Foreign Discount in International Corporate Bonds

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Abstract

In the dollar-denominated corporate bond market, 41% of bonds with an amount outstanding of USD 6.2 Trillion are issued by non-US firms by 2023. Despite the increasing importance of cross-border financing, foreign issuers are paying an extra premium of 22 bps, compared with their US counterparts. A similar foreign discount exists in the euro-denominated corporate bond and dollar-denominated sovereign bond market. While the standard risk measures can not explain the discount, I propose a theoretical explanation based on uncertainty aversion. Empirically, I find that most of the discount can be explained away by the Economic Policy Uncertainty (EPU) index from Baker, Bloom, and Davis (2016). Taking COVID-19 as an event study, I further document a foreign squeeze effect by showing that foreign dollar bonds suffer higher selling pressure than US dollar bonds during market turmoil. Such foreign discount (USA effect) dominates the dollar safety premium (USD effect). My results highlight the foreign discount and foreign squeeze effects in international corporate bonds.

Keywords: international corporate bonds, foreign discount, foreign squeeze, economic political uncertainty, home bias

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1 Introduction

In the international financial system, dollar-denominated debts have surged in the past two decades, especially after the 2008 global financial crisis.[1] By 2023, 41% of the dollar-denominated corporate bonds are issued by non-US entities, with an amount outstanding of USD 6.2 Trillion.[2] While the current literature mainly focuses on US corporate bonds, the pricing of dollar bonds issued by these non-US firms is not well understood. Given the increasing importance of cross-border dollar financing, this paper examines an important asset pricing question: When issuing dollar bonds, can foreign firms enjoy the same dollar premium as their US counterparts? Studying this question can also shed light on the classical home bias effect by quantifying the magnitude in the pricing level, complementary to the existing holding level evidence in the literature.

Empirically, I find foreign issuers are paying an extra premium of 22 bps relative to US issuers from January 2005 to June 2023, which is denoted as the foreign discount (FD). The discount is measured as the credit spread difference between dollar-denominated bonds issued by non-US firms and US firms, controlling for rating, bond-level characteristics and liquidity, as well as industry-fixed effects and year-fixed effects. Across countries, the foreign discounts are all positive and significant for developed countries like Canada (CA, 13 bps), Japan (JP, 18 bps), Eurozone (EU, 19 bps), United Kingdom (GB, 21 bps), and even larger for developing countries like China (CN, 66 bps) and Mexico (MX, 60 bps). As over 90% of dollar bonds issued by non-US firms in TRACE are from developed countries, the main result of this paper is then mostly driven by developed countries rather than developing countries. In the time series, the discount becomes more prominent in stressful times like the global financial crisis, the European debt crisis, the oil price collapse, the COVID-19 pandemic, the Russia-Ukraine War and the Fed rate hike.

Moreover, I show that the foreign discount is not unique to dollar-denominated corporate bonds, it also exists within euro-denominated corporate bonds. In this case, the EU issuers will be viewed as home issuers, while non-EU issuers like US firms will be regarded as foreign issuers. Along with the US, I also include the United Kingdom (GB), Switzerland (CH), Sweden (SE) and Norway (NO) based on the amount outstanding of euro-denominated corporate bonds. Symmetrically, these non-EU issuers also pay an extra 23 bps relative to their

[1] See Shin (2012), Cetorelli and Goldberg (2012), McCauley, McGuire, and Sushko (2015), Ivashina, Scharfstein, and Stein (2015), Bruno and Shin (2014, 2017) and Maggiori, Neiman, and Schreger (2020).

[2] The existing literature documents why and when non-US firms issue dollar bonds, including the special role of the dollar, the dollar bias, the safe dollar premium and the dollar carry trade by Krishnamurthy and Vissing-Jorgensen (2012), Caballero, Farhi, and Gourinchas (2017), Bruno and Shin (2017), Caballero and Farhi (2017), Jiang, Krishnamurthy, and Lustig (2018, 2020, 2021), Liao (2020), Maggiori, Neiman, and Schreger (2020), Caramichael, Gopinath, and Liao (2021) and others.

EU counterparts. Furthermore, such foreign discount also prevails in dollar-denominated sovereign bonds. Even after adjusting for the sovereign CDS spreads, the discounts are 7 bps, 13 bps and 23 bps for Germany, Canada and Japan, respectively.[3] To sum up, the foreign discount is a quite general and symmetric effect in the international bond market.

To understand the potential drivers behind the foreign discount, I examine whether the standard risk measures can explain the discount effect, including issuer-level risks, country-level risks and US risks. Focusing first on issuer-level risks, I mainly consider credit risk and liquidity risk. Specifically, to control for the credit risk beyond ratings, I focus on the non-US issuers with listed equity in the US and construct the credit risk proxy based on Merton's distance-to-default. Moreover, from Moody's default and recovery data, I find that non-US issuers on average have lower default probability and higher recovery rates compared to US issuers, suggesting that non-US issuers tend to have better credit quality than US issuers. Nonetheless, they still need to pay a non-trivial discount to investors for being foreigners. For the liquidity risk, I use both a quantity-based measure – turnover, and a price-based measure – gamma from Bao, Pan, and Wang (2011). Although both the credit risk and liquidity risk measures are important in credit pricing, they can not explain away the discount.

For the country-level risks, I consider country-level currency risk, political risk and credit risk, proxied by exchange rate movements, the International Country Risk Guide (ICRG) political risk index and local corporate bond index return, respectively. Moving to US risks, following Longstaff et al. (2011), I choose three risk premia proxies, including equity risk premium proxied by the changes in S&P 500 Shiller PE ratio, variance risk premium proxied by the changes in the spreads between implied and realized volatility for S&P 500, and term premium proxied by the changes in the expected excess returns of 10-year treasury bond. In addition to these risk channels, the institutional differences including tax, default and bankruptcy, collateral and covenants and investor clientele also fail to explain the pricing difference between foreign dollar bonds and US dollar bonds.

After documenting the persistence and robustness of the foreign discount, I now turn to explore a potential explanation based on uncertainty aversion. Theoretically, the equilibrium asset returns are driven by risk and risk aversion. On top of that, the investors could also exhibit uncertainty aversion towards assets which are difficult for them to estimate the true distribution.[4] In the context of cross-border investment, this uncertainty effect could be quite relevant. Since the major business of the foreign issuer happens outside the US, the

[3]They are the top three countries based on the amount outstanding of dollar-denominated sovereign bonds.

[4]See Gilboa and Schmeidler (1989), Anderson, Hansen, and Sargent (2003), Uppal and Wang (2003), Maenhout (2004, 2006), Liu, Pan, and Wang (2005), and others.

US investors may find it more difficult to collect accurate and timely information about the foreign asset-generating process. Thereby they ask for higher compensation on the bond issued by a foreign firm, especially during high uncertainty times.

To provide a theoretical underpinning, I build a Leland-type model augmented with model uncertainty to illustrate the basic mechanics. There is one representative home investor and two perpetual bonds, one issued by a home firm while the other issued by a foreign firm. To differentiate the two firms, I first assume that the foreign firm's cash flow can be affected by both the home aggregate shock and foreign aggregate shock, while the home firm's cash flow is only related to the home market shock. To make it comparable, I fix the total risk faced by the two firms to be the same. Secondly, I assume that the investor knows precisely about the true process of the home process but is uncertain about the true growth rate of the foreign process. Thus the pricing of the two bonds depends on the degree of uncertainty, giving rise to the foreign discount. If there is no model uncertainty, the discount will be reduced to zero. When the uncertainty is present, the foreign discount $FD = f(\phi, \rho_i, \gamma, \sigma)$ is an increasing function of country-level uncertainty (ϕ), investor's risk aversion (γ) and market volatility (σ), and is decreasing in foreign issuer's correlation with the US (ρ_i). I find supporting evidence across countries (ϕ), across issuers (ρ_i), and over time (γ, σ).

Firstly, to measure heterogeneous degrees of uncertainty across countries (ϕ), I use the country-level Economic Policy Uncertainty (EPU) index from Baker, Bloom, and Davis (2016). The foreign discount decreases from 17 bps to 6 bps before and after adding the EPU index, implying that the majority of the foreign discount can be explained away by country-level uncertainty proxies. The result is also robust after controlling for risk measures. Besides, I use the 2020 GDP growth forecasts on different countries reported by large US and local institutions from the Consensus Economics survey.[5] For each foreign country, I find that the dispersion of forecasts among US investors tends to be larger than that of local investors, indicating that US investors indeed exhibit uncertainty aversion toward foreign countries.

Secondly, I explore the relation between the foreign discount and the foreign issuer's correlation with the US market (ρ_i). To measure the correlation between the foreign issuer and the US market, I focus on two indirect proxies: (1) the age of the issuer in the US bond market; (2) the fraction of sales in the US. Intuitively, the longer the foreign issuers stay in the US bond market, the more likely the investors are to build up familiarity and ask

[5] Consensus Economics is an international survey of professional forecasters from a variety of economists, industry and research institutions. This data has been used in papers like Marco, Macchiavelli, and Valchev (2021).

for a lower discount. Likewise, for foreign issuers with a higher fraction of sales in the US market, we should expect the uncertainty to be smaller, and so should the foreign discount. I find consistent results in the data. Moreover, I show that bonds with higher institutional holdings have a lower discount.

Thirdly, in time series, I document that the foreign discount can be predicted by risk aversion (γ) and volatility (σ) proxy – VIX index. One standard deviation increase in the VIX index is associated with an increase in foreign discount of 4.1 bps (t-stat=2.32). The higher the VIX Index is, the higher the degree of risk aversion among investors. As they are more concerned about the market, they will require a higher discount to hold less safe foreign dollar bonds. Moreover, the aggregate corporate yield can also positively predict the discount. Intuitively, an increase in the yield of the investment-grade bond is a sign of a worsening credit environment. Thus the investors are more likely to demand high compensation on foreign dollar bonds when the market becomes stressful.

Taking COVID-19 as an event study, I take a close look at the investors' trading behavior on the US dollar bonds v.s. foreign dollar bonds. The current literature documents the dash for cash and dash for dollar effects during Covid-19 pandemic,[6] I further show that it is the foreign dollar bonds that suffer higher selling pressure and more severe discounts relative to US dollar bonds.[7] The discount jumps from below 20 bps before the pandemic to well over 60 bps afterward. Across countries, the selling pressure is highest for CN, followed by JP, GB, UK and CA. In addition to the foreign discount, this quantity level evidence further provides a new economic channel, foreign squeeze during market turmoil, as an important implication of the classical home bias literature.

Lastly, I study the comparison between the foreign discount and the currency premium (from Liao (2020)). In principle, the pricing of the foreign dollar bond depends on the tradeoff between the dollar safety premium (USD effect) and the foreign discount (USA effect). Examining the time variations, I find that the foreign discount tends to dominate the dollar safety premium, especially for the EU and GB in market turmoil like the global financial crisis and the European debt crisis. In other words, the dollar safety premium can only be fully enjoyed by US issuers.

Related Literature – This paper contributes to several streams of literature. First, my paper is part of the literature on corporate and sovereign bond pricing. The determinants of credit spreads in the US corporate bonds are well documented by Collin-Dufresne, Goldstein,

[6]Haddad, Moreira, and Muir (2021), Ma, Xiao, and Zeng (2021), O'Hara and Zhou (2021), Cesa-Bianchi and Eguren-Martin (2021), Li et al. (2021), Kargar et al. (2021).

[7]The selling pressure is defined as the fraction of sell-initiated transactions by customers within all the customer-dealer transactions for each bond each day.

and Martin (2001), Campbell and Taksler (2003), Longstaff, Mithal, and Neis (2005a), Edwards, Harris, and Piwowar (2007), Bao, Pan, and Wang (2011), Kuehn and Schmid (2014), Culp, Nozawa, and Veronesi (2018). Moreover, Longstaff et al. (2011) study the sovereign credit risk for 26 countries and find the sovereign credit spreads are more related to US factors than local factors. Recently, Huang, Nozawa, and Shi (2020) show the global credit spread puzzle within G7 countries' corporate bonds and how it co-moves with the US and affects economic growth. Unlike these studies either focusing on the US corporate bonds or non-US corporate bonds denominated in local currency, I look at the dollar bonds issued by non-US firms and examine the underlying drivers behind the pricing difference relative to US dollar bonds. My paper is the first to document the foreign discount effect as an important factor in international bond pricing, which can not be explained away by the standard risk and risk premium.

Secondly, my paper contributes to the home bias literature as the first comprehensive study on the foreign discount effect or the home country effect in the pricing space rather than in the holding level documented in previous papers.[8] The most related paper is Maggiori, Neiman, and Schreger (2020). They show that the investors' bond portfolios exhibit a strong dollar or home-currency bias in international cross-border investment. Unlike their evidence in the holding level, I examine the pricing implication given that the investors have already held these foreign dollar bonds in their portfolios. Controlling for the currency effect, I find that the home country effect is still important in pricing foreign dollar bonds. With the rapid development of international cross-border investment, the home bias effect in terms of quantities could be less pervasive as Coeurdacier and Rey (2013) shows. However, even if the investors become more willing to hold foreign assets and expand their investment frontier, it is still not clear what price they are willing to offer. Hence, examining the home bias effect in the pricing level should yield useful insights and additional evidence to this classical puzzle. Moreover, I show that foreign dollar bonds suffer higher selling pressure than US dollar bonds, highlighting a new economic channel, foreign squeeze during market turmoil, as an important implication of this literature.

Thirdly, my paper is also related to the literature on the dollar debt dominance and safe dollar premium. The dollar bonds have been increasingly prevalent, outweighing the wealth share of the US in the world.[9] There are several papers studying why and when non-US

[8]See French and Poterba (1991), Coval and Moskowitz (1999), Obstfeld and Rogoff (2001), Coeurdacier and Rey (2013), Cooper, Sercu, and Vanpée (2013), Burger, Warnock, and Warnock (2018).

[9]See Shin (2012), Cetorelli and Goldberg (2012), Bruno and Shin (2014, 2017), McCauley, McGuire, and Sushko (2015), Ivashina, Scharfstein, and Stein (2015), and Maggiori, Neiman, and Schreger (2020).

entities issue dollar-denominated bonds,[10] which is not the focus of this paper. I mainly explore the pricing implications for foreign dollar bonds. The pricing of the dollar bond issued by non-US firms could depend on both the currency (USD) effect and the foreign (USA) effect. While the literature has so far been focused on the benefits of issuance of dollar-denominated bonds due to the USD premium[11], this paper is more about the potential cost side of the dollar bond issuance arising from the foreign effect. I find that the foreign discount tends to dominate the dollar safety premium, especially for the EU and GB in stressful times like the global financial crisis and the European debt crisis.

The rest of our paper is organized as follows. Section 2 summarizes the data. Section 3 documents the main empirical results on the foreign discount, its cross-sectional and time-series variations, as well as its persistence and robustness. Section 4 provides a simple theoretical framework based on uncertainty aversion to illustrate the basic mechanism. Section 5 provides supporting evidence on model implications. Section 6 studies the foreign squeeze effect during the Covid-19 pandemic, as well as the comparison between the foreign discount and safe dollar premium. Section 7 concludes.

2 Data

This section summarizes the sample of international corporate bonds employed in this paper. First, I present an overview on international corporate bonds across countries and currencies. Then I show the summary statistics for the main sample of this paper, dollar-denominated corporate bonds in the US bond market, taking advantage of the detailed pricing and description information from TRACE and Mergent FISD. Next, I discuss the data on Bloomberg's euro-denominated corporate bonds and dollar-denominated sovereign bonds. The last subsection is a summary of market-level variables in the US and other countries from various data sources. Firm-level equity and financial data are obtained from standard CRSP and Compustat datasets.

2.1 Overview of International Corporate Bonds

From Bloomberg, I can calculate the total amount outstanding of all the bonds around the world by country or currency. In total, the amount outstanding is 103 trillion USD by the end

[10]See Bruno and Shin (2017), Liao (2020), Maggiori, Neiman, and Schreger (2020) and others.

[11]See Krishnamurthy and Vissing-Jorgensen (2012), Caballero, Farhi, and Gourinchas (2017), Caballero and Farhi (2017), and Mota (2021) for the shortage of safe assets, Jiang, Krishnamurthy, and Lustig (2018, 2021, 2020) for safe dollar premium in the international treasury market, Liao (2020) and Caramichael, Gopinath, and Liao (2021) for safe dollar premium in the international corporate bond market.

of 2019, consistent with the 106 trillion USD reported by BIS. Unlike the BIS classification, Bloomberg can trace back the ultimate country of origin for each issuer, which can be used to better identify country-level bond financing.[12]

Figure 1 plots the distribution of corporate bond amount outstanding across countries from 2014 to 2023.[13] Panel (a) shows the distribution within dollar-denominated corporate bonds. The left axis is the fraction of the amount outstanding by country and the right axis is the total amount outstanding in trillion USD. The corporate bonds are categorized into nine groups based on their ultimate country of origin, including the United States (US), Eurozone (EU), China Mainland (CN), United Kingdom (GB), Canada (CA), Japan (JP), Asia excluding China Mainland and Japan, Europe excluding Eurozone and the United Kingdom, and the rest of the world. The black line is the total amount outstanding for all countries while the green line refers to the amount outstanding for the US. As we can see, US-issued bonds account for the majority of the dollar bonds, with the share rising from 56.2% in 2014 to 59.4% in 2023. In other words, 40.6% of the dollar-denominated corporate bonds are issued by non-US entities, with an amount outstanding of 6.2 trillion USD. The main focus of this paper is to compare the pricing of the foreigner-issued dollar bonds to the dollar bonds issued by US firms. Besides the US, other countries or economies like the EU, CN, GB, CA and JP also have a large portion of dollar corporate bonds. Moving to panel (b) for euro-denominated bonds, the overwhelming majority are EU-issuers (72.0%), followed by US-issuers (8.4%) and then GB-issuers (6.8%) by 2023. In Section 3.2, I will investigate the pricing difference between home bonds (in this case, EU-issued bonds) and foreign bonds (mainly US-issued and GB-issued bonds).

