shocks can have significant implications for non-U.S. firms and investors, given their exposure to exchange rate risk.

3.2 Market-clearing and Equilibrium

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

$$\begin{cases} n_i^* + m_i^* = D_i \\ n_j^* + m_j^* = D_j \end{cases} \quad (11)$$

Combing these two conditions, we can get $n_i^* - n_j^* + m_i^* - m_j^* = D_i - D_j$

$$\begin{aligned}
&n_i^* - n_j^* + m_i^* - m_j^* \\
&\quad = D_i - D_j \\
&\quad = \frac{1}{\gamma\alpha}\left[v(\epsilon_{fx})(y - y^{rf}) + [V + v(\epsilon_{fx}) + Cov(i,j)](\mu_i + \frac{\partial \mu_i}{\partial n_i}) - [Cov(i,j) + V]y_x\right] \\
&\quad + \frac{1}{\gamma(c+\epsilon_{fx})V_{y_x} + \gamma^2\alpha}\left[\gamma v(\epsilon_{fx})(y - y^{rf}) - [2(c+\epsilon_{fx}) + \gamma Cov(i,j) + \gamma V]((\mu_j + \frac{\partial \mu_j}{\partial m_j}) + y_x)\right]
\end{aligned} \tag{12}$$

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

I can endogenize y_x

$$\begin{aligned}
y_x = \frac{1}{\beta}\Bigg\{ &\gamma\alpha\Bigg[2v(\epsilon_{fx})\underbrace{(y - y^{rf})}_{\text{common risk premium}} + [V + v(\epsilon_{fx}) + Cov(i,j)]\underbrace{(\mu_i + \frac{\partial \mu_i}{\partial n_i})}_{\text{U.S. investor's marginal home bias utility}} - (Cov(i,j) + V)\overbrace{(\mu_j + \frac{\partial \mu_j}{\partial m_j})}^{\text{non-U.S. investor's marginal home bias utility}} - \gamma\alpha\underbrace{(D_i - D_j)}_{\text{relative issuance}}\Bigg] \\
&+ \underbrace{(c + \epsilon_{fx})}_{\text{average FX cost}}\Bigg[V_{y_x} v(\epsilon_{fx})(y - y^{rf}) + V_{y_x}[V + v(\epsilon_{fx}) + Cov(i,j)](\mu_i + \frac{\partial \mu_i}{\partial n_i}) - 2\alpha(\mu_j + \frac{\partial \mu_j}{\partial m_j}) - V_{y_x}\gamma\alpha(D_i - D_j)\Bigg]\Bigg\}
\end{aligned} \tag{13}$$

where $\beta = (c + \epsilon_{fx})[V_{y_x}(Cov(i,j) + V) + 2\alpha] + 2\gamma\alpha(Cov(i,j) + V)$. There are non-negative restrictions for μ_j and a convex function of μ_j to m_j. Then, $(\mu_j + \frac{\partial \mu_j}{\partial m_j})$ is positive but decreasing with a higher m_j. The same condition applies to $(\mu_i + \frac{\partial \mu_i}{\partial n_i})$.

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

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

1. increases with a higher common bond risk premium ($y - y^{rf} \uparrow$), as investors demand a higher return for taking on more risk.

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

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

These factors contribute to explaining the equilibrium level of the Foreign Discount (y_x) in the USD bond market under various conditions.

3.3 Proposition

Utilizing the equilibrium equation (Equation (13)), I examine the impact of exchange rate shocks ϵ_{fx} on the additional risk premium y_x. This paper focuses on the effects of demand-side factors on the Foreign Discount, while controlling for the influence of supply-side factors, such as relative bond issuance.

3.3.1 Without FX Cost

First, I look at only the balance sheet channel by muting the FX cost as $f(\epsilon_{fx}) = 0$. Then, the equilibrium of y_x is:

$$y_x = \frac{1}{2(Cov(i,j)+V)} \left[2v(\epsilon_{fx})(y-y^{rf}) + [V+v(\epsilon_{fx})+Cov(i,j)](\mu_i + \frac{\partial \mu_i}{\partial n_i}) - (Cov(i,j)+V)(\mu_j + \frac{\partial \mu_j}{\partial m_j}) - \gamma\alpha(D_i - D_j)\right] \tag{14}$$

Since the equilibrium of y_x is affected by the level of $v(\epsilon_{fx})$, the correlation between bond i and j is decreasing under the exchange rate shock. This is consistent with $\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} < 0$ condition.

I assume that $\frac{\partial \rho_{i,j}}{\partial \epsilon_{fx}} \in \left(-\frac{2\sqrt{V(V+v(\epsilon_{fx}))}+V\rho_{i,j}}{2V(V+v(\epsilon_{fx}))}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}}, -\frac{\rho_{i,j}}{2(V+v(\epsilon_{fx}))}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}}\right)$, then $\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} < 0$, $\frac{\partial [v(\epsilon_{fx})+Cov(i,j)]}{\partial \epsilon_{fx}} > 0$ and $\frac{\partial \alpha}{\partial \epsilon_{fx}} > 0$. (*Proof: See Appendix A.1*) In addition, there is no marginal effect of relative bond issuance $D_i - D_j$ on y_x as I mute the supply-side factor.

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

1. *increases the riskiness of non-U.S. USD bonds* ($\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} > 0$),
2. *decreases the covariance between non-U.S. USD bonds and U.S. USD bonds* ($\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} < 0$).

This shock amplifies the positive effect of $y - y^{rf}$ *and* $\mu_i + \frac{\partial \mu_i}{\partial n_i}$ *and mitigates the negative effect of* $\mu_j + \frac{\partial \mu_j}{\partial m_j}$ *in Equation (14). As a result, the exchange rate shock leads to a higher risk premium for non-U.S. USD bonds compared to U.S. USD bonds* ($\frac{\partial y_x}{\partial \epsilon_{fx}} > 0$).

Proof: See Appendix A.2

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

3.3.2 With FX Cost

Next, I study the equilibrium of y_x with the FX cost.

$$y_x = \frac{1}{\beta}$$

$$\Bigg\{ \underbrace{\gamma\alpha\left[2v(\epsilon_{fx})(y-y^{rf}) + [V+v(\epsilon_{fx})+Cov(i,j)](\mu_i + \frac{\partial \mu_i}{\partial n_i}) - (Cov(i,j)+V)(\mu_j + \frac{\partial \mu_j}{\partial m_j}) - \gamma\alpha(D_i - D_j)\right]}_{\text{Component 1: links with the balance sheet channel}} +$$

$$\underbrace{(c+\epsilon_{fx})\left[V_{y_x} v(\epsilon_{fx})(y-y^{rf}) + V_{y_x}[V+v(\epsilon_{fx})+Cov(i,j)](\mu_i + \frac{\partial \mu_i}{\partial n_i}) - 2\alpha(\mu_j + \frac{\partial \mu_j}{\partial m_j}) - V_{y_x}\gamma\alpha(D_i - D_j)\right]}_{\text{Component 2: links with the dollar home bias channel}} \Bigg\} \tag{15}$$

V_{y_x} is the volatility of the additional risk premia y_x and is increasing with the FX shock because $\frac{\partial V_{y_x}}{\partial \epsilon_{fx}} = \frac{\partial[V+(V+v(\epsilon_{fx}))-2Cov(i,j)]}{\partial \epsilon_{fx}} = \frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} - 2\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} > 0$.

I subdivide y_x into two components. The *component 1* links with the balance sheet channel, and the *component 2* links with the dollar home bias channel. β is the coefficient of these two components. $\frac{\partial \beta}{\partial \epsilon_{fx}}$ is negative while there is a large exchange rate shock. (*Proof: See Appendix A.3*). Since I focus on the Balance Sheet Channel and Dollar Home Bias Channel, I simplify assume that $\frac{\partial \beta}{\partial \epsilon_{fx}}$ would not materially affect the sign of $\frac{\partial y_x}{\partial \epsilon_{fx}}$ because the first order derivative of numerator on ϵ_{fx} is positive such as $\frac{\partial \gamma\alpha}{\partial \epsilon_{fx}} > 0$ and $\frac{\partial(c+\epsilon_{fx})}{\partial \epsilon_{fx}} > 0$.

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

$$y_x \sim \underbrace{(c+\epsilon_{fx})}_{\text{average FX cost}}\left[\overbrace{V_{y_x} v(\epsilon_{fx})(y-y^{rf}) + V_{y_x}[V+v(\epsilon_{fx})+Cov(i,j)](\mu_i + \frac{\partial \mu_i}{\partial n_i}) - 2\alpha(\mu_j + \frac{\partial \mu_j}{\partial m_j}) - V_{y_x}\gamma\alpha(D_i - D_j)}^{\text{the standard factor term}}\right] \tag{16}$$

The *Component 2* illustrates that an appreciation in the exchange rate increases the average FX cost for non-U.S. investors, which, in turn, diminishes their risk-taking capacity. This leads to reduced demand for U.S. dollar assets among these investors, further exacerbating the impact of exchange rate shocks on non-U.S. USD bonds. Essentially, an elevated FX cost amplifies the standard factor's effect on y_x, particularly when non-U.S. investors exhibit a lower marginal home bias utility $(\mu_j + \frac{\partial \mu_j}{\partial m_j})$, intensifying the selling pressure on non-U.S. USD bonds.

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

Proof: See Appendix A.4

Proposition 2 highlights the interplay of home bias and FX cost for non-U.S. investors. A pronounced ex-ante home bias leads to significant holdings of non-U.S. USD bonds. In the event of an exchange rate shock, the increased FX cost for non-U.S. investors prompts selling of these bonds. This effect is accentuated with a larger ex-ante home bias (m_j), as it correlates with a lower ex-post average home bias utility μ_j. Therefore, $\frac{\partial \text{Component 2}}{\partial \epsilon_{fx}} > 0$ and is more pronounced with a stronger ex-ante home bias among non-U.S. investors. When combining Propositions 1 and 2, the result $\frac{\partial y_x}{\partial \epsilon_{fx}} > 0$ arises from both $\frac{\partial \text{Component 1}}{\partial \epsilon_{fx}} > 0$ and $\frac{\partial \text{Component 2}}{\partial \epsilon_{fx}} > 0$. Consequently, an exchange rate shock increases the additional risk premium y_x (or the Foreign Discount) through both the balance sheet and dollar home bias channels.

4 Data and Definitions

Corporate Bond Data

I construct the corporate bond dataset using bond issuance information from the SDC Platinum Global New Issues database. This database includes various characteristics of each issue, such as notional principal, maturity date, coupon structure, denomination currency, issuer's nation, issuer's ultimate parent, and option-like feature indicators. I focus on USD-denominated bonds. Following Hu et al. (2023) and Liao (2020), I further filter the bonds based on three criteria: (1) the bond is unsecured, non-putable, non-convertible, non-perpetual, and has fixed-rate coupons; (2) the issuer is not in a government-related industry such as City government, National Government, or City agency; (3) the bond has an initial maturity of at least one year and a notional principal of at least \$50 million. A significant number of USD bonds issued by non-U.S. firms, especially emerging market firms, are intermediated through offshore subsidiaries (Du and Schreger 2022; Coppola et al. 2021; Maggiori, Neiman, and Schreger 2020). Therefore, nationality-based data better measures the issuer's country of origin. Specifically, I trace each bond back to its ultimate parent's nationality by linking it to the issuer's CUSIP, issuer's nation, and ultimate parent's CUSIP from the SDC database. I can match around 96% of bonds with their ultimate parent's nationality. Approximately 37% of non-U.S. USD bonds are issued by non-U.S. firms through their offshore subsidiaries.

I merge the filtered bond data with month-end price quotes (bid-, mid-, and ask-yield to maturity) from Bloomberg based on ISIN. This is a widely used data source for studies on the international corporate bond markets (Valenzuela 2016; Geng 2022). The sample period is from January 2004 to March 2021. For each bond-month observation, I assign a credit rating following Dick-Nielsen, Feldhütter, and Lando (2012)'s approach: I first look up its credit rating in the Standard & Poor's Global Ratings database; if its rating in that month is missing, I turn to the Moody's Default & Recovery Database; if the rating information is still unavailable, I use the rating from other agencies as displayed in Bloomberg (e.g., Fitch). Finally, I winsorize the yield-to-maturity and bid-ask spread[4] at the 1% level on a monthly basis to remove outliers.

