Who Holds Sovereign Debt and Why It Matters*

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Abstract

This paper studies the impact of investor composition on the sovereign debt market. We construct an aggregate data set of sovereign debt holdings by foreign and domestic bank, non-bank private, and official investors for 95 countries over twenty years. We find that private non-bank investors absorb most of the increase in sovereign debt supply. We further find that foreign non-bank investor demand is most responsive to the yield for emerging market (EM) debt, while yield elasticity for all investors is much lower for advanced economy debt. We show that EM sovereigns are highly vulnerable to losing their foreign non-bank investors.

JEL-Codes: F34, G11, G15, F41
Keywords: Sovereign debt, Banks and Non-banks, Advanced Economies and Emerging Markets

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1 Introduction

The ability to issue debt is an important instrument at the government's disposal. Sovereign borrowing can help buffer the economy from the impact of adverse macroeconomic shocks. Conversely, indebtedness can also make a country vulnerable to financial distress as crisis episodes have illustrated. Indeed, the sharp increase in fiscal expenditures and debt issuance during the recent pandemic period, as well as concerns from the fallout of war, has brought more urgency to understanding how a government can borrow. Answering this question requires knowledge of who invests in sovereign debt and how these investors impact borrowing costs. Therefore, this paper provides an analysis of who holds sovereign debt and what this investor composition implies for governments' borrowing costs.

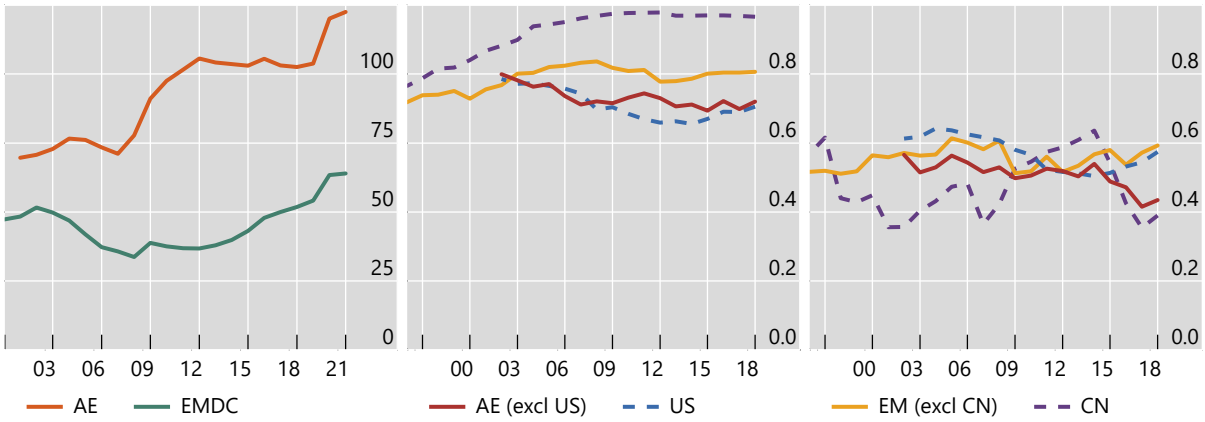
We begin by documenting the investor base of government debt around the world and establishing some new empirical regularities. For this purpose, we first assemble a dataset that distinguishes the holders of each country's sovereign debt by foreign and domestic investors and into three subgroups within those categories. Specifically, the data set categorizes these three subgroups into private banks, other private investors that we term "non-banks", and official creditors consisting largely of central banks and international organizations like the World Bank.[1] Assembling these data series provides 1744 country-year observations for which we can decompose the holders of debt, spanning 95 countries over 1991-2018.[2]

Figure 1 shows both the growing importance of government debt as well as how the investor base has changed. Specifically, Panel (a) shows that aggregate government debt as a proportion of GDP has increased to the highest levels in recent history, spurred on by the Covid-19 pandemic for both for advanced and emerging economies. Furthermore, the types of investors have changed significantly over time. For example, as Panel (b) shows, the share of domestic versus foreign investors has evolved with marked differences between advanced economies (AEs) and emerging markets (EMs). In particular, the share of aggre-

[1] This decomposition follows that of Arslanalp and Tsuda (2012) and Arslanalp and Tsuda (2014).
[2] A partial decomposition is available for 151 countries.

gate debt holdings by domestic investors has decreased for AEs while that same share has increased for EMs. The share of debt held by non-bank investors, shown in panel (c) shows less of a steady trend but more short-term fluctuations.

Figure 1: Trends in General Government Debt



(a) Debt/GDP (b) Share Held Domestically (c) Share Held by Non-banks

Note: Panel (a) of this figure plots the time-series of general government debt-to-GDP ratio for the advanced economies, emerging market and developing countries from IMF WEO. Panel (b) plots the share of general government debt held by domestic investors by country group. Panel (c) plots the share of general government debt held by non-banks. Panels (b) and (c) consist of balanced samples of 15 AEs (including the US) and 15 EMs (including CN).