2.2 USD-denominated Corporate Bonds in TRACE

Taking advantage of the detailed pricing and characteristics information of the corporate bonds from TRACE and Mergent FISD, I can uncover the most important piece of dollar-denominated bonds in the world. According to my estimation, the total amount outstanding of corporate bonds in TRACE is 9.4 trillion USD by 2021Q1, accounting for 67% of the global dollar-denominated corporate bonds.[14] To further identify the ultimate country of origin for

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[12] A similar point made by Coppola et al. (2021) on the international cross-border financing.

[13] I choose 2014 as the starting year because the Bloomberg BQL function and the underlying dataset are only available after 2014. Later on, I will provide summary statistics for a longer period starting from 2002 in TRACE.

[14] This number is slightly smaller than the number reported by SIFMA (10.7 trillion USD). See https://www.sifma.org/resources/research/fixed-income-chart/. The discrepancy primarily arises because some bonds may not be recorded in the Mergent FISD dataset, even if their pricing information is available. However, without bond characteristics information like issue date and maturity date, it is infeasible to add

each issuer in TRACE, I first use the ISIN code information in TRACE to merge with the Bloomberg and then use the variable "ult_parent_cntry_domicile" in Bloomberg to trace back the ultimate parent country of domicile for each issuer.[15] Then I can group the corporate bonds based on their ultimate country of origin and calculate the corresponding amount outstanding.

Within the universe of TRACE dollar bonds, US firms issue 7.0 trillion USD bonds, and the rest of 2.4 trillion USD bonds are issued by non-US firms. Although the market share of foreign bonds in TRACE (26%) is smaller than that of the share in the global market (42%), 2.4 trillion USD is still significant and sizable. I focus on the TRACE sample because TRACE has been widely used in the US corporate bond literature due to its comprehensive information about secondary market pricing. Meanwhile, the Mergent FISD dataset also provides detailed bond descriptions to facilitate the analysis. Moreover, any result found in this most transparent sample could be potentially applied to a more general setting, like offshore dollar-denominated corporate bonds.

Figure 2 outlines the dynamics of foreign bonds as a fraction of all bonds in TRACE along three dimensions, including the number of bonds (red line), amount outstanding (blue line) and trading volume (yellow line). Starting from 2002 when TRACE became available, the three measures are around 17%. Over time, we can see a gradually increasing trend for foreign bonds in the amount outstanding. There is a sudden jump for all three measures in June 2014. The amount outstanding sharply increases to over 30%. This is because FINRA brings 144A corporate debt transactions into the TRACE system.[16] Since most of the 144A corporate bonds are issued by foreign firms, a steep increase is to be expected. Based on this observation, I will consider both the shorter but more complete sample period from July 2014 to June 2023, as well as the longer period from January 2005 to June 2023. After the inclusion of 144A corporate bonds, the fraction of non-US bonds stays relatively stable and has a slight decline post-Covid-19 pandemic. Meantime, the trading volume experiences a more significant drop to around 18% in 2023Q2. As for the number of bonds (red line), the pattern is relatively stable from July 2014 to June 2023.

Based on the amount outstanding of dollar corporate bonds across countries, I choose the US, EU, GB, CA and JP as the main sample. I also include the CN and MX to shed light

the bond into calculating the amount outstanding.

[15] In Mergent FISD, the variables related to country information are "Country Domicile (country_domicile)" and "Country (country)", which are more likely to be the operating country. It fails to track the ultimate country of domicile information due to the absence of parent country information. As a robustness check, I also examine the main results based on the operating country and find similar effects.

[16] https://www.finra.org/media-center/news-releases/2014/finra-brings-144a-corporate-debt-transactions-light

on developing countries. As over 90% dollar bonds issued by non-US firms in TRACE are from developed countries, the main result of this paper is then mostly driven by developed countries rather than developing countries. Table 1 summarizes more detailed statistics before and after July 2014. For each bond and during each month, we consider its yield to maturity using the last trading-day price. Following the convention, we use the Treasury Constant Maturity Rate (CMT) released by the St. Louis Fed as the base rate and adopt the interpolation method to expand the full yield curve for the calculation of credit spreads. Specifically, credit spread is measured as the difference between the corporate bond yield and the CMT yield of the same maturity. To be included in the empirical analysis, I apply the following standard filters to the TRACE corporate bonds dataset. Firstly, I only include fixed-coupon or zero-coupon bonds. Secondly, bonds due within one year are excluded from our sample. Thirdly, bonds without any trading during a month are excluded from that month. Fourthly, bonds with an issuance size of less than 100 thousand dollars are excluded from our sample. Lastly, as most foreign bonds are issued by relatively large corporations with high ratings, I only include investment-grade (IG) bonds. Thus any results found within the IG sample would suggest even more dramatic effects for the high-yield bonds sample.

Panel A reports the summary statistics for the sample period from July 2014 to June 2023. Overall, there are 1448 US issuers with 13179 bonds, 192 EU issuers with 1028 bonds, 114 GB issuers with 729 bonds, 99 CA issuers with 710 bonds, 54 JP issuers with 515 bonds, 56 CN issuers with 214 bonds. Panel B reports the summary statistics for the sample period from January 2005 to June 2014. Compared to the more recent and complete sample, the number of issuers and bonds is similar for the US. For EU, GB and CA, the numbers are relatively smaller but are still non-trivial. However, for JP and CN, the numbers are too small to conduct any meaningful statistical references. In addition to the number of issuers and bonds, the bond-level variables reported in the summary tables include bond characteristics such as rating, maturity, age, issuance size and coupon rate; and bond trading variables such as credit spreads, monthly turnover, number of transactions per month (NumTrades), number of trading days per month (NumTradingDays), average trading size per monthly (TradeSize), and the monthly illiquidity measure gamma from Bao, Pan, and Wang (2011). In addition, we also control for issuers' industry in our analysis using two-digit industry categorization from the SIC industry code.

For credit ratings, we apply a numerical translation of Moody's rating by assigning 1 to Aaa, 2 to Aa+, and so on until 21 to C. As shown in Panel A of Table 1, the average credit ratings vary between 6 (A) to 8 (BBB) across the six countries. The US on average has lower ratings than other countries except for CA. Comparing the US and non-US samples further, we see that US-issued bonds on average have longer maturity, smaller issuance size, higher coupon rate and are older. Because of these differences in bond characteristics, a direct comparison between their credit spreads is therefore not meaningful. For this reason, we will compare their bond pricing after controlling for credit ratings and other bond characteristics. Furthermore, the bond trading variables give us a sense of the overall liquidity condition across countries. Interestingly, different measurements of liquidity yield different conclusions. For example, in terms of trading turnover, which is measured as the average monthly trading volume as a percentage of its amount outstanding, US-issued bonds are traded more frequently than bonds issued by EU, GB, JP and CN. So is NumTrades, which is measured as the average number of trades per month. For the number of trading days per month, the bonds issued by US firms are only larger than CA and CN, but not for EU, GB and JP. As for trade size, measured as the average trade size of the bond in millions of dollars of face value, and Gamma, measured as the negative auto-correlation between daily log bond prices following Bao, Pan, and Wang (2011), US-issued bonds have a smaller trade size and higher gamma thus less liquid compared to the rest countries. The negative correlation between trade size and gamma is consistent with Bao, Pan, and Wang (2011)'s findings.

2.3 Corporate and Sovereign Bonds in Bloomberg

In addition to dollar-denominated bonds recorded in TRACE (onshore dollar bonds), I also collect data for euro-denominated corporate bonds and dollar-denominated sovereign bonds from Bloomberg. Following the literature (Longstaff, Mithal, and Neis (2005b), Chen, Lesmond, and Wei (2007) and Bao, Pan, and Wang (2011)), I use Bloomberg Generic Quote (BGN) to download the yields information as BGN provides both executable and indicative quotes (as opposed to a model-based valuation). Standard data cleaning filters as in the previous subsection also apply. As I mentioned before, the critical variable to identify the ultimate country of origin of the parent firm for each issuer is the "ult_parent_cntry_domicile". As for the industry classification, I choose the BICS level one industry categorization ("BICS_level_1_sector_name"). Lastly, I choose January 2015 as the starting date as Bloomberg's BQL algorithm only applies to data after 2014. This selection also roughly coincides with the starting date in TRACE and makes the results easy to compare with each other.

As shown in Panel A of Table 2, from January 2015 to March 2021, there are in total 75 EU issuers with 752 bonds, 40 US issuers with 401 bonds, 22 GB issuers with 221 bonds, 15 CH (Switzerland) issuers with 62 bonds, 10 SE (Spain) issuers with 36 bonds, 10 CN issuers with 25 bonds. Panel B reports the summary statistics for the sample period from July

2000 to December 2014, which are too few to study. So I will mostly focus on the period after 2015. Comparing the EU and US samples further, we observe that EU-issued bonds on average have lower ratings (high numerical value), shorter maturity, a slightly larger issuance size, higher coupon rate and are older. Due to those differences in bond characteristics, a careful examination of differences in credit spreads after controlling for credit ratings and other essential bond characteristics would be necessary, which will be provided in the next section.

3 Empirical Results: Foreign Discount

In this section, I estimate the foreign discount based on the credit spreads difference between bonds issued by US issuers v.s. foreign issuers from the following panel regression,

$$\text{CreditSpread}_{i,t} = a + b\,\text{Foreign}_{i,t} + c\,\text{Rating}_{i,t} + \sum_k \text{Controls}^k_{i,t} + \epsilon_{i,t}\,, \tag{1}$$

where the credit spread of bond i in month t is regressed on the dummy variable $Foreign_{i,t}$, which equals one if the ultimate country of origin for bond i in month t is non-US and zero otherwise. Moreover, I control for credit rating and other bond characteristics including maturity, issuance size, age, and liquidity. The panel regressions further include year and industry-fixed effects to control for potential market-wide fluctuations and industry differences in credit spreads. Hence, the coefficient b captures the credit spread difference between bonds issued by non-US firms and US firms. The main results are reported in Table 3. The reported t-stats are in squared brackets by using standard errors double clustered by year and issuer to take into account cross-sectional and time-series correlations in credit spreads. The first column is for all countries, aiming to quantify the extent of the foreign discount at the aggregate level.

To estimate the tension between a specific country and the US, I run the regression for each foreign country within the sample consisting of the bonds issued by firms from that foreign country and the US. For example, if the foreign country is GB, by focusing on the sample consisting of only US dollar bonds and GB dollar bonds, I can estimate the foreign discount for GB relative to the US. Here I choose the four largest developed economies, including EU, GB, CA, JP, and two developing countries, CN and MX, based on the amount outstanding of dollar bonds. Furthermore, to better capture the dynamic variations of the foreign discount, I estimate the time series of coefficient b_t by performing the cross-sectional regression each month for each foreign country and plot the results in Figure 3.

3.1 Foreign Discount in Dollar-Denominated Corporate Bonds

Focusing first on the dollar-denominated bonds in TRACE, Panel A of Table 3 reports the regression results for the sample period from July 2014 to June 2023. The aggregate discount in the first column ("All") is 22.06 bps with t-statistics 6.57. This suggests that the bonds issued by US firms in general enjoy a premium of about 22 bps over their foreign counterparts after controlling for credit rating, other bond characteristics and liquidity. In other words, the borrowing cost measured by credit spread in the bond market for foreign issuers is on average 22 bps higher than their US counterparts. This difference is significant both economically and statistically. As a robustness check, I use the operating country information to redefine the country attribution. The aggregate foreign discount is 23.61 bps, which is similar to 22.91 bps.

Moreover, columns 2-7 in Panel A show the country-level foreign discounts, which are 19.44 bps (t-stat=5.17) for EU, 20.70 bps (t-stat=3.80) for GB, 12.65 bps (t-stat=2.21) for CA, 18.17 bps (t-stat=2.67) for JP, 65.70 bps (t-stat=8.06) for CN, and 60.24 bps (t-stat=3.77) for MX, respectively. Not surprisingly, developing countries like CN and MX have considerably higher discounts compared to developed countries. Across countries, CA has the smallest discount, followed by JP, EU and GB. As firms in developing countries share less similar backgrounds with the US and are potentially exposed to higher risk than firms in developed countries, the lower discount in developed countries is to be expected. Panel B of Table 3 shows the estimation of foreign discount for a longer period sample from January 2005 to June 2023. The aggregate foreign discount is 19.69 bps with t-statistics of 5.10, similar in magnitude to the more recent sample period in Panel A. The country-level discounts are 25.67 bps (t-stat=3.54) for EU, 18.80 bps (t-stat=3.38) for GB, and 5.03 bps (t-stat=0.83) for CA. The increase in the EU discount is mainly driven by the Global Financial Crisis and the European Debt Crisis.

Next, I take a close look at the foreign discount over time. Panel A in Figure 3 plots the aggregate discount from January 2005 to June 2023. When there is a crisis, we see a significant increase in the foreign discount. The first peak happens during the global financial crisis and the discount rises to about 100 bps. The second one coincides with the European debt crisis and the third spike happens at the end of 2015 when the Fed starts a new round of rising interest rates after the global financial crisis. In the recent COVID-19 pandemic, we also find a steep increase in the discount to around 50 bps. Panel B in Figure 3 further plots the country-level discount over time. The discounts are all positive for the six economies since July 2014. Before that, we still see a positive discount most of the time except for CA in the earlier period. During global financial crisis, the discounts in all three countries (EU, GB and CA) have substantially increased. Interestingly, when it comes to the European debt crisis, the discount for EU and GB both spike up and stay at a high level. At the same time, we do not see such a pattern for CA, implying that the European debt crisis should be more relevant for European countries. More recently, during the Covid-19 pandemic, we also find a steep increase across countries.

To sum up, when there is a bad shock to the global economy, US investors will become more worried about the future economic situation. Therefore, the investors are more likely to demand high compensation for holding foreign bonds in worsening economic conditions. When the bad shock happens particularly to a specific country or region, everything else being equal, the investor would require higher credit spreads to hold bonds issued in that country or region, as we observed for the European debt crisis. For control variables, the credit rating and maturity are informative in explaining the credit spreads, so are issuance size, age and liquidity.

3.2 Foreign Discount in Euro-Denominated Corporate Bonds

In this subsection, I show that the foreign discount is not unique to dollar-denominated corporate bonds. Such discount also exists within euro-denominated corporate bonds. In this case, the EU firms will be considered as the home issuers, while firms in the US, as well as in other countries, will be viewed as foreign issuers. The Panel A of Table 4 reports the estimates of coefficient b for a set of countries chosen based on the amount outstanding of euro-denominated corporate bonds, including US, GB, CH, SE, NO and CN. The coefficients for dummy variable $Foreign$ are all positive and statistically significant: 22.59 (t-stat=4.07) for All, 18.54 (t-stat=3.66) for US, 22.22 (t-stat=4.83) for GB, 26.70 (t-stat=1.59) for CH, 13.98 (t-stat=2.89) for SE, 20.79 (t-stat=2.76) for NO and 80.34 (t-stat=10.92) for CN. This implies that EU-issued bonds overall enjoy a premium of 23 bps compared to bonds issued by other countries after controlling for credit rating and other bond characteristics.[17] The magnitude is essentially the same as in the dollar-denominated sample, meaning that the foreign discount is quite general and symmetric between the dollar and the euro.

To better capture how the foreign discount evolves over time and across countries, the top panel of Figure 4 outlines the time-series variation of the slope coefficient b using the cross-sectional regression by month and by country. Post 2014, the discount is basically all positive for six countries. There are two peaks over the sample period. The first one is from mid-2015 to the beginning of 2016, which could be related to the tightening regulation on the banking sectors in the summer of 2015 and the rising interest rates at the end of 2015. The second

[17] As it is difficult to obtain the daily trading volume in Bloomberg, I do not use the turnover variable to control for liquidity.

peak is in March 2020 due to the coronavirus outbreak. The sharp increases in crisis periods confirm that the home (EU) investors tend to price foreigner-issued bonds more negatively in bad states. Bonds issued by foreign firms are perceived to be less secure compared to the treasuries or investment grades bonds issued by home firms. This observation coincides with the model calibration result in Jiang, Krishnamurthy, and Lustig (2021). In their argument, around 90% of the convenience yield on the US treasury is attributable to the dollar exposure rather than the safety/liquidity of the treasury department. That is to say, if the US treasury department issues euro-denominated bonds, it should not be able to explore the advantage of the convenience yield. Instead, they are likely to face a discount. This is also an indication of the home-country bias. And this discount, while staying at a modest level during normal times, tends to break open rapidly amid market turmoil.

3.3 Foreign Discount in Dollar-Denominated Sovereign Bonds

Next, I consider the foreign discount in dollar-denominated sovereign bonds. Instead of using the regression setting to estimate the magnitude of foreign discount, I directly compute the sovereign spread by subtracting the US treasury yield from the foreigner-issued sovereign dollar bond yield with the same maturity. To control for the sovereign credit risk, I download the sovereign CDS spread from Bloomberg and subtract the sovereign CDS spread from the sovereign spread, denoted as the adjusted sovereign spread. As the most liquid sovereign CDS spread is 5 years, I choose all the foreign sovereign dollar bonds with maturity from 3 years to 7 years and calculate the average adjusted sovereign spread each month as the measure of foreign discount. Since the majority (90%) of the dollar-denominated government bonds are issued by the US government, I only include CA, DE and JP in the main analysis based on the amount outstanding of dollar-denominated sovereign bonds.

On average, the sovereign spreads for CA, DE and JP are 43.9 bps, 21.8 bps and 53.9 bps, respectively. After adjusting by the 5-year sovereign CDS spread, the adjusted sovereign spreads or the foreign discounts are 12.9 bps for CA (t-stat=9.03), 7.2 bps for DE (t-stat=10.53), and 22.5 bps for JP (t-stat=12.06). Examining the time-series variations, as shown in Panel B of Figure 4, the foreign discounts for the three countries are basically all positive. These results indicate that the foreign discount is not unique to corporate bonds, it also prevails in dollar-denominated sovereign bonds. To sum up, the foreign discount is a much more general effect in the international bond market.

