Corporate Debt Structure with Home and International Currency Bias*

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Abstract

We explore the consequences of global capital market segmentation by currency for the optimal currency composition of borrowing by firms. Global bond portfolios are driven by the currency of denomination of assets as investors prefer to lend in their home currency or the international currency, the US Dollar. Larger and more productive firms select into foreign currency issuance. International segmentation results in a quantity-dimension of the exorbitant privilege whereby US firms that only issue in the domestic currency benefit from being able to more easily borrow from global investors.

JEL Codes: E42, E44, F3, F55, G11, G15, G23, G28.
Keywords: Capital Flows, Exorbitant Privilege, Home Currency Bias, Reserve Currencies.

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1 Introduction

How do firms decide which currencies to borrow in? In this paper, we present evidence and a minimalist model of international bond issuance based on the idea that investors are segmented by currency. In Maggiori, Neiman and Schreger (2020) we demonstrate that investors around the world have a strong tendency to invest in bonds denominated in their own currency, an effect which we refer to as home-currency bias. This means that if, for instance, a Canadian firm wants to borrow from US investors it will not do so by issuing bonds denominated in Canadian dollars. Instead, it will issue bonds in US dollars.

If there were no frictions in international capital markets, this home currency bias would not affect portfolio choice at the issuer level. Each investor could simply buy the bonds from the issuers it wants to hold and then separately hedge the currency. Maggiori, Neiman and Schreger (2020) provide evidence that this is not the case and investors skew their portfolios towards those issuers that have bonds outstanding in the investor desired currency. Furthermore, firms behave as if they face fixed costs to borrow in foreign currency. Much as how the evidence on large firms sorting into exporting led to a generation of trade theory featuring fixed costs of export, we begin by demonstrating that it is primarily the largest borrowers that issue in multiple currencies.

While investors are segmented by currency and exhibit a strong preference for lending in their own currency, there is an important exception to this rule: the US dollar. The dollar is the one currency that foreign investors appear willing to lend in other than their own. We then demonstrate the strong pecking order of currencies in bond denomination. Firms begin by issuing in their local currency, then turning to the dollar, and then largely the euro.

Motivated by these facts, we sketch a model of borrowing in segmented capital markets. Firms choose the amount and currency of their debt in order to raise capital for production. If they choose to borrow in foreign currency, they need to pay a fixed cost. Since we assume that firms hedge all currency risk, the only reason to borrow in foreign currency is effectively to tap a new set of investors for their debt. The model, therefore, bears a strong resemblance to the Melitz (2003) model of international trade, wherein firms pay a fixed cost to export, with the benefit being the sale of goods to a new set of consumers. Here, rather than selling goods in foreign markets, firms sell their debt. Paralleling the trade literature, smaller, less-productive firms issue debt only in local currency in the home market, just as in trade these firms only sell their goods domestically. There is an endogenous productivity threshold above which firms decide to issue in foreign currency. This threshold varies by country and is lowest in those countries that have relatively shallower domestic debt markets.

The model highlights a benefit of being a firm based in the country that issues an international currency. An international currency, defined here as the currency with the deepest investor pool comprising both domestic and foreign investors, enables firms to borrow more in that currency without generating a large increase in the interest rate they pay. Effectively, this means that firms based in countries other than the United States need to take a costly action and borrow in foreign currency in order to tap foreign sources of capital, but US firms do not. Smaller and less productive firms in the United States experience a reduction in their cost of capital as a result of the dollar's role as an international currency. Importantly, this effect is distinct from the benefits that might accrue to the US government because of low risk free rates. The effect is occurring in the corporate bond market because firms face a different demand curve for debt in different currencies and there is a fixed cost of foreign currency issuance.

The paper proceeds as follows. Section 2 documents the key empirical facts motivating our modeling choices. Section 3 introduces the model. Section 4 extends the baseline model to include currency-specific fixed costs. Section 5 concludes.

1.1 Related Literature

This paper contributes to a number of different strands of the literature. First, it relates to the international role of currencies and the global importance of the US dollar. Ilzetzki, Reinhart and Rogoff (2019) and Ilzetzki, Reinhart and Rogoff (2022) document the role of the dollar as the key anchor of exchange rate regimes. Other contributions include Gourinchas et al. (2011), Eichengreen (2011), Gourinchas and Rey (2007), Coppola et al. (2023), Jiang et al. (2021), Farhi and Maggiori (2018), He et al. (2019), and Hassan (2013). Second, it relates to a broad literature on the currency composition of corporate borrowing. Salomao and Varela (2022) characterize the optimal currency composition of corporate borrowing with a dynamic heterogeneous firm model. Richers (2019) demonstrates that the currency composition of corporate borrowing has explanatory power for firms' return on assets, consistent with the evidence in Hassan et al. (2016) on the connection between exchange rate risk and capital accumulation. Other contributions in the area include works such as Bruno and Shin (2017), Du et al. (2020), Eren and Malamud (2022), Eren et al. (2022), Tietz (2020), Calomiris et al. (2019), Hale and Obstfeld (2016), Kalemli-Ozcan et al. (2016), and Di Giovanni et al. (2022). We also connect to the literature on the hedging of currency risk as in Liao (2020), Sialm and Zhu (2021), Alfaro et al. (2021). Third, it relates to the literature on international finance and macroeconomics with segmented financial markets. Contributions in this area include Gabaix and Maggiori (2015), Greenwood et al. (2023), and Gourinchas et al. (2022), with the literature surveyed in Maggiori (2022). The paper also contributes to the literature on global capital allocation, as surveyed in Florez-Orrego et al. (2023). Finally, the model relates to the large heterogeneous firm trade literature, with the structure of the model most closely related to Melitz (2003).

2 Motivating Facts

In this section, we present three empirical facts that motivate the model. Versions of these facts were first documented in Maggiori et al. (2020) and we update and extend them here. First, we present evidence that bond markets are segmented by currency, with investors displaying a systematic bias towards investing in their own currency or the international currency, the US dollar. Second, we demonstrate that there is size-dependent selection of which firms issue bonds in foreign currency. The larger borrowers do so in more currencies. Third, we demonstrate that there is a pecking order of international currency issuance, with the US dollar being by far the most common second currency to issue in after the domestic currency.

2.1 Data

For this paper, we use the data assembled by the Global Capital Allocation Project.

First, we use the universe of security-level portfolio holdings of mutual funds and exchange-traded funds (ETFs) from Morningstar analyzed by the Global Capital Allocation Project in Maggiori et al. (2020), Lilley et al. (2022), and Coppola et al. (2021). In 2020, these positions account for more than $30 trillion of security holdings. We restrict our attention to 8 developed countries for which we have sufficiently high coverage of funds. We treat the Euro Area as one country for the purpose of this study as investment of Euro Area countries may be routed through funds in Luxembourg and Ireland or their domestic mutual funds.[1]

Second, we use the aggregation algorithm of the Global Capital Allocation Project introduced in Coppola et al. (2021) to map the universe of debt securities issued worldwide to the identity and geography of their ultimate parent issuer. This aggregation algorithm combines data from the Cusip Global Services Associated Issuer database, the Refinitiv SDC Platinum New Issues database, S&P Capital IQ, Dealogic Debt Capital Markets, Bureau van Dijk's Orbis database, Factset Data Management Solutions, and Morningstar. Without this step, the primary concern would be that if a firm issued a bond through a subsidiary with a different firm identifier, then we would consider it as issuance by a distinct firm rather than a subsidiary in the same group. For the economics of the model, the costs of setting up this type of financing subsidiary to tap international markets might be an important part of the fixed cost that the theory aims to capture. The code used to construct this aggregation is available at globalcapitalallocation.com/data.