In this paper, we use these data to document how increases in sovereign debt are absorbed by the six different investor groups (foreign vs domestic and bank vs non-bank vs official). Strikingly, we find that Non-Bank private investors increase their holdings of sovereign debt at significantly higher rates than any other group, including private banks. Furthermore, this absorption rate is greater than proportional to their average holdings. Across all countries for instance, when there is an increase in debt, 69% of the increase is allocated to non-bank investors, even though they make up only 46% of holdings on average. For increases in foreign-held debt, 75% of the increase is due to Non-bank investors, even though they comprise only 42% of all foreign holdings. By contrast, banks take up less than their average holdings of sovereign debt. Overall, banks hold 28% of the debt on average, but only take up 20% of new debt on the margin. Moreover, this pattern holds for increases in foreign and domestically held debt as well as in subsamples of AEs and EMs separately. Furthermore, the general results are robust to accounting for currency valuation effects on

foreign-held debt. Thus, when the supply of government debt increases, private Non-bank investors play a significantly larger role than other investors in holding this new level of supply in the government debt market.

These aggregate results highlight the importance of Non-bank private investors, a large and heterogeneous group. To disentangle the behavior of different investors within this group, we turn to a more granular data set of Euro Area investors.[3] This data set allows us to disaggregate the Non-Bank investor group into non-financial corporations, pensions and insurance companies, households, and a category of other financial institutions, largely representing investment funds. With this more disaggregated group of investors, we find once again the importance of Non-bank private investors as the largest marginal investor group. Furthermore, our analysis indicates that within this group, financial institutions such as investment funds drive the large response of non-banks.[4]

In order to understand the impact on borrowing costs of the aggregate investor groups, we develop a conceptual investor framework that allows us to uncover the yield elasticity of each group. Similar to Koijen and Yogo (2020), we consider a two-step investor decision process. Initially, investors decide how much of their portfolio to allocate to sovereign debt holdings in total. Given this decision, investors choose the countries in which to lend based upon country-specific variables. We then cast the framework into an empirically estimable demand function format and explore the response of holdings to bond yields and other macro-financial factors for AE and EM debt separately.

One challenge with this estimation is that investor demand depends endogenously on the sovereign debt yield-to-maturity. To address this issue, we construct an instrument exploiting the fact that our data set provides all of the holders of a given sovereign's debt. Specifically, this construction allows us to estimate the market value of holdings for each investor group, take these predicted values, and solve for the pseudo-yield that would

[3] Although we use these data to supplement our analysis of sovereign debt holdings, Faia, Salomao, and Veghazy (2022) provide a much more granular study of Euro Area investor portfolio holdings.

[4] By contrast, households and non-financial corporations appear to play little to no part in sovereign debt holdings.

clear the market. This pseudo yield serves as an instrument for the actual yield in our investor demand estimation. Exogeneity is implied by under the plausible assumption that the sovereign's macro characteristics are exogenous to investors. Moreover, we show that this instrument has good predictive power.

Our analysis provides striking results that highlight important differences between the demand for AE and EM sovereign debt. For the EM sovereign debt, all investors increase their holdings with higher yield, but at different rates. Specifically, Non-bank investor holdings increase by the most. Computing the elasticity of response to the yield, we find that Foreign Non-bank investors have the highest elasticity at 1.68, while those of the other investor groups are below one.

By contrast, estimates of demand for AE debt show quite different behavior. In particular, demand by the banking sector and the official sector are barely affected by the sovereign bond yield. For Banks, this pattern may reflect holdings of AE sovereign debt as liquid assets to satisfy liquidity needs and liquidity regulation requirements. Similarly, in the official sector, central banks may hold AE sovereign debt as foreign reserves. Clearly, these sectors do not hold AE sovereign debt for yield and thus do not respond much to yield changes. Nevertheless, both Domestic and Foreign Non-bank holdings of AE sovereign debt are responsive to yields, again pointing to the importance of these investors.

Finally, we combine our estimates of yield elasticity with the marginal holder decomposition to compute the borrowing cost exposure faced by sovereigns. We show that the overall exposure of a government is a weighted average of the yield elasticity of each investor group, with the weights determined by the investor's marginal share. Given the significant response of investors to yield across investor groups for EM government debt, we focus on sovereign debt exposure for these countries.

This analysis shows that sovereigns have a high exposure to their investors, with overall borrowing costs rising more than proportional to debt increases (1.38% to a 1% debt increase). To isolate the impact of specific investor groups, we examine two types of coun-

terfactuals for the cost exposure: relying on just one type of investor, and removing just one type of investor. These counterfactuals highlight important relationships. First, since foreign non-banks have the highest elasticity and a high marginal participation, removing these creditors from the set of EM sovereign debt investors would increase borrowing costs the most. Thus, EM sovereigns are vulnerable to losing these investors, for example in the event of a risk-off shock.

The structure of the paper is as follows. Section 2 describes the data and some basic stylized facts, including a decomposition that highlights how much government debt each investor group absorbs on the margin. It also reports the same decomposition using disaggregated non-bank investor holdings in the Euro Area. Section 3 sets up a simple conceptual framework to explore investor demand in the sovereign debt market and reports estimates of this demand by investor groups for AE and EM sovereign debt. Section 4 combines the country-level investor demand identification with the marginal absorption estimates to develop the counterfactual analysis. Concluding remarks follow.