3.4 Foreign Discount: Risk and Risk Aversion

After documenting the persistence of the foreign discount in dollar-denominated corporate bonds, euro-denominated corporate bonds and dollar-denominated sovereign bonds, I then turn to explore the potential drivers. Theoretically, the equilibrium asset returns are driven by risk and risk aversion. Hence, I examine whether the standard risk and risk aversion can explain away the foreign discount, including issuer-specific risk, country-specific risk and US risk premium. Compared to US issuers, the foreign issuers could have higher firm-specific risk like credit risk and liquidity risk, or have additional country-specific risk exposures like currency risk, political risk and local credit risk, or co-move more with US risk premium embedded in US investors' pricing kernel, leading to the foreign discount.

3.4.1 Issuer-Level Risk

First is the issuer-specific risk, I mainly look at issuer-level credit risk and liquidity risk. Specifically, to control the credit risk beyond ratings, I consider three dimensions: default risk measure from the Merton (1974) model, ex-post real default probability and recovery rate. To estimate the issuer-level default risk, I focus on a subsample in which the issuers also have listed equity in the US. By taking advantage of the public equity and balance-sheet information, including leverage, asset growth and equity volatility, I can construct the credit risk proxy based on Merton's distance-to-default. To control for the liquidity risk, I use both a quantity-based measure – turnover and a pricing-based illiquidity measure – gamma from Bao, Pan, and Wang (2011). All the results are reported in Table 5.

Column 1 shows the aggregate discount without controlling for any credit risk or liquidity risk. The magnitude (17 bps) is smaller than the whole sample (20 bps) as we now focus on the sample with listed stocks in the US. After adding the two liquidity proxies (column 2), although the two liquidity proxies are significant in pricing the credit spreads, the discount remains around 17.86 bps. While higher turnovers are associated with larger credit spreads, the illiquidity measure gamma is positively correlated with the credit spread. The former suggests the reaching for yield story and the latter is better to reflect the liquidity risk. Column 3 further reports the estimation result after controlling for the leverage, asset growth and equity volatility, the three critical inputs in constructing Merton's distance-to-default. Consistent with our intuition, I find that both leverage and equity volatility are positively and significantly correlated with credit spreads, while asset growth has a negative relation with credit spreads. To better control the credit risk, I further add the default risk measure. In the absence of Moody's EDF data, I simply use the inverse of the distance-to-default to account for the fat tail issue with the normal distribution, denoted as the "DefaultRisk".

While this credit risk proxy is important in explaining the credit spreads, it cannot explain away the discount. The discount remains at 17.01 bps.

Moreover, I manually collect ex-post bond default and recovery data from Moody's Annual Default Study. The default data is in the aggregate level, across major regions from 2014 to 2020. The recovery data is based on one-month bond trading prices after defaulting in 2020. On the one hand, the fraction of defaults by non-US issuers is on average 26.4%. Compared to the fraction of the amount outstanding by non-US issuers (28.3%), it suggests that non-US issuers have a similar or even lower default probability than US issuers. On the other hand, the recovery rate across countries shows that the US issuers in general have a lower recovery rate (19.5%) relative to CA (29.5%), EU (19.8%), CN (59.3%), and MX (32.1%), and higher than GB (7.1%). Documented by Maggiori, Neiman, and Schreger (2020), only large foreign firms can be able to issue bonds denominated in multi-currencies, which could potentially explain why these foreign firms on average have lower default probability and higher recovery rates than US issuers. Overall, these pieces of evidence on ex-post actual default rate and recovery rate suggest that non-US issuers are more likely to have similar or better credit quality than US issuers. Nonetheless, they still need to pay a non-trivial discount to US investors for being foreigners.

3.4.2 US Risk Premium

Next, I investigate whether the foreign discount is driven by the variations of the US risk premia. From US investors' perspective, the key risk premia in the US will enter into their pricing kernel. If foreign bonds and US bonds have different correlations with these US risk premia, it could potentially explain the foreign discount. To conduct a rigorous analysis, following Longstaff et al. (2011), I choose three risk premia proxies, including equity risk premium proxied by the changes in S&P 500 Shiller PE ratio, variance risk premium proxied by the changes in the spreads between implied and realized volatility for S&P 500, and term premium proxied by the changes in the expected excess returns of 10-year treasury bond. I further include these proxies into the regression setting in Equation (1) and report the results in Table 5. Consistent with the common view, the increases in variance risk premium are associated with the increase in credit spreads. When the stock market performs well, the credit spreads become smaller. However, they can not explain away the discount. The magnitude of foreign discount remains stable at 16.96 bps with t-stats 3.45 after the inclusion of these risk premium proxies.

3.4.3 Country-Level Risk

Lastly, I examine whether the country-level risks can explain the foreign discount, including currency risk, political risk and local economic risk. In choosing the proxies of country-level risks, I use the log of exchange rate movement to proxy for currency risk, the International Country Risk Guide (ICRG) political risk index to proxy for sovereign risk,[18] and local corporate bond index return to proxy for local credit risk. In ICRG's construction, they calculate the country-level political index to assess a country's political stability based on 12 components, including government stability, conflict, law and order and so on. Column 7 in Table 5 reports the results after adding the country-level risks to the regression. The foreign discount becomes 14.83 bps with t-stats 2.56, which is still economically and statistically significant. To summarize, the standard risk and risk premia together can not explain away the foreign discount in the data. There is still a significant portion of the foreign discount left unexplained.

3.4.4 Institutional Differences

In addition to the standard risk and risk premia considered above, the pricing difference between foreign and US dollar bonds could also be driven by institutional differences. In principle, the bonds issued by non-US and US issuers could have different treatments for tax, bankruptcy, collateral or investor clientele. To address this concern, I look into the institutional knowledge and go through these dimensions one by one. In general, there are three ways of issuing dollar-denominated bonds for a non-US firm. The foreign issuer can choose to register the bond under the SEC, which has the most stringent disclosure requirement. Alternatively, the foreign firm can choose to register the bond under Rule 144A, which has less strict disclosure requirements and is held by qualified institutional buyers (QIBs). Lastly, the bond can also be registered under Reg S, which is open to global investors in the euro-dollar market. The issuer can also decide to register the bond under multiple regulations to access more investors.

For tax treatment, foreign firms need to pay corporate income tax, branch profits tax and withholding tax in the US. Moreover, since GB, JP, CA and most EU countries like DE and FR adopt territorial international taxation, firms from these countries effectively pay similar tax rates as US firms. For bankruptcy, if foreign firms run into trouble, it is attractive for them to file for Chapter 11 as the US has the most flexible legal system in terms of reorganization and restructuring. Even in the event of liquidation, the US court can

[18] The ICRG Researcher Dataset is a widely used dataset to measure country-level risks, which provides annual averages of the components of political, financial, and economic risk ratings for individual countries.

apply for international law and get approval in the local court to freeze assets. Since most of my samples are from developed countries, it should be less of a concern. Moreover, from Moody's default and recovery data, non-US issuers tend to have lower default probability and higher recovery rates than US firms, which could be driven by higher quality or reputation concerns. In terms of collateral, most of the bonds in TRACE are deposited in the DTC. Thus they share the same haircut as US bonds, 20% to 30% for investment-grade bonds. Furthermore, the covenants are also light for investment-grade bonds issued by foreign firms. Usually, it only includes a negative pledge.

3.4.5 Investor Clientele

One potential concern is that the foreign discount could be driven by the investor clientele effect. To address this issue, I first obtain the bondholders' information from eMAXX from 2018Q2 to 2021Q1 and merge it with my sample from TRACE. On average, the eMAXX uncovers 48% holdings by investors like mutual funds, insurance companies and pension funds. Among the 48% holdings, 94% of the investors are from the US and 59% of the investors are insurance companies. As shown in Figure 5, I find EU, GB and CA have very similar holding structures as in the US in terms of overall coverage, the fraction of US investors and the fraction of insurance companies. Nonetheless, foreign issuers from these large developed countries still pay a sizable discount as shown in Table 3.

Besides, I use trade size to reversely control for the investor heterogeneity issue. By separating the bonds into three subsamples based on two cutoffs of trade size, 100K and 25K, I investigate how the foreign discount varies across different trade size groups. I find that the foreign discount is 22.29 bps (t-stats=5.76) for the large trade size group ($\geq$100K), 22.20 (t-stats=5.20) bps for the median trade size group (25K$\sim$100K), 20.58 bps (t-stats=4.65) for the small trade size group ($\leq$25K). Hence, the investor clientele should not be the main driver for the foreign discount.

4 Model

After documenting the persistence and robustness of the foreign discount, I now turn to explore the potential explanation. On top of risk and risk aversion, the investors could also exhibit uncertainty aversion towards assets that are difficult to estimate the true distribution. In the context of cross-border investment, this uncertainty effect could be quite relevant. Since the major business, cash flows, and operating headquarters of the foreign issuer are outside the US, and investors may find it more challenging to collect accurate and timely information about the asset-generating process. Thereby they are more uncertainty/ambiguity averse about the foreign process relative to the US process. To provide a theoretical underpinning, I build a simple Leland-type model augmented with model uncertainty/ambiguity. The basic model setting is the same as in Leland (1994) except that there are two perpetual bonds, one issued by the home issuer while another issued by a foreign issuer. I first describe the basic model setup and the key ingredients in determining the price difference between home and foreign bonds. Then I derive the foreign discount and characterize its properties with respect to the key parameters. Lastly, I discuss the main mechanism delivered by the model.

4.1 Preferences

First I introduce the aggregate output process for home country Y_t^H and foreign country Y_t^F, which follows the simple geometric Brownian motion,

$$\frac{dY_t^H}{Y_t^H} = \mu^H dt + \sigma^H dB_t^H, \quad \frac{dY_t^F}{Y_t^F} = \mu^F dt + \sigma^F dB_t^F, \tag{2}$$

where μ^H (μ^F) and σ^H (σ^F) are the expected growth rate and volatility of aggregate output for the home (foreign) country, respectively. Both the mean and volatility are assumed to be constant. B_t^H and B_t^F are the mutually independent standard Brownian motions.

Assuming that the representative home investor knows exactly about the true process of home aggregate output while is uncertain about the true expected growth rate of the foreign aggregate output process. Following Anderson, Hansen, and Sargent (2003), Uppal and Wang (2003), Maenhout (2004, 2006), Liu, Pan, and Wang (2005), I adopt the similar form of the expected utility by allowing model misspecification about the expected growth rate in foreign aggregate output as follows,

$$U_t = \inf_{P^\zeta} \left\{ E_t^\zeta \left[\int_t^T e^{-\rho(s-t)} \left\{ \psi\left(U_s\right) \frac{1}{\phi} L^F(\zeta) + \frac{c_s^{1-\gamma}}{1-\gamma} \right\} ds \right] \right\} \tag{3}$$

where $U_s = c_s^{1-\gamma}/(1-\gamma)$ is the standard CRRA utility with relative risk aversion coefficient γ. ρ is a constant discount rate. E_t^ζ is expectation under P^ζ and ζ is the density of probability distribution P^ζ with respect to P. P is the reference distribution, estimated by the investor from historical data and subjected to the misspecification error. P^ζ is the alternative model chosen by the investor in evaluating the continuation value. According to Girsanov's Theorem, there exists appropriately adapted process η^ζ satisfying $d\zeta/\zeta = \eta^\zeta dB_t^F$

and $dB_t^{F,\zeta} = dB_t^F + \eta^\zeta dt$. Under P^ζ, the aggregate output process now become,

$$\frac{dY_t^H}{Y_t^H} = \mu^H dt + \sigma^H dB_t^{H,\zeta}, \quad \frac{dY_t^F}{Y_t^F} = (\mu^F - \eta^\zeta \sigma^F)dt + \sigma^F dB_t^{F,\zeta}, \tag{4}$$

Effectively, $\eta^\zeta \sigma^F$ is the drift adjustment on the foreign output process. To evaluate the alternative model P^ζ (or η^ζ), $\frac{1}{\phi}L^F(\zeta)$ is introduced as the penalty function for rejecting P and accepting P^ζ. ϕ measures the level of ambiguity. Lower ϕ means a larger penalty and smaller degree of model misspecification. When $\phi \to 0$, Equation (3) reduces to the standard expected utility case with no model uncertainty. $L^F(\zeta)$ is the relative entropy, measuring the distance between the reference distribution P^ζ and the alternative distribution P. The superscript F refers to the penalty function associated with the foreign aggregate output process. By assuming there is only model uncertainty about Y_t^F, effectively, I allow for the heterogeneity in the degree of ambiguity as in Uppal and Wang (2003). Lastly, for analytical convenience, $\psi(U_s)$ is used as a normalization term that converts the penalty to units of utility, which is set to be $\psi(U_s) = [(1-\gamma)/\gamma]U_s$ following Uppal and Wang (2003).

To solve for the equilibrium, I first consider the standard portfolio-consumption problem. Assume the endowment are traded as stocks and the payout rate of the stock S_t^H (S_t^F) is Y_t^H (Y_t^F). Denote the portfolio weights on home stock and foreign stock are θ_t^H and θ_t^F. Then the budget constraint can be written as

$$dW_t = \left[r + \theta_t^H(\mu^H - r) + \theta_t^F(\mu^F - r)\right] W_t dt + \theta_t^H W_t \sigma^H dB_t^H + \theta_t^F W_t \sigma^F dB_t^F - c_t dt,$$

where r is the risk-free rate. Denote J_t as the indirect utility function $J(t,W) = \sup_{\{c,\theta^H,\theta^F\}} U_t$ and the HJB equation is the following,

$$\sup_{c,\theta^H,\theta^F} \left\{ u(c) - \rho J(t,W) + \mathcal{A}J(t,W) + \inf_{\eta^\zeta} \left\{ \theta^F W \sigma^F \eta^\zeta J_W + \frac{\psi(J)}{2\phi} {\eta^\zeta}^2 \right\} \right\}. \tag{5}$$

where $\mathcal{A}J(t,W)$ is the standard infinitesimal generator for W. The solution is given by $J(t,W) = \frac{W^{1-\gamma}}{1-\gamma} f(t)^\gamma$. In equilibrium, to clear the market, $\theta_t^H = \theta_t^F = 1$ and investor consumes the composite consumption goods $c_t = (Y_t^H)^\beta (Y_t^F)^{1-\beta}$ for tractability. Then we can solve for the optimal alternative measure $\eta^{\zeta^*} = \frac{\phi}{1+\phi} \frac{\mu^F - r}{\sigma^F}$ and the corresponding pricing kernel as follows

$$\frac{dm_t}{m_t} = -r dt - \eta^H dB_t^H - \eta^F dB_t^F, \quad \eta^H = \gamma \sigma^H \beta, \quad \eta^F = \gamma \sigma^F (1-\beta)(1+\phi). \tag{6}$$

where η^H is the risk price for systematic Brownian shock from B_t^H, which equals to $\gamma \sigma^H \beta$. η^F

is the market price of risk for the foreign Brownian shock B_t^F, equaling to $\gamma\sigma^F(1-\beta)(1+\phi)$. The term ϕ arises from the home investor's uncertainty aversion with respect to the foreign aggregate output process. When $\phi = 0$, it reduces to the standard case. The robust control framework yields a nice and simple close-form solution.

4.2 Firms

Next I specify the dynamics of the asset generating process for home firm and foreign firm, respectively. There are two perpetual bonds with coupon rate of C^H and C^F, respectively, one issued by home firm and the other issued by foreign firm. I assume the home (foreign) firm's asset-in-place generates before-tax cash flows at a rate of δ_t^H (δ_t^F) as follows,

$$\frac{d\delta_t^F}{\delta_t^F} = \mu dt + \sigma_{i,F,H} dB_t^H + \sigma_{i,F,F} dB_t^F + \sigma dB_t^{i,F}, \quad \frac{d\delta_t^H}{\delta_t^H} = \mu dt + \sigma_{i,H,H} dB_t^H + \sigma dB_t^{i,H}, \tag{7}$$

where μ and σ are the firm's expected growth rate and idiosyncratic volatility, which are both constant over time. $B_t^{i,H}$ ($B_t^{i,F}$) is a standard Brownian motion that generates idiosyncratic shocks specific to the home (foreign) issuer. $B_t^{i,H}$ and $B_t^{i,F}$ are mutually independent and both are independent of the systematic shock B_t^H and B_t^F. $\sigma_{i,F,H}$ ($\sigma_{i,F,F}$) denotes the foreign firm's systematic volatility of the cash flows with respect to the home (foreign) aggregate output process while $\sigma_{i,H,H}$ denotes the home firm's systematic volatility of the cash flows with respect to the home aggregate output process. To make the model as simple as possible, I make the assumption that both home issuer and foreign issuer have the same μ and σ.

To differentiate the foreign issuer from the home issuer, two key ingredients are integrated into the model. First, as shown in Equation (7), I assume the foreign firm's cash flow can be affected by both the home aggregate output shock and foreign aggregate output shock while the home firm's cash flow is only related to the home market shock. Intuitively, for foreign firms listed in the US market, the US investors care about both the overall market risk in the US and the foreign country's local risk. This additional risk exposure for the foreign firm is captured by the constant $\sigma_{i,F,F}$, measuring the degree of co-movement between the firm and the foreign market. To make it comparable, I fix the total risk faced by two firms to be the same by choosing $\sigma_{i,F,H}$ and $\sigma_{i,F,F}$ to satisfy the conditions below for any given $\sigma_{i,H,H}$,

$$\sigma_{i,F,H}\gamma\sigma^H\beta + \sigma_{i,F,F}\gamma\sigma^F(1-\beta) = \sigma_{i,H,H}\gamma\sigma^H\beta, \quad \sigma_{i,F,H}^2 + \sigma_{i,F,F}^2 = \sigma_{i,H,H}^2. \tag{8}$$

Hence, in the absence of model uncertainty, the foreign bond will have the same total risk as the home bond. There is no foreign discount.

To generate the foreign discount, I introduce the second assumption based on uncertain aversion toward the foreign process. As shown in Equation (3), I assume that the home investor is only concerned about gauging the true growth rate of the foreign market process. As a consequence, the default boundary for the foreign firm could be closer than the one without model misspecification. Thus the investors would require higher credit spreads. This intuition is also captured in earlier works.[19] The reason I follow the model specification from Uppal and Wang (2003) is that they provide a nice framework with a simple closed-form solution, which is easy to interpret and can capture the key intuition.