Finally, for global firm-level bond issuance data, we utilize the dataset constructed for Coppola

[1] Beck et al. (2023) use the administrative Securities Holdings Statistics of the European Central Bank to match the holdings of individual European countries through Luxembourg and Ireland funds. Around half of the fund holdings in Luxembourg and Ireland can be traced to Euro Area investors and half cannot, with the latter portion likely representing immediate claims by non-Euro Area investors. Therefore, holdings that we ascribe to the Euro Area here include investments of non-Europeans routed through Europe.

et al. (2021) combining primary market bond issuance data from Dealogic, SDC Platinum, and Factset Debt Capital Structure. We utilize the Global Capital Allocation Project's security master file to match each bond to its characteristics.

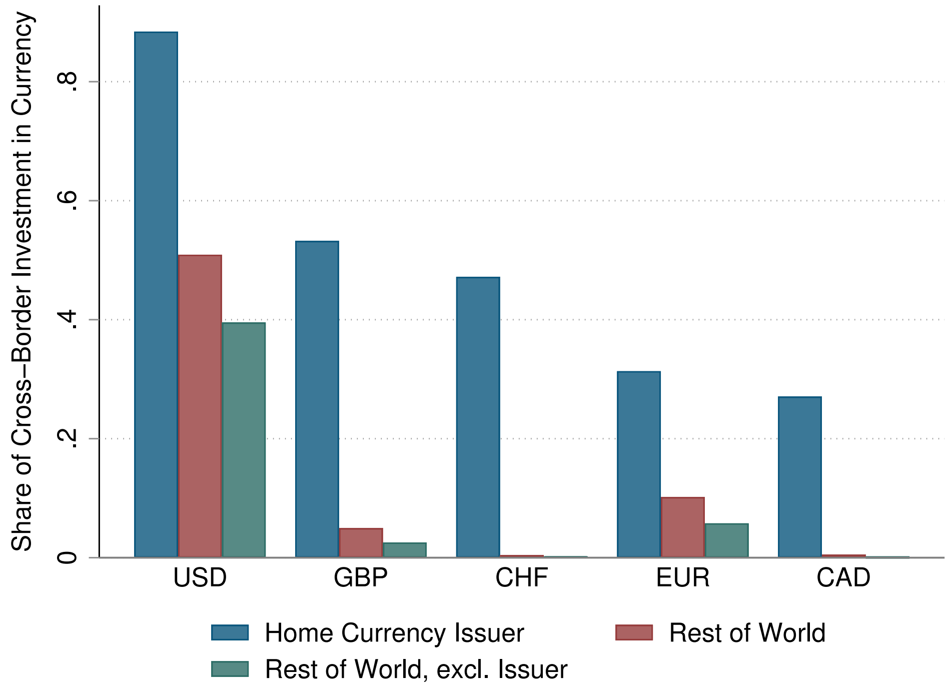
2.2 Home Currency Bias and Segmentation by Currency

We begin by providing evidence that bond markets are segmented by currency. In the context of our model, this evidence illustrates why firms would want to borrow in foreign currency: the desire to access foreign investors. In Figure 1, we document the share of cross-border corporate bond positions on a nationality basis that is in a given currency for a group of five major currencies: the US dollar, British Pound, Swiss Franc, and Canadian dollar. For each currency, the left-most bar (in blue) plots the share of foreign bond positions held by investors domiciled in the country that issues that currency. For example, the blue bar for GBP displays the fraction of foreign corporate bond positions held by UK domiciled investors that are pound denominated. The middle (red) bar plots the share of foreign bond positions held by all other countries in the Morningstar data that are denominated in that particular foreign currency. The right-most (green) bar plots the same share as the middle (red) bar but excludes from the positions the bonds issued by firms from the country that issues that currency. For example, the rightmost (green) bar for the USD is analogous to the middle (red) bar but excludes bonds issued by US entities on a nationality basis.

Two prominent patterns are visible in Figure 1. First, for all currencies, conditional on investing abroad, the investors domiciled in the country that issues a given currency invest a vastly larger share of their bond portfolio in that particular currency than do investors from other countries. Second, the gap between domestic and foreign investors is the smallest for the US dollar. While US investors hold the largest share of their foreign portfolio in US dollars, in excess of 80%, foreign investors also hold a significant share of their portfolio in US dollars. Contrast this with Canadian dollars: while Canadians hold more than 20% of their foreign portfolio in Canadian dollar denominated bonds, other countries' portfolios have negligible allocations in these bonds. This tendency of investors to lend disproportionately in their domestic currency is what we refer to as "Home Currency Bias."

This pattern is stronger than it may first appear for one important reason: issuance by firms in the home country appears in the cross-border portfolio of the rest of the world but not in that of the issuer country. Consider the USD: the United States puts over 80% of its foreign investment in dollars and the rest of the world puts a bit more than half in dollars, but importantly the rest of the world's investment includes investment in the United States in dollars. In the third bar, we remove this component and see an even starker pattern. We refer to the willingness of the world to lend in dollars when they do not lend in their own currency as "International Currency Bias."

Figure 1: Share of Cross-Border Investment by Currency



Notes: This figure measures the share of cross-border investment denominated in each currency. The blue bar reports the share of cross-border investment in a given currency in the portfolio of the issuer of a currency (i.e., for USD, this is the share of American foreign corporate bond investment denominated in US dollars). The red bar, "Rest of World," reports the share of cross-border investments of all countries excluding the issuer of the currency denominated in a given currency (i.e., the share of the cross-border investment portfolio of non-American investors denominated in dollars). Finally, "Rest of World, excl. Issuer," reports the share of cross-border investments of all countries excluding the issuer of the currency denominated in a given currency, excluding investment in the country of the currency issuer (i.e., the share of the cross-border investment portfolio of non-American investors denominated in dollars to countries other than the United States). Data from 2019Q4.

2.3 Size-Dependent Selection into Foreign Currency Issuance

We next turn to demonstrating that firms select into foreign currency issuance, with larger borrowers disproportionately likely to borrow in multiple currencies.[2] To do so, we take the universe of bond issuance globally, aggregated to the firm-group level, and measure borrower size by the notional value of bonds outstanding. In Figure 2, we consider the 500 largest corporate issuers in four currency areas, Canada,[3] the Euro Area, Great Britain, and the United States. In all four panels, we show that the number of currencies that firms borrow in increases sharply with the relative borrowing size. In all currency areas, even among the 500 largest borrowers, the vast majority of firms only borrow in a single currency. Almost always, firms borrowing in a single currency do so in the local currency.

2.4 Pecking Order of Currency Issuance

When a firm decides to raise capital from foreign investors, which currency does it choose? In Figure 3, we show that the pattern of currency of issuance is common across countries by plotting the share of the largest firms that issue in a given currency. Firms overwhelmingly issue in their own currency, mostly targeting domestic investors. In the Euro Area, Canada and the United Kingdom, the next most popular currency is the dollar. For the US, the second most popular currency is the Euro.

By aggregating all firms together, Figure 3 does not reveal the order in which firms choose their currency. In Figure 6, we narrow our focus to firms that exclusively issue bonds in two currencies: their local currency and one foreign currency.[4] While this significantly reduces the sample to a more selective group of firms, it provides a clearer view of the pecking order in currency selection. The pecking order of currency choice is strong: the dollar is the dominant choice of foreign currency for most countries.[5] The exception are the countries closest to the Euro Area. Great Britain firms issue in euros, Norwegian firms in euros and Swedish krona, Swedish firms in euros and Norwegian krona.