The final dataset consists of 15,411 bonds issued by 1,265 U.S. firms and 971 non-U.S. firms with a total notional of $11.92 trillion. Figure 1 displays the dynamics of USD bonds outstanding notional from January 2004 to March 2021. I disaggregate USD bonds based on the issuer's country of origin into U.S. and non-U.S. I further classify non-U.S. into non-U.S. AE and EME. Figure 1a and 1b report the time-series outstanding notional in $ billions and the percentage of total USD bond outstanding notional, respectively. The total USD bond outstanding notional exhibits a clear upward trend, peaking at around $6 trillion. The outstanding notional of non-U.S. USD bonds has sharply increased since the 2008 global financial crisis, and the share of non-U.S. USD bonds outstanding notional over the total USD bond outstanding notional has doubled from 21% to 42%. Non-U.S. AE USD bonds account for a significant portion of non-U.S. USD bonds. Figure 1 highlights the importance of non-U.S. issuers in the USD bond issuance market.

Table 1 presents the monthly average of the number of bonds, the notional value in $ billions, and the number of corresponding firms by rating and maturity categories. On average, there are approximately 3,484 bonds with notional values of $2,752 billion issued by 1,207 firms each month. The A&BBB rating classes and the maturity group of 3-7 years hold the largest share in terms of both issuance and outstanding notional. With respect to the market size of each issuer, U.S. USD bonds comprise around 67% (2,350) of bonds, 63% ($1,747 billion) of notional values, and 60% (726) of issuers in the sample. Within the non-U.S. USD bonds, non-U.S. AE USD bonds account for approximately 74% (833) of bonds, 77% ($777 billion) of notional values, and 63% (303) of issuers in the sample.

Table 2 provides the summary statistics of USD bond characteristics, including credit spread, rating, remaining maturity, age, issuance size, and coupon rate. I employ a numerical translation of credit rating by assigning 1 to AAA, 2 to AA+, and progressively increasing the numerical value until assigning 21 to C. The mean level of a USD bond features a 1.90% credit spread with a rating of 7.93, remaining maturities of 8.65 years, an age of 5.06 years, issuance size of $743 million, a 5.07% coupon rate, and 0.16% bid-ask spreads. On average, non-U.S. USD bonds exhibit slightly lower credit spreads, bid-ask spreads, and ratings compared to U.S. USD bonds. Among the non-U.S. USD bonds, EME USD bonds have a significantly larger credit spread (2.93%), bid-ask spreads (0.18%), and a worse rating (9.10).

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

Institutional Investors' Holding Data

I acquire data on U.S. institutional investors' holdings from Thomson Reuters Lipper eMaxx. This dataset is free from survivorship bias and is widely employed in the literature (e.g. Becker and Ivashina 2015; Jiang et al. 2022). The data includes security-level fixed income holdings at quarter-ends from 2003Q4 to 2021Q1. I match the holding data with the SDC Platinum Global New Issues database based on bonds' ISIN. Figure 3a illustrates the covered U.S. institutional investors in my dataset, and I classify U.S. institutional investors into Mutual Funds, Property/Casualty Insurance Companies, Life Insurance Companies, and Others. Notably, mutual funds have doubled from 1,000 to around 2,000. Figure 3b plots the average shares of USD bonds held by U.S. institutional investors from 2004Q1 to 2021Q1. The share is measured by the percentage of U.S. institutional investors holding over the bond total issuance size. I categorize USD bonds based on the issuer's country of origin into U.S., non-U.S., EME, and G10 (non-U.S.). Approximately 46% of U.S. USD bonds outstanding notional are held by U.S. institutional investors. However, only 27% (10%) of non-U.S. (EME) USD bonds outstanding notional (EME firms) are held by U.S. institutional investors.

Other Data

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

I construct the firm-level debt capital structure using data from Capital IQ and total asset data from the Compustat Fundamentals. I then match the firm-level fundamental data with the bond-level data based on the firm-level ID. Details of the matching steps between the Capital IQ and Compustat databases, and the SDC Platinum Global New Issues database, are available in Appendix B.

5 Empirical Evidence: Exchange Rate Risk

5.1 Exchange Rate Risk Exposure

My theoretical model highlights the significant role of exchange rate risk in affecting the Foreign Discount. Starting with anecdotal evidence, a model-free estimation of the

Foreign Discount can be obtained by comparing two similar bonds issued by comparable firms within the same industry and with the same credit rating, one based in the U.S. and the other outside the U.S.. Notably, Airbus and Boeing are dominant players in the commercial aircraft market, characterized as a duopoly. Airbus is located in France, while Boeing is based in the U.S.. These companies, while competing fiercely, share many similarities in terms of market dominance, product families, global presence, and technological advancements. Therefore, I construct a model-free estimation of the Foreign Discount by comparing similar USD bonds issued by Airbus (ISIN: US26824KAA25) and Boeing (ISIN: US097023BG91).[5]

Figure 2 presents the time series of the model-free Foreign Discount as a blue bar, the USD/EUR exchange rate as a green line, and the scaled broad USD index as an orange line. The U.S. dollar experienced significant depreciation in 2017, attributable to pronounced political risks and uncertainty surrounding the U.S. economy.[6] Interestingly, this marked depreciation of the U.S. dollar coincided with a considerable contraction of the Foreign Discount, highlighting potential linkages between exchange rate risk and the Foreign Discount.

I formally examine the effect of exchange rate risk exposure on the Foreign Discount through a panel specification in Equation (17):

$$\text{CreditSpread}_{i,t} = \alpha + \beta\text{Foreign}_i + \lambda\Delta\text{Dollar}_t + \theta\text{Foreign}_i \times \Delta\text{Dollar}_t + \text{controls}_{i,t} + \epsilon_{i,t} \quad (17)$$

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 U.S. dollar value at time t. An increase in Dollar_t represents an appreciation of the U.S. dollar. Other control variables include bond characteristics such as rating, bid-ask spreads, remaining maturity, age, issuance size, and coupon rate. I mainly employ time (year-month) and firm-fixed effects to control for time-varying shocks and firm-specific time-invariant shocks.

Table 3 presents the results. Column (1) replicates the findings of Geng (2022) with time and industry fixed effects but includes an additional interaction term between Foreign_i and ΔDollar. The coefficient of Foreign_i, β, is 0.418 at a 1% significance level. I demonstrate that, on average, without the exchange rate shock, non-U.S. USD bonds have an average 41.8 basis point higher credit spread than U.S. USD bonds, illustrating the Foreign Discount. Importantly, the coefficient of the interaction term, θ, is positive

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

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

at a 1% significance level. Therefore, non-U.S. USD bonds have a larger exposure to exchange rate risk than U.S. USD bonds. Furthermore, I replace the industry fixed effect in Geng (2022) with the firm-fixed effect to better control for unobserved firm-level factors. As a result, Foreign_i would be absorbed by the firm fixed effect. Columns (2) and (3) of Table 3 present the results using the broad U.S. dollar index and bilateral exchange rate, respectively. The coefficient of the interaction term, θ, remains highly positive and significant at a 1% significance level. For example, in column (3), a 0.024 value of θ indicates that a one standard deviation appreciation shock to the bilateral exchange rate (1.61) increases the Foreign Discount by 3.9 basis points, which is about 9% of the Foreign Discount.

To visually represent the relationship between the Foreign Discount and heterogeneous exchange rate exposure, I estimate a cross-sectional regression of Equation (17) each month and display the results in Figure 4. Figure 4a shows the time series of the Foreign Discount[7] [8], while Figure 4b highlights the contribution of heterogeneous exchange rate exposure, accounting for 27 basis points and 56% of the Foreign Discount, on average, from January 2004 to March 2021.

A natural follow-up question to the exchange rate risk analysis is which exchange rate matters. In column (4) of Table 3, I include interaction terms of the Foreign dummy with both the broad U.S. dollar index and the bilateral exchange rate. Only the coefficient of the interaction term using the bilateral exchange rate remains highly significant. Furthermore, following Avdjiev, Bruno, et al. (2019), I construct orthogonalized components of the two exchange rates relative to each other. Column (5) includes both interaction terms using the broad U.S. dollar and the orthogonalized component of the bilateral exchange rate relative to the broad U.S. dollar. Since the broad U.S. dollar acts *de facto* as a global factor, the orthogonalized component of the bilateral exchange rate captures the country-specific shock. Column (6) includes both interaction terms using the bilateral exchange rate and the orthogonalized component of the broad U.S. dollar relative to the bilateral exchange rate.[9] For example, the orthogonalized component of the broad U.S. dollar relative to the EUR/USD bilateral exchange rate captures exogenous shocks affecting the U.S. dollar but unrelated to any shocks affecting the relative valuation of EUR/USD. Only the coefficient of the interaction term using the orthogonalized component of the bilateral exchange rate remains highly significant, while the coefficient of the

7. From July 2008 to December 2008, the Foreign Discount experienced a sharp increase from -31 basis points to 200 basis points, closely related to a significant appreciation of the U.S. dollar during the same period. For example, the U.S. broad dollar index rose by approximately 10% in that time.

8. The Foreign Discount exhibits a pattern similar to the CIP deviations documented by Du, Tepper, and Verdelhan (2018). In Appendix C, I investigate the extent to which CIP deviations can fully account for the Foreign Discount. The findings suggest that while CIP deviations partially explain the Foreign Discount, exchange rate risk remains a significant factor.

9. I construct the orthogonalized component of the broad U.S. dollar for each bilateral exchange rate separately, instead of regressing the broad U.S. dollar on all bilateral exchange rates at once.

interaction term using the orthogonalized component of the broad U.S. dollar is statistically insignificant. Overall, the impact of exchange rate risk on the Foreign Discount is primarily attributed to shocks affecting the bilateral exchange rate, rather than the broad U.S. dollar. Therefore, in subsequent empirical analyses, I will use the bilateral exchange rate.

5.2 Robustness check

I conduct a series of robustness checks presented in Table 4. First, the exposure of corporate bonds, issued by both US and non-US firms, to conventional bond characteristics may vary. Consequently, a prevalent question arises: Is the impact of exchange rate risk on the Foreign Discount unique, or does it merely reflect conventional bond risk? To investigate this query, interaction terms between the Foreign dummy and a series of bond-level characteristics, including rating, remaining maturities, age, issuance size, coupon rates, and bid-ask spread, are added in column (1). The coefficient (θ) of the interaction between the Foreign dummy and exchange rate risk is 0.027, and it is highly significant at the 1% level. Additionally, the magnitude of 0.027 aligns closely the previous findings of 0.029 in column (3) of Table 3.. This outcome indicates that the effects of exchange rate risk exposure are independent of the differential risk loadings of bonds to common bond-level characteristics. In column (2), I address the non-stationarity problem by adding the lag of the credit spread into the control variables. In column (3), I include only the sample from 2010 to 2019 to eliminate the effects of the global financial crisis and the Covid period. θ remains positive and highly significant in columns (2) and (3).

Moreover, in column (4), I introduce a three-way interaction term among Foreign_i, $\Delta\text{Dollar}_t^{Bilateral}$, and VIX_t^{High}. VIX_t^{High} is a dummy variable indicating periods of heightened market volatility, taking a value of 1 when the VIX is higher than 30.[10]. Excluding the global financial crisis period, I show that the effect of exchange rate risk is more pronounced during market turmoil, given the significant and positive coefficient of this three-way interaction term. Quantitatively, the additional exchange rate risk exposure during high-VIX periods is nearly 4 times greater. In unreported results, I find that the findings are robust when using the continuous VIX variable or alternative measures of market stress, such as the BEX uncertainty index (Bekaert, Engstrom, and Xu 2022). In column (5), I introduce a three-way interaction term: $\text{Foreign}_i \times \Delta\text{Dollar}_{i,t}^{Bilateral} \times \text{EME}_i$. EME_i is a dummy variable that takes a value of 1 for issuers from emerging market economies. The positive coefficient of this three-way interaction term indicates that USD bonds issued by EME firms have more exposure to exchange rate risk than those issued by non-U.S. AE firms. Lastly, in column (6), I introduce a four-way interaction

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

term: $\text{Foreign}_i \times \Delta\text{Dollar}_{i,t}^{Bilateral} \times \text{Fin}_i \times \text{G10}_i$. Fin_i is a dummy variable that takes a value of 1 for financial firm issuers. G10_i is a dummy variable that takes a value of 1 for issuers from G10 countries. The coefficient of this four-way interaction term is significantly negative, at -0.033, while the corresponding three-way interaction term ($\text{Foreign}_i \times \Delta\text{Dollar}_{i,t}^{Bilateral} \times \text{Fin}_i$) has a significantly positive coefficient, at 0.035. Therefore, non-U.S. USD bonds issued by G10 financial firms exhibit lower exchange rate risk exposures compared to other non-U.S. USD bonds.