4.3 Foreign Discount

In order to price the assets in the model, we need to define the risk-neutral probability measure Q to discount the cash flows of any asset with risk-free rate. By specifying the density process $\xi_t = E_t\left[\frac{dQ}{dP}\right]$ from P to Q and applying the Girsanov theorem, we have

$$dB_t^{H,Q} = dB_t^H + \eta^H dt, \quad dB_t^{F,Q} = dB_t^F + \eta^F dt, \tag{9}$$

Thus, under Q, the firm j's ($j \in (H,\ F)$) cash flows process can be converted to the standard form as in Leland (1994), $d\delta_t^j/\delta_t^j = \mu_j^Q dt + \sigma_j^Q dB_t^{j,Q}$, where

$$\begin{aligned} \mu_F^Q = \mu - \sigma_{i,F,H}\gamma\sigma^H\beta - \sigma_{i,F,F}\gamma\sigma^F(1-\beta)(1+\phi), \quad \mu_H^Q = \mu - \sigma_{i,H,H}\gamma\sigma^H\beta, \\ \sigma_F^Q = \sqrt{\sigma_{i,F,H}^2 + \sigma_{i,F,F}^2 + \sigma^2}, \quad \sigma_H^Q = \sqrt{\sigma_{i,H,H}^2 + \sigma^2}. \end{aligned} \tag{10}$$

Next, we consider the debt pricing and equity pricing in the model. According to the classical trade-off between debt tax shield and bankruptcy cost in the original model, the debt interest expenses are tax-deductible at the tax rate of τ and debt holders only recover a fraction α of first-best firm value at bankruptcy, which is the unlevered asset value $\frac{\delta_t}{r-\mu^Q}$. After paying out the coupon C to the debt holders, the taxable earnings of the firm is $\delta_t - C$, implying that the after-tax cash flow to equity holders is $(1-\tau)(\delta_t - C)$. Because the default decision is made by equity holders, the endogenous default boundary δ_B is then chosen to satisfy the valuing matching condition $E(\delta_B) = 0$ and the smooth pasting condition $E'(\delta_B) = 0$. The idea is that when δ goes to 0, the firm value also converges to 0. In that

[19] Duffie and Lando (2001) assume bond investors cannot perfectly observe the issuer's assets. Instead, they receive imperfect and periodic information at selected times. After deriving the conditional distribution of the assets, given accounting data and survivorship, they find that the default barrier could be closer than the standard one, leading to a larger credit spread. Shi (2019) assume that the investors can not observe the drift of the consumption growth process. She parameterizes an ambiguity belief set by an interval centered around the long-run mean of the growth rate. The larger the set of beliefs is, the less confidence the agent has in her probability assessment of the growth rate. The model can generate large credit spreads matched with the empirical data.

case, the equity holders will walk away without further servicing the debt due to the limited liability. In the event of default, all the remaining value of the firm will go to debt holders and the equity holders get nothing. The smooth pasting condition states that in determining the default boundary δ_B, it is indifferent to the equity holders to default right at δ_B or wait a little longer. Then we are ready to solve for the debt price $D(\delta)$ and equity price $E(\delta)$ in a closed-form following the standard procedure. First, given some default boundary δ_B, I solve the debt price and equity price. Then I use the smooth pasting condition to get the optimal default boundary. Finally, by maximizing the total levered firm value at time 0 $(E(\delta_0) + D(\delta_0))$, I derive the optimal capital structure for the firm. As the home issuer and foreign issuer only differ in μ_j^Q and σ_j^Q $(j \in (H,\ F))$, I will price each firm separately as if the investors independently price the two issuers. The solutions are the following,

Proposition 1 *The foreign discount (FD) is given by given by*

$$FD(\delta) = \frac{C^F}{\left[\frac{(1-\alpha)(1-\tau)\delta_B^F}{r-\mu_F^Q} - \frac{C^F}{r}\right](\delta/\delta_B^F)^{-\kappa_F} + \frac{C^F}{r}} - \frac{C^H}{\left[\frac{(1-\alpha)(1-\tau)\delta_B^H}{r-\mu_H^Q} - \frac{C^H}{r}\right](\delta/\delta_B^H)^{-\kappa_H} + \frac{C^H}{r}}, \quad (11)$$

where optimal default boundary, coupon rate and constant coefficients κ_j for the j-firm, $j \in (F,\ H)$, are given by

$$\delta_B^j = AC^j, \quad C^j = \left(1 + \kappa_j + \frac{\alpha\kappa_j(1-\tau)}{\tau}\right)^{-\frac{1}{\kappa_j}} \frac{\delta_0}{A},$$

$$A = \frac{(r-\mu_i^Q)\kappa_j}{r(1+\kappa_j)}, \quad \kappa_j = \frac{\mu_i^Q - \frac{1}{2}\sigma_i^{Q^2} + \sqrt{(\mu_i^Q - \frac{1}{2}\sigma_i^{Q^2})^2 + 2\sigma_i^{Q^2} r}}{\sigma_i^{Q^2}}.$$

Thus the pricing of the foreign bond v.s. home bond depends on the degree of uncertainty ϕ, giving rise to the foreign discount. I now move to calibrate the model.[20] I borrow the standard calibration parameters from the literature, including risk aversion coefficient, moments of the asset market, moments of the firm-level performance, bond recovery rate, tax rate, correlation with the home and foreign market, and the degree of uncertainty. Table 6 summarizes the basic parameters used in the calibration exercise. I set the risk aversion coefficient γ to be 2, risk-free rate r to be 4%, the tax rate τ to be 25% and the bond recovery rate α to be 50%. As for the expected growth rate and volatility of the market, I choose μ^H and μ^F to be 10%, and σ^H and σ^F to be 20%. The expected growth rate of a firm's asset μ and the idiosyncratic volatility σ are calibrated to be 4% and 40%, respectively. The

[20] Note that the model is not designed to match the credit spreads puzzle as many other papers are targeted at in the literature. (See Chen, Collin-Dufresne, and Goldstein (2008), Chen (2010) and Shi (2019)). Instead, the main objective of the model is to compare the difference in bond pricing between the foreign issuer and the home issuer.

correlation between home firm and home market movement is set to be 40%. The degree of uncertainty aversion ϕ is 2.

The model calibration result is reported in Figure 6. The top-left panel shows the result for debt pricing, and the top-right panel shows the result for the credit spread. We can see that the foreign bond (blue line) has a lower bond price and higher credit spread than the home bond (red line), which is driven by the uncertainty effect in the model. The bottom-left panel shows the result for the default boundary, and the bottom-right panel shows the result for the leverage. The foreign issuer has a lower default boundary and a lower leverage than the home issuer. After generating the foreign discount in the model, I then characterize its properties with respect to the key parameters in the model.

4.4 Model Mechanics

While the model is relatively simple and mainly serves as a framework, the key is to illustrate the basic mechanics in driving the foreign discount. To understand what gives rise to the foreign discount and how does it respond to the variations in model parameters, I derive the following proposition,

Proposition 2 *The foreign discount (FD) has the following properties: (a) When there is no uncertainty $\phi = 0$, there is no foreign discount (FD=0). (b) FD is increasing in the level of uncertainty ϕ, risk aversion coefficient γ, the foreign market volatility σ^F, the home market volatility σ^H, and is decreasing in the correlation with US market $\sigma_{i,F,H}$.*

Note that both the foreign and home bond have the same structure of the solution, with different expected growth rates μ_j^Q and volatility σ_j^Q $(j \in (H,\ F))$. From the insights in the Leland model, we know that the bond price is increasing in the expected growth rate and decreasing in volatility. When the growth rate increases, the present value of future dividend payments goes up. Thus the probability of default decreases (cash flow channel). When the volatility drops, the present value of future dividend payments rises due to a decline in risk premia (discount rate channel). Although there is an additional option-related volatility effect in which a decrease in volatility makes it less attractive for the firm to stay longer as the option value falls. The cash flow effect and discount rate effect dominate the volatility effect. That is to say, in a state with a high growth rate or low volatility, the firm is willing to wait longer as the probability of default decreases. Besides, there is also a concavity effect. The slope of bond price is larger for low growth rate and high volatility, meaning that following the same magnitude reduction in growth rate, the bond price will drop more dramatically in a low growth rate state compared to a high growth rate state. A similar effect applies to volatility as well.

Armed with this intuition in determining the endogenous default boundary and bond price, let me walk through the results in the Proposition (2). When there is no uncertainty $\phi = 0$, from Equation (8) and Equation (10), we have $\mu_F^Q = \mu_H^Q$ and $\sigma_F^Q = \sigma_H^Q$. Thus the foreign discount equals zero. For the second part of the Proposition (2), I consider the response from the model parameters on the growth rate μ^Q and volatility σ^Q one by one. From Equation (10), (b.1) an increase in ϕ implies an increase in the degree of uncertainty. Through foreign issuer's exposure to the foreign market, the growth rate on the foreign bond decreases. It can be viewed as if the home investor uses a lower expected growth rate due to uncertainty aversion. Since there is no uncertainty about the home output process by assumption, we do not see any adjustment in the home bond's growth rate. Therefore, the foreign discount responds negatively to the increase in uncertainty; (b.2) an increase in risk aversion coefficient γ is associated with a decrease in the expected growth rate for both the foreign bond and home bond. However, the extent of that decrease is larger for the foreign bond as opposed to the home bond due to the additional effect from the uncertainty item ϕ. Hence, we should expect the foreign discount will rise accordingly; (b.3) if the home aggregate volatility σ^H increases, signaling a volatile and shaky market. It will negatively affect the expected growth rate for foreign and home issuers with the same magnitude, given that the total risk should be the same. Note that the growth rate of the foreign issuer is already smaller than that of the home issuer because of the uncertainty item ϕ. Due to the concavity effect, the bond price will drop more dramatically for the foreign issuer relative to the home issuer. As a result, the foreign discount will ascend along; (b.4) when the foreign market experiences turmoil, proxied by an increase in the foreign aggregate volatility σ^F, the expected growth rate of the foreign firm decreases due to the additional uncertainty item ϕ. Consequently, we see a rise in foreign discount; (b.5) when the correlation with US market $\sigma_{i,F,H}$ increases, $\sigma_{i,F,F}$ has to decrease to satisfy Equation (8). The reduction in $\sigma_{i,F,F}$ has a large impact than the increase in $\sigma_{i,F,H}$ due to the uncertainty item ϕ. Hence, the expected growth rate of the foreign firm increases, leading to a drop in the foreign discount.

To sum up, from Proposition (2), when $\phi > 0$, the model can generate the uncertainty effect and the volatility effect. For the uncertainty effect, the investor will require a higher discount for the country with higher uncertainty (ϕ), or for the foreign issuer with a lower correlation with the home market ($\sigma_{i,F,H}$, intuitively, we can also denote it as ρ_i). For the volatility effect, the investor will ask for more compensation in bad states when the risk aversion (γ) increases or the home or foreign market volatility (σ^F or σ^H) spikes up. Next I will show supporting evidence across countries (ϕ), across issuers (ρ_i) and over time (γ, σ^F, σ^H) in the next section.

5 Foreign Discount and Model Implications

5.1 Foreign Discount: Country-Level Uncertainty

Firstly, I study whether the foreign discount can be attributed to country-level uncertainty. To measure heterogeneous degrees of uncertainty across countries (ϕ), I use the country-level Economic Policy Uncertainty (EPU) index from Baker, Bloom, and Davis (2016). The construction of the EPU index is mainly based on own-country newspaper coverage of policy-related economic uncertainty. For the US, Baker, Bloom, and Davis (2016) also considers the number of federal tax code provisions set to expire from the Congressional Budget Office (CBO) and dispersion among economic forecasters from the Federal Reserve Bank of Philadelphia's Survey of Professional Forecasters. I add the country-level uncertainty proxy – EPU index into the regression (1) and report the results in Table 7.

The first column shows the foreign discount without controlling for any risk and risk premia, which is the same as the first column in Table 5. The second column is the results after adding the country-level uncertainty proxy. We can see the EPU has positive explanatory power on the credit spread. The coefficient estimate is 1.98 with t-stats 4.66. More importantly, the EPU can help explain a large fraction of the foreign discount. Specifically, the foreign discount decreases from 17.00 bps to 5.91 bps, a reduction of 11.09 bps or 65%. Meanwhile, the discount is no longer significant. The t-stats drop from 3.26 to 0.99. When we further control for risk and risk premia proxies, the foreign discount is 14.83 bps, the same as the number in the last column in Table 5. After including the EPU, the discount becomes 6.06 with t-stats 0.98. Overall it suggests that the majority of the foreign discount can be explained away by this country-level uncertainty proxy.

Besides, I also use the 2020 GDP growth forecasts on different countries reported by large global (mainly US) and local institutions from the Consensus Economics survey and report the results in Table 8. The typical global institutions include Goldman Sachs, JP Morgan, Bank of America - Merrill, Morgan Stanley, Citigroup, Markit, Moody's from the US, and Barclays, Deutsche, Credit Suisse, UBS, HSBC, Nomura Securities, Oxford Economics and Capital Economics from other countries. The domestic institutions are mainly large banks, insurance companies and security firms. The number of forecasts by global and domestic institutions are more or less comparable, as shown in Columns 2 and 3 from Table 8. Due to the data limitation, I only obtain a snapshot of June 2020 on the 2020 GDP growth forecasts.

Interestingly, for each foreign country, the average forecasts among US investors are all smaller than the average forecasts made by local investors in that country. Moreover, the realized GDP growth implies that the precision of the forecast by local investors is higher than that of US investors, suggesting that US investors behave as if they are relatively more "pessimistic" about other countries' economies. When forecasting the US, the reverse and symmetrical effect is found. The US investors predict a better and more accurate GDP growth than non-US investors. Related to the country-level uncertainty, I find that the dispersion of forecasts among US investors tends to be larger than that of local investors. More importantly, the extent of that dispersion across countries lines up with the corresponding foreign discount, pointing to the possibility that US investors exhibit uncertainty aversion toward foreign countries and then ask for a higher discount on countries with larger uncertainty.[21]

5.2 Foreign Discount: Foreign Issuer's Correlation with the US

Next moving to the cross-issuers (ρ_i), explore the relation between the foreign discount and the foreign issuer's correlation with the US market (ρ_i). To measure the correlation between the foreign issuer and the US market, I focus on two indirect proxies: (1) the age of the issuer in the US bond market; (2) the fraction of sales in the US from the Compustat Segments dataset. Intuitively, the longer the foreign issuers stay in the US bond market, the more likely the investors are to build up familiarity and ask for a lower discount. Likewise, for foreign issuers with a higher fraction of sales in the US market, we should expect the uncertainty to be smaller, so is the foreign discount. I also look at whether the bond with higher institutional holdings has a lower discount. To proxy for higher institutional holdings, I first pick up the bonds registered under Rule 144A as Rule 144A bonds are mainly held by qualified institutional buyers (QIBs) who are more sophisticated. Alternatively, I compute the percentage of institutional holdings from eMAXX. The results are reported in Table 9.

Column 1 in Table 9 shows the result for the age of the issuer in the US bond market. The interaction term Foreign*Age_in_US is -1.11 with t-stats -3.48. The negative and significant coefficient implies that the age effect does mitigate the foreign discount to some extent. In the extreme case where Age_in_US equals 0, the foreign discount increases to 28 bps. For Sales_in_US, which is computed as the fraction of the issuer's revenues (REVTS) in the US to the total revenues, using data from Compustat Segments Dataset. Higher Sales_in_US means that the issuer has a higher fraction of sales in the US market, which is also found to have a negative effect on the foreign discount, consistent with the intuition. The coefficient estimate is -0.36 with t-stats -2.19. In other words, for issuers with no sales in the US market, the foreign discount is around 27 bps.

Next, I study the sophistication of investors along two dimensions. First, I consider

[21] The dispersion information is also analogous to the third data source used in Baker, Bloom, and Davis (2016)

whether bonds are issued under Rule 144A sample or not.[22] I find that for bonds registered under Rule 144A, the interaction term is negative as expected but not significant. Alternatively, I compute the percentage of holdings by large institutions at the bond level from eMAXX. For each bond, I calculate the percentage of the holding from mutual funds and insurance companies. Then I use the variable $InstHoldings$ to interact with the dummy variable $Foreign$ and find the interaction term to be negative and significant. It suggests that if more institutional investors hold the bond, the foreign discount is smaller, which is consistent with the intuition that more sophisticated investors demand a lower discount on the foreign dollar bonds, everything else being equal.

5.3 Foreign Discount: Time Series Volatility

In this subsection, I perform the predictability test for the risk aversion (γ) and volatility (σ) proxy – CBOE VIX index. Specifically, the aggregate foreign discount in month $t + 1$ is regressed on the VIX index in month t. The lag of discount in month t is also added into the regression to control for the auto-correlation of the discount. As for other market-level variables, I include the yields of "A"-rated bonds, proxying for overall credit market condition. Moreover, the stock market index – S&P 500 index is included in the test. I also use the dollar index to proxy for the macro-level economic performance. Either in the times when the US trade balance improves or in crisis when the demand for safe dollar fuels, the dollar index tends to rise. The results are reported in Table 10.

Panel A shows the results for the recent sample from June 2014 to March 2021 and Panel B shows the results for the longer sample from January 2005 to March 2021. The VIX index can positively predict the future foreign discount after controlling for the current foreign discount. To be more specific, one standard deviation of increase in VIX can predict an increase in the aggregate foreign discount of 4.1 bps. Since the higher the VIX Index is, the higher the degree of fear among investors is. Consequently, the investors would become more worried about the future economic situation and require a higher discount to hold less safe foreign dollar bonds. The next variable – corporate yield can also positively predict the discount. I find that one standard deviation of increase in investment-grade credit spreads can predict an increase in the aggregate foreign discount of 4.9 bps. Intuitively, an increase in the yield of the investment-grade bond is a sign of a worsening credit environment. Thus

[22] Note that most of the foreign bonds are actually issued under Rule 144A, which was introduced in 2012 and loosened restrictions on certain privately placed securities by allowing qualified institutional buyers (QIBs) to trade on those securities amongst themselves. Since then, the liquidity of the affected securities has substantially increased. Rule 144A has become more popular and provides a safe harbor on which non-US companies rely when accessing the US capital markets. It also helps facilitate faster and easier bond offerings even for US issuers.

the investors are more likely to demand high compensation for holding foreign dollar bonds than US dollar bonds. The US stock index also exhibits predictive power in forecasting the foreign discount. Moving next to the dollar index, one standard deviation of increase in the dollar index can predict an increase in the foreign discount of 3.5 bps. When the dollar index rises, the dollar strengthens against other major currencies in the global market. Hence the US issuers would benefit more from a stronger US economy, leading to an increase in the foreign discount.