Related Literature Since our paper studies investor behavior of sovereign debt holdings, it relates to a number of different strands of research in macro-finance. First, it contributes to a growing literature that uses the demand system approach to asset pricing introduced by Koijen and Yogo (2019) and applied in domestic and international financial markets as in Koijen and Yogo (2020), Koijen, Richmond, and Yogo (2020), Koijen, Koulischer, Nguyen, and Yogo (2021), Jiang, Richmond, and Zhang (2020), and Bretscher, Schmid, Sen, and Sharma (2020). While our estimation of different investor groups' demand and the construction of instruments follows the basic approach of this literature, we exploit the market clearing condition from the issuer side. This identity arises naturally in our data because the supply of debt for each country is matched to the full breakdown of holdings by investor groups. As such, this feature contrasts with the common data structure in the literature that focuses upon the portfolio allocation of specific investor groups. See for example, Hau and Rey (2006), Maggiori, Neiman, and Schreger (2020), Coppola, Maggiori, Neiman, and

Schreger (2021). We instead choose a borrower-focused approach that analyzes the investors of a given country government debt supply to understand the exposure of issuers. Clearly, both approaches complement each other.

Given this borrower focus, our analysis also advances the literature on risk exposure by developing a new measure of Borrowing Cost Exposure. In the existing literature, exposure studies typically focus upon risk faced by a firm as measured by the impact of risk measures on its stock return or profits. See for example, Bodnar and Gentry (1993), Bodnar, Dumas, and Marston (2002) and Adams and Verdelhan (2021). To our knowledge, we are the first to develop and implement a borrowing cost exposure based upon differences in investor preferences.

Our paper is also related to the literature on investor demand for Advanced Economy sovereign debt. This strand of research includes, for example, Krishnamurthy and Vissing-Jorgensen (2012), Jiang, Krishnamurthy, and Lustig (2018), Jiang, Lustig, Van Nieuwerburgh, and Xiaolan (2019), Liu, Schmid, and Yaron (2020), and Liu (2021). Consistent with the view in this literature that banks and the official sector hold government debt for liquidity and other purposes, we show that holdings by these groups are relatively insensitive to yields. We also analyze the role of the global financial intermediaries and financial conditions, as highlighted by Miranda-Agrippino and Rey (2021), Bruno and Shin (2015), Gabaix and Maggiori (2015), Fang and Liu (2020), in driving the holding of sovereign debt by different investor groups. By contrast to these papers, we also find that Non-bank private investors increase holdings of AE sovereign debt in response to increases in yield. We therefore contribute to the AE sovereign investor demand literature by demonstrating the importance of Non-bank investors.

We also further the defaultable sovereign debt literature that has highlighted the importance of different types of investors. For instance, this literature often focuses on the role of foreign investors, particularly foreign banks. See, for example, Arellano (2008), Arellano and Ramanarayanan (2012), Arellano, Bai, and Mihalache (2020), Eaton and Gersovitz (1981),

Cruces and Trebesch (2013), Mendoza and Yue (2012). On the other hand, the sovereign-bank nexus ("doom-loop") literature focuses on domestic bank investors as in, for example, Gennaioli, Martin, and Rossi (2014),Perez (2014), Fahri and Tirole (2018), Chari, Dovis, and Kehoe (2020), Bocola (2016), Brunnermeier et al. (2016). A further area focuses on explaining the reserve accumulation behavior of foreign official investors. See Ghosh, Ostry, and Tsangarides (2017), Wooldridge (2006), Dominguez, Hashimoto, and Ito (2012), to name a few. We contribute to these literatures by showing the importance of each investor to the borrowing of sovereigns.

Lastly, we contribute to the literature by constructing a comprehensive dataset of investor groups' holdings in order to analyze the impact of investor composition on sovereign financing cost and fragility. As noted above, this data decomposition is close to Arslanalp and Tsuda (2012) and Arslanalp and Tsuda (2014). In order to examine the impact of marginal investors and their demand, however, we construct a data set that dates back earlier and encompasses a broader set of countries. This more expansive base allows us to better estimate the impact of investor composition on sovereigns' financing costs.[5] It also complements other studies based upon securities level issuances aimed at foreigners such as Maggiori, Neiman, and Schreger (2019) and Maggiori, Neiman, and Schreger (2020). Relative to these data sets, our holdings measures provide balance sheet data that allow analysis of domestic investor groups as well as foreigners.

2 Evolving Composition of Sovereign Debt Investor Groups

We begin with a general discussion of the investor group definitions and the data, as well as some basic empirical regularities about how the investor holdings vary with issuances.

[5]These papers also analyse a funding shock scenario, but largely emphasize the role of foreign investors. We emphasize the role of non-bank investors, particularly noting the composition of the marginal investors (as opposed to average holdings) as important for understanding debt financing exposure of sovereigns.

2.1 Investor Group Definitions

In order to focus on the evolving behavior of foreign and domestic holders of government debt, we consider three basic investor groups categorized as: (1) banks; (2) private non-banks; and (3) official creditors. We describe briefly these three categories below before detailing their construction in the data.