Another empirical challenge is that, given the large cross-country bond panel dataset, there are noticeable differences among countries, firms, and bonds. To establish robust results, I further leverage the advantage of fixed effects to control for all possible factors. The results are presented in panel (a) of Table 9. All regressions control for the time fixed effect. Columns (1) and (2) add the country and bond fixed effects to control for fundamental differences between each country and bond, respectively. Column (3), in addition to the standard time and firm-fixed effects, adds the country-year fixed effect to account for the time-varying shocks in each country, such as sovereign risk, economic policy uncertainty, capital controls, and the macroprudential index. The country-year fixed effect also controls for the uncertainty aversion hypothesis, which is an alternative explanation of the Foreign Discount proposed by Geng (2022), linked with non-U.S. country-level risk. Column (4) adds the firm-year fixed effect to control for the 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.

6 Empirical Evidence: Balance Sheet and Dollar Home Bias Channels

Section 5 establishes a robust link between bond-level exchange rate risk exposures and the Foreign Discount. In this section, I provide empirical evidence for Propositions 1 and 2 in my model discussed in section 3.

6.1 Balance Sheet Channel

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

6.1.1 USD Bond Liabilities

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

The bond's outstanding notional data is inferred from the international bond issuance data in the SDC database. In detail, I follow the same data filtering process as in Section 4 but retain bonds of all currency denominations. Since the remaining bonds are non-putable and non-convertible, I estimate an approximate bond outstanding notional based on the issue date and maturity date, and aggregate this to the firm level. Then, I calculate the proportion of USD-denominated bonds to the total bonds' outstanding notional and aggregate this at the firm level to the U.S., non-U.S., G10 (non-U.S.), and EME levels by taking the average value for each month. Figure 5 presents the dynamic proportion of USD bonds in the total bonds' outstanding notional. USD bonds account for around 52% of the total bonds' outstanding notional for non-U.S. firms, and firms from EME have a significantly higher USD bond proportion (60% - 70%) than firms from non-U.S. G10 countries (40% - 45%). Unsurprisingly, U.S. firms have only a small proportion of bonds denominated in non-USD.

$$\text{CreditSpread}_{i,t} = \alpha + \theta \text{Foreign}_i \times \Delta\text{Dollar}_t + \gamma \text{Foreign}_i \times \Delta\text{Dollar}_t \times \text{USDShare}_{f,t} + \text{controls}_{i,t} + \epsilon_{i,t} \quad (18)$$

Table 5 provides evidence for the balance sheet channel, estimated from Equation (18). Importantly, I add a new variable, $\text{USDShare}_{f,t}$, which represents the proportion of USD bonds to the total bond's outstanding notional for firm f at time t. Therefore, γ reflects the significance of the balance sheet channel. Column (1) shows that USD bonds issued by firms with larger USD liabilities have higher exposure to exchange rate risk. The coefficient of the triple interaction term, γ, is 0.056 and significant at the 1% level. Therefore, for a USD bond issued by a non-U.S. firm with an average $\text{USDShare}_{f,t}$ of 0.52[11], a one standard deviation appreciation shock to the bilateral exchange rate (1.61)

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

increases the Foreign Discount by 4.7 basis points. This is approximately 11.2% of the Foreign Discount.

The measure of $\text{USDShare}_{f,t}$ is not perfect but can cover the full sample of my data. I further construct alternative measures of USD liabilities using the firm-level debt capital structure from Capital IQ. The Capital IQ data provides detailed information on the currency composition of outstanding debt for individual firms.[12] I can match around 86% of my sample to the Capital IQ database and I resample the firm-level debt capital structure to monthly level data using the last available data. In particular, I construct two variables: $\text{USDLiabShare}_{f,t}$ and $\text{USDLiabShare}_{f,t}^{Long-term}$. $\text{USDLiabShare}_{f,t}$ is the proportion of USD liabilities to total liabilities, and $\text{USDLiabShare}_{f,t}^{Long-term}$ is the proportion of long-term USD liabilities to total long-term liabilities. For long-term liabilities, I use the most representative types of liabilities in the Capital IQ database, which are *Notes Payable* and *Bonds and Notes*. Columns (2) and (3) replace $\text{USDShare}_{f,t}$ with $\text{USDLiabShare}_{f,t}$ and $\text{USDLiabShare}_{f,t}^{Long-term}$, respectively. I find that γ is significant only when using $\text{USDLiabShare}_{f,t}^{Long-term}$. Therefore, this confirms the important role of long-term USD liabilities in affecting exchange rate risk exposures and validates the use of $\text{USDShare}_{f,t}$, as it reflects the share of long-term USD bonds to total long-term bonds.

Another challenge of using $\text{USDShare}_{f,t}$ is that this measure only considers the liability side and cannot fully reflect the magnitude of currency mismatch. Thus, I construct an alternative measure of currency mismatch—$\text{USDBond2TA}_{f,t}$—which represents the ratio of the outstanding USD bonds' notional value ($\text{USDShare}_{f,t}$) to a firm's total assets for firm f at time t. The firm's total assets are sourced from the Compustat Fundamentals database and resampled to monthly level using the last available data. I can match around 84% of my sample. $\text{USDBond2TA}_{f,t}$ is winsorized at the 0.1% level for the full sample. Column (4), which employs $\text{USDBond2TA}_{f,t}$, yields results consistent with those obtained when using $\text{USDShare}_{f,t}$. Therefore, the balance sheet channel hypothesis is robust across different specifications of currency mismatch levels for non-U.S. firms.

6.1.2 Financial, Tradable, and Non-Tradable Sectors

Next, I examine the effect of the balance sheet channel across different sectors. First, I consider the differences between the financial and non-financial sectors. Column (5) of Table 5 shows insignificant coefficients for both the four-way interaction term ($\text{Foreign}_i \times \Delta\text{Dollar}_t \times \text{USDShare}_{f,t} \times \text{Fin}_i$) and the five-way interaction term ($\text{Foreign}_i \times \Delta\text{Dollar}_t \times \text{USDShare}_{f,t} \times \text{Fin}_i \times \text{G10}_i$). These results suggest that financial firms from the G10 non-U.S. firms, cannot effectively hedge their balance sheet's exchange rate risk exposure. This may be due to the high costs and complexities associated with dynamic financial hedging (Du and Schreger 2022).

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

Considering the dollar's dominant role in international trade, as highlighted by Gopinath et al. (2020), the foreign currency revenues of non-U.S. firms are intricately linked to the U.S. dollar, both directly and indirectly. Consequently, these revenues can serve as a natural hedge against exchange rate risks associated with their USD liabilities. This strategy, known as operational hedging, is further explored in Black and Munro (2010). Accordingly, my analysis focuses on the balance sheet channel, specifically examining how it is influenced by the foreign currency revenues of these firms. Therefore, I further subdivide non-financial firms into tradable and non-tradable sectors. The definition of tradable sectors follows Sachs and Larrain (1993) and includes manufacturing, agriculture, forestry, and other natural resource extraction sectors, which are more likely to have exposure to foreign currency revenues. Figure 6 displays the density of the USD bonds' proportion of total bonds' outstanding notional value for non-U.S. firms in March 2021. Firms in the tradable sectors show a high density in areas representing a large proportion of USD bonds to total bonds' outstanding notional value.

Then, I investigate, within non-financial non-U.S. firms, whether those in tradable sectors, under the same level of $\text{USDShare}_{f,t}$, have less exposure to exchange rate risk. The results, presented in column (6) of Table 5, introduce a new interaction term ($\text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} \times \text{USDShare}_{f,t} \times \text{Tradable}_f$), where Tradable_f is a dummy variable that takes a value of 1 for tradable firms. Interestingly, the coefficient of this interaction term is positive but insignificant, indicating that operational foreign currency revenues cannot effectively hedge the balance sheet effect.

6.2 Dollar Home Bias Channel

I propose the dollar home bias channel in Proposition 2 of my model. This channel connects bond-level exchange rate risk exposures to investor-level exchange rate risk exposures and comprises two main elements. First, there is a home bias in investing in USD bonds. As shown in Figure 3b, Investors exhibit a home bias towards USD bonds issued by their own local firms.[13] Second, an appreciation of the U.S. dollar is associated with stress on cross-border dollar liquidity and higher indirect dollar funding costs for non-U.S. investors (Avdjiev, Du, et al. 2019), leading to a decrease in the risk-taking ability of these investors.

Combining these two elements, due to the ex-ante home bias, non-U.S. investors predominantly hold non-U.S. USD bonds in their portfolios. Consequently, an appreciation of the U.S. dollar reduces the risk-taking capabilities of non-U.S. investors, exerting selling pressure on their holdings, mainly affecting non-U.S. USD bonds. Therefore, I hypothe-

13. I am unable to examine the home bias in USD bonds for each non-U.S. country due to limitations in my current eMaxx data, which only provides comprehensive holding data for U.S. institutional investors. Nevertheless, the evidence at least offers clear indications of the home biases of U.S. and non-U.S. investors at an aggregate level.

size that non-U.S. USD bonds with a higher proportion of non-U.S. investors have more significant exposure to exchange rate risk.

6.2.1 Non-U.S. Investors Holdings

I test this hypothesis through a panel specification in Equation (19).

$$\begin{aligned}\text{CreditSpread}_{i,t} =& \alpha + \theta \text{Foreign}_i \times \Delta \text{Dollar}_t^{Bilateral} \\ &+ \omega \text{Foreign}_i \times \Delta \text{Dollar}_t^{Bilateral} \times \text{NonUSHolding}_{i,t-1} + \text{controls}_{i,t} + \epsilon_{i,t}\end{aligned} \tag{19}$$

I create a new variable, $\text{NonUSHolding}_{i,t-1}$, which represents the proportion of bond i's outstanding notional held by non-U.S. investors at time $t-1$, calculated as one minus the total proportion of holdings by U.S. institutional investors. I winsorize $\text{NonUSHolding}_{i,t-1}$ at the 1% level to mitigate the impact of outliers. Consequently, ω reflects the significance of the dollar home bias channel. The eMaxx database provides only quarterly-level holding data, so I resample it to monthly using the last available holding data. The lag of non-U.S. investors' holdings is used to measure the level of ex-ante investors' home bias, and this lag variable also helps to avoid any contemporaneous impact on the U.S. dollar and investors' holdings.

Table 6 supports the existence of the dollar home bias channel. Column (1) indicates that for USD bonds issued by non-U.S. firms, an (ex-ante) average $\text{NonUSHolding}_{i,t-1}$ of 0.73 combined with a one standard deviation appreciation shock to the bilateral exchange rate (1.61) leads to an increase in the Foreign Discount by approximately 3.2 basis points, which is about 7.7% of the Foreign Discount. Furthermore, the negative and statistically significant coefficient of the interaction term between Foreign_i and $\text{NonUSHolding}_{i,t-1}$ highlights the specific home bias utility for non-U.S. investors in holding non-U.S. USD bonds, as evidenced by their acceptance of a lower bond return.

Additionally, the dollar home bias channel appears to similarly affect USD bonds issued by both financial and non-financial firms, as shown in column (2). Column (3) demonstrates that this channel is more pronounced for EME USD bonds. Column (4) indicates that the dollar home bias channel is especially pronounced during periods of market turmoil.

6.2.2 Central Bank Swap Line

In addition to standard panel data regression, I conduct a DiD analysis to assess the effectiveness of the dollar home bias channel. This analysis focuses on the impact on non-U.S. investors during periods of tightened cross-border dollar liquidity, potentially influenced by exogenous policy shocks. A prime example is the reactivation of the central bank swap line policy during the Covid-19 crisis.

First, the international fallout from Covid-19 in March 2020 led to an unexpected shortage of cross-border dollar liquidity. Cesa-Bianchi, Czech, and Eguren-Martin (2023) document a "Dash for Dollars" phenomenon, where investors, especially those from non-U.S. countries, liquidated their U.S. dollar assets to meet dollar-denominated obligations. This action significantly widened the credit spreads of USD bonds compared to non-USD bonds. Based on the dollar home bias channel, non-U.S. USD bonds likely experienced more severe impacts due to this liquidity shortage. Subsequently, the central bank swap line was reactivated to distribute low-cost U.S. dollar liquidity to dealers at the counterparty central banks.[14] Investors with access to the swap line were therefore less affected by the scarcity of cross-border dollars. Hence, within non-U.S. USD bonds, I differentiate between a treatment group of "Swap" USD bonds and a control group of "Other" USD bonds. The "Swap" USD bonds include those issued by firms in countries linked to central banks with swap line access, providing local investors with this inexpensive U.S. dollar liquidity.