Overall, studying the predictability of foreign discount with respect to these market-level variables, we find that VIX and the US corporate yield have a better ability in forecasting the discount. Both the statistical and economic significance are sizable and significant, which is consistent with our intuition and model implication.

6 Implications

6.1 COVID-19 Pandemic and foreign squeeze

Taking COVID-19 as an event study, I closely look at the investors' trading behavior on the US dollar bonds v.s. foreign dollar bonds. The previous literature documents the dash for cash and dash for dollar effects during COVID-19 pandemic.[23] They show that investors tend to sell bonds with high ratings, short maturity and denominated in dollars to obtain liquidity during market turmoil. I further study the heterogeneity effect from the angle of the bond's ultimate country of origin. First, I construct the bond-level selling pressure proxy, defined as the fraction of sell-initiated transactions by customers within all the customer-dealer transactions for each bond each day. Then I adopt the similar regression framework specified in Equation (1) except replacing the monthly bond-level credit spread with the daily bond-level selling pressure. To smooth out the noise in daily observations, I use the panel regression over a rolling window of the past seven days. Moreover, I estimate the daily foreign discount before and after the COVID-19 pandemic and compare it with the selling pressure. All the results are reported in Figure 7.

Panel (a) plots the difference in selling pressure (left axis) and in credit spreads (right axis) between foreign and US dollar bonds during the COVID-19 pandemic. Before March 09, 2020, the selling pressure of non-US dollar bonds relative to US dollar bonds is fairly small, which is not statistically different from 0. Beginning in early March 2020, the bond market plunged, with climbing yield spreads and worsening liquidity conditions. The difference in

[23] Haddad, Moreira, and Muir (2021), Ma, Xiao, and Zeng (2021), O'Hara and Zhou (2021), Cesa-Bianchi and Eguren-Martin (2021), Li et al. (2021), Kargar et al. (2021).

selling pressure between non-US bonds and US bonds also soared to the peak of 5%, which is statistically significant. Meanwhile, the foreign discount jumped from below 20 bps before the pandemic to well over 60 bps afterward. To improve the liquidity conditions in the corporate bond markets, the Fed responded by creating the Primary Dealer Credit Facility (PDCF) to enhance funding conditions for primary dealers, and the Secondary Market Corporate Credit Facility (SMCCF) to purchase corporate bonds and bond ETFs directly. Then we see the bond market stabilized and bond yield fell back. Consistently, I find both the selling pressure and foreign discount relative to the US dropped at the end of March.

Panel (b) plots the monthly average of the fraction of sell-initiated transactions for six major countries before and after the COVID-19 pandemic. Compared with the monthly average of selling pressure in January and February, all the countries experienced an increase in selling pressure in March. Across countries, the selling pressure is highest for CN, followed by JP, GB, EU and CA, consistent with the corresponding magnitude of foreign discount at that time except for GB. In summary, I show that it is the foreign dollar bonds that suffer more selling pressure and more severe discounts relative to US dollar bonds during market turmoil. This quantity level evidence also provides a new economic channel, foreign squeeze on foreign dollar bonds during market turmoil, as an important implication of the classical home bias literature.

With the rapid development of economic globalization, international cross-border investment and financing could become more and more pervasive. Meanwhile, we also see the world has become more volatile than ever before. All kinds of bad shocks happen more frequently, including geopolitical conflicts, trade wars, viruses, climate issues, and so on. In light of the increasing trend for international finance and the more volatile environment, the foreign discount and foreign squeeze effects identified in this paper could be relevant and important going forward.

6.2 Comparison with Dollar Safety Premium

In this subsection, to further show the importance of the foreign discount, I study the comparison between the foreign discount and the safe dollar premium. In principle, the pricing of the foreign dollar bond depends on the tradeoff between the dollar safety premium (USD effect) and the foreign discount (USA effect). On the one hand, the USD effect benefits the non-US issuer by reducing its borrowing cost due to the safe dollar premium. On the other hand, the USA effect could induce higher credit spread arising from higher uncertainty. In this paper, I study the foreign effect by fixing the currency to be the dollar. For the USD effect, I use the "corporate bases" from Liao (2020).

As documented in Figure 7 from Liao (2020), he constructs the "corporate bases" for each major currency, which is calculated from the sum of the credit spread differential between the local-currency-denominated bond and dollar-denominated bond issued by the same issuer and the CIP deviation between their local currency and the dollar. He uses a local-currency bond as the benchmark and compares it with a currency-hedged dollar bond to disentangle the currency effect from the entity effect. I instead use the dollar bond issued by an ideally identical US issuer as the benchmark and compare it with the dollar bond issued by the non-US issuer to isolate the identity effect from the currency effect. The question is which effect plays a bigger role in determining the pricing of the dollar bonds issued by non-US issuers. With the assumption that most of the bonds denominated in one currency (e.g. GBP) are issued by firms in that country (e.g. GB), I can compare the magnitude of foreign discount (USA effect) for any given country (e.g. EU) with the safe dollar premium (USD effect) for the currency in that country (e.g. EUR). The results are reported in Figure 8.

Figure 8 plots the spreads over US or USD for each foreign country and the corresponding currency. The top-left panel is for EU/EUR. The blue line refers to the foreign discount for the EU, while the red line refers to the corporate base or safe dollar premium for EUR. The foreign discount has a larger magnitude than that of the safe dollar premium. After 2013, the corporate base for EUR turns negative. In this case, it is cheaper to borrow in EUR-denominated bonds than USD-denominated bonds. Liao (2020) links this negative corporate base with the positive debt issuance flow from the US to the EU. On the contrary, the foreign discount is always positive, suggesting that the investors always ask for compensation for holding foreign dollar bonds. Moving to other panels, the results are very similar. The blue lines are almost all above the red lines. In this regard, the foreign discount is more robust and has a larger magnitude than the safe dollar premium.

The negative corporate base could arise from the fact that the foreign discount (or home bias) is different for the local-currency-denominated bonds and dollar-denominated bonds issued by the same issuer. As the local-currency bonds are mainly held by local investors who are more familiar with the issuer's business, the foreign discount is negligible. However, for dollar bonds mainly held by international investors (US investors), the uncertainty aversion effect should be more relevant in bond pricing, giving rise to larger credit spreads in dollar bonds. Hence, we may observe a negative corporate base. A more recent paper by Caramichael, Gopinath, and Liao (2021) further studies a cleaner setting in which they compare the credit spreads between euro-denominated bonds and dollar-denominated bonds issued by global firms outside the EU and US. In this case, they do not find a significant dollar premium. Consistent with my explanation, due to the presence of a foreign discount effect, EU investors and US investors may ask for similar compensation for holding these bonds issued by firms outside the EU and US, leading to a negligible dollar premium.

7 Conclusions

In this paper, I study the foreign discount effect in the international corporate bond market. Examining the credit spreads difference between the dollar-denominated bonds issued by non-US firms and US firms after controlling for ratings and other bond-level characteristics and liquidity, I quantify the foreign discount or home-country premium as an important pricing factor in the context of international bond pricing. Moreover, the foreign discount is not specific to dollar-denominated corporate bonds. I also find a similar result in the euro-denominated bonds and dollar-denominated sovereign bonds. Contrary to the common view, the standard risk measures can not explain away the discount.

After documenting the robustness of the foreign discount, I then turn to the potential explanation based on uncertainty aversion. On top of risk and risk aversion, the investors could also exhibit uncertainty aversion towards assets that are difficult to estimate the true distribution, which could be quite relevant in cross-border investment. To provide a theoretical underpinning, I build a simple Leland-type model augmented with model uncertainty. While the model is relatively simple and mainly serves as a framework, the key is to illustrate the basic mechanics in driving the foreign discount. The model can generate the uncertainty effect and the volatility effect. In the data, I show that the majority of the foreign discount can be explained away by country-level uncertainty proxy using the Economic Policy Uncertainty (EPU) index from Baker, Bloom, and Davis (2016).

As an implication, I further document the foreign squeeze effect during market turmoil. By studying investors' trading behavior on the US dollar bonds v.s. foreign dollar bonds, I take COVID-19 as an event study and show that it is the foreigner-issued dollar bonds that suffer more selling pressure and more severe discounts relative to US-issued dollar bonds. The discount jumps from below 20 bps before the pandemic to over 60 bps afterward. Across countries, the selling pressure is highest for CN, followed by JP, GB, UK and CA. In addition to the foreign discount, this quantity level evidence further provides a new economic channel, foreign squeeze during market turmoil, as an important implication of the classical home bias literature.

Lastly, I explore the implication of the foreign discount by comparing it with the safe dollar premium in the literature. For dollar-denominated bonds issued by foreign firms, their prices depend on the tradeoff between the foreign discount (USA effect) and the dollar safety premium (USD effect). I show that the foreign discount tends to dominate the safe dollar premium, especially in bad times like the global financial crisis.

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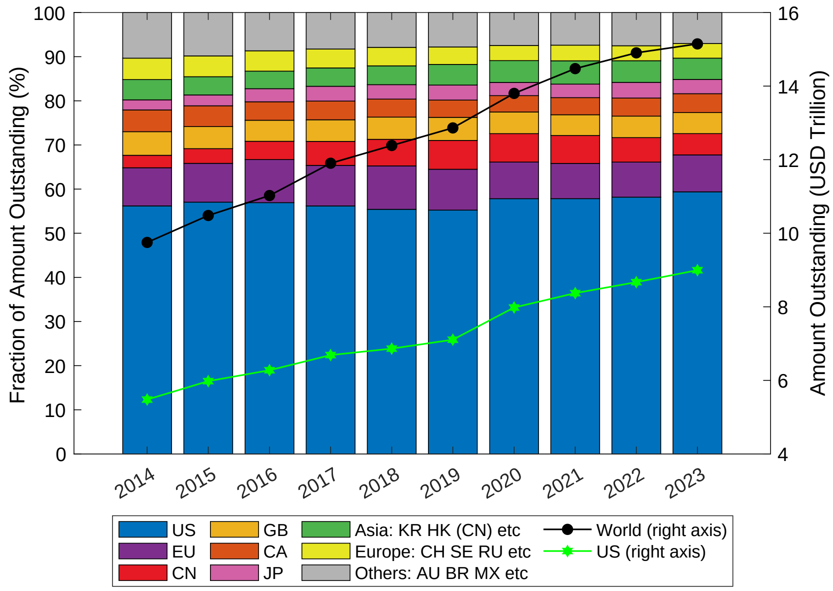
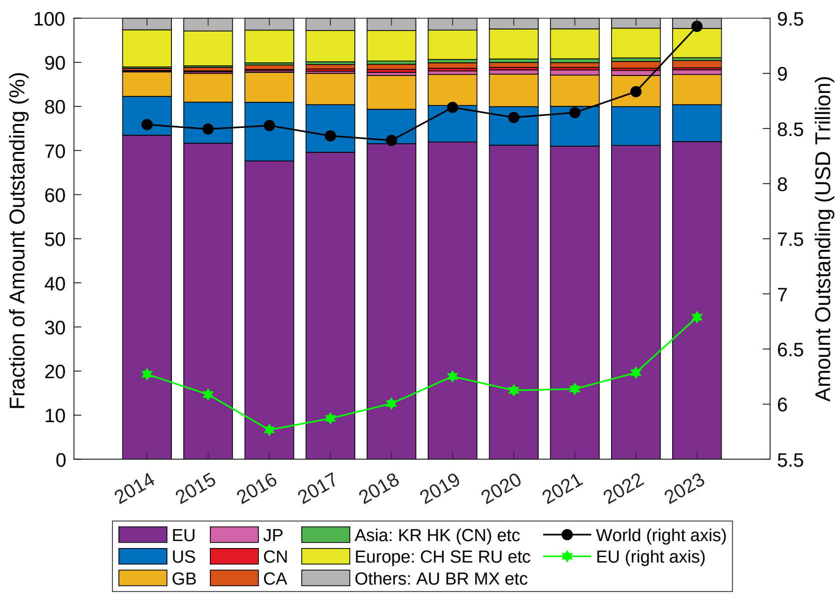


(a) **Dollar Corp Bonds: Across Countries**



(b) **Euro Corp Bonds: Across Countries**

Figure 1: This figure plots the amount of outstanding distribution across countries within dollar-denominated bonds (panel a) and within euro-denominated bonds (panel b). The left axis is the fraction of the amount outstanding by country, and the right axis is the total amount outstanding in trillions of USD. Based on the bonds' ultimate country of origin, I categorize the corporate bonds into nine groups, including the United States (US), Eurozone (EU), China Mainland (CN), United Kingdom (GB), Canada (CA), Japan (JP), Asia excluding China Mainland and Japan, Europe excluding Eurozone and United Kingdom, and the rest of the world. The black line is the total amount outstanding for the world, and the green line refers to the amount outstanding for the US or EU. All the data are obtained from Bloomberg.

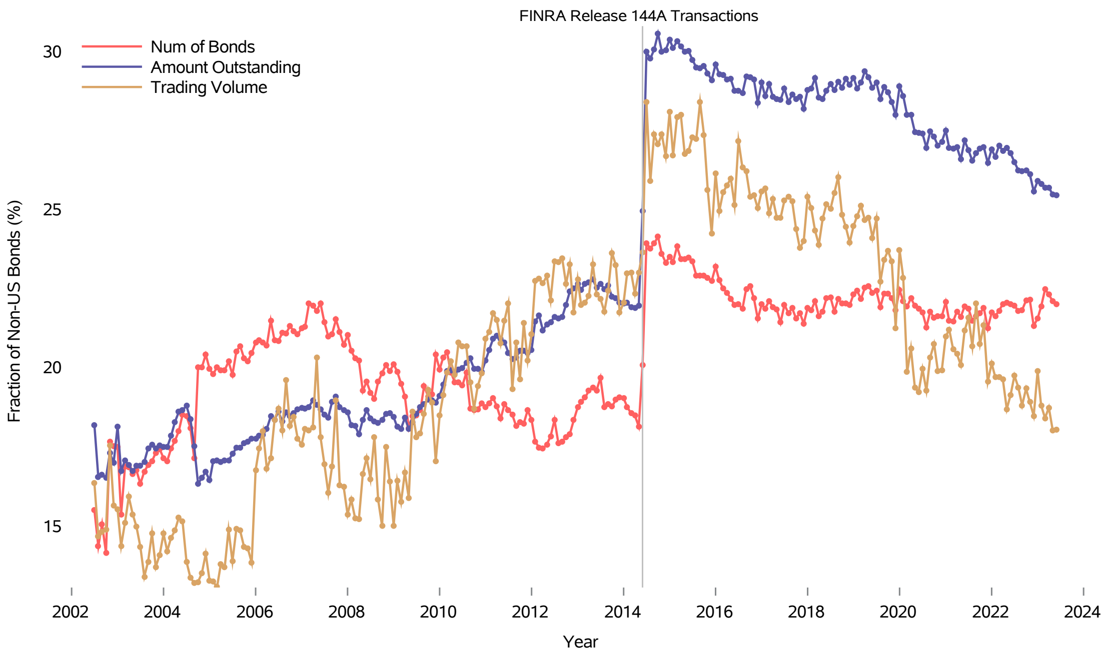
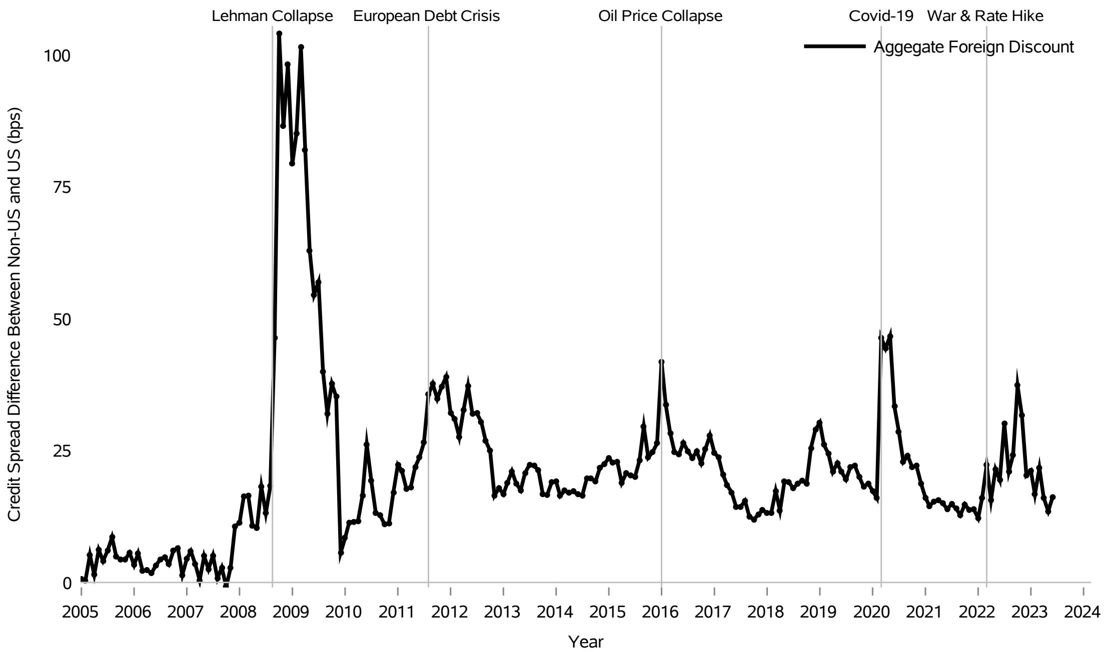
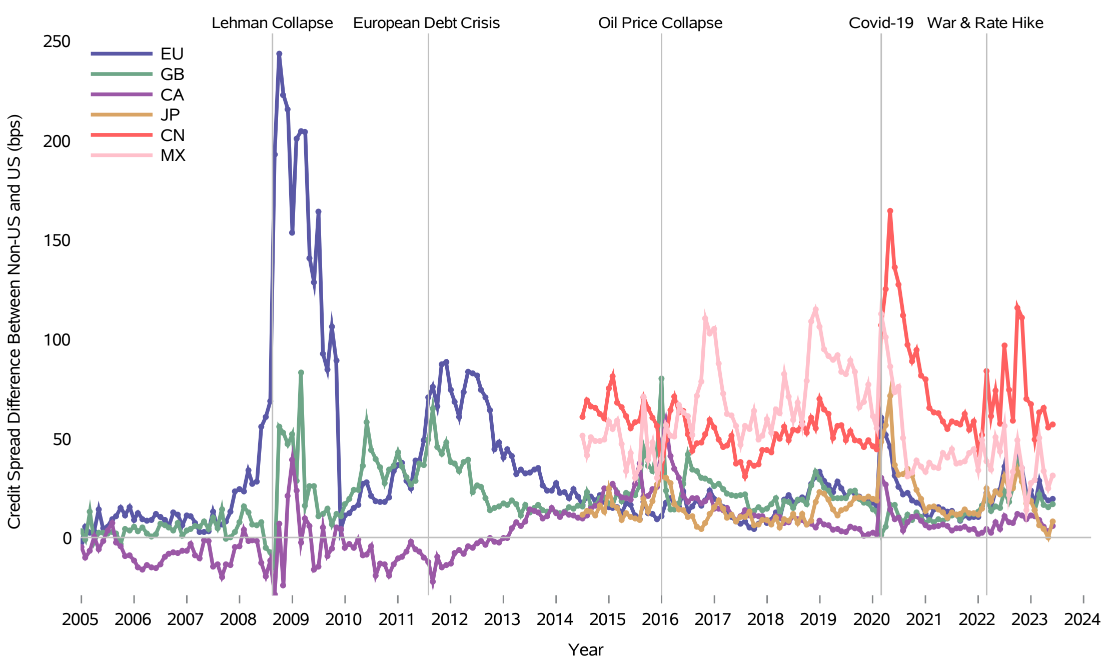