The first investment group is comprised of private banks. These institutions are often considered primary intermediaries for debt markets and have therefore been the focus of both the Emerging Market (EM) and Advanced Economy (AE) branches of sovereign debt studies. In the literature on emerging market borrowing, foreign global banks are often modeled as the primary creditor. In advanced economies, capital regulation typically incentivizes domestic banks to hold domestic government debt due to their zero risk weight, potentially creating a bank-sovereign doom loop.[6] Below, we call the foreign and domestic investors in this group, "Foreign Banks" and "Domestic Banks", respectively.

The second group of private investors is a combination of all private investors who are not banks. These investors are not subject to bank regulatory restrictions but may face other constraints depending on the nature of their business. Overall, this investor group encompasses financial institutions such as pension funds and insurance firms, endowments, mutual funds, and hedge funds, as well as non-financial entities like corporations and households. We refer to the domestic and foreign counterparts of this diverse investor group as, respectively, "Domestic Non-Banks" and "Foreign Non-Banks".[7]

Finally, we consider official creditors, a group made up of central banks and supranational government agencies. Specifically, the home official creditor group is simply the "Domestic Central Bank" while the "Foreign Official" group includes foreign central banks, other governments, and international organizations such as the World Bank and Interna-

[6] Bank regulation typically uses risk-weighted assets to compute capital ratios. So, acquiring an asset with a zero risk weight does not reduce the bank's regulatory capital ratios, though it can affect other bank constraints like the leverage ratio. On the bank-sovereign doom loop, see Fahri and Tirole (2018) and the Related Literature section above.

[7] Below, we study these individual groups on a more disaggregated basis using data for Euro Area investors.

tional Monetary Fund.

We focus on the issuers of debt, rather than track the securities held by investors. Specifically, we are interested in how the holdings of these investor groups respond to changes in debt and the attributes of the issuing country. For this purpose, we study the portion of debt on the government's balance sheet held by different investors. In particular, our data set provides sovereign debt holdings of each country disaggregated by the investor group. It will therefore be useful to define the debt of a given country, indexed by j, held by each investor group, indexed by i, as H_j^i. Then, clearly, the investor groups for country j debt can be aggregated across the investor groups to provide a measure of the holdings of each country's creditors as:

$$\overline{H}_j \equiv \sum_{i=1}^{I} H_j^i \tag{1}$$

where I is the number of investor groups. For example, in our aggregate data set above, $I = 6$ since we have 3 types of investors with domestic and foreign counterparts for each. Moreover, since these holdings account for the outstanding debt of sovereign j, the total supply of debt D_j must equal the holdings of debt held by Home and Foreign investors through the accounting identity:

$$D_j = \overline{H}_j, \forall j \tag{2}$$

Thus, these holdings allow for a decomposition of domestic and foreign investor groups using the shares of banks, non-banks, and official holdings. For this purpose, let lower cases refer to the shares of each sovereign's debt held by investor group i as: $h_j^i \equiv H_j^i / D_j$. Then clearly these investor shares sum to one. That is,

$$1 = \sum_{i=1}^{I} h_j^i \tag{3}$$

We will use the decompositions of the shares in equations (2) and (3) below to uncover the changing patterns of ownership over time. In Section 4, we will combine this information with demand estimates to uncover the risk to borrowers. Before doing so, we describe the data.

2.2 Data

The annual data series for the debt and holding groups come from various sources. Here we describe briefly the overall approach in constructing these data series, although a more complete discussion can be found in Appendix A. The general approach follows the work of Arslanalp and Tsuda (2012, 2014). We modify their methodology in order to broaden the time period and sample of countries. We point interested researchers to their papers and associated database for a full description of the approach.

The overall total debt levels are derived primarily from the IMF Historical Public Debt Database (HPDD) that provides debt-to-GDP for a large number of countries over a long time horizon. We multiply this series by GDP from the World Bank to recover the value of debt in current US dollars.[8] The foreign total holdings are constructed following the methodology in Avdjiev, Hardy, Şebnem Kalemli-Özcan, and Servén (2018) (hereafter, AHKS). Constructing the foreign holdings with this methodology relies on data such as the IMF International Investment Position (IIP) data, the Quarterly External Debt Statistics (QEDS), and the BIS international banking and international debt securities statistics. The domestic total holdings are the complement of this series to total debt, and are computed as the difference between total debt and foreign debt.

The domestic and foreign holdings are further decomposed into the three groups described above. Data for foreign bank holdings are estimated using the approach in AHKS. Foreign official holdings for advanced economies and China are taken directly from Arslanalp and Tsuda (2012, 2014), capturing the use of such debt as foreign reserves. For all other countries, we use the sum of bilateral and multilateral lending from the World Bank Debtor Reporting System (DRS). Foreign Non-Bank holdings are the difference between these measures and total foreign holdings.