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

Figure 7 presents the Foreign Discount for both "Swap" and "Other" bonds around the reactivation of the Federal Reserve's standing swap lines on March 15, 2020. This analysis uses daily bond yield data. Before Event Day Zero, there is a noticeable parallel trend in the Foreign Discount between "Swap" and "Other" bonds. However, following the reactivation, the Foreign Discount for "Swap" bonds began to decrease, in contrast to an increase in the "Other" bonds.

$$\Delta \text{CreditSpread}_{i,t} = \alpha + \lambda \text{Foreign} \times \text{D}_{Covid} \times \text{D}_{Swap} + \eta \text{Foreign} \times \text{D}_{Covid} + \phi \text{D}_{Covid} + \text{controls}_{i,t} + \epsilon_{i,t} \quad (20)$$

I formally test the effect of standing swap lines using a triple difference specification in Equation (20). The first difference in credit spread serves as the dependent variable to control for the non-stationary problem of daily bond yield. D_{Covid} is a dummy variable,

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

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

assigned a value of 1 after the reactivation of standing swap lines on March 15th, 2022. D_{Swap} is another dummy variable, given a value of 1 for "Swap" USD bonds. The sample period includes daily data from March 9, 2020, to March 18, 2020. Table 7 presents the results. The coefficient of the triple DiD interaction term is negative and significant, with values of -0.043 in both column (1) and (2), which use firm-fixed effects and 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 "Other" USD bonds. This divergence is further evidence of the dollar home bias channel. During tight cross-border dollar liquidity, non-U.S. investors with swap line access exerted less selling pressure on USD bonds issued by their local firms, thereby reducing the exchange rate risk exposures of non-U.S. USD bonds.

6.3 Channel Comparison and Robustness Tests

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

$$\begin{aligned}\text{CreditSpread}_{i,t} =& \alpha + \theta \text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} + \gamma \text{Foreign}_i \times \Delta\text{Dollar}_t \times \text{USDShare}_{f,t} \\ &+ \omega \text{Foreign}_i \times \Delta\text{Dollar}_t^{Bilateral} \times \text{NonUSHolding}_{i,t-1} + \text{controls}_{i,t} + \epsilon_{i,t}\end{aligned} \quad (21)$$

Table 8 examines these two channels using Equation (21). 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 credit spread differential by 2.4 basis points between non-U.S. and U.S. USD bonds, equivalent to a 5.8% increase in the Foreign Discount. 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.

Additionally, I explore the dynamic significance of the two channels by conducting a rolling regression of Equation (21) with a 36-month window from January 2004 to March 2021. Figure 8 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 been continually significant at the 5% level since 2008.

Finally, I assess the robustness of these two channels by leveraging fixed effects. The results presented in panels (b), (c), and (d) of Table 9 control for fundamental differences between countries, firms, and bonds, as well as time-varying shocks affecting each country and firm. All previous findings remain consistent and highly significant after incorporating these fixed effects.

7 Conclusion

This paper investigates the impact of exchange rate risk on the Foreign Discount within USD bonds. Non-U.S. USD bonds generally exhibit higher credit spreads than U.S. USD bonds, primarily due to their greater exposure to exchange rate risk. While differing exposures to exchange rate risk among bonds are not surprising, the consequential noticeable pricing difference between non-U.S. and U.S. USD bonds is intriguing. Furthermore, considering the significant presence of non-U.S. issuers in the USD bond market, it is crucial to understand the origins of this additional exchange rate risk exposure in non-U.S. USD bonds and how it leads to a persistent pricing disparity between non-U.S. and U.S. USD bonds. Therefore, this paper delves into the newly observed phenomenon of the Foreign Discount within USD bonds to further explore the influence of exchange rate risk.

Theoretically, I develop a model that explains the additional exchange rate risk exposure of non-U.S. USD bonds through two channels. The first, the balance sheet channel, reveals that non-U.S. firms with currency mismatches in their balance sheets experience a decline in net worth when the U.S. dollar appreciates. This depreciation affects the fundamentals of these firms and, consequently, the pricing of their USD bonds. The second channel, the dollar home bias channel, highlights the tendency of international investors to favor domestic issuers when investing in USD bonds. An appreciation of the U.S. dollar undermines the risk-taking abilities of non-U.S. investors, subsequently influencing the pricing of non-U.S. USD bonds, which are predominantly held by these investors.

Empirically, I document the significant role of additional exchange rate risk exposures in affecting the Foreign Discount. Specifically, this exposure is linked with bilateral exchange rates rather than the broad U.S. dollar index. By analyzing firm-level USD liabilities, I demonstrate that USD bonds issued by non-U.S. firms with a higher volume of outstanding USD bonds are more adversely affected by the appreciation of the U.S. dollar, evidencing the balance sheet channel. Furthermore, this channel appears to be impervious to hedging through derivatives instruments or foreign currency revenues. Relying on detailed investor holding data from the eMaxx database, I show that non-U.S. USD bonds with a higher proportion of non-U.S. investor holdings experience a larger increase in credit spread when the U.S. dollar appreciates, supporting the dollar home bias channel.

Additionally, I corroborate the effectiveness of the dollar home bias channel using a DiD analysis, based on the implementation of central bank swap lines during the Covid-19 period. My findings indicate that the alleviated exchange rate risk exposures of non-U.S. investors also reduce the exchange rate risk exposures of non-U.S. USD bonds.

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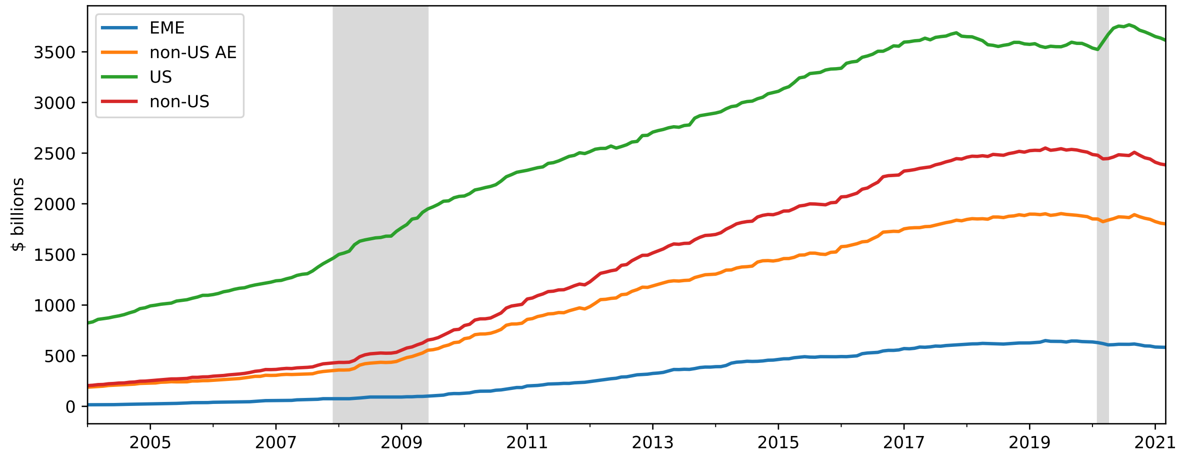
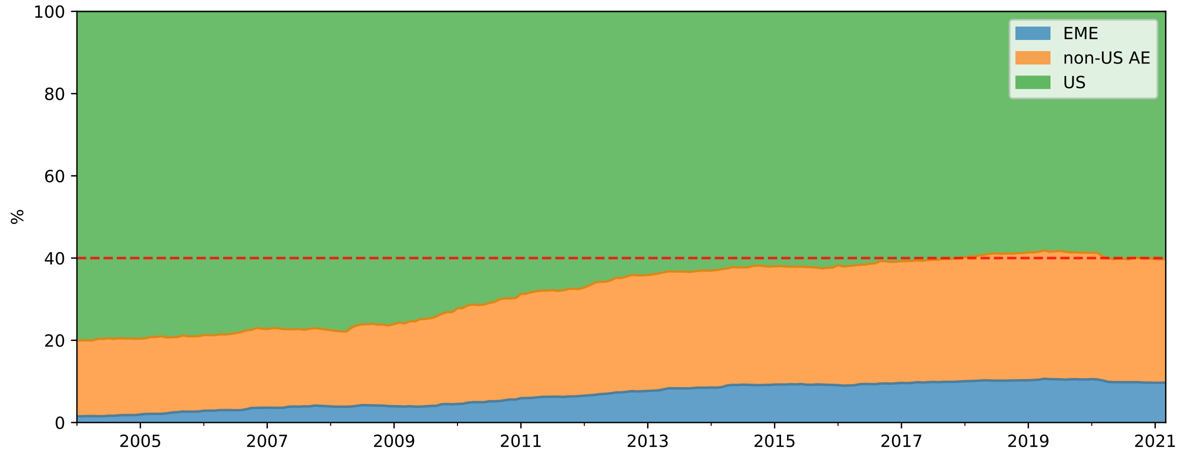
Figure 1: Outstanding Notional Amounts of Dollar Bonds

(a) Outstanding Notional in $ Billions

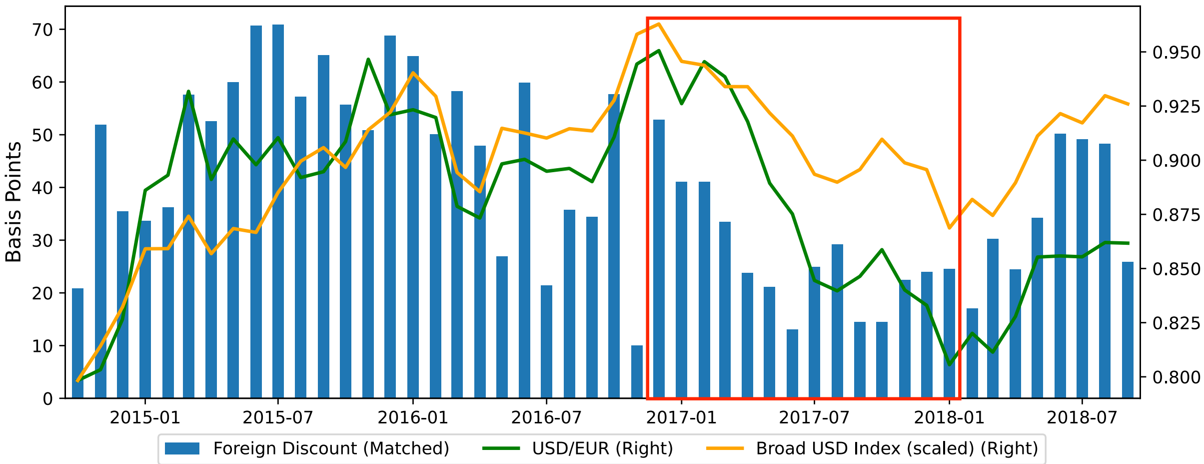


(b) Shares of Outstanding Notional



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

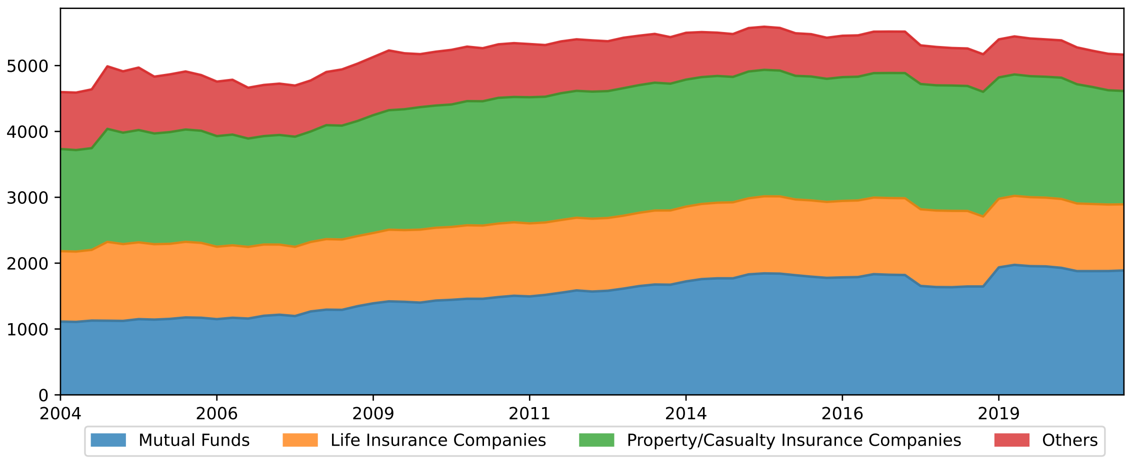
Figure 2: Anecdotal Evidence: Airbus and Boeing