Figure 2: This figure plots the fraction of non-US-issued dollar bonds to all dollar bonds in TRACE along three dimensions: the number of bonds (red line), the amount outstanding (blue line) and trading volume (orange line). The vertical grey line refers to the event that FINRA brings 144A corporate debt transactions into the TRACE system on June 30, 2014. To identify the ultimate country of origin for each issuer, I first use the ISIN code information in the TRACE to merge with the Bloomberg and then use the variable "ult_parent_cntry_domicile" in Bloomberg to trace back the ultimate parent country of domicile for each issuer.

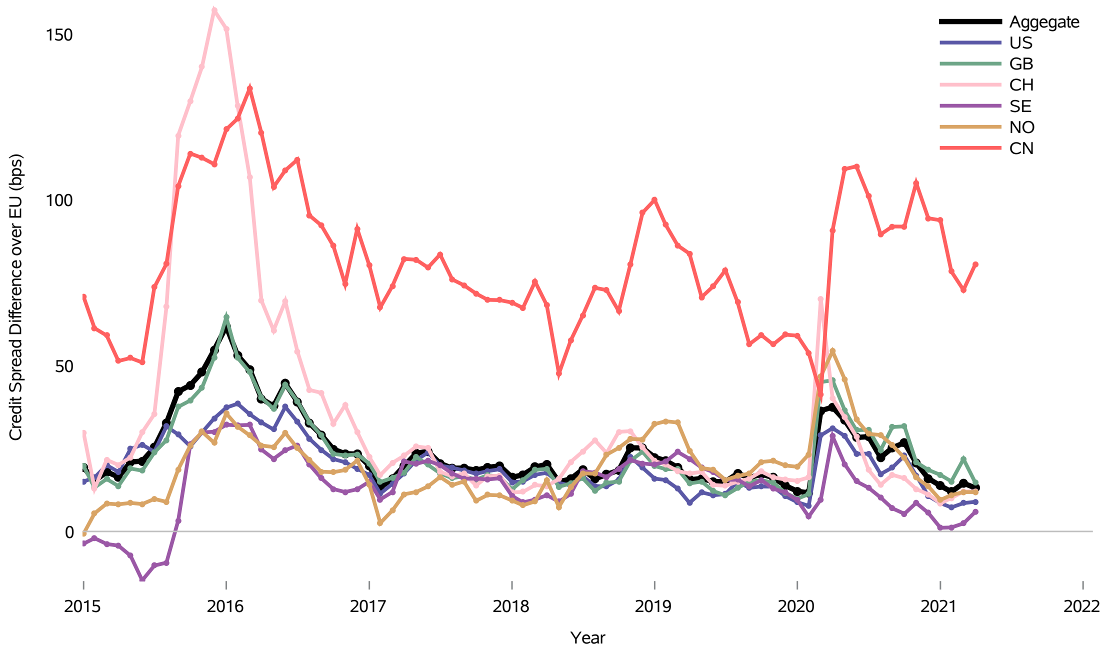


(a) **Foreign Discount: Aggregate**

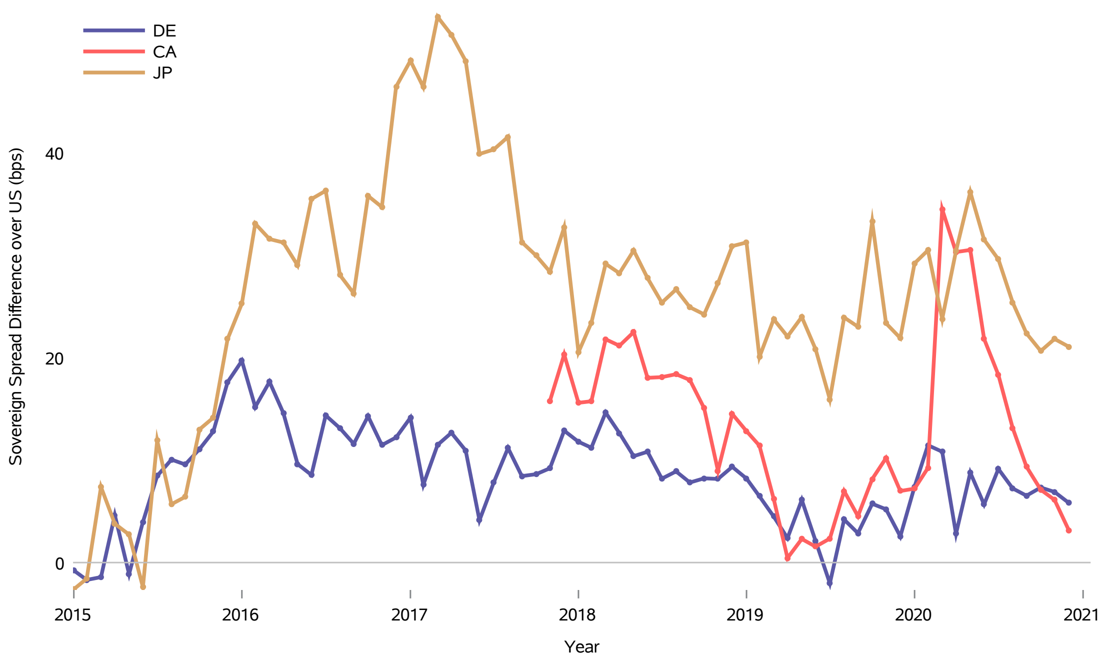


(b) **Foreign Discount: Across Countries**

Figure 3: This figure plots the credit spreads difference between non-US-issued bonds and US-issued bonds within dollar-denominated corporate bonds, estimated using monthly regressions of credit spreads on a dummy variable *Foreign*, which equals one if the bond is issued by non-US issuers and zero otherwise, controlling for credit ratings, bond characteristics and liquidity. Panel (a) is the foreign discount in the aggregate level and Panel (b) is the foreign discount for six major economies, including EU, GB, CA, JP, CN and MX. The sample period is from January 2005 to June 2023.



(a) **EUR-denominated Corporate Bonds: Spread Over EU**



(b) **USD-denominated Sovereign Bonds: Spread Over US**

Figure 4: The top panel plots the credit spreads difference between non-EU-issued bonds and EU-issued bonds within euro-denominated corporate bonds, estimated using monthly regressions of credit spreads on a dummy variable *Foreign*, which equals one if the bond is issued by non-EU issuers and zero otherwise, controlling for credit ratings, bond characteristics. The sample period is from January 2015 to March 2021. The bottom panel plots the sovereign spread difference between non-US-issued bonds and US-issued bonds within USD-denominated sovereign bonds after adjusting by the sovereign CDS spread. The sample period is from January 2015 to December 2020.

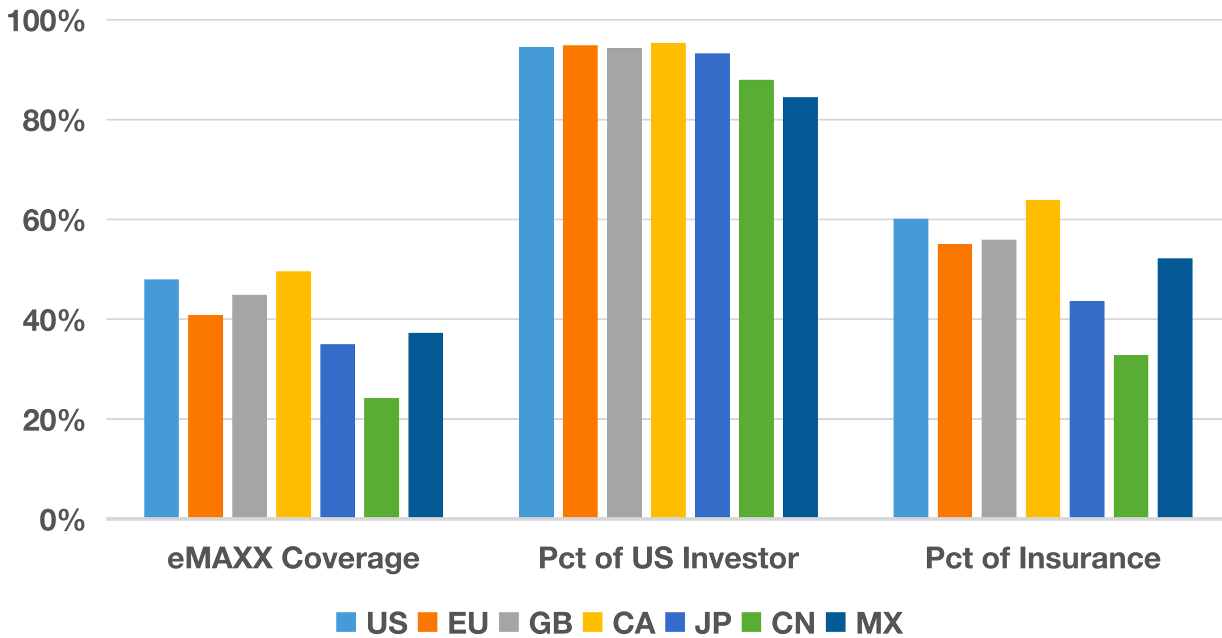


Figure 5: This figure plots the distribution of bond investors in the country-level from eMAXX along three dimensions, including overall coverage, percentage of US investor and percentage of insurance company. The bondholders' information from eMAXX is from 2018Q2 to 2021Q1.

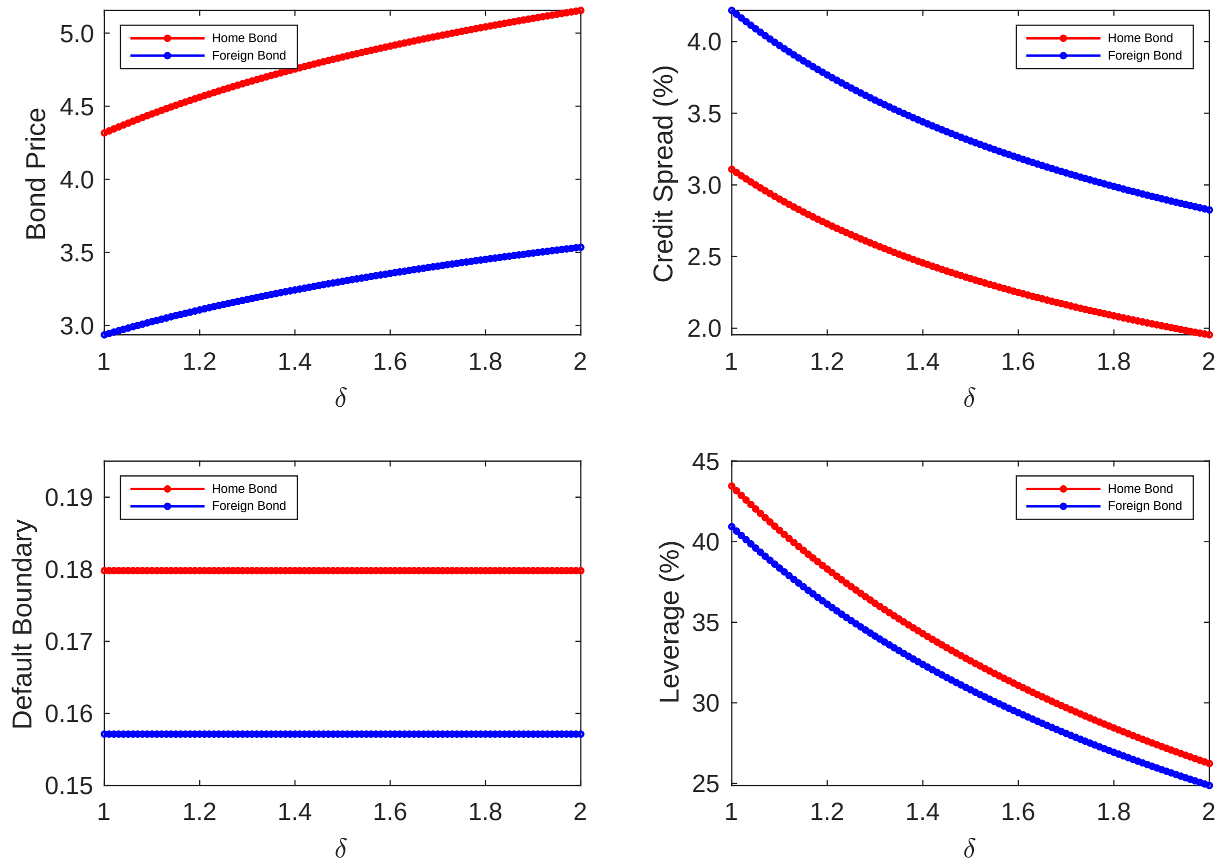
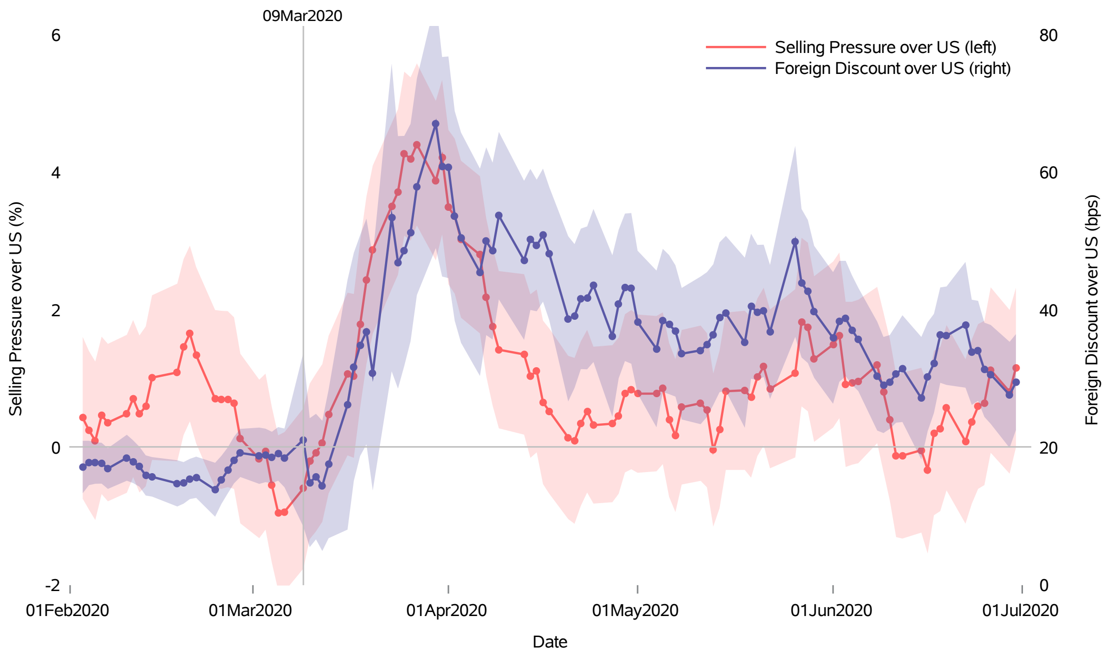
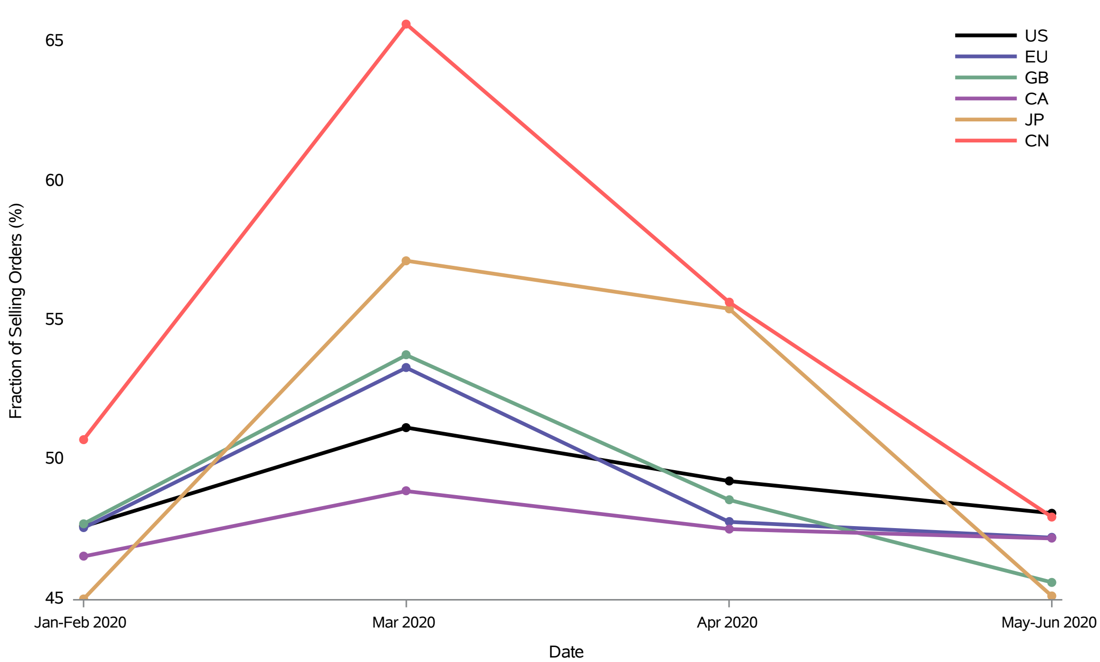


Figure 6: This figure plots the model calibration results, including the bond pricing (top-left panel), the credit spread (top-right panel), the default boundary (bottom-left panel) and the leverage (bottom-right panel). Table 6 summarizes the basic parameters used in the calibration exercise. I set the risk aversion coefficient γ to be 2, risk-free rate r to be 4%, the tax rate τ to be 25% and the bond recovery rate α to be 50%. As for the expected growth rate and volatility of the market, I choose μ^H and μ^F to be 10%, and σ^H and σ^F to be 20%. The expected growth rate of a firm's asset μ and the idiosyncratic volatility σ are calibrated to be 4% and 40%, respectively. The correlation between home firm and home market movement is set to be 40%. The degree of uncertainty aversion ϕ is 2.