Sovereign debt holdings by domestic banks and domestic central banks are taken from

[8]For some countries, the HPDD data series stop in 2015. For these countries, we obtain post-2015 values by applying the growth rate in total debt from the Quarterly Public Debt Statistics (QPSD), which has excellent coverage of the recent period, to the last available level computed from the HPDD.

the IMF's International Financial Statistics (IFS) dataset, supplemented with data from the official websites of central banks when the data was incomplete. The domestic total is computed as the difference between the total debt and the foreign-held debt. Domestic Non-Bank holdings are measured as the difference between the domestic total and the sum of domestic banks and domestic central banks. All holdings in the baseline data series are measured in current US dollars.[9]

Overall, this construction provides a balanced sample of 95 countries from 1995 to 2018 and a full unbalanced sample from 1991 for 152 countries. For some of the analysis, we split the sovereigns into 3 groups: advanced economies (AEs), emerging markets (EMs), and developing countries (DCs).

2.3 Investor Trends and Marginal Holders

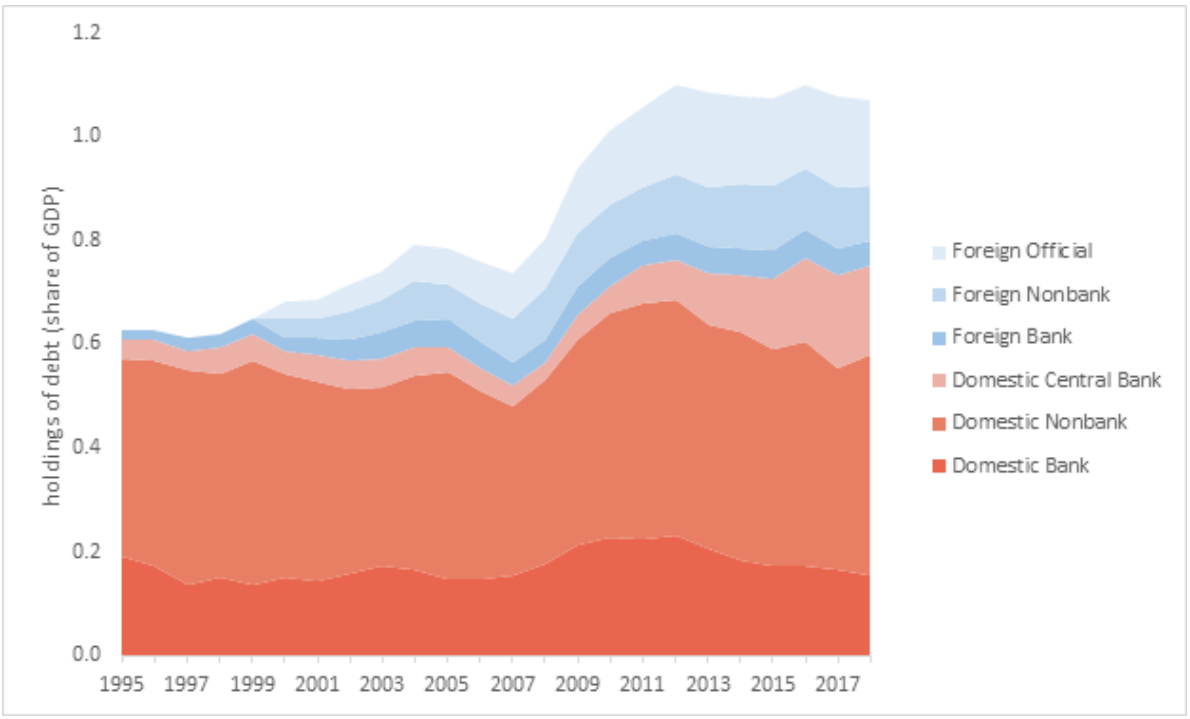
Given these definitions, we now examine the relative behavior of each investor group's holdings as government debt changes. Panel (a) of Figure 2 begins by showing the average holdings-to-GDP shares of advanced economy (AE) investors while Panel (b) of the same figure shows the same for the emerging and developing economies (EMDC). These figures show distinctive differences within the groups. For both groups, the foreign bank and non-bank shares have been stable, though small, over time.[10] However, the proportion of foreign official holdings has become larger for AEs, as central banks have increased their holdings of safe haven government debt for reserve purposes, while that proportion has declined for emerging markets. Strikingly, the share of domestic non-banks has increased over time for EMs relative to AEs, perhaps reflecting growing financial development within these economies. By contrast, the AE holdings of domestic central banks has expanded over time, likely due to the use of unconventional monetary policies.

These trends raise an important question. When the size of debt increases, which in-