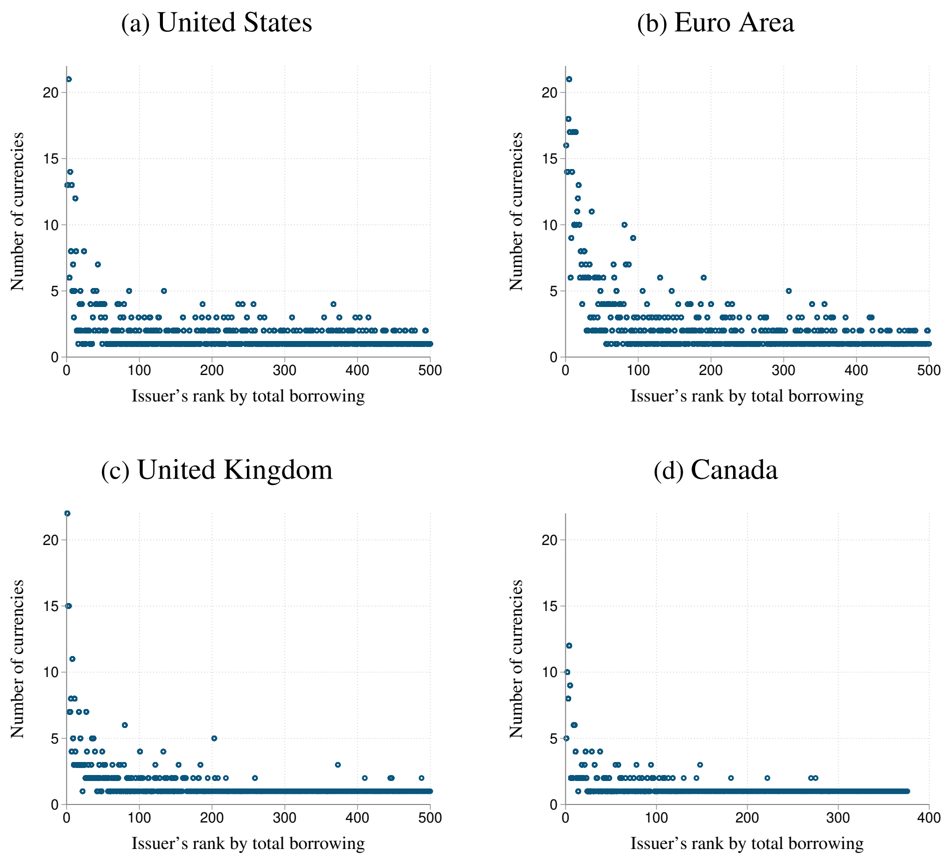
[2]Here, we focus on the amount each firm borrows. See Maggiori et al. (2020) for analysis using measures of firm size like revenue.

[3]There are only 376 firms for Canada.

[4]We restrict our sample to the set of countries where there are at least 15 firms of this type.

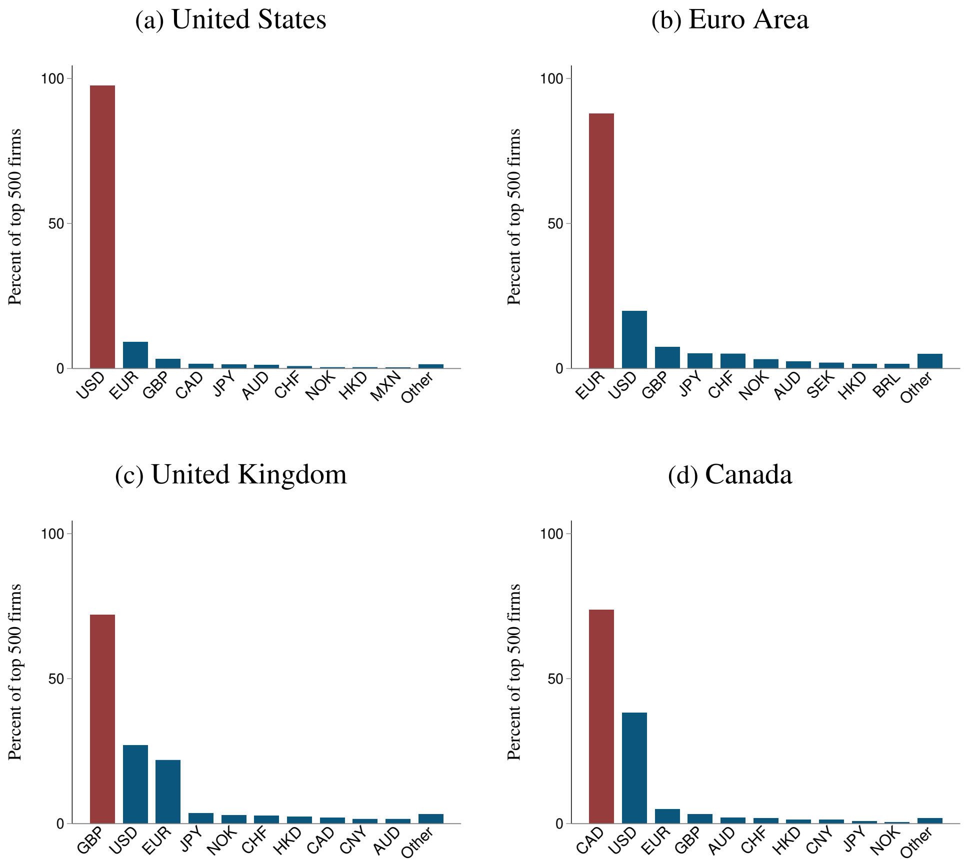
[5]The pecking order of currencies for debt issuance is similar to that found for exchange rate pegs (see Ilzetzki et al. (2019) and Hassan et al. (2023). Whether or not a currency is pegged is likely to affect a firm's issuance decision.

Figure 2: Size-Dependent Selection into Foreign Currency Issuance



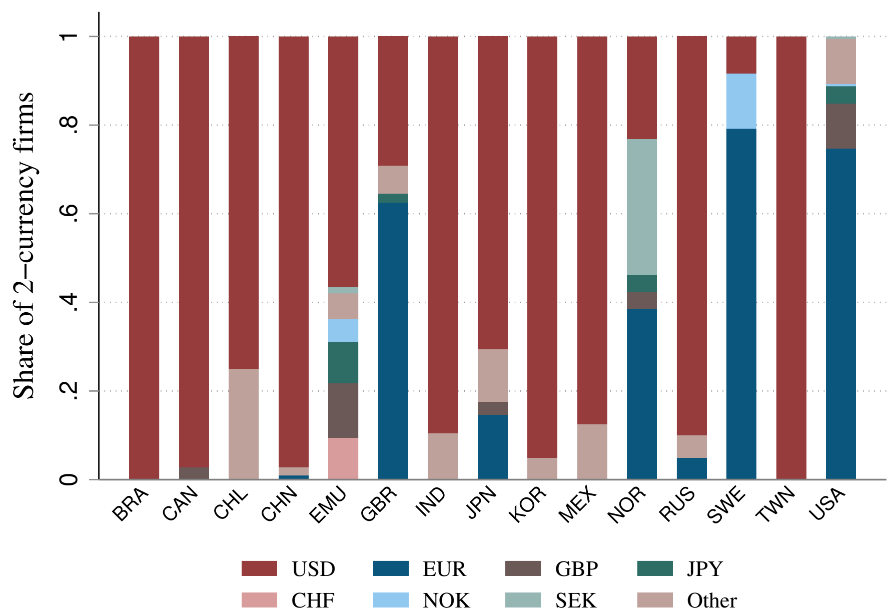
Note: In each figure, firms are ranked on the x-axis in order of their total amount outstanding (or face value) of bonds in 2019Q4, with the largest borrower ranked first. We plot the top 500 ranked firms within four economies: United States (a), Euro Area (b), United Kingdom (c), and Canada (d). Each firm is represented by a blue dot. Firms are analyzed on a nationality basis according to the GCAP aggregation. The y-axis denotes the total number of currencies in which that particular firm has an outstanding bond in 2019Q4.

Figure 3: Currency Denomination of Bonds by Large Firms



Note: This figure plots the share of the largest borrowers from the United States (a), the Euro Area (b), the UK (c), and Canada (d) that have issued bonds in various currencies in 2019Q4. The bars show the percent of top 500 firms within each economy (ranked by total amount outstanding of bonds) that issue in a particular currency shown on the x-axis. The red bar denotes the home currency of the economy, and the blue bars denote foreign currencies. The "Other" category represents percent of top borrowers issuing in any currency outside of the ten charted currencies.