(a) **Aggregate Foreign Discount and Selling Pressure**



(b) **Selling Pressure Across Acountries**

Figure 7: Panel (a) plots the difference in selling pressure (left axis) and in credit spreads (right axis) between non-US-issued bonds and US-issued bonds within dollar-denominated corporate bonds during Covid-19 pandemic, estimated using panel regressions specified in equation (1) over a rolling window of the past week. The selling pressure is defined as the fraction of sell-initiated transactions by customers within all the customer-dealer transactions for each bond each day. Panel (b) plots the monthly average of the fraction of sell-initiated transactions for six major countries before and after the Covid-19 pandemic.

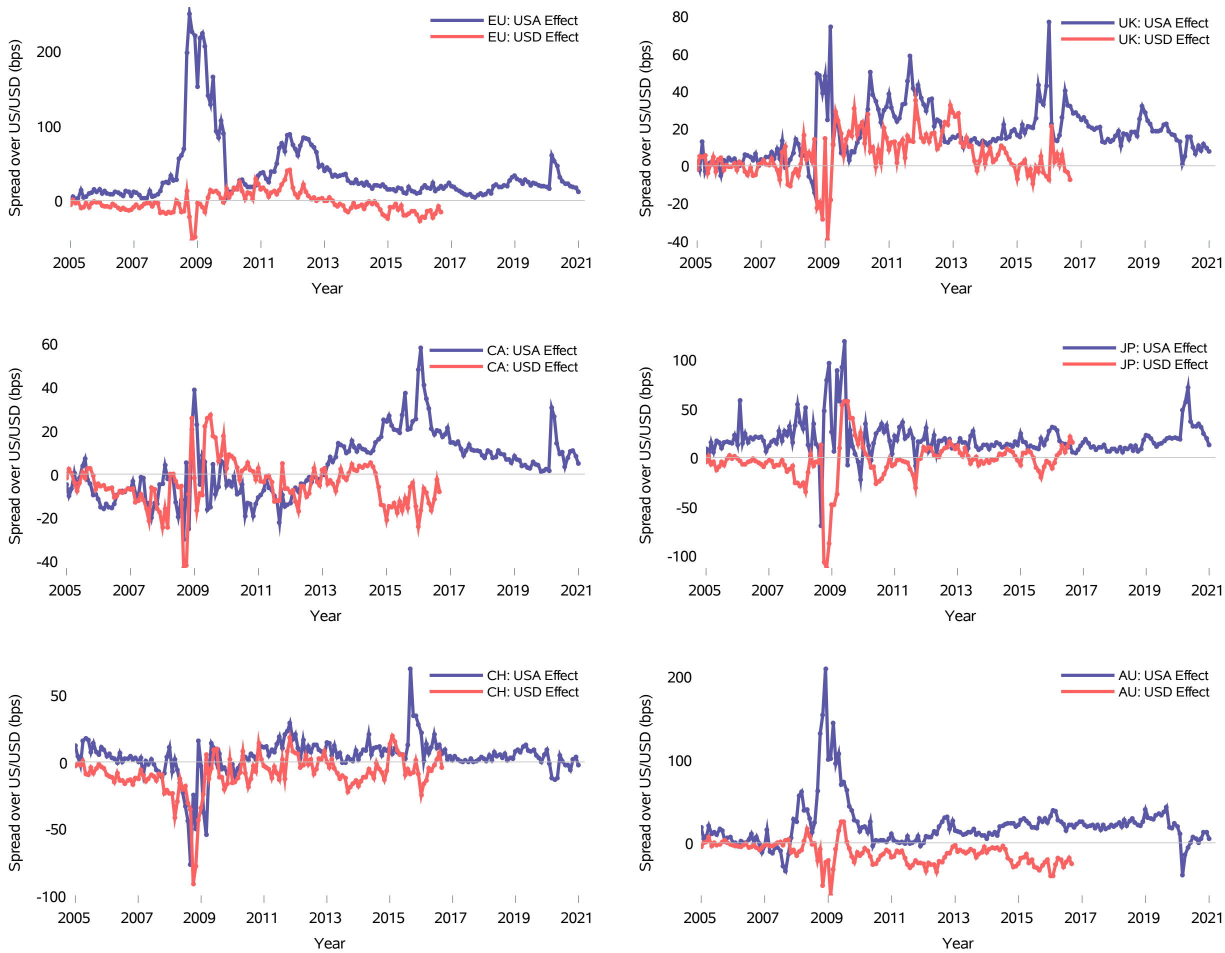


Figure 8: This figure plots the comparison between foreign discount (USA effect) and the safe dollar premium (USD effect). The red line refers to the corporate base or safe dollar premium for the six major currencies in Liao (2020), including EUR, GBP, CAD, CHF, AUD and JPY. The blue line refers to the foreign discount for the six corresponding major economies, including EU, GB, CA, CH, AU and JP.

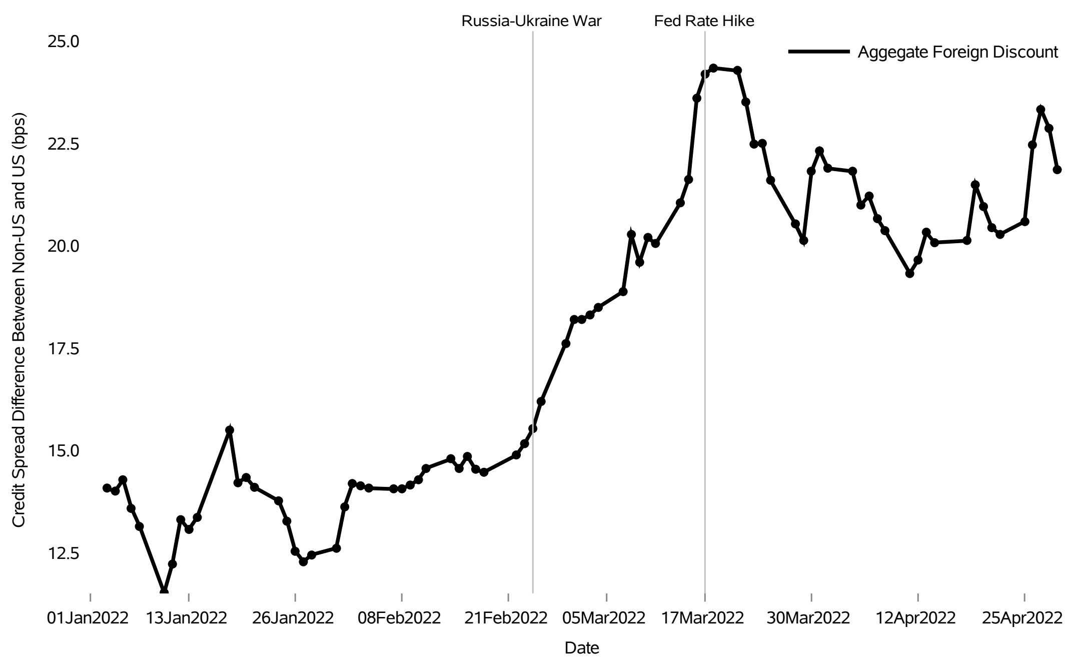


Figure 9: This figure plots the difference in credit spreads between non-US-issued bonds and US-issued bonds within dollar-denominated corporate bonds from January 2022 to April 2022, estimated using panel regressions specified in equation (1) over a rolling window of the past week.

Table 1: **Summary Statistics: USD-Denominated Bonds**

	Panel A: 2014/07 - 2023/06																	
	Mean						Median						STD					
Variable	US	EU	GB	CA	JP	CN	US	EU	GB	CA	JP	CN	US	EU	GB	CA	JP	CN
NumIssuers	1,448	192	114	99	54	56	1,448	192	114	99	54	56	1,448	192	114	99	54	56
NumBonds	13,179	1,028	729	710	515	214	13,179	1,028	729	710	515	214	13,179	1,028	729	710	515	214
CreditSpread	1.26	1.29	1.35	1.47	0.98	1.55	1.12	1.10	1.18	1.30	0.84	1.37	0.81	0.82	0.93	1.01	0.76	0.93
Yield	3.36	3.24	3.34	3.58	2.82	3.48	3.32	3.11	3.24	3.58	2.61	3.35	1.42	1.47	1.53	1.57	1.49	1.44
Rating	7.37	7.20	7.33	7.39	6.36	6.21	8.00	8.00	7.00	8.00	6.00	5.00	1.99	2.10	1.75	2.09	1.64	1.90
Maturity	11.02	8.15	9.05	10.92	4.98	8.82	7.38	5.04	6.01	7.30	3.84	5.92	8.99	7.79	8.06	9.01	4.28	7.97
Age	5.21	4.41	4.97	5.98	2.77	3.57	3.75	3.15	3.47	4.12	2.04	2.53	4.93	4.43	4.91	5.66	2.83	3.67
IssueSize	13.24	13.61	13.55	13.21	13.50	13.63	13.12	13.74	13.53	13.12	13.53	13.53	0.67	0.60	0.68	0.61	0.58	0.58
Coupon	4.23	4.02	4.27	4.45	3.10	3.87	4.00	3.88	4.13	4.38	2.93	3.75	1.57	1.61	1.62	1.86	1.35	1.28
Turnover	3.67	3.27	3.47	3.16	3.06	2.12	2.56	2.27	2.44	2.06	2.09	1.10	4.06	3.62	3.84	3.73	3.35	3.01
NumTrades	102.13	54.36	73.54	59.96	59.65	21.91	49.00	24.00	37.00	30.00	33.00	9.00	138.88	85.14	99.62	86.13	77.17	39.22
NumTradingDays	13.97	14.31	14.98	12.16	14.71	9.92	16.00	16.00	17.00	13.00	16.00	9.00	6.46	6.19	6.04	6.48	5.88	5.95
TradeSize	0.42	0.94	0.71	0.53	0.75	1.08	0.26	0.73	0.50	0.35	0.50	0.85	0.48	0.76	0.66	0.57	0.72	0.83
Gamma	0.39	0.25	0.29	0.50	0.17	0.36	0.09	0.03	0.05	0.07	0.02	0.05	1.37	1.13	1.17	1.82	0.97	1.61
	Panel B: 2005/01 - 2014/06																	
NumIssuers	1,242	132	86	70	26	13	1,242	132	86	70	26	13	1,242	132	86	70	26	13
NumBonds	8,683	497	414	397	138	31	8,683	497	414	397	138	31	8,683	497	414	397	138	31
CreditSpread	1.73	2.13	1.70	1.78	1.73	2.02	1.33	1.48	1.34	1.48	1.28	1.83	1.61	2.43	1.41	1.36	1.57	1.02
Yield	4.53	4.78	4.38	4.47	4.18	5.10	4.78	4.92	4.71	4.81	4.38	5.31	2.15	2.72	1.99	2.06	2.21	1.67
Rating	7.11	6.78	6.35	7.89	6.26	8.36	7.00	7.00	7.00	8.00	7.00	10.00	2.10	2.24	2.03	1.62	2.87	2.34
Maturity	9.96	8.80	9.06	11.56	6.99	15.65	6.78	5.48	6.08	7.49	4.47	14.84	8.61	8.10	8.10	9.55	6.91	9.42
Age	4.83	4.39	4.90	4.90	3.32	4.17	3.63	3.21	3.56	3.80	2.36	3.06	4.21	3.89	4.43	4.24	3.07	3.91
IssueSize	12.96	13.32	13.31	12.89	12.99	13.08	12.90	13.30	13.30	12.90	12.72	13.12	0.74	0.76	0.83	0.60	0.80	0.61
Coupon	5.73	5.75	5.69	5.84	4.83	5.73	5.80	5.75	5.65	6.00	5.00	5.88	1.58	1.80	1.72	1.68	1.94	1.61
Turnover	4.09	4.37	3.96	3.38	3.62	5.36	2.51	2.83	2.66	1.98	1.77	3.00	5.07	5.01	4.61	4.38	5.04	6.61
NumTrades	84.27	81.01	85.72	30.47	65.05	35.52	30.00	40.00	39.00	13.00	28.00	18.00	137.40	121.73	123.09	55.47	100.85	57.57
NumTradingDays	11.65	12.61	12.77	8.31	10.69	9.24	12.00	14.00	14.00	7.00	10.00	8.00	6.87	6.63	6.85	5.96	6.77	6.06
TradeSize	0.54	0.69	0.60	0.80	0.52	1.10	0.28	0.44	0.39	0.53	0.24	0.96	0.65	0.70	0.63	0.80	0.69	0.91
Gamma	1.36	1.30	1.13	1.23	1.23	1.11	0.34	0.24	0.24	0.23	0.28	0.33	3.29	3.54	3.05	3.22	3.14	2.87

This table reports the summary statistics for the USD-denominated investment-grade corporate bonds issued by six major countries in the TRACE sample, including US, EU, GB, CA, JP and CN. Panel A reports the sample period from July 2014 to June 2023 and Panel B reports the sample period from July 2002 to June 2014. The separation arise from the event that the FINRA brings 144A corporate debt transactions into the Trace system on June 30, 2014. *Creditspread* is measured as the difference between the corporate bond yield and Treasury Constant Maturity Rate of the same maturity in percent. *Rating* is a numerical translation of Moody's rating: 1=Aaa, 2=Aa+ and so on until 21 to C. *Maturity* is the bond's time-to-maturity in years. *Age* is the time since issuance in years. *IssueSize* is the log of bond issuance size. *Coupon* is the bond's coupon payment in percent. *Turnover* is the average monthly trading volume as a percentage of its issuance. *NumTrades* is the total number of transactions in a month. *NumTradingDays* counts the number of trading days per month. *TradeSize* is the average trade size of the bond in millions of dollars. *Gamma* measures the negative auto-correlation between daily bond prices following Bao, Pan, and Wang (2011).

Table 2: **Summary Statistics: EUR-Denominated Bonds**

	2015/01 - 2021/03																	
	Mean						Median						STD					
Variable	EU	US	GB	CH	SE	CN	EU	US	GB	CH	SE	CN	EU	US	GB	CH	SE	CN
NumIssuers	75	40	22	15	10	10	75	40	22	15	10	10	75	40	22	15	10	10
NumBonds	752	401	221	62	36	25	752	401	221	62	36	25	752	401	221	62	36	25
CreditSpread	0.92	1.09	1.12	0.97	0.98	1.45	0.81	0.95	0.95	0.72	0.90	1.36	0.52	0.56	0.69	0.77	0.33	0.42
Yield	0.72	0.92	0.90	0.71	0.81	1.05	0.61	0.82	0.78	0.52	0.73	0.98	0.73	0.78	0.87	0.92	0.66	0.56
Rating	7.39	7.19	7.90	6.37	7.71	6.28	8.00	8.00	8.00	7.00	8.00	6.00	1.90	2.22	1.58	2.02	0.98	1.46
Maturity	7.32	7.93	6.90	6.71	7.16	4.86	6.68	7.01	6.33	6.13	6.40	4.56	3.99	4.29	3.62	3.50	4.05	2.49
Age	3.42	2.60	2.89	2.48	4.17	2.24	2.48	2.15	2.37	2.21	3.42	1.93	3.24	2.08	2.42	1.81	3.45	1.63
IssueSize	20.41	20.39	20.30	20.30	20.00	20.13	20.44	20.37	20.29	20.21	20.03	20.03	0.47	0.41	0.35	0.29	0.33	0.34
Coupon	1.99	1.69	1.75	1.36	2.29	1.61	1.50	1.63	1.60	1.35	1.88	1.63	1.48	0.86	1.00	0.82	1.51	0.41

This table reports the summary statistics for the EUR-denominated investment-grade corporate bonds issued by six countries in the Bloomberg sample, including EU, US, GB, CH, SE and CN. The sample period is from January 2015 to March 2021. *Creditspread* is measured as the difference between the corporate bond yield and Treasury Constant Maturity Rate of the same maturity in percent. *Rating* is a numerical translation of Moody's rating: 1=Aaa, 2=Aa+ and so on until 21 to C. *Maturity* is the bond's time-to-maturity in years. *Age* is the time since issuance in years. *IssueSize* is the log of bond issuance size. *Coupon* is the bond's coupon payment in percent.