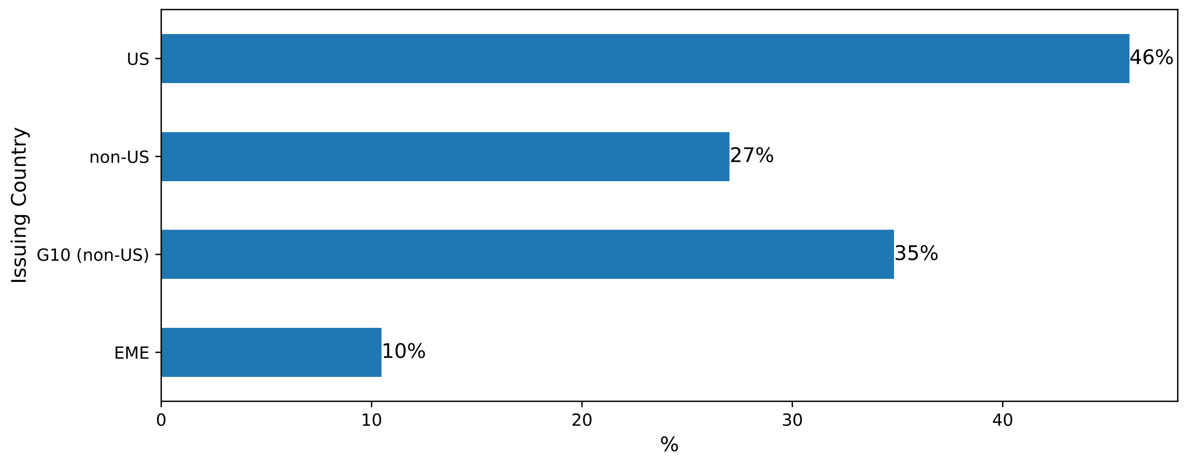
Note: The figure presents the Foreign Discount (Matched) as a blue bar, alongside the USD/EUR exchange rate and the broad USD index, depicted by green and orange lines, respectively. The Foreign Discount (Matched) is calculated as the difference in credit spreads between the USD bonds issued by Airbus (ISIN: US26824KAA25) and those issued by Boeing (ISIN: US097023BG91). The USD/EUR exchange rate represents the value of one U.S. dollar in terms of euros. The broad USD index, measuring the value of one U.S. dollar 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 3: U.S. Institutional Investor Holding Data

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



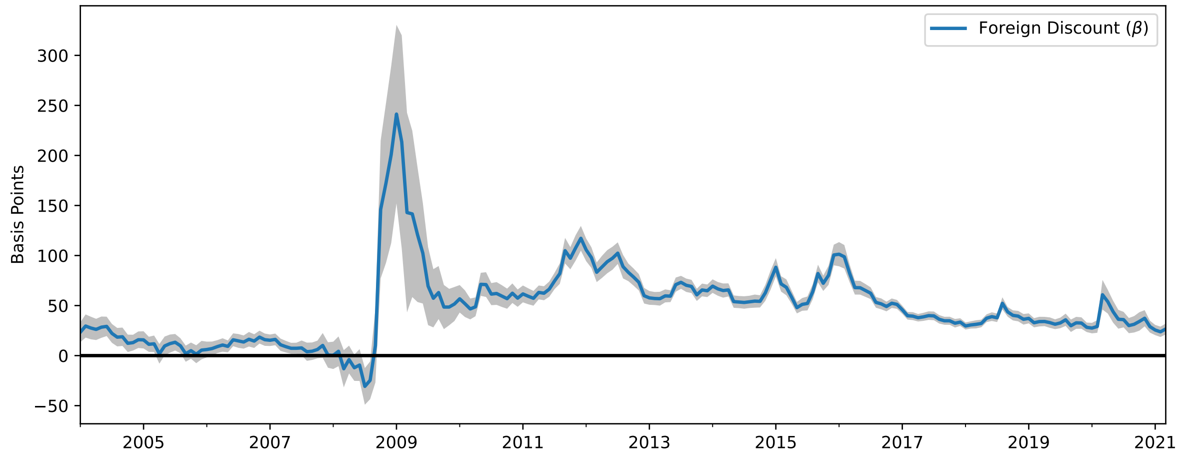
(b) Average Shares of Dollar Bonds Held by U.S. Institutional Investors



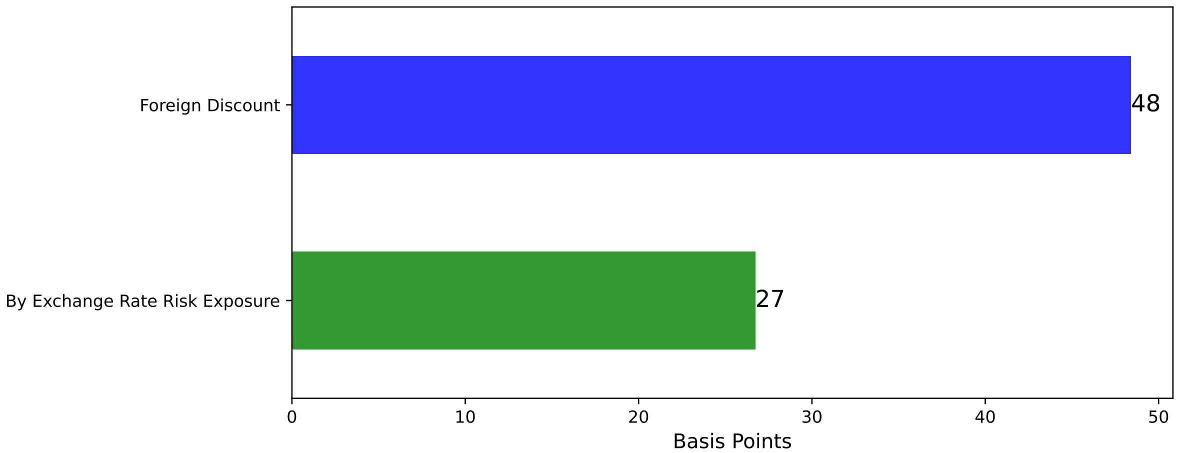
Note: This figure presents data on U.S. institutional investor holdings. Panel (a) shows the dynamics of covered U.S. institutional investors from 2004Q1 to 2021Q1. I classify U.S. institutional investors into Mutual Funds, Property/Casualty Insurance Companies, Life Insurance Companies, and Others. Panel (b) illustrates the average share of USD bonds held by U.S. institutional investors from the 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 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:

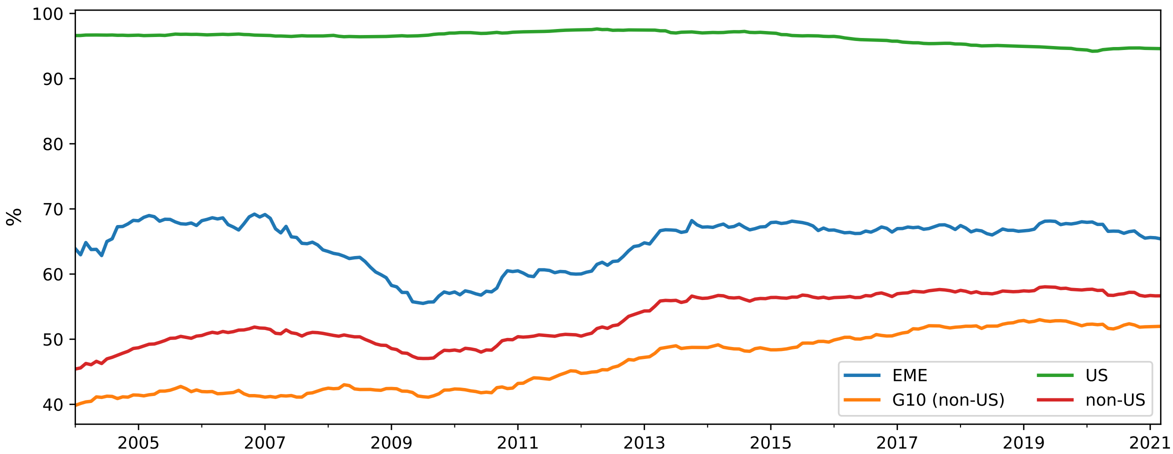
$$\text{CreditSpread}_{i,t} = \alpha + \beta\text{Foreign}_i + \text{controls}_{i,t} + \epsilon_{i,t}$$

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 which are non-U.S. firms. ΔDollar_t is the log change in the broad dollar index at time t. Control variables include bond characteristics such as rating, bid-ask spreads, remaining maturity, age, issuance size, and coupon rate.

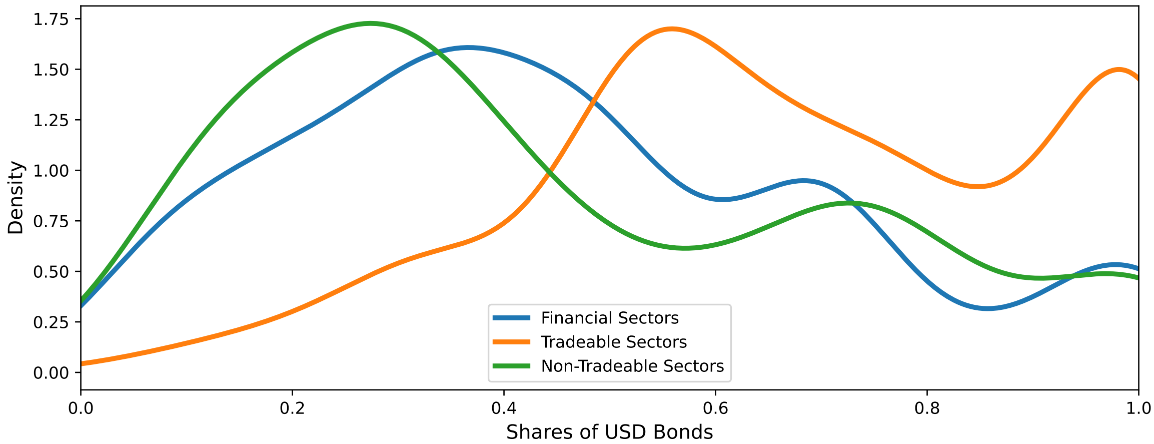
Figure 5: The Share of USD Bonds in Total Outstanding Bond Notional



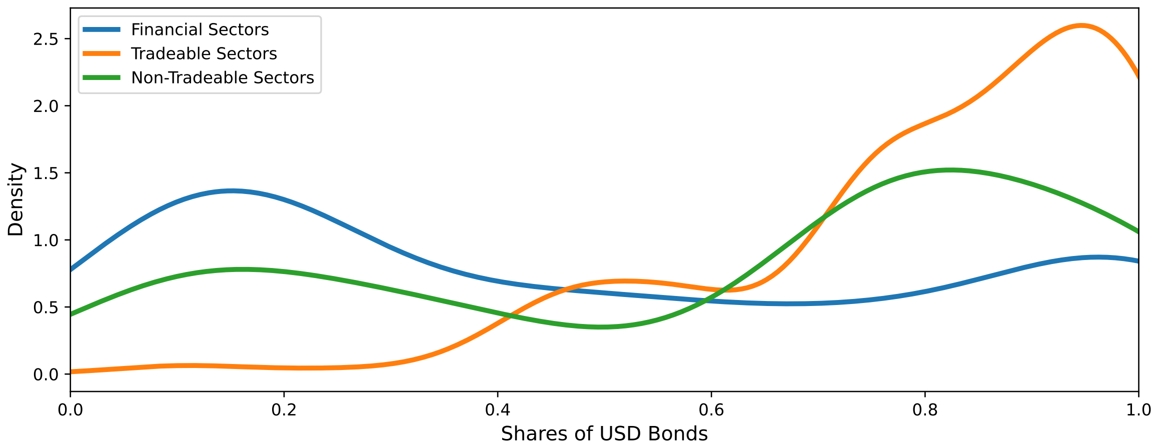
Note: This figure presents the share of USD bonds in the total outstanding bond notional. I classify firms based on the issuer's country of origin into U.S., non-U.S., EME and G10 (Non-U.S.). I infer the bond outstanding using the SDC Platinum Global New Issues database.