Figure 4: Pecking Order of Currency Choice



Note: This figure examines the currency choice of firms that borrow in two currencies, one of which is their local currency. The figure plots what share of firms choose each currency as their second currency of issuance. On the x-axis, we plot every country which has at least fifteen firms that issue in exactly two currencies (including their local currency) in 2019Q4. The y-axis shows the percent of two-currency issuers that issue in a given currency as their second currency of issuance. Currencies which represent more than nine percent of any country's second currency share are plotted for all countries. The "Other" category includes any currency which does not constitute nine percent of second currency share for any country.

3 A Simple Model of Corporate Bond Issuance

Having documented size-dependent selection in foreign currency borrowing, investor segmentation by currency, and heterogeneity in currency preferences, we now turn toward presenting a model of corporate debt issuance in which investors have a home-currency bias and markets are segmented. Firms face a downward sloping demand for their bonds in each currency: the more debt they issue in each currency the higher the interest rate, a form of price pressure. This demand structure implies that firms would like to borrow in multiple currencies to lower their total borrowing costs. We assume that all firms can borrow in their local currency, but that a fixed cost has to be paid to borrow in foreign currency. As a result, only the firms with the largest desired borrowing do so in foreign currencies, a size-dependent selection in the spirit of Melitz (2003), where in our case the selection is into foreign currency borrowing rather than into exporting.

The model incorporates forces consistent with our empirical findings and generates cross-country differences in the size, number, and borrowing behavior of firms that issue only in their local currency. In particular, local currency borrowers and local currency borrowing are more prominent in countries whose currencies denominate a larger share of global assets, also consistent with our empirical results.

The model is static and all decisions happen in the current period in the absence of uncertainty. All values are expressed in US dollars. Firms differ in their productivity A and borrow to operate a constant returns to scale technology. The firm's output is sold in a perfectly competitive goods market at a price normalized to one.

We assume there are N currencies available to all firms to borrow in, if they choose to do so. Firm p can borrow in currency k by issuing bonds $Q_{k,p}$ denominated in that currency and faces a demand curve from world investors given by:

$$R_{k,p} = \bar{R}_p + \Gamma_k Q_{k,p},$$

where $\bar{R}_p > 1$ is a firm specific interest rate, and $\Gamma_k > 0$. The more debt a firm issues in that currency, the higher the corresponding interest rate. Currencies with large values of Γ_k have shallow markets. Firms borrowing in those currencies experience faster increases in their funding costs as they borrow more compared to borrowers in currencies with deeper markets.

All firms can borrow in their local currencies, but must pay a fixed cost c_{k_p} if they wish to borrow in foreign currency, where we use k_p to denote firm p's local currency. This fixed cost, which has a subscript to allow for the possibility of cross-currency differences in fixed issuance costs, is motivated by the size-dependent likelihood of foreign currency issuance shown in Section 2. The cost represents, for example, the need for firms to have treasury and legal departments of sufficient sophistication to issue and then to hedge these debts.

Firm p solves the issuance problem given by:

$$\max_{\{Q_{k,p}\}_{k=1}^{N}} Y_p - \sum_{k=1}^{N} R_{k,p} Q_{k,p} - c_{k_p} \mathbf{1}_{\{FC_p\}}, \tag{1}$$

$$s.t. \quad Y_p = A_p K_p; \quad K_p = \sum_{k=1}^{N} Q_{k,p},$$

$$R_{k,p} = \bar{R}_p + \Gamma_k Q_{k,p},$$

where $\mathbf{1}_{\{FC_p\}}$ is an indicator for issuance in foreign currency. Since there is no exchange-rate risk, firms care only about the interest differential coming from our assumption of segmented markets and are otherwise indifferent between bonds in any of the currencies. In our environment, and in practice, firms have a meaningful portfolio choice among debt in different currencies even in the absence of exchange-rate risk, such as when comparing debt that would be hedged back to a common currency (see Liao (2020) for empirical evidence).

We analyze the firm problem by breaking it down into two different optimization problems, one for firms that only issue in local currency and one for firms that issue in multiple currencies.[6] A firm that borrows only in its domestic currency optimally borrows an amount:

$$Q_{k,p_{LC}} = \frac{A_{p_{LC}} - \bar{R}_{p_{LC}}}{2\,\Gamma_{k_{p_{LC}}}}, \tag{2}$$

where we used the subscript p_{LC} to denote that firm p is a local currency firm.[7] Firms borrow more if they are more productive (higher A), because they have higher marginal products of capital, as well as if the demand curve for their debt is flatter (lower Γ_k), as this limits the increase in their capital costs as they borrow more.

Firms that borrow in multiple currencies choose the same optimal debt composition regardless of their nationality. The optimal issuance problem of multi-currency firms can be broken down into two separate problems: (i) choosing the optimal currency composition for each unit of debt issued, (ii) choosing the total (in all currencies) debt to be issued. The first problem solves:

$$\begin{aligned} \min_{\{\omega_{k,p}\}_{k=1}^{N}} \quad & \sum_{k=1}^{N} R_{k,p} \quad \omega_{k,p} \\ s.t. \quad & \sum_{k=1}^{N} \omega_{k,p} = 1, \\ & R_{k,p} = \bar{R}_p + \Gamma_k \omega_{k,p} Q_p, \end{aligned}$$

where $\omega_{k,p}$ is the fraction of the firm-p's debt that is denominated in currency k, and Q_p is total firm borrowing across all currencies which in this optimization is taken as given. The first order condition implies that $\Gamma_i \omega_{i,p} = \Gamma_j \omega_{j,p}$ for all currencies i and j. The optimal issuance decision by multi-currency firms equalizes their marginal cost of borrowing across currencies. The optimal fraction of total firm debt that is denominated in currency k is then given by:

$$\omega_{k,p} = \frac{\Gamma_k^{-1}}{\sum_{i=1}^{N} \Gamma_i^{-1}},$$

Currencies with deeper markets (lower Γ_k) account for a larger share of multi-currency firms debt.

[6]The optimization problem in equation (1) is not standard (convex) due to the presence of the fixed cost. The resulting value function is discontinuous. There are two local maxima corresponding to the optimal issuance in just one currency or in all currencies. The global maximum is simply the local maximum that generates the highest profits net of the fixed cost.

[7]We allow firms to decide not to borrow, but they cannot short the production technology. Therefore, $Q_{k,p_{LC}} = 0$ whenever $A_{p_{LC}} - \bar{R}_{p_{LC}} < 0$.

This is consistent with the empirical evidence that the euro and the dollar are the main currencies used by multi-currency firms, even those firms that are not US or Euro Area firms by nationality. In the model, given the absence of other differences, all multi-currency firms choose the same debt composition.

Since the optimal issuance decision by multi-currency firms equalizes their marginal cost of borrowing across currencies, in the data one would not find deviations in their borrowing costs across currencies. The benefits accrue to the firms not on their marginal units of debt, but on the infra-marginal units. Multi-currency firms borrow more at the same interest rate by spreading their debt optimally across all debt markets in different currencies. Liao (2020) provides evidence for this opportunistic issuance in multiple currencies. He shows that firms at each point in time do not completely arbitrage away all debt markets (i.e. yields are not fully equalized), but they systematically attempt to do so by issuing more in currencies that, on a currency-hedged basis, offer a lower yield on their debt.[8]

Given the optimal debt composition, it is convenient to think of multi-currency firms as facing a demand curve for their total debt given by:

$$R_{w,p} = \bar{R}_p + \Gamma_w Q_p,$$
$$\Gamma_w = \omega_{k,p} \Gamma_k = \frac{1}{\sum_{i=1}^{N} \Gamma_i^{-1}}.$$

The slope Γ_w summarizes the depth of the world debt market. The choice of total debt issuance by a multi-currency firm, therefore, is given by:

$$Q_{p_{MC}} = \frac{A_{p_{MC}} - \bar{R}_{p_{MC}}}{2\,\Gamma_w}, \tag{3}$$

where we use the subscript p_{MC} to denote that firm p is a multi-currency firm.