Table 3: **Foreign Discount in USD-Denominated Corporate Bonds**

	Panel A: 2014/07 - 2023/06							Panel B: 2005/01 - 2023/06			
	All	EU	GB	CA	JP	CN	MX	All	EU	GB	CA
Foreign	22.06***	19.44***	20.70***	12.65**	18.17***	65.70***	60.24***	19.69***	25.67***	18.80***	5.03
	[6.57]	[5.17]	[3.80]	[2.21]	[2.67]	[8.06]	[3.77]	[5.10]	[3.54]	[3.38]	[0.83]
Rating	18.40***	18.19***	18.07***	18.19***	18.19***	18.31***	18.20***	20.24***	20.24***	20.09***	20.27***
	[10.58]	[10.75]	[10.51]	[10.39]	[10.35]	[10.36]	[10.45]	[12.47]	[12.31]	[12.59]	[12.45]
Maturity	3.68***	3.64***	3.65***	3.65***	3.65***	3.63***	3.66***	3.00***	2.97***	3.00***	2.99***
	[18.52]	[18.84]	[18.55]	[18.29]	[18.41]	[18.52]	[18.18]	[6.61]	[6.38]	[6.56]	[6.60]
IssueSize	-5.19**	-5.57**	-5.26**	-5.55**	-5.41**	-5.32**	-5.36**	-4.63	-4.74	-4.67	-4.81
	[-2.32]	[-2.45]	[-2.37]	[-2.49]	[-2.38]	[-2.37]	[-2.33]	[-0.72]	[-0.73]	[-0.73]	[-0.74]
Age	2.92***	3.03***	3.04***	3.02***	3.05***	3.05***	3.05***	3.36***	3.42***	3.39***	3.42***
	[7.89]	[7.92]	[7.89]	[7.68]	[7.80]	[7.82]	[7.74]	[6.39]	[6.32]	[6.35]	[6.21]
Turnover	1.71***	1.78***	1.80***	1.77***	1.75***	1.77***	1.81***	1.53***	1.58***	1.53***	1.49***
	[4.47]	[4.72]	[4.85]	[4.58]	[4.55]	[4.68]	[4.71]	[2.71]	[2.72]	[2.75]	[2.69]
Constant	30.43	36.6	31.51	36.05	32.82	30.3	31.33	12.97	12.9	11.91	15.05
	[1.05]	[1.23]	[1.08]	[1.23]	[1.11]	[1.03]	[1.04]	[0.14]	[0.13]	[0.13]	[0.16]
Obs	700476	612396	604455	602414	590928	581290	579428	1105040	976310	968247	966561
Adj R^2	0.35	0.36	0.35	0.36	0.36	0.36	0.37	0.15	0.15	0.15	0.15

This table reports the foreign discount within USD-denominated corporate bonds, estimated using panel regressions of credit spreads on a dummy variable *Foreign*, which equals one if the bond is issued by non-US issuers and zero otherwise, controlling for credit ratings, other bond characteristics and liquidity, as well as industry and year fixed effect. Panel A shows the results for All, EU, GB, CA, JP, CN and MX from July 2014 to June 2023. Column *All* means all the foreign issuers in the six countries above. Panel B shows the results for EU, GB and CA in a longer period from January 2005 to June 2023. Reported in square brackets are tstat's using standard errors clustered by issuer and year. See Table 1 for bond-level variable definitions.

Table 4: **Foreign Discount in EUR-Denominated Corporate Bonds**

	Panel A: 2014/06 - 2021/03							Panel B: 2005/01 - 2021/03			
	All	US	GB	CH	SE	NO	CN	All	US	GB	CH
Foreign	22.59***	18.54***	22.22***	26.7	13.98***	20.79***	80.34***	20.89***	18.68***	20.41***	27.51*
	[4.07]	[3.66]	[4.83]	[1.59]	[2.89]	[2.76]	[10.92]	[4.00]	[3.66]	[4.55]	[1.68]
Rating	12.07***	11.82***	14.65***	12.98***	13.22***	13.14***	13.13***	12.52***	12.43***	15.00***	13.72***
	[8.27]	[9.21]	[8.86]	[9.16]	[8.96]	[8.56]	[8.61]	[8.13]	[8.73]	[8.48]	[8.68]
Maturity	2.71***	2.84***	3.66***	3.09***	3.43***	3.34***	3.37***	2.41***	2.42***	3.02***	2.50***
	[5.85]	[7.74]	[7.55]	[6.51]	[8.85]	[8.84]	[8.20]	[4.20]	[5.41]	[4.87]	[5.19]
IssueSize	1.82	2.55	-0.56	0.08	-1.52	-0.67	-0.62	1.17	1.28	-1.46	-1.12
	[0.71]	[1.21]	[-0.22]	[0.03]	[-0.60]	[-0.26]	[-0.23]	[0.43]	[0.50]	[-0.57]	[-0.39]
Age	-5.96***	-5.69***	-4.85***	-5.56***	-5.13***	-5.17***	-5.26***	-6.02***	-5.84***	-5.39***	-5.94***
	[-4.67]	[-5.15]	[-4.44]	[-5.39]	[-4.82]	[-4.80]	[-4.85]	[-5.43]	[-7.55]	[-6.14]	[-7.97]
Coupon	16.09***	15.34***	14.20***	15.25***	14.04***	14.24***	14.42***	17.19***	16.81***	16.44***	17.39***
	[5.07]	[5.66]	[5.09]	[5.42]	[4.93]	[4.99]	[5.05]	[5.72]	[7.81]	[6.64]	[8.02]
Constant	-84.3	-100.25**	-68.37	-61.2	-32.11	-47.93	-49.1	-71.29	-75.67	-46.86	-38.59
	[-1.48]	[-2.44]	[-1.18]	[-1.23]	[-0.67]	[-1.00]	[-0.94]	[-1.21]	[-1.58]	[-0.81]	[-0.68]
Obs	59686	44853	38271	31188	30421	29805	29878	66719	50618	43998	36270
Adj R^2	0.26	0.28	0.25	0.24	0.24	0.24	0.26	0.23	0.25	0.22	0.22

This table reports the foreign discount within euro-denominated corporate bonds, estimated using panel regressions of credit spreads on a dummy variable *Foreign*, which equals one if the bond is issued by non-EU issuers and zero otherwise, controlling for credit ratings, other bond characteristics and liquidity, as well as industry and year fixed effect. Panel A shows the results for All, US, GB, CH, SE, NO and CN from January 2015 to March 2021. Column *All* means all the foreign issuers in the six countries above. Panel B shows the results for US, GB and CH in a longer period from January 2005 to March 2021. Reported in square brackets are tstat's using standard errors clustered by issuer and year. See Table 2 for bond-level variable definitions.

Table 5: **Foreign Discount After Controlling for Risk and Risk Premia**

Foreign	17.00***	17.86***	16.38***	17.01***	16.96***	14.83***
	[3.26]	[3.79]	[3.66]	[3.44]	[3.45]	[2.56]
Rating	19.03***	18.23***	16.21***	16.23***	16.28***	16.36***
	[10.10]	[10.88]	[10.13]	[10.38]	[10.59]	[10.84]
Maturity	3.32***	2.73***	2.76***	2.75***	2.77***	2.78***
	[12.78]	[6.49]	[6.89]	[6.90]	[6.89]	[7.10]
IssueSize	-0.03	3.45	1.85	0.42	0.21	0.09
	[-0.01]	[1.10]	[0.66]	[0.16]	[0.08]	[0.03]
Age	2.23***	2.13***	1.93***	1.84***	1.86***	1.84***
	[5.44]	[5.34]	[5.72]	[5.44]	[5.41]	[5.96]
Turnover		1.73***	1.48***	1.42***	1.41***	1.40***
		[3.12]	[2.93]	[2.86]	[2.82]	[2.88]
Gamma		17.22***	16.46***	16.31***	15.58***	15.52***
		[3.42]	[3.77]	[3.79]	[3.51]	[3.72]
Leverage			0.44***	0.46***	0.46***	0.46***
			[4.38]	[4.84]	[4.79]	[5.01]
AssetGrowth			-0.34***	-0.08	-0.08	-0.09
			[-2.82]	[-0.94]	[-0.95]	[-1.09]
EquityVolatility			1.37***	0.65**	0.65***	0.64***
			[6.83]	[2.51]	[2.61]	[2.56]
DefaultRisk				1.00***	1.01***	1.00***
				[2.65]	[2.65]	[2.68]
EquityPremium					-14.49**	-15.78***
					[-2.36]	[-3.11]
VariancePremium					0.52	0.54
					[1.19]	[1.33]
TermPremium					0.72	-0.91
					[0.51]	[-0.57]
DefaultPremium					-1.05	-0.32
					[-1.47]	[-0.71]
PoliticalRisk						-0.99
						[-0.85]
CurrencyRisk						-0.68
						[-1.07]
CreditRisk						1.73
						[1.37]
Constant	8.06	-41.63	-55.36	-38.17	-47.07	33.53
	[0.12]	[-0.92]	[-1.40]	[-1.00]	[-1.25]	[0.33]
Obs	425866	425866	425866	425866	424948	424948
Adj R^2	0.23	0.37	0.43	0.44	0.45	0.46

This table reports the foreign discount after controlling for the issuer-level risk, US risk premia and country-level risk. Specifically, to control for the credit risk beyond ratings, I focus on the non-US issuers with listed equity in the US market and construct the credit risk proxy based on Merton's distance-to-default. To control for the liquidity risk, I use both a quantity-based measure – turnover and a pricing-based illiquidity measure – gamma from Bao, Pan, and Wang (2011). To control for US risk premia, I choose four risk premium proxies, including equity risk premium, variance risk premium, term premium and default premium. To control for country-level risk, I use the log of exchange rate movement to proxy for currency risk, the ICRG political index to proxy for political risk and the local corporate bond index return to proxy for local credit risk. The sample period is from January 2005 to June 2023.

Table 6: **Calibration Parameters**

Variable	Definition	Value
γ	Risk Aversion	2
r	Riskfree Rate	4%
α	Recovery Rate	50%
τ	Corporate Tax Rate	25%
δ_0	Initial Cash Flow Level	1
μ^H	Market Growth Rate	10%
σ^H	Market Volatility	20%
μ^F	Market Growth Rate	10%
σ^F	Market Volatility	20%
μ	Firm Asset Growth Rate	4%
σ	Firm Asset Idiosyncratic Volatility	40%
$\sigma_{i,H,H}$	Home Firm's Correlation with Home Market	40%
ϕ	Uncertainty Aversion	2

This table summarizes the basic parameters used in the calibration exercise, including the risk aversion coefficient γ, risk-free rate r, the tax rate τ and the bond recovery rate α, the expected growth rate μ^H (μ^F) and volatility σ^H (σ^F) the of the market, the expected growth rate of firm's asset μ and the idiosyncratic volatility σ, the correlation variable $\sigma_{i,H,H}$ and the uncertainty aversion ϕ.

Table 7: **Foreign Discount and Country Level Uncertainty**

Foreign	17.00***	5.91	17.01***	7.48	14.83***	6.06
	[3.26]	[0.99]	[3.44]	[1.40]	[2.56]	[0.98]
EPU		1.98***		1.71***		1.47***
		[4.66]		[7.03]		[5.66]
Rating	19.03***	18.95***	16.23***	16.14***	16.36***	16.31***
	[10.10]	[10.19]	[10.38]	[10.26]	[10.84]	[10.79]
Maturity	3.32***	3.31***	2.75***	2.76***	2.78***	2.78***
	[12.78]	[12.78]	[6.90]	[6.93]	[7.10]	[7.12]
IssueSize	-0.03	-0.14	0.42	0.21	0.09	-0.10
	[-0.01]	[-0.03]	[0.16]	[0.08]	[0.03]	[-0.04]
Age	2.23***	2.19***	1.84***	1.82***	1.84***	1.82***
	[5.44]	[5.92]	[5.44]	[5.69]	[5.96]	[6.11]
IssuerRisk	No	No	Yes	Yes	Yes	Yes
USRiskPremium	No	No	No	No	Yes	Yes
CountryRisk	No	No	No	No	Yes	Yes
Industry&Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	425866	425866	425866	425866	424948	425866
Adj R^2	0.23	0.24	0.44	0.44	0.46	0.46

This table reports the foreign discount after controlling for country-level uncertainty, proxied by the Economic Policy Uncertainty (EPU) index from Baker, Bloom, and Davis (2016). Reported in square brackets are tstat's using standard errors clustered by issuer and year. The sample period is from January 2005 to June 2023.

Table 8: **Foreign Discount and 2020 GDP Forecasts**

	Num of Investors		Dispersion of GDP Forecast (%)				Mean of GDP Forecast (%)				
Country	Local	US	Local	US	FValue	Pvalue	Local	US	Diff	tValue	Realized
CA	11	8	0.79	1.60	4.11**	0.04	-6.12	-7.26	-1.14*	-1.87	-5.40
DE	17	13	1.47	1.70	1.34	0.57	-6.09	-7.05	-0.97*	-1.67	-4.90
FR	9	13	0.90	1.78	3.92*	0.06	-10.06	-9.41	0.65	1.12	-8.10
JP	12	13	0.71	1.18	2.73*	0.10	-5.18	-5.36	-0.19	-0.48	-4.80
UK	17	14	2.02	2.35	1.35	0.56	-8.39	-9.68	-1.29*	-1.65	-9.80
US	10	14	1.20	1.32	1.21	0.80	-6.28	-5.18	1.10**	2.09	-3.50

This table reports the results of 2020 GDP growth forecasts on different countries reported by the large institutions from the Consensus Economics survey on June 8, 2020, including the number of investors, the dispersion of GDP growth forecasts and the mean of GDP growth forecasts. Local refers to investors from the local country and US means investors from the US. To examine the difference between the two groups, I report the double t-test for the mean of forecasts and the F test for the dispersion of the forecasts.

Table 9: **Foreign Discount and Cross-Issuers/Investors Evidences**

X	Age_in_US	Sales_in_US	Rule144A	InstHoldings
Foreign	28.01***	27.25**	18.35***	46.95***
	[6.59]	[2.42]	[4.60]	[4.73]
X	-6.20***	-0.06	27.78***	0.03
	[-4.10]	[-0.99]	[5.78]	[0.38]
Foreign*X	-1.11***	-0.36**	-7.84	-0.51***
	[-3.48]	[-2.19]	[-1.26]	[-5.40]
Rating	19.04***	17.82***	19.01***	20.97***
	[9.83]	[7.59]	[9.97]	[5.35]
Maturity	3.90***	4.15***	3.94***	3.69***
	[24.20]	[22.49]	[24.60]	[16.75]
IssueSize	-4.51*	-6.08*	-4.19*	-11.33***
	[-1.92]	[-1.77]	[-1.77]	[-2.67]
Age	10.17***	2.91***	3.68***	3.76***
	[6.62]	[6.69]	[8.67]	[6.76]
Turnover	2.08***	1.88***	2.11***	2.53***
	[4.70]	[4.52]	[4.60]	[4.07]
Industry&Year FE	Yes	Yes	Yes	Yes
Constant	-43.57*	124.15***	-54.93**	46.71
	[-1.65]	[2.67]	[-2.10]	[1.11]
Obs	504194	147429	504194	140103
Adj R^2	0.37	0.42	0.38	0.28

This table reports the relation between the foreign discount and the foreign issuer's correlation with the US market. To measure the correlation between the foreign issuer and the US market, I focus on two indirect proxies: (1) the age of the issuer in the US bond market (Age_in_US); (2) the fraction of sales in the US (Sales_in_US) from the Compustat Segments dataset. Rule144A is a dummy variable, which equals one if the bond is issued under Rule 144A and zero otherwise. InstHoldings refers to the percentage of the holding by large institutions at the bond level, including mutual funds and insurance companies from eMAXX.

Table 10: **Foreign Discount and Time-Series Predictability**

	Panel A: 2014/06-2021/03						Panel B: 2005/01-2021/03					
Foreign	0.66***	0.45**	0.47**	0.36	0.47*	0.17	0.87***	0.70***	0.56***	0.81***	0.79***	0.42***
	(3.83)	(2.23)	(2.09)	(1.34)	(1.99)	(0.68)	(10.31)	(7.71)	(5.78)	(8.61)	(8.90)	(3.67)
VIX		0.54**				0.40**		0.50***				0.41**
		(2.32)				(2.34)		(2.64)				(2.59)
CorpYield			7.99**			3.71*			10.75***			9.64***
			(2.13)			(1.81)			(3.19)			(2.94)
S&P500				-0.23*		-0.07				-0.13*		0.03
				(-1.90)		(-0.81)				(-1.76)		(0.35)
DollarIndex					0.73*	0.64***					0.44**	0.28
					(1.86)	(2.68)					(2.09)	(1.62)
Constant	7.57**	3.54*	-10.96	46.43**	23.80**	21.54	0.74	-5.09**	-50.67***	12.52*	7.16**	-48.39**
	(2.27)	(1.79)	(-1.60)	(2.07)	(2.15)	(1.08)	(0.84)	(-2.10)	(-3.12)	(1.83)	(2.26)	(-2.32)
Obs	79	79	79	79	79	79	192	192	192	192	192	192
Adj $R2$	0.57	0.68	0.64	0.65	0.63	0.76	0.83	0.84	0.87	0.83	0.83	0.88

This table reports the predictability results for the aggregate foreign discount on a set of important macro-level variables. Specifically, the aggregate foreign discount in month $t+1$ is regressed on the lag of discount in month t and the set of US market-level variables in month t, including CBOE VIX index, the yields of "A"-rated bonds (CorpYield), and the S&P 500 index, the dollar index. Panel A shows that results from June 2014 to March 2021 and Panel B shows the results for a longer period from January 2005 to March 2021.