Figure 6: Density Distribution of USD Bonds Share in Total Outstanding Bond Notional (March 2021)

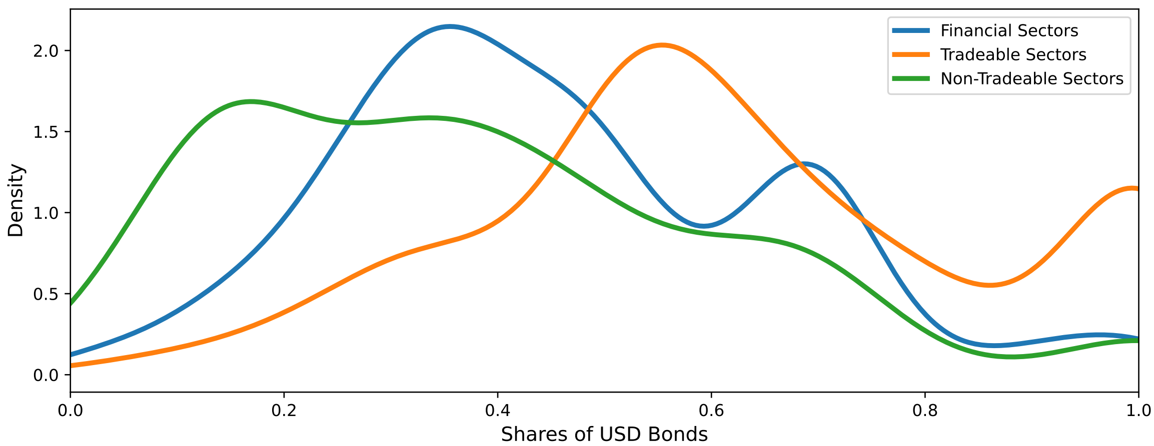
(a) Non-U.S. Firms



(b) Non-U.S. EME Firms

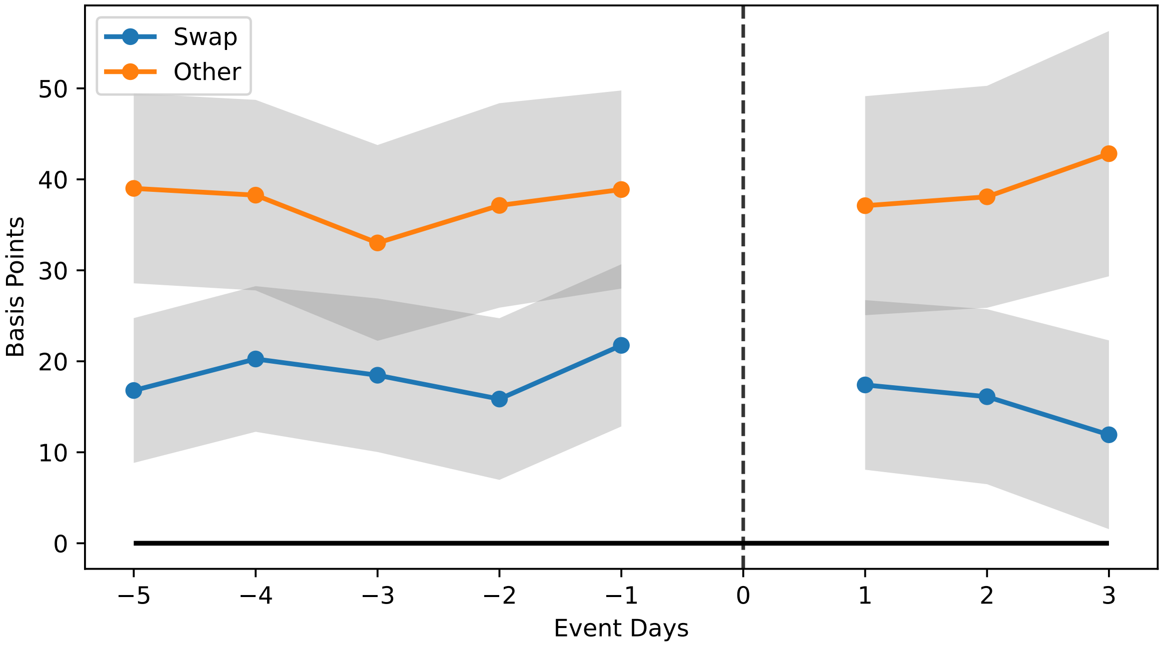


(c) Non-U.S. G10 Firms



Note: This figure presents the kernel density estimates of the proportion of USD bonds to the total bond outstanding notional for non-U.S. firms. I classify firms into financial sectors, tradable sectors and non-tradable sectors. The classification of tradable sector follows Sachs and Larrain (1993) and Du and Schreger (2022).

Figure 7: Foreign Discount in the COVID-19 Pandemic

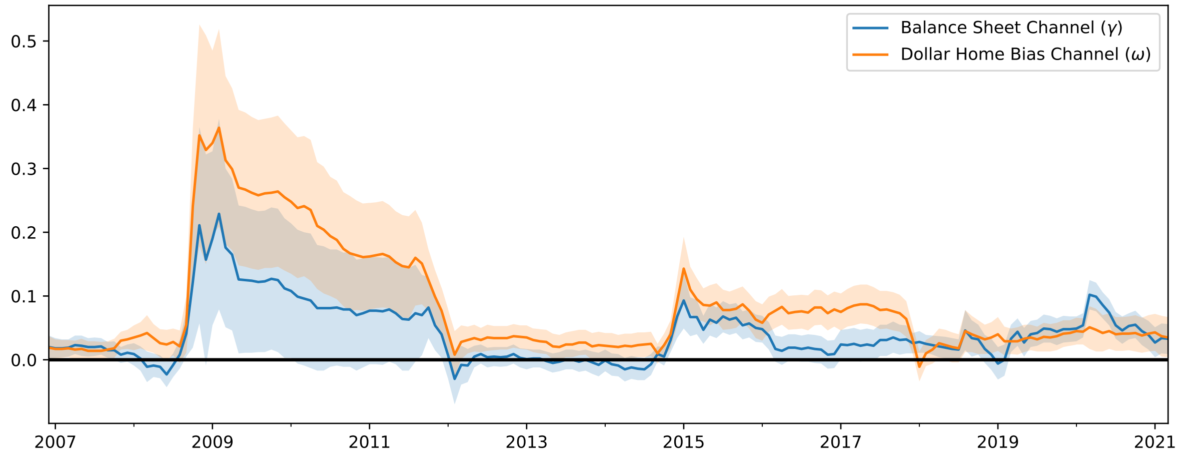


Note: The figure presents the Foreign Discounts for USD bonds issued by non-U.S. firms from "Swap" countries and "Other" countries, respectively. The "Swap" countries refer to countries of the five other Central Banks (the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank,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

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

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

Figure 8: Channel Comparison: Rolling Windows Analysis



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

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

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

Table 1: Corporate Bond Information - Issuer Level

	No.	Notl. $bil	No. Firms
All			
Total	3,484.00	2,752.07	1,207.20
Rating			
AAA&AA	475.61	497.24	131.28
A	1,235.40	1,032.79	351.71
BBB	1,294.38	917.23	493.85
HY (BB and below)	478.60	304.81	253.71
Maturity			
1-3 yrs	859.15	699.47	515.56
3-7 yrs	1,317.90	1,051.30	733.60
7-10 yrs	642.65	513.84	436.21
10+ yrs	664.29	487.46	321.47

	No.	Notl. $bil	No. Firms		No.	Notl. $bil	No. Firms
U.S.				**non-U.S.**			
Total	2,350.96	1,747.23	726.63	Total	1,133.04	1,004.84	481.96
Rating				**Rating**			
AAA&AA	244.23	272.11	56.50	AAA&AA	231.39	225.14	74.92
A	816.23	636.47	200.78	A	419.17	396.31	151.08
BBB	963.67	646.00	329.66	BBB	330.71	271.23	164.69
HY (BB and below)	326.83	192.65	155.42	HY (BB and below)	151.77	112.16	98.50
Maturity				**Maturity**			
1-3 yrs	508.21	389.81	295.04	1-3 yrs	350.94	309.66	220.65
3-7 yrs	861.01	639.82	444.46	3-7 yrs	456.89	411.48	289.44
7-10 yrs	455.99	341.36	299.73	7-10 yrs	186.66	172.48	136.56
10+ yrs	525.74	376.23	239.72	10+ yrs	138.56	111.22	81.90
non-U.S. AE				**EME**			
Total	833.83	777.02	302.99	Total	299.21	227.82	179.51
Rating				**Rating**			
AAA&AA	214.66	210.40	65.85	AAA&AA	16.73	14.73	9.07
A	343.59	336.31	112.56	A	75.58	60.01	38.52
BBB	207.87	178.65	90.14	BBB	122.84	92.59	74.71
HY (BB and below)	67.71	51.66	39.76	HY (BB and below)	84.06	60.50	58.95
Maturity				**Maturity**			
1-3 yrs	261.61	250.86	144.15	1-3 yrs	89.32	58.79	76.56
3-7 yrs	324.94	311.20	186.15	3-7 yrs	131.95	100.28	103.43
7-10 yrs	137.32	128.81	95.63	7-10 yrs	49.34	43.67	40.94
10+ yrs	109.96	86.15	62.16	10+ yrs	28.60	25.08	19.74

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 value 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	721,188	1.90	2.63	0.00	0.75	1.25	2.15	94.48
Rating	721,188	7.70	3.17	1	6	8	9	21
Maturity	721,188	7.97	7.70	1.00	3.03	5.27	9.01	99.41
Age	721,188	4.55	4.54	0.00	1.48	3.25	6.14	34.21
IssueSize	721,188	790	694	50	350	585	1,000	15,000
Coupon	721,188	4.87	1.88	0.00	3.49	4.88	6.12	15.50
BidAskSpread	721,188	0.15	0.19	0.00	0.06	0.10	0.17	4.07
U.S.								
CreditSpread	486,648	1.90	2.77	0.00	0.75	1.26	2.11	94.48
Rating	486,648	7.93	3.10	1	6	8	9	21
Maturity	486,648	8.65	8.08	1.0	3.3	5.9	9.6	99.4
Age	486,648	5.06	4.88	0.00	1.68	3.65	6.80	30.93
IssueSize	486,648	743	706	50	300	500	1,000	15,000
Coupon	486,648	5.07	1.81	0.00	3.75	5.12	6.25	15.50
BidAskSpread	486,648	0.16	0.20	0.00	0.06	0.11	0.18	4.07
Non-U.S.								
CreditSpread	234,540	1.88	2.32	0.00	0.75	1.25	2.24	94.40
Rating	234,540	7.22	3.25	1	5	7	9	21
Maturity	234,540	6.56	6.64	1.0	2.6	4.4	7.6	96.7
Age	234,540	3.50	3.51	0.00	1.19	2.57	4.61	34.21
IssueSize	234,540	887	656	50	500	750	1,000	11,000
Coupon	234,540	4.46	1.94	0.00	2.93	4.30	5.75	15.00
BidAskSpread	234,540	0.14	0.17	0.00	0.06	0.10	0.15	4.07
Non-U.S. AE								
CreditSpread	172,603	1.51	1.92	0.00	0.63	1.01	1.76	94.40
Rating	172,603	6.54	2.99	1	4	6	8	21
Maturity	172,603	6.68	6.71	1.00	2.62	4.44	7.82	96.68
Age	172,603	3.56	3.76	0.00	1.15	2.51	4.58	34.21
IssueSize	172,603	932	671	50	500	750	1,250	11,000
Coupon	172,603	4.17	1.87	0.00	2.70	3.95	5.45	13.00
BidAskSpread	172,603	0.12	0.15	0.00	0.06	0.09	0.14	4.07
EME								
CreditSpread	61,937	2.93	2.92	0.00	1.37	2.14	3.50	70.42
Rating	61,937	9.10	3.20	1	7	9	11	21
Maturity	61,937	6.23	6.42	1.00	2.70	4.41	7.17	96.41
Age	61,937	3.33	2.69	0.00	1.29	2.73	4.68	23.05
IssueSize	61,937	761	596	50	500	600	1,000	6,750
Coupon	61,937	5.29	1.91	0.00	3.88	5.12	6.45	15.00
BidAskSpread	61,937	0.18	0.20	0.00	0.07	0.12	0.22	4.07

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	0.418***					
	(0.047)					
Foreign× ΔDollar	0.030***	0.024***		-0.009	0.025***	
	(0.005)	(0.005)		(0.006)	(0.006)	
Foreign× $\Delta\text{Dollar}^{Bilateral}$			0.029***	0.031***		0.092***
			(0.003)	(0.004)		(0.013)
Foreign× $\Delta\text{Dollar}^{Orth}$						0.009
						(0.006)
Foreign× $\Delta\text{Dollar}^{Bilateral,Ortho}$					0.029***	
					(0.004)	
$\Delta\text{Dollar}^{Bilateral,Ortho}$						0.171***
						(0.028)
Rating	0.370***	0.411***	0.411***	0.411***	0.411***	0.411***
	(0.023)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
Maturity	0.038***	0.040***	0.040***	0.040***	0.040***	0.040***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Age	0.008	0.020***	0.020***	0.020***	0.020***	0.020***
	(0.008)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
log(IssueSize)	0.018	-0.049***	-0.050***	-0.050***	-0.049***	-0.050***
	(0.033)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Coupon	0.112***	0.062***	0.062***	0.062***	0.062***	0.062***
	(0.026)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
BidAskSpread	2.103***	1.534***	1.532***	1.531***	1.532***	1.528***
	(0.214)	(0.145)	(0.145)	(0.145)	(0.145)	(0.145)
Constant	-2.415***	-1.893***	-1.893***	-1.893***	-1.893***	-1.909***
	(0.277)	(0.257)	(0.257)	(0.257)	(0.257)	(0.257)
R^2	0.48	0.58	0.58	0.58	0.58	0.58
N	721,188	721,172	721,172	721,172	721,172	721,172
Time-FE	✓	✓	✓	✓	✓	✓
Industry-FE	✓					
Firm-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 U.S. dollar index and the bilateral exchange rate of the U.S. dollar 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. Other controlled bond characteristics include rating, bid-ask spreads, remaining maturity, age, issuance size, and coupon 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.