Finally, we turn to the decision by each firm of whether to issue only in local currency or to pay the fixed cost and issue in all currencies. Firms issue in foreign currency if their operating profits under foreign currency issuance less the fixed cost they must pay exceeds their profits when issuing only in local currency. Since the benefit of foreign currency issuance is to allow firms to grow with a gentler increase in their borrowing costs, this option is more valuable for more productive firms that want to borrow and produce large amounts.

The incentives to issue in foreign currency are not identical across countries, even when holding

[8] The yield comparison across any two markets has three sub-components in the data: the firm credit spreads in each local currency, and the cross-currency basis. The cross-currency basis, the direct cost of hedging, used to be small (zero) until the 2008 financial crisis and has been much larger ever since (Du et al. (2018)). We stress that a zero cross-currency basis does not imply that before 2008 firms' borrowing costs, once currency hedged, were always equalized since there could be differences in the local currency credit spreads.

fixed productivity differences. Firms in countries whose currencies have steep demand curves relative to the effective global demand curve Γ_w find foreign currency issuance relatively more attractive.

We define net productivity as $\hat{A}_p = A_p - \bar{R}_p$, and denote by $\hat{A}_p^*$ the net productivity $\hat{A}_p$ that makes a firm indifferent between issuance in local and multiple currencies, and write:

$$\hat{A}_p^* = \left(4c_{k_p}\frac{\Gamma_w \Gamma_{k_p}}{\Gamma_{k_p} - \Gamma_w}\right)^{\frac{1}{2}} = 2\left(c_{k_p}\,\Gamma_{w-k_p}\right)^{\frac{1}{2}}, \tag{4}$$

where $\Gamma_{w-k_p} = \frac{1}{\sum_{i=1, i\neq k_p}^{N} \Gamma_i^{-1}}$ is the effective depth of the foreign debt market from the perspective of a firm with domestic currency k_p (i.e. it includes all N currencies except currency k_p). Firms in each country issue in local currency if and only if their net productivity $\hat{A}_p$ is greater than this threshold, $\hat{A}_p > \hat{A}_p^*$.

We think of the international currency in this environment as having the deepest market or, equivalently, the flattest demand curve (the lowest Γ_k). The benefits of being an international currency in this view are linked to greater worldwide capital allocation to local-currency firms, if the local currency is the international one. We have intentionally muted other important effects on risk-free rates and the role of risk and the safe haven properties of exchange rates. This sharpens the extent to which the benefits of being an international currency analyzed here are distinct from the mechanisms more commonly emphasized in the literature (Caballero et al. (2008), Gourinchas et al. (2011), Mendoza et al. (2009), Maggiori (2017), Farhi and Maggiori (2018), and He et al. (2019)).

3.0.1 Discussion of Model Structure

Operational Hedging While our model focuses on segmented capital markets as the driver of the debt denomination choice, in practice the choice of debt interacts with the real operations of the firm. Colacito et al. (2022) demonstrate that firms tend to borrow more in currencies that correspond to the geographies of their sales. Since they find this pattern to be weaker for firms that invoice more of their sales in their local currency or in a vehicle currency, it suggests that firms utilize the currency of denomination of their borrowing as a hedge against currency fluctuations in their revenue. However, they also find a tilt towards international currencies (like the dollar and euro) above and beyond the geography of sales consistent with the mechanisms highlighted in this paper. In Appendix Table A.7 of Maggiori et al. (2020), we demonstrated that firm size continues to be an important predictor of foreign currency borrowing controlling for a firm's foreign sales share. Extending the model to include export sales denominated in foreign currency along with partially hedged debt would be a natural direction forward.

CIP Failures and UIP Deviations In our benchmark framework, we assume that the risk-free rate R_f is the same across currencies. This can be understood as assuming that covered interest rate parity holds for minimal amounts of bond issuance (before price pressure). Of course, CIP has failed among risk-free rates since the global financial crisis (Du et al. (2018), and surveyed in Du and Schreger (2022)) and this deviation would introduce another reason why firms may wish to tilt their borrowing towards foreign currency. Exploring how risk-free CIP deviations affect corporate currency composition decisions in a segmented market framework would connect the literature on this important failure of arbitrage to real corporate decisions, as in Keller (2021). In the context of our model, this could materialize as heterogeneity in a currency-specific intercept rather than the different slopes that are the focus of this paper. The present model assumes complete hedging and so borrowing is driven by firm-level deviations in CIP. However, if firms do not fully hedge, uncovered interest rate parity deviations may drive borrowing decisions. See Salomao and Varela (2022) for a detailed treatment of corporate debt issuance decision with UIP failures.

3.1 Illustrating the Model Mechanism

In this section, as an illustration, consider the case of only two currencies ($N = 2$), the US Dollar and the Euro. We further assume that the fixed cost of foreign borrowing is equal across currencies and firms and given by c. With only two currencies, the expression for the effective multi-currency slope of the demand curve simplifies to

$$\Gamma_w = \frac{\Gamma_{USD}\Gamma_{EUR}}{\Gamma_{USD}+\Gamma_{EUR}}.$$

Multi-currency firms set their debt shares to:

$$\omega_{USD,p} = \frac{\Gamma_{EUR}}{\Gamma_{USD}+\Gamma_{EUR}}; \qquad \omega_{EUR,p} = \frac{\Gamma_{USD}}{\Gamma_{EUR}+\Gamma_{USD}}.$$

The profits of US firms that only borrow in the dollar, Euro Area firms that only borrow in the euro, and multi-currency firms in both countries are given by:

$$\begin{aligned}
\pi_{USD,p_{LC}} &= \frac{\hat{A}_p^2}{4\Gamma_{USD}}, \\
\pi_{EUR,p_{LC}} &= \frac{\hat{A}_p^2}{4\Gamma_{EUR}}, \\
\pi_{p_{MC}} &= \frac{\hat{A}_p^2}{4\Gamma_w} - c = \frac{\hat{A}_p^2\left(\Gamma_{USD}+\Gamma_{EUR}\right)}{4\Gamma_{EUR}\Gamma_{USD}} - c.
\end{aligned}$$

We can then solve for the productivity threshold for a US and Euro Area firm to be indifferent between borrowing local currency only or multiple currencies as $\pi_{USD,p_{LC}} = \pi_{p_{MC}}$ and $\pi_{EUR,p} = \pi_{p_{MC}}$, respectively. With two currencies, we can write these currency-specific productivity thresholds as

$$\hat{A}^*_{USD} = 2\left(c\,\Gamma_{EUR}\right)^{1/2},$$
$$\hat{A}^*_{EUR} = 2\left(c\,\Gamma_{USD}\right)^{1/2}.$$

Taking the ratio of these thresholds, we find that

$$\frac{\hat{A}^*_{USD}}{\hat{A}^*_{EUR}} = \left(\frac{\Gamma_{EUR}}{\Gamma_{USD}}\right)^{1/2}.$$

Since the dollar is the international currency, we imagine that $\Gamma_{USD} < \Gamma_{EUR}$ in the context of the model. This implies that in the Euro Area, compared the to the US, relatively less productive (and smaller) Euro Area firms already issue in foreign currency.