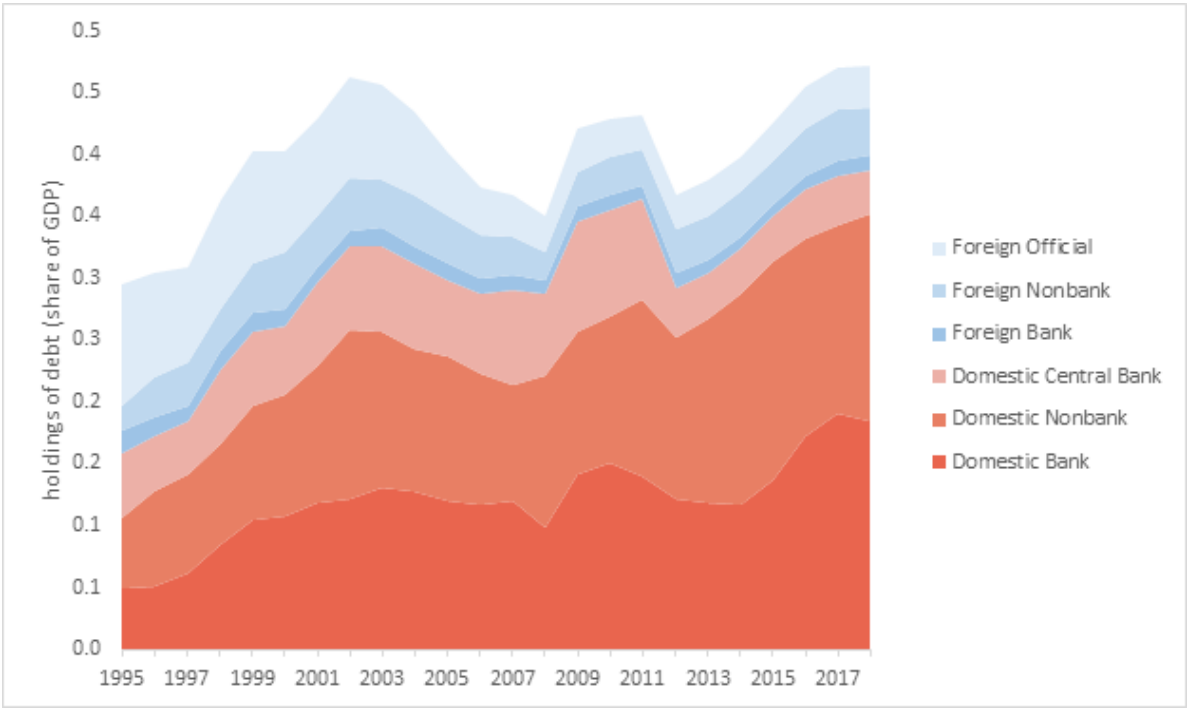
[9] Alternative measures are also constructed to evaluate robustness to currency valuation effects, as described below.

[10] Foreign official data for advanced economies are not available until 2000, so foreign holdings are not fully reported before that point.

Figure 2: Trends in Sovereign Debt



(a) AEs



(b) EMs and DCs

Note: This Figure plots the debt-to-GDP ratio held by different investor groups for advanced economies (Panel a) and emerging market and developing countries (Panel b).

vestors absorb the additional amount? In other words, who are the marginal investors for the sovereign? To explore this question, we regress the change in debt held by each investor group on the change in total debt:

$$\frac{H^i_{jt} - H^i_{jt-1}}{D_{jt-1}} = \alpha_j + \alpha_t + \beta^i_0 \frac{D_{jt} - D_{jt-1}}{D_{jt-1}} + \epsilon^i_{jt}, \quad \forall i \tag{4}$$

where the subscript t indicates time, and where α_j and α_t represent country fixed effects and time fixed effects, respectively. Using the identities in equations (1), (2), and (3)), the sum of the investor groups add up to the total so that:

$$\frac{D_{jt} - D_{jt-1}}{D_{jt-1}} = \sum_{i=1}^{I} \frac{H^i_{jt} - H^i_{jt-1}}{D_{jt-1}}. \tag{5}$$

Since all of the debt is absorbed by some investor, the coefficients estimated from this regression will sum to 1: $\sum_{i=1}^{I} \beta^i_0 = 1$. As a result, each coefficient reflects the marginal holding response of each investor group to variations in the supply of debt.

Table 1 shows the results of this regression. Panel A provides a baseline estimate labeled "All" based upon a balanced sample of countries. The first two columns provide these results for an aggregated group of domestic and foreign investors, respectively. Columns (1) and (2) show that for every additional unit of debt supplied, 60% is absorbed by domestic investors while the other 40% is picked up by foreign investors. In AEs and DCs, this split is roughly equal, whereas for EM sovereign debt, domestic investors take over two-thirds of additional debt.

Breaking down foreign and domestic investors by type in columns (3) through (8) reveals additional insights. For the "All" country estimates, non-bank investors tend to be the most important, taking on 39% and 30% of additional debt holdings for domestic and foreign entities, respectively. As reported in the following rows, decomposing estimates into country groups shows the relative importance of investor groups across these countries. In particular, foreign non-banks are more important for AEs and DCs, while domestic non-banks matter more for EMs.

Table 1: Marginal Holders of Sovereign Debt

	(1) Dom	(2) For	(3) DomBK	(4) DomNB	(5) DomCB	(6) ForBK	(7) ForNB	(8) ForCB
Panel A: Marginal Share								
All	0.60***	0.40***	0.16***	0.39***	0.05***	0.04***	0.30***	0.06***
	(0.05)	(0.05)	(0.04)	(0.05)	(0.01)	(0.01)	(0.05)	(0.02)
AE	0.50***	0.50***	0.02	0.39***	0.09	0.06**	0.40***	0.04
	(0.12)	(0.12)	(0.03)	(0.09)	(0.07)	(0.02)	(0.12)	(0.03)
EM	0.68***	0.32***	0.21***	0.43***	0.04**	0.05***	0.24***	0.04
	(0.05)	(0.05)	(0.05)	(0.07)	(0.02)	(0.02)	(0.05)	(0.03)
DC	0.50***	0.50***	0.11***	0.34***	0.05***	0.01	0.40***	0.09***
	(0.09)	(0.09)	(0.03)	(0.09)	(0.02)	(0.02)	(0.10)	(0.02)
Panel B: Average Share								
All	0.57	0.43	0.22	0.28	0.07	0.06	0.18	0.19
AE	0.55	0.45	0.19	0.32	0.04	0.10	0.21	0.14
EM	0.61	0.39	0.26	0.28	0.07	0.06	0.17	0.16
DC	0.49	0.51	0.16	0.24	0.09	0.04	0.17	0.30