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

	(1)	(2)	(3)	(4)	(5)	(6)
	Full	Full	2010 to 2019	Excluding GFC	Full	Full
Foreign$\times$ ΔDollar^{Bilateral}	0.027***	0.026***	0.018***	0.016***	0.006**	0.043***
	(0.003)	(0.004)	(0.002)	(0.002)	(0.003)	(0.006)
Foreign$\times$ Rating	-0.105**					
	(0.053)					
Foreign$\times$ Maturity	0.005					
	(0.004)					
Foreign$\times$ Age	-0.038***					
	(0.009)					
Foreign$\times$ log(IssueSize)	0.074*					
	(0.043)					
Foreign$\times$ Coupon	0.051*					
	(0.027)					
Foreign$\times$ BidAskSpread	0.973***					
	(0.270)					
CreditSpread$_{t-1}$		0.918***				
		(0.010)				
Foreign$\times$ ΔDollar^{Bilateral}$\times$VIX^{High}				0.065***		
				(0.015)		
Foreign$\times$ VIX^{High}				-0.084		
				(0.059)		
Foreign$\times$ ΔDollar^{Bilateral}$\times$EME					0.055***	
					(0.007)	
Foreign$\times$ ΔDollar^{Bilateral}$\times$ Fin						0.035**
						(0.015)
Foreign$\times$ ΔDollar^{Bilateral}$\times$ Fin $\times$ G10						-0.033**
						(0.015)
ΔDollar^{Bilateral} $\times$ G10						-0.038***
						(0.006)
Controls	✓	✓	✓	✓	✓	✓
R^2	0.58	0.92	0.75	0.71	0.58	0.58
N	721,172	678,197	500,613	670,414	721,172	721,172
Time-FE	✓	✓	✓	✓	✓	✓
Frim-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 U.S. dollar to the issuers' local currency. VIX$^{High}_t$ 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. Other bond characteristics controlled for include rating, bid-ask spreads, remaining maturity, age, issuance size, and coupon rate, all 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.

Table 5: Balance Sheet Channel

	(1)	(2)	(3)	(4)	(5)	(6)
	Full	Full	Full	Full	Full	Non-Financial
Foreign× ΔDollar^{Bilateral}	-0.006	0.022***	0.016***	0.019***	-0.012	-0.008
	(0.005)	(0.005)	(0.004)	(0.003)	(0.012)	(0.006)
Foreign× ΔDollar^{Bilateral} × USDShare	0.056***				0.072***	0.047***
	(0.011)				(0.017)	(0.015)
Foreign× ΔDollar^{Bilateral} × USDLiabShare		0.004				
		(0.008)				
Foreign× ΔDollar^{Bilateral} × USDLiabShare$^{Long-term}$			0.015**			
			(0.006)			
Foreign× ΔDollar^{Bilateral} ×Bond2TA				0.007***		
				(0.002)		
Foreign× ΔDollar^{Bilateral} × USDShare × Fin					-0.003	
					(0.041)	
Foreign× ΔDollar^{Bilateral} × USDShare × Fin × G10					-0.044	
					(0.053)	
Foreign× ΔDollar^{Bilateral} × Tradable						0.002
						(0.013)
Foreign× ΔDollar^{Bilateral} × Tradable × USDShare						-0.002
						(0.022)
Controls	✓	✓	✓	✓	✓	✓
R^2	0.58	0.59	0.59	0.57	0.58	0.57
N	721,172	626,440	626,440	605,366	721,172	489,050
Time-FE	✓	✓	✓	✓	✓	✓
Firm-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 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$_{f,t}^{Long-term}$ 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 value to a firm's total assets for firm f at time t. Other bond characteristics controlled for include rating, bid-ask spreads, remaining maturity, age, issuance size, and coupon rate, all 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 outstanding USD bonds are inferred from the SDC new issuance data. The liabilities and total assets of firms are sourced from Capital IQ Capital Structure Debt. 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}	-0.034***	-0.036***	-0.004	-0.009
	(0.008)	(0.008)	(0.007)	(0.007)
Foreign× NonUSHolding$_{t-1}$	-0.340**	-0.373*	-0.294**	-0.198
	(0.156)	(0.191)	(0.149)	(0.135)
Foreign× ΔDollar^{Bilateral} × NonUSHolding$_{t-1}$	0.074***	0.079***	0.011	0.033***
	(0.011)	(0.012)	(0.010)	(0.009)
Foreign× ΔDollar^{Bilateral} × NonUSHolding$_{t-1}$×Fin		-0.008		
		(0.027)		
Foreign× ΔDollar^{Bilateral} × NonUSHolding$_{t-1}$×EME			0.120***	
			(0.037)	
Foreign× ΔDollar^{Bilateral} × NonUSHolding$_{t-1}$×VIX^{High}				0.158***
				(0.039)
NonUSHolding$_{t-1}$	0.321***	0.414***	0.321***	0.087
	(0.109)	(0.140)	(0.109)	(0.089)
Controls	✓	✓	✓	✓
R^2	0.58	0.58	0.58	0.59
N	664,645	664,645	664,645	664,645
Time-FE	✓	✓	✓	✓
Firm-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, bid-ask spreads, remaining maturity, age, issuance size, and coupon rate, 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} × D_{Swap}	-0.043**	-0.043**
	(0.022)	(0.022)
Foreign× D_{Covid}	0.012	0.012
	(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***	0.018***
	(0.004)	(0.004)
Coupon	0.019***	0.019***
	(0.003)	(0.003)
VIX	0.007***	
	(0.000)	
BidAskSpread	0.107***	0.116***
	(0.011)	(0.011)
Constant	-0.438***	-0.043
	(0.044)	(0.039)
R^2	0.12	0.17
N	42,440	42,440
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 assessed the standing swap line. There are 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$\times$ ΔDollar^{Bilateral}	-0.061***	0.008
	(0.011)	(0.014)
Foreign$\times$ ΔDollar^{Bilateral} $\times$ USDShare	0.044***	-0.063***
	(0.009)	(0.024)
Foreign$\times$ ΔDollar^{Bilateral} $\times$ NonUSHolding$_{t-1}$	0.073***	-0.014
	(0.011)	(0.019)
Foreign$\times$ ΔDollar^{Bilateral} $\times$ USDShare $\times$ NonUSHolding$_{t-1}$		0.134***
		(0.035)
USDShare	-1.078*	-1.144**
	(0.608)	(0.561)
NonUSHolding$_{t-1}$	0.316***	0.210
	(0.109)	(0.655)
Foreign$\times$ USDShare	0.640	0.500
	(0.648)	(0.638)
Foreign$\times$ NonUSHolding$_{t-1}$	-0.332**	-0.382
	(0.156)	(0.683)
Controls	✓	✓
R^2	0.58	0.58
N	664,645	664,645
Time-FE	✓	✓
Firm-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, bid-ask spreads, remaining maturity, age, issuance size, and coupon rate, all 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 9: Foreign Discount and Exchange Rate Risk Exposure: Fixed Effects

	(1)	(2)	(3)	(4)	(5)
	Full	Full	Full	Full	Full
(a) Exchange Rate Risk Exposures					
Foreign$\times$ ΔDollar^{Bilateral}	0.029***	0.027***	0.022***	0.022***	0.022***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
R^2	0.47	0.65	0.60	0.80	0.83
N	721,186	721,018	721,159	720,618	720,475
(b) Balance Sheet Channel					
Foreign$\times$ ΔDollar^{Bilateral}	-0.006	-0.007	-0.006	-0.004	-0.003
	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)
Foreign$\times$ ΔDollar^{Bilateral} $\times$ USDShare	0.057***	0.054***	0.046***	0.042***	0.041***
	(0.011)	(0.010)	(0.009)	(0.009)	(0.009)
R^2	0.48	0.65	0.60	0.80	0.83
N	721,186	721,018	721,159	720,618	720,475
(c) Dollar Home Bias Channel					
Foreign$\times$ ΔDollar^{Bilateral}	-0.035***	-0.035***	-0.030***	-0.031***	-0.029***
	(0.008)	(0.007)	(0.006)	(0.006)	(0.006)
Foreign$\times$ ΔDollar^{Bilateral} $\times$ NonUSHolding$_{t-1}$	0.078***	0.075***	0.062***	0.064***	0.062***
	(0.011)	(0.011)	(0.010)	(0.009)	(0.008)
R^2	0.48	0.65	0.60	0.80	0.83
N	664,670	664,523	664,634	664,164	664,058
(d) Channel Comparison					
Foreign$\times$ ΔDollar^{Bilateral}	-0.064***	-0.061***	-0.052***	-0.052***	-0.049***
	(0.011)	(0.010)	(0.010)	(0.009)	(0.008)
Foreign$\times$ ΔDollar^{Bilateral} $\times$ USDShare	0.047***	0.041***	0.034***	0.034***	0.033***
	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)
Foreign$\times$ ΔDollar^{Bilateral} $\times$ NonUSHolding$_{t-1}$	0.076***	0.074***	0.061***	0.063***	0.061***
	(0.011)	(0.011)	(0.009)	(0.008)	(0.008)
R^2	0.48	0.65	0.60	0.80	0.83
N	664,670	664,523	664,634	664,164	664,058
Controls	✓	✓	✓	✓	✓
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$_{i,t}$. Controls$_{i,t}$ encompasses the two-way interaction terms associated with the three-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.

Appendix

A Model

A.1 Proof 1

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

$$\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} = \frac{\partial \rho_{i,j}\sqrt{V(V+v(\epsilon_{fx}))}}{\partial \epsilon_{fx}} = \frac{\partial \rho_{i,j}}{\partial \epsilon_{fx}}\sqrt{V(V+v(\epsilon_{fx}))} + \frac{V\rho_{i,j}}{2\sqrt{V(V+v(\epsilon_{fx}))}}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} < 0 \tag{22}$$

$$\frac{\partial \rho_{i,j}}{\partial \epsilon_{fx}} < -\frac{\rho_{i,j}}{2(V+v(\epsilon_{fx}))}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} \tag{23}$$

In addition,

$$\begin{aligned}\frac{\partial[v(\epsilon_{fx})+Cov(i,j)]}{\partial \epsilon_{fx}} &= \frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} + \frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} = \frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} + \frac{\partial \rho_{i,j}}{\partial \epsilon_{fx}}\sqrt{V(V+v(\epsilon_{fx}))} + \frac{V\rho_{i,j}}{2\sqrt{V(V+v(\epsilon_{fx}))}}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} \\ &= \frac{2\sqrt{V(V+v(\epsilon_{fx}))}+V\rho_{i,j}}{2\sqrt{V(V+v(\epsilon_{fx}))}}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} + \sqrt{V(V+v(\epsilon_{fx}))}\frac{\partial \rho_{i,j}}{\partial \epsilon_{fx}}\end{aligned} \tag{24}$$

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

$$\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} < 0 \text{ and } \frac{\partial[v(\epsilon_{fx})+Cov(i,j)]}{\partial \epsilon_{fx}} > 0 \tag{25}$$

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

$$\frac{\partial \alpha}{\partial \epsilon_{fx}} = \frac{\partial[(1-\rho_{i,j}^2)V(V+v(\epsilon_{fx}))]}{\partial \epsilon_{fx}} = -2\rho_{i,j}\frac{\partial \rho_{i,j}}{\partial \epsilon_{fx}}V(V+v(\epsilon_{fx})) + (1-\rho_{i,j}^2)V\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} \tag{26}$$