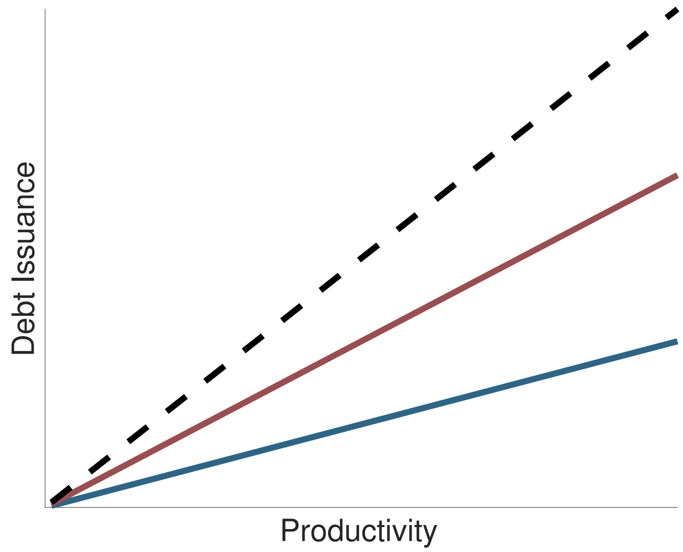
We present the intuition of this two-currency version of the model graphically in Figure 5. In Panel (a), we plot the optimal debt issuance of firms as a function of their productivity depending on whether they borrow in EUR, USD, or both. Because for a given level of borrowing, the interest rate is highest in EUR, borrowers that only issue in EUR borrow the least for any given level of productivity. USD-only firms borrow more, with multi-currency borrowers issuing the most debt, minimizing their interest rate by spreading their borrowing across the two currencies. In Panel (b), we plot the profit function of firms employing these different borrowing strategies. Profits increase more gradually for EUR borrowers than USD borrowers as the higher borrowing rates reduce firm size. These Euro Area firms find it optimal to pay the fixed cost at a relatively lower productivity threshold than US firms that only borrow in dollars. This endogenous productivity threshold mirrors the exporting decision in Melitz (2003). Firms whose home-currency has shallower debt markets compared to foreign currencies find it optimal to pay the fixed cost to tap global capital markets at a lower firm scale.

3.2 Towards Aggregation and Quantification

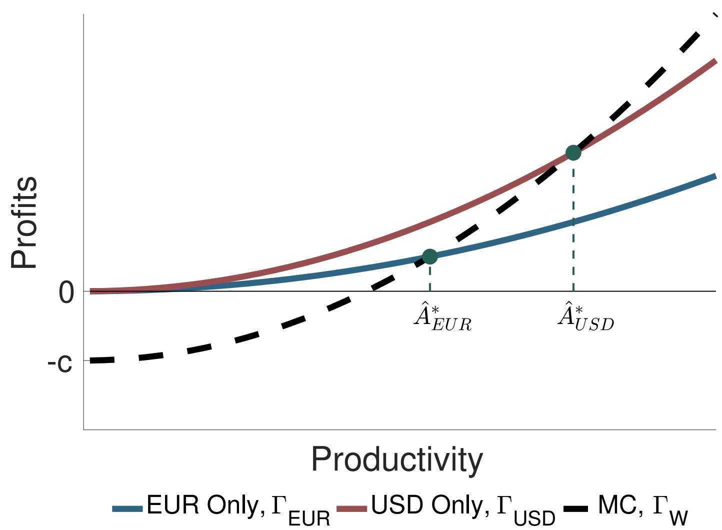
While leaving the model in partial equilibrium, we show how one can perform a simple aggregation and move towards quantification. We view this exercise as providing guidance for what one would need to measure to estimate aggregate consequences of moving towards becoming the international currency issuer.

To allow us to connect with country-level aggregates, we next make the assumption that net productivity $\hat{A}_p$ in country i is distributed Pareto with shape parameter α_i and minimum net pro-

Figure 5: Model Mechanisms: Two-Country Example



(a) Debt Issuance



(b) Profits

Note: Panel (a) plots the debt issuance policy function for firms conditional on borrowing in EUR only, USD only or in both currencies. Panel (b) plots the profits achieved by firms under the different issuance policies. The example sets $\Gamma_{EUR} = 0.6$, $\Gamma_{USD} = 0.3$ and $c = 0.25$.

ductivity $\hat{A}_i^{\text{Min}}$ so the CDF of the net productivity distribution in country i is:

$$g_i(\hat{A}_p) = 1 - \left(\frac{\hat{A}_p}{\hat{A}_i^{\text{Min}}}\right)^{-\alpha_i},$$

where $g_i(\hat{A}_p) = 0$ if $\hat{A}_p < \hat{A}_i^{\text{Min}}$ and where $\alpha_i > 2$. The corresponding PDF is $f_i(\hat{A}_p) = \alpha_i \frac{(\hat{A}_i^{\text{Min}})^{\alpha_i}}{(\hat{A}_p)^{\alpha i+1}}$. We index firms in each country by their net productivity $\hat{A}_p$, denote by $Q_i(\hat{A}_p)$ the amount of total borrowing done by a firm of type $\hat{A}_p$ resident in country i and denote by $\hat{A}_i^*$ the net productivity threshold where firms in country i are indifferent between borrowing only in the local currency (LC) or borrowing in all currencies (MC).[9]

We assume country i to have a unit mass of firms and write total borrowing B_i by country i as:

$$\begin{aligned}
B_i &= \int_{\hat{A}_i^{\text{Min}}}^{\infty} Q_i(a) f_i(a) da \\
&= \int_{\hat{A}_i^{\text{Min}}}^{\hat{A}_i^*} Q_i(a) f_i(a) da + \int_{\hat{A}_i^*}^{\infty} Q_i(a) f_i(a) da \\
&= \underbrace{\int_{\hat{A}_i^{\text{Min}}}^{\hat{A}_i^*} \frac{a}{2\Gamma_i} f_i(a) da}_{\text{Borrowing from LC firms}} + \underbrace{\int_{\hat{A}_i^*}^{\infty} \frac{a}{2\Gamma_w} f_i(a) da}_{\text{Borrowing from MC firms}} \\
&= B_i^{LC} + B_i^{MC},
\end{aligned}$$

where we have substituted in from equations 2 and 3. The term B_i^{LC} does not denote local currency borrowing but, rather, denotes total borrowing by LC-only firms. We write the total amount of LC borrowing L_i as:

$$L_i = B_i^{LC} + \omega_{i,p_{MC}} B_i^{MC},$$

where $\omega_{i,p_{MC}} = \Gamma_w / \Gamma_i$ denotes the share of borrowing done by the MC firms in country i in that country's local currency, and we write the amount of FC borrowing F_i as:

$$F_i = (1 - \omega_{i,p_{MC}}) B_i^{MC}.$$

Integrating, we find that the borrowing of LC firms can be written as:

$$B_i^{LC} = \frac{\alpha_i}{\alpha_i - 1} \frac{\left(\hat{A}_i^{\text{Min}}\right)^{\alpha_i}}{2\Gamma_i} \left(\left(\hat{A}_i^{\text{Min}}\right)^{1-\alpha_i} - \left(\hat{A}_i^*\right)^{1-\alpha_i} \right).$$

[9] Since we assume net productivity to always be above $\hat{A}_i^{\text{Min}}$, the threshold for multi-currency borrowing is now more generally defined as $\hat{A}_i^* = \max\left(\hat{A}_i^{\text{Min}}, 2\left(c_{k_p}\,\Gamma_{w-k_p}\right)^{\frac{1}{2}}\right)$, so that for sufficiently low fixed costs all firms in a country might be borrowing in foreign currency. In the analysis below, we focus on the case $\hat{A}_i^{\text{Min}} < 2\left(c_{k_p}\,\Gamma_{w-k_p}\right)^{\frac{1}{2}}$.

Similarly, we find that the borrowing of MC firms can be written as:

$$B_i^{MC} = \frac{\alpha_i}{\alpha_i - 1} \frac{\left(\hat{A}_i^{\text{Min}}\right)^{\alpha_i}}{2\Gamma_w} \left(\hat{A}_i^*\right)^{1-\alpha_i},$$

where we have used the assumption $\alpha_i > 2$. The value of local currency borrowing equals:

$$L_i = B_i^{LC} + \omega_{i,p_{MC}} B_i^{MC} = \frac{\alpha_i}{\alpha_i - 1} \frac{\hat{A}_i^{\text{Min}}}{2\Gamma_i}. \tag{5}$$

This shows that the fixed cost c_i is irrelevant for the total amount of local currency borrowing.