Note: Panel A of the table reports the regression coefficients for Equation (4) for each investor group. The first two columns represent domestic and foreign investors, respectively. Columns (3) through (8) correspond to the six investor groups. Standard errors clustered at the country level are reported in the parentheses. Panel B of the table reports the average share of holding by each investor group.

More important, however, is the role of investor groups relative to each other. Here, Non-bank investors again demonstrate the most striking results. For example, Foreign Non-banks play a much stronger role in expanding holdings in response to new debt than do Foreign Banks. In particular, the takeup of new EM debt by foreign non-bank investors is 24% of the total in contrast to only 5% by foreign banks. These findings are in stark contrast to a view that foreign banks play the biggest role in the EM debt market. And lastly, foreign official investors are more important as marginal investors for DCs, where they serve as an important source of financing (9% of the increased supply). These patterns are illustrated in panel (a) of Figure 3.

These results consider the marginal decomposition of investor groups in response to an expansion in country debt and therefore one might wonder whether these holdings are consistent with average holdings. To answer this question, Panel B of Table 1 reports the average holdings by investor group over the period. As these numbers show, the large marginal contribution of non-bank investor holdings are greater than the average holdings. For example, in the baseline "All" results, the average holdings of Domestic Non-banks and Foreign Non-banks sum to only 46% (that is, $0.28 + 0.18$). At the same time, the marginal holdings reported in Panel A are jointly 69% ($0.39 + 0.30$). This pattern is clearly robust across all the remaining decompositions including AE, EM, and DC.

Given that these shares are averages over the sample period, another possibility is that these shares have changed over time, and the marginal share is capturing an increasing trend in the average non-bank holding share over time. Therefore, we compared the averages to the most recent shares in the sample. These more recent shares for the EM country debt were essentially the same as the averages. By contrast, the Non-bank shares for the AE country debt were slightly lower, implying that trends cannot explain the marginal responses for these countries. Therefore, the finding that the Non-bank sector is the most important investor on the margin is not generated by trends but rather by variations in debt holdings.

The responses reported in Table 1 simply capture variations in holdings by investor groups measured in a common currency. However, such changes in holdings may arise from currency valuation effects for debt that is originally issued in local currency. Indeed, the importance of valuation effects in the balance sheet adjustment of countries has been shown in a number of papers (e.g. Gourinchas and Rey (2007)).[11] We therefore return to examine more carefully the effects of changes in market valuations in Section 3.2.

Nevertheless, at this general level, we first consider whether currency changes may impact the general marginal investor findings in Table 1. To see the potential impact of cur-

[11] Valuation effects have also been shown to be important more generally in the portfolio allocation of investors using disaggregated data on holdings of specific investors. See, for example, Curcuru, Thomas, Warnock, and Wongswan (2011) for an analysis of US portfolio investment in foreign equity markets.

rency, we define the impact of currency valuation on holdings of sovereign debt j by investor group i as $CV^i_{j,t}$. Then we can rewrite the general relationship for holdings above as:

$$H^i_{jt} - H^i_{jt-1} = \Delta\tilde{H}^i_{jt} - CV^i_{j,t} \tag{6}$$

where $\Delta\tilde{H}^i_{jt}$ is the change in holdings excluding currency valuation effects.

To compute $\Delta\tilde{H}^i_{jt}$, we make two assumptions. First, domestic investors hold sovereign debt in local currency. Second, the local currency share of foreign investors may be proxied by the BIS data on the share of local currency among bonds issued in international financial markets. In the absence of data on the currency breakdown by investor group, we treat this share as applying equally across all foreign investors.

Under these assumptions, we then calculate the currency valuation adjustment as:

$$CV^i_{jt} = H^i_{jt-1} \times LC^i_{jt-1} \times \frac{S_{jt} - S_{jt-1}}{S_{jt-1}}$$

where LC^i_{jt} is country j local currency share of debt investor group i's holding of country j's debt, and $S_{j,t}$ is the price of currency j in terms of dollar, both at time t. We define the currency valuation adjusted change in total debt as $\Delta\tilde{D}_{jt} = \sum_{i=1}^{I} \Delta\tilde{H}^i_{jt}$. The regression Equation (4) is in turn written as

$$\frac{\Delta\tilde{H}^i_{jt}}{D_{jt-1}} = \alpha_j + \alpha_t + \beta^i_0 \frac{\Delta\tilde{D}_{jt}}{D_{jt-1}} + \epsilon^i_{jt}, \quad \forall i \tag{7}$$

Appendix subsection B.2 reports these regression results on the marginal investor of sovereign debt taking into consideration the currency valuation effect. As these results show, the general finding that Non-banks have an larger response is robust to this currency valuation adjustment.