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

$$\begin{aligned}\frac{\partial \alpha}{\partial \epsilon_{fx}} &= [-2\rho_{i,j}V(V+v(\epsilon_{fx}))]\left[-\frac{\rho_{i,j}}{2(V+v(\epsilon_{fx}))}\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}}\right] + (1-\rho_{i,j}^2)V\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} \\ &= \rho_{i,j}^2 V\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} + (1-\rho_{i,j}^2)V\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} = \frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} > 0\end{aligned} \tag{27}$$

A.2 Proof of Proposition 1

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

$$\begin{aligned}y_x &= \frac{1}{2(Cov(i,j)+V)} \\ &\left[2v(\epsilon_{fx})(y-y^{rf}) + [V+v(\epsilon_{fx})+Cov(i,j)](\mu_i+\frac{\partial \mu_i}{\partial n_i}) - (Cov(i,j)+V)(\mu_j+\frac{\partial \mu_j}{\partial m_j}) - \gamma\alpha(D_i-D_j)\right]\end{aligned} \tag{28}$$

Then, taking the first-order derivatives:

$$\frac{\partial y_x}{\partial \epsilon_{fx}} = \underbrace{\frac{\partial[Cov(i,j)^{-1}]}{\partial \epsilon_{fx}}}_{>0} \underbrace{\left[2v(\epsilon_{fx})(y-y^{rf}) + [V+v(\epsilon_{fx})+Cov(i,j)](\mu_i + \frac{\partial \mu_i}{\partial n_i}) - (Cov(i,j)+V)(\mu_j + \frac{\partial \mu_j}{\partial m_j}) - \gamma\alpha(D_i - D_j)\right]}_{\text{term 1>0}}$$
$$+ \underbrace{\frac{1}{2(Cov(i,j)+V)}}_{>0} \left[\underbrace{2\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}}(y-y^{rf})}_{>0} + \underbrace{\frac{\partial[v(\epsilon_{fx})+Cov(i,j)]}{\partial \epsilon_{fx}}(\mu_i + \frac{\partial \mu_i}{\partial n_i})}_{>0} - \underbrace{\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}(\mu_j + \frac{\partial \mu_j}{\partial m_j})}_{>0} \underbrace{-\gamma\frac{\partial \alpha}{\partial \epsilon_{fx}}(D_i - D_j)}_{?}\right] \quad (29)$$

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 (29) 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, $\frac{\partial y_x}{\partial \epsilon_{fx}} > 0$.

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

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

$$\begin{aligned}
\frac{\partial \beta}{\partial \epsilon_{fx}} &= V_{y_x}(Cov(i,j)+V) + 2\alpha + (c+\epsilon_{fx})\left[\frac{\partial V_{y_x}}{\partial \epsilon_{fx}}(Cov(i,j)+V) + V_{y_x}\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} + 2\frac{\partial \alpha}{\partial \epsilon_{fx}}\right] \\
&+ \left[2\gamma\frac{\partial \alpha}{\partial \epsilon_{fx}}(Cov(i,j)+y) + 2\gamma\alpha\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}\right] \\
&= [V + (V+v(\epsilon_{fx})) - 2Cov(i,j)][Cov(i,j)+V] + 2[V(V+v(\epsilon_{fx})) - Cov(i,j)^2] \\
&+ (c+\epsilon_{fx})\Bigg[[\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} - 2\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}](Cov(i,j)+V) + [V+(V+v(\epsilon_{fx})) - 2Cov(i,j)]\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}} \\
&+ 2[V\frac{\partial v(\epsilon_{fx})}{\partial \epsilon_{fx}} - 2Cov(i,j)\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}]\Bigg] \\
&+ \left[2\gamma\frac{\partial \alpha}{\partial \epsilon_{fx}}(Cov(i,j)+y) + 2\gamma\alpha\frac{\partial Cov(i,j)}{\partial \epsilon_{fx}}\right]
\end{aligned} \quad (30)$$

The first part:

$$
\begin{aligned}
&[V+(V+v(\epsilon_{fx}))-2Cov(i,j)][Cov(i,j)+V]+2[V(V+v(\epsilon_{fx}))-Cov(i,j)^2]= \\
&VCov(i,j)+V^2+(V+v(\epsilon_{fx}))Cov(i,j)+(V+v(\epsilon_{fx}))V-2Cov(i,j)^2-2Cov(i,j)V \\
&+2V(V+v(\epsilon_{fx}))-Cov(i,j)^2= \\
&VCov(i,j)+V^2+(V+v(\epsilon_{fx}))Cov(i,j)+3(V+v(\epsilon_{fx}))V-3Cov(i,j)^2-3Cov(i,j)V \\
&=VCov(i,j)+V^2+VCov(i,j)+v(\epsilon_{fx})Cov(i,j)+3V^2+3v(\epsilon_{fx})V \\
&-3\rho_{i,j}^2V^2-3\rho_{i,j}^2Vv(\epsilon_{fx})-3Cov(i,j)V \\
&=Cov(i,j)[V+V+v(\epsilon_{fx})-3V]+V^2[1+3-3\rho_{i,j}^2]+3v(\epsilon_{fx})V(1-\rho_{i,j}^2) \\
&=Cov(i,j)[v(\epsilon_{fx})-V]+V^2[4-3\rho_{i,j}^2]+3v(\epsilon_{fx})V(1-\rho_{i,j}^2) \\
&>Cov(i,j)[v(\epsilon_{fx})-V]+V^2=Cov(i,j)v(\epsilon_{fx})+V(V-Cov(i,j)) \\
&=\rho_{i,j}\sqrt{V(V+v(\epsilon_{fx}))}v(\epsilon_{fx})+V(V-\rho_{i,j}\sqrt{V(V+v(\epsilon_{fx}))}) \\
&\geq \rho_{i,j}V(v(\epsilon_{fx}))+V(V-\rho_{i,j}(V+v(\epsilon_{fx})))=\rho_{i,j}V(v(\epsilon_{fx}))+V^2-\rho_{i,j}V^2-\rho_{i,j}V(v(\epsilon_{fx})) \\
&=V^2-\rho_{i,j}V^2>0
\end{aligned}
\tag{31}
$$

The second part:

$$
\begin{aligned}
&[\frac{\partial v(\epsilon_{fx})}{\partial\epsilon_{fx}}-2\frac{\partial Cov(i,j)}{\partial\epsilon_{fx}}](Cov(i,j)+V)+[V+(V+v(\epsilon_{fx}))-2Cov(i,j)]\frac{\partial Cov(i,j)}{\partial\epsilon_{fx}} \\
&+2[V\frac{\partial v(\epsilon_{fx})}{\partial\epsilon_{fx}}-2Cov(i,j)\frac{\partial Cov(i,j)}{\partial\epsilon_{fx}}]= \\
&[-2(Cov(i,j)+V)+V+(V+v(\epsilon_{fx}))-2Cov(i,j)-4Cov(i,j)]\,\frac{\partial Cov(i,j)}{\partial\epsilon_{fx}} \\
&+[(Cov(i,j)+V)+2V]\,\frac{\partial v(\epsilon_{fx})}{\partial\epsilon_{fx}}= \\
&=[v(\epsilon_{fx})-8Cov(i,j)]\,\frac{\partial Cov(i,j)}{\partial\epsilon_{fx}}+[Cov(i,j)+3V]\,\frac{\partial v(\epsilon_{fx})}{\partial\epsilon_{fx}}
\end{aligned}
\tag{32}
$$

Then,

$$
\begin{aligned}
&\frac{\partial\beta}{\partial\epsilon_{fx}}=V_{y_x}(Cov(i,j)+V)+2\alpha+(c+\epsilon_{fx})\left[\frac{\partial V_{y_x}}{\partial\epsilon_{fx}}(Cov(i,j)+V)+V_{y_x}\frac{\partial Cov(i,j)}{\partial\epsilon_{fx}}+2\frac{\partial\alpha}{\partial\epsilon_{fx}}\right] \\
&+\left[2\gamma\frac{\partial\alpha}{\partial\epsilon_{fx}}(Cov(i,j)+y)+2\gamma\alpha\frac{\partial Cov(i,j)}{\partial\epsilon_{fx}}\right] \\
&=\underbrace{Cov(i,j)[v(\epsilon_{fx})-V]+V^2[4-3\rho_{i,j}^2]+3v(\epsilon_{fx})V(1-\rho_{i,j}^2)}_{>0} \\
&+(c+\epsilon_{fx})\left[[v(\epsilon_{fx})-8Cov(i,j)]\underbrace{\frac{\partial Cov(i,j)}{\partial\epsilon_{fx}}}_{<0}+\underbrace{[Cov(i,j)+3V]\,\frac{\partial v(\epsilon_{fx})}{\partial\epsilon_{fx}}}_{>0}\right] \\
&+\left[\underbrace{2\gamma\frac{\partial\alpha}{\partial\epsilon_{fx}}(Cov(i,j)+y)}_{>0}+\underbrace{2\gamma\alpha\frac{\partial Cov(i,j)}{\partial\epsilon_{fx}}}_{<0}\right]
\end{aligned}
\tag{33}
$$

$\frac{\partial\beta}{\partial\epsilon_{fx}}$ 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 FX cost $(c+\epsilon_{fx})$, risk $(v(\epsilon_{fx}))$ and hedging abilities $(\frac{\partial Cov(i,j)}{\partial\epsilon_{fx}})$ of USD bonds issued by non-U.S. firms.

A.4 Proof of Proposition 2

The *component 2* is:

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

where $\frac{\partial V_{y_x}}{\partial\epsilon_{fx}}>0$, $\frac{\partial v(\epsilon_{fx})}{\partial\epsilon_{fx}}$, $\frac{\partial V+v(\epsilon_{fx})+Cov(i,j)}{\partial\epsilon_{fx}}>0$, $\mu_i+\frac{\partial\mu_i}{\partial n_i}>0$ and $\mu_j+\frac{\partial\mu_j}{\partial m_j}>0$. 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 ex-post marginal home bias $(\mu_j+\frac{\partial\mu_j}{\partial m_j})$ approaches zero. The intuition behind this is that the average home bias utility μ_j decreases when non-U.S. investors already possess a significant amount of USD bonds issued by domestic firms.

B Data Set Construction and Details

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 U.S. dollar 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, we 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*.

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 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 U.S. dollar values using the end-of-month bilateral exchange rates obtained from Bloomberg.

C Empirical Evidence: 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 dollar funding costs and direct dollar funding costs, reflect the stress in cross-border U.S. dollar 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 dollar 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 dollar liquidity, as the cost of synthetic dollar funding rises relative to that of direct dollar funding. Subsequently, I revise Equation (17) to include the interaction between the Foreign dummy and CIP deviation. The results, presented in Table C1, indicate that the coefficient for the interaction between the Foreign dummy and CIP deviation is positive for both the 1-month and 3-month CIP deviations. This suggests that stress in cross-border U.S. dollar liquidity exacerbates the Foreign Discount, particularly affecting non-U.S. entities. However, this new interaction term's coefficient is only significant at the 10% level. In contrast, the main coefficient of the interaction term between the Foreign dummy and the exchange rate remains positive and highly significant at the 1% level, 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 C1: Foreign Discount and CIP Deviations

	(1)	(2)
	Full	Full
Foreign× ΔDollar^{Bilateral}	0.011***	0.010***
	(0.003)	(0.003)
Foreign× ΔCIP^{1m}	0.053*	
	(0.031)	
Foreign× ΔCIP^{3m}		0.167*
		(0.087)
Rating	0.421***	0.421***
	(0.036)	(0.036)
Maturity	0.039***	0.039***
	(0.002)	(0.002)
Age	0.026***	0.026***
	(0.006)	(0.006)
log(IssueSize)	-0.059***	-0.059***
	(0.020)	(0.020)
Coupon	0.051***	0.051***
	(0.018)	(0.018)
BidAskSpread	1.415***	1.415***
	(0.157)	(0.157)
Constant	-1.954***	-1.954***
	(0.291)	(0.291)
R^2	0.56	0.56
N	592,384	592,384
Time-FE	✓	✓
Firm-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 U.S. dollar to the issuers' local currency. ΔCIP$_{i,t}^{1m}$ and ΔCIP$_{i,t}^{3m}$ represent the change in one-month and three-month Covered Interest Parity (CIP) deviations of the U.S. dollar to the issuers' local currency. Other bond characteristics controlled for include rating, bid-ask spreads, remaining maturity, age, issuance size, and coupon rate, all 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.