Each firm's value added (gross of fixed costs) in our model is firm profits. Aggregating across all firms in a country, we define GDP of country i (Y_i) as the sum of value added. Under optimal issuance, firm profits excluding the fixed cost are $A_p Q(\hat{A}_p) - (\bar{R}_p + \Gamma Q(\hat{A}_p))Q(\hat{A}_p) = \frac{Q(\hat{A}_p)\hat{A}_p}{2} = \frac{\hat{A}_p^2}{4\Gamma}$. Aggregating, we have:

$$\begin{aligned} Y_i &= \underbrace{\int_{\hat{A}_i^{\text{Min}}}^{\hat{A}^*} \frac{a^2}{4\Gamma_i} f_i(a) da}_{\text{Output from LC firms}} + \underbrace{\int_{\hat{A}^*}^{\infty} \frac{a^2}{4\Gamma_W} f_i(a) da}_{\text{Output from MC firms}} \\ &= Y_i^{LC} + Y_i^{MC}. \end{aligned} \tag{6}$$

We start by solving for the output of the LC firms:

$$\begin{aligned} Y_i^{LC} &= \int_{\hat{A}_i^{\text{Min}}}^{\hat{A}^*} \frac{a^2}{4\Gamma_i} f_i(a) da \\ &= \alpha_i \left(\hat{A}_i^{\text{Min}}\right)^{\alpha_i} \frac{1}{4\Gamma_i} \int_{\hat{A}_i^{\text{Min}}}^{\hat{A}^*} a^{1-\alpha_i} da \\ &= \frac{\alpha_i}{\alpha_i - 2} \left(\hat{A}_i^{\text{Min}}\right)^{\alpha_i} \frac{1}{4\Gamma_i} \left[\left(\hat{A}_i^{\text{Min}}\right)^{2-\alpha_i} - \left(\hat{A}^*\right)^{2-\alpha_i} \right]. \end{aligned} \tag{7}$$

Next, we solve for the output of the MC firms:

$$Y_i^{MC} = \frac{\alpha_i}{\alpha_i - 2} \left(\hat{A}_i^{\text{Min}}\right)^{\alpha_i} \frac{1}{4\Gamma_w} \left(\hat{A}^*\right)^{2-\alpha_i}.$$

Finally, we add them together to get:

$$Y_i = \frac{\alpha_i}{\alpha_i - 2} \left(\hat{A}_i^{\text{Min}}\right)^{\alpha_i} \frac{1}{4} \left[\frac{1}{\Gamma_i} \left(\hat{A}_i^{\text{Min}}\right)^{2-\alpha_i} + (4c_i)^{\frac{2-\alpha_i}{2}} \left(\Gamma_{w-i}\right)^{-\frac{\alpha_i}{2}} \right]. \tag{8}$$

The share (by count) of LC firms in country i, s_i, is given by:

$$s_i = 1 - \left(\frac{\hat{A}_i^{\text{Min}}}{\hat{A}_i^*} \right)^{\alpha_i} = 1 - \left(\hat{A}_i^{\text{Min}} \right)^{\alpha_i} (4 c_i \Gamma_{w-i})^{-\frac{\alpha_i}{2}} . \tag{9}$$

The total fixed cost paid by MC firms in country i is $(1 - s_i) c_i$.

A country with an international currency, which has a low Γ_k, benefits from its LC firms scaling up without needing to borrow internationally. Other countries access those benefits only once their firms pay the fixed costs of issuing in foreign currency (of which the international currency, the dollar, is a big part of the portfolio). The differences are more muted if the country is dominated by a few extremely productive firms, because those borrow in all currencies and are a large contribution to country level output.

While the model delivers the unambiguous result that firms from the issuer of an international currency (lower Γ_k) earn higher profits for any given level of productivity, the present paper stops short of estimating the magnitude of these effects at the firm or country level. The aggregation results in this section, however, demonstrate how this framework could be used by the future literature to measure the quantity dimension of the exorbitant privilege.

The results above deliver key observable aggregates, such as the amount of local currency borrowing, foreign currency borrowing, and the share of multi-currency borrowers in terms of model parameters. These quantities can be measured using public data and commercially available datasets such as those described in Section 2. These moments, along with macro aggregates such as GDP, can help to pin down the shape of the productivity distribution. To complete a quantification, one would need to estimate two classes of novel parameters: the slopes of the currency-specific yield curves, Γ_k, and the size of the fixed cost of issuing in foreign currency, c_k. While the structure of the model, and in particular the pecking order results of Figures 3 and 4, may indirectly shed light on these Γ_k, direct estimation of these parameters may be feasible (i.e. Gorodnichenko and Ray (2018)). Finally, to quantify the benefits of being an international currency, one would also need to estimate the size fixed cost of borrowing in foreign currency. Since the problem that we study is nearly isomorphic to estimating the fixed cost of entry into export markets, it should be promising to apply methodologies from the trade literature to infer the magnitude of these costs.

As the magnitude of the benefit of issuing the international currency has long been challenging to measure, we hope that additional structures like this framework may open the door to progress in the area. Through the lens of the model, one could quantify the benefit the US receives from issuing the international currency as the increase in firms profits or GDP the US experiences as a result of the global demand for dollars, or one could explore how much more European firms would produce (or make profits) if the Euro was an international currency like the dollar. We think these are exciting questions for the future literature.

3.3 Investor Demand

While maintaining the model in partial equilibrium, it is useful to consider where the demand curve for the debt of each firm might be coming from and how the Γ_k is related to the popularity of a particular currency with investors worldwide.

Consider a set-up in which each investor type is fully characterized by its specialization in a firm and currency pair (k,p). Investors have bonds in the utility function, such that an investor of type (k,p) solves the following problem:[10]

$$\max_{q_{k,p}} \quad q^f R_f + q_{k,p} R_{k,p} - \frac{1}{2}\gamma \left(q_{k,p}\right)^2 - q_{k,p}x_p$$
$$s.t. \quad 1 = q^f + q_{k,p},$$

where R_f is the rate of return on a risk-free asset that is perfectly elastically supplied and identical across currencies, and q^f and $q_{k,p}$ are the investor's holdings of the risk-free asset and the bonds of firm p denominated in currency k, respectively. The term $\frac{1}{2}\gamma\left(q_{k,p}\right)^2$ is a disutility due to satiation typical of bonds in the utility function set-up. The last term $x_p \geq 0$ allows for a linear disutility attached to the bonds of firm p; this disutility is common across all bonds of firm p irrespective of currency and we include it for generality. The optimality condition implies: $R_{k,p} = R_f + x_p + \gamma\, q_{k,p}$. The term x_p acts in reduced-form as a firm specific credit spread. We define $\bar{R}_p = R_f + x_p$ as the firm's benchmark rate, the rate at which the firm could borrow if markets were perfectly integrated and the demand for debt infinitely elastic.

We assume that for each firm p and currency k there is a mass of investors Θ_k that are specialists. We allow the mass to vary by currency, but not by firm. Aggregating the individual investor demand curves to find the aggregate demand curve for k,p bonds:

$$R_{k,p} = \bar{R}_p + \frac{\gamma}{\Theta_k} Q_{k,p} = \bar{R}_p + \Gamma_k Q_{k,p}, \tag{10}$$

where $\Gamma_k = \frac{\gamma}{\Theta_k}$. Currencies with few specialist investors have shallow markets and large values of Γ (Gabaix and Maggiori (2015)). Firms borrowing in those currencies will experience faster increases in their funding costs as they grow compared to borrowers in currencies with deep markets. While this set-up matches by assumption the facts on home-currency and international-currency bias from Maggiori et al. (2020), by varying the mass of investors, it leaves open for future work

[10] Bonds in the utility function are a convenient if reduced form foundation for a flexible demand curve, for recent examples see: Stein (2012); Engel (2016); Farhi and Maggiori (2018); Nagel (2016).

to provide the deeper foundations for the reduced-form preferences that we simply assume.

4 Currency-Specific Fixed Costs

We extend the model to include currency-specific fixed costs. This extension allows us to better connect the model to the staggered entry of firms into foreign currencies, but the structure of the model is otherwise unchanged. If firms need to pay a fixed cost c for each foreign currency they borrow in, the profit maximization problem becomes:[11]

$$\max_{\{Q_{k,p}\}} A_p K_p - \sum_{k=1}^{N} R_{k,p} Q_{k,p} - \sum_{k=1}^{N} c\mathbf{1}_{\{Q_{k,p}>0 \text{ and } k\neq LC\}} \tag{11}$$

with the production function and currency-specific interest rate schedules unchanged. In this case, conditional on borrowing, the optimal quantity issued takes the same form for all currencies (with a different slope Γ_k in the denominator):

$$Q_{k,p} = \frac{A_p - \bar{R}_p}{2\Gamma_k}. \tag{12}$$

Because the fixed cost is now currency-specific, we now need to consider whether firm profits are higher when borrowing in a given currency and paying the fixed cost than avoiding debt issuance in that currency entirely. This reduces to the simple condition of whether productivity exceeds a currency-specific cut-off:

$$\hat{A}_p \geq 2\left(c\Gamma_k\right)^{1/2}. \tag{13}$$

For notational simplicity, we order the local currency first ($k = 1$), and then order the remaining currencies in inverse order of the slope of the corresponding interest rate schedule (i.e. the foreign currency with the deepest markets or lowest Γ_k is $k = 2$, and so on). We then have to consider three cases. First, if $\hat{A}_p < 2\left(c\Gamma_2\right)^{1/2}$, then a firm only borrows in its local currency, and we define its optimal number of currencies to borrow in to be $n^* = 1$. Second, if $\hat{A}_p \geq 2\left(c\Gamma_N\right)^{1/2}$ then the firm optimally borrows in all $n^* = N$ currencies. Third, firm p optimally issues in an interior $n^* > 1$ currencies if there is a foreign currency $n^* < N$ such that $\hat{A}_p \geq 2\left(c\Gamma_{n^*}\right)^{1/2}$ and $\hat{A}_p < 2\left(c\Gamma_{n^*+1}\right)^{1/2}$.

From this point forward, the model behaves analogously to our baseline models as firms optimally allocate their borrowing across the currencies in which they borrow. In particular, total firm borrowing is given by

[11] Here, we assume the fixed cost c is the same for each firm and currency.

$$Q_p = \sum_{i=1}^{n^*} \frac{A_p - \bar{R}_p}{2\Gamma_i} = \frac{A_p - \bar{R}_p}{2} \sum_{i=1}^{n^*} \frac{1}{\Gamma_i}. \tag{14}$$

We can also equivalently define the share of total debt that a firm borrows in any given currency $k \in [1, ..., n^*]$ as

$$\omega_{k,p} = \frac{Q_{k,p}}{Q_p} = \frac{\Gamma_k^{-1}}{\sum_{i=1}^{n^*} \Gamma_i^{-1}}.$$

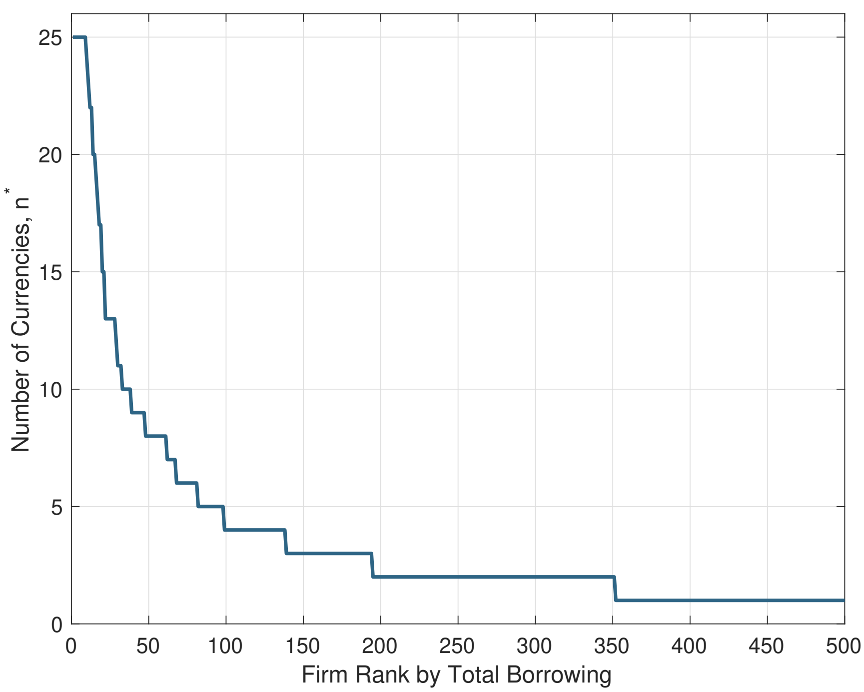
This is the same formula as before except the number of currencies borrowed in is n^* instead of N. Firms in this model extension behave similarly to the main model, but now the optimal number of currencies is endogenously determined. Conditional on a firm choosing the optimal number of currencies to borrow in, the model outcomes are observationally equivalent to the baseline model with the fixed cost in the original model for the set $n^* - 1$ given by $c_{k,p} = (n^* - 1)\, c$.

We explore optimal currency choice in a simple numerical example. In Figure 6, we consider 500 firms' decisions to borrow in 25 potential currencies. Each firm's productivity is drawn from a Pareto distribution and the slope of the interest rate schedule increases linearly across the 25 currencies. In this numerical example, we are able to qualitatively replicate the patterns in Figure 2. With a currency-specific fixed cost, not only do more productive firms borrow more, but they do so in more currencies. In this extension, we also have a perfect pecking order of currencies, as we abstract from any sources of firm heterogeneity other than productivity, such as the geography of sales. While this example stops short of a calibration, we view it is a proof-of-concept that models of segmented markets with currency-specific fixed costs hold the potential to explain the capital structure choices of global firms. We posit that the reality likely lies between our baseline model and this extension: although there are compelling reasons to believe that each additional currency incurs a fixed cost, it is also plausible that common costs (such as establishing relationships with dealer banks for hedging currency risks) may span multiple currencies.

5 Conclusion

This paper explores the consequences of investor segmentation by currency for corporate debt issuance decisions. We present a minimalist model of firms choosing their optimal currency debt composition when facing downward sloping demand curves and fixed costs to issue in foreign currencies. We demonstrate how the international role of currencies generates an additional "quantity" channel for the exorbitant privilege, distinct from typical risk-free rate mechanisms. Firms based in countries with international currencies face better debt market conditions, enabling smaller firms to scale up production without tapping foreign markets. The model matches key stylized facts

Figure 6: Number of Foreign Currencies Issued with Currency-Specific Costs



Note: We provide a simple numerical simulation of firms' decision to borrow from 25 potential currencies. The model parameters include a fixed cost value of $c = 1$, with a different slope (Γ_k) for each currency that ranges from 0.1 to 5 linearly, 500 total firms, and random draws from a Pareto distribution for firm productivity levels with shape value $\alpha = 2.5$ and scale (or minimum) value of $\hat{A}_i^{\text{Min}} = 1$. We the set interest rate intercept $\bar{R}_p = 0.05$.

about size-dependent selection into foreign currency issuance.

There are several potential areas to explore using this framework for corporate borrowing in a world of segmented markets. First, in the present framework, the key difference between currencies is the elasticity of their interest rates with respect to issuance size, Γ_k. Countries with shallower markets correspond to countries with a high Γ_k. This means there should be significant cross-country heterogeneity in the firm size, borrowing amount, and productivity of the marginal firm selecting into foreign currency issuance. In particular, we should see emerging market firms and even firms from developed countries with smaller domestic bond markets, selecting into foreign currency issuance at a much smaller size than firms from the United States or the Euro Area. This offers a clear path for future empirical work. Second, in the present framework, we assume that firms hedge all of their foreign currency issuance back into their local currency. Although researchers have a limited picture on the degree of firm currency hedging, hedging is most likely incomplete and heterogeneous. With complete hedging, exchange rate volatility is irrelevant for firm profits. Extending the model to allow for a joint foreign currency issuance and hedging decision is a natural direction forward.

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