2.4 Marginal investors during different circumstances

While these relationships consider the responses of investor holdings over all periods, the composition of marginal investors may change depending on the time period or circumstance. Indeed, the literature on marginal investors has highlighted their importance and

differences during crises and recessions (e.g., Bruno and Shin (2015) and Miranda-Agrippino and Rey (2021).) During these times, banks may cut back lending and central banks may intervene to stabilize the economy. Moreover, these cut-backs may impact the overall responses of investor holdings of government debt. Therefore, we examine the sensitivity of investor group holdings to crises and other special circumstances.

To examine marginal investor responses during these time periods, we estimate Equation 4 separately when the country-year is, alternatively, (i) in a recession and not; (ii) during a banking crisis and not; and (iii) in different sub-periods.[12] We consolidate the results of these regressions into Figures 3 (panels (b) and (c)) and Figures 4, relegating detailed reporting of the regression coefficients to Tables B1, B2, and B3 in Appendix B.

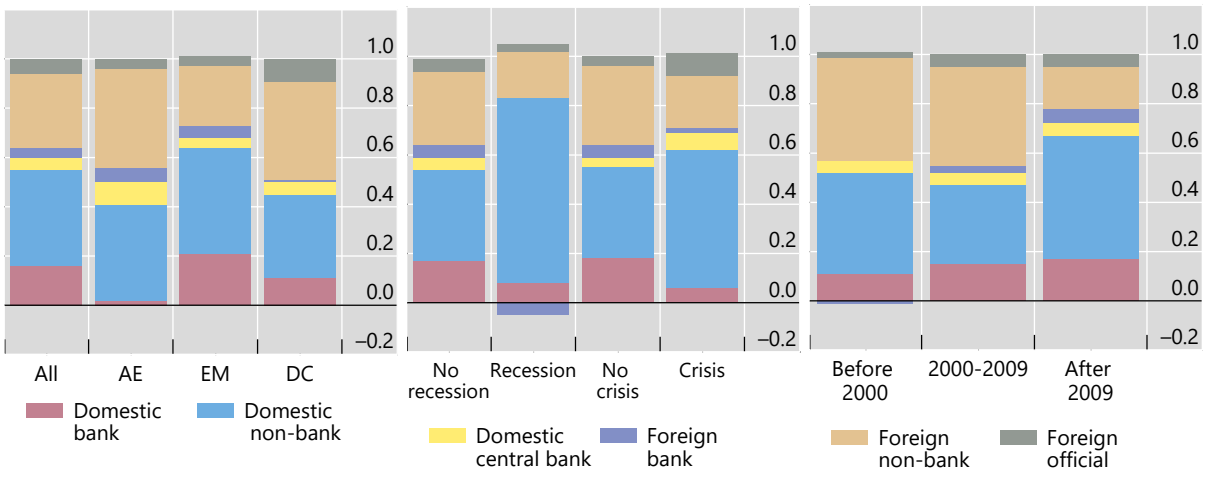
The figures highlight important patterns. Both Advanced Economies and Emerging Market sovereign debt show marked differences in their marginal investors across different circumstances. For example, domestic non-banks absorb more emerging market debt during recessions or banking crises, whereas domestic banks decrease their absorption. In advanced economies, the domestic central bank becomes a key investor during a crisis. After the Global Financial Crisis (GFC), both domestic banks and domestic non-banks increase the share of debt they absorb. A similar pattern holds for foreign official lenders in the case of advanced economies. This latter trend may reflect increased holdings of debt in the form of reserves by foreign central banks, particularly those in EM countries.[13]

For developing countries, the role of domestic investors expands considerably during recessions. The pattern over time is also interesting. From 2000-2009, foreign investors play a larger role in picking up debt issued by DC sovereigns, but after the GFC domestic investors' share increases substantially as foreign non-bank investors contract. The share of foreign official has been increasing over time.

[12] We define a country as in a recession if its real GDP growth rate is negative, and a country as in a banking crisis if there is or was a banking crisis in the past 3 years. Banking crises indicators follow Laeven and Valencia (2020). For the sub-periods, we break the sample up into periods around the Global Financial Crisis (GFC), in particular before 2000, from 2000-2008, and after 2009.

[13] If these data were extended through 2020, we might see a much higher marginal share for the domestic central bank, as some in AEs purchased amounts roughly equal to the net issuance of debt during that year (see the IMF Fiscal Monitor).

Figure 3: Marginal Holders



(a) By country group (b) Crisis and recession (c) By time period

Note: This figure plots the regression coefficients in Equation (4) for all countries under different circumstances. Panel (a) shows the coefficients for each investor group during recession and non-recession times, and during crisis and non-crisis times. A recession is defined by a negative real GDP growth rate. A crisis is identified following Laeven and Valencia (2020), which includes a banking crisis, a currency crisis, and a debt crisis. Panel (b) shows the coefficients for each investor group in three subsamples: pre-2000, 2000-2009, and post-2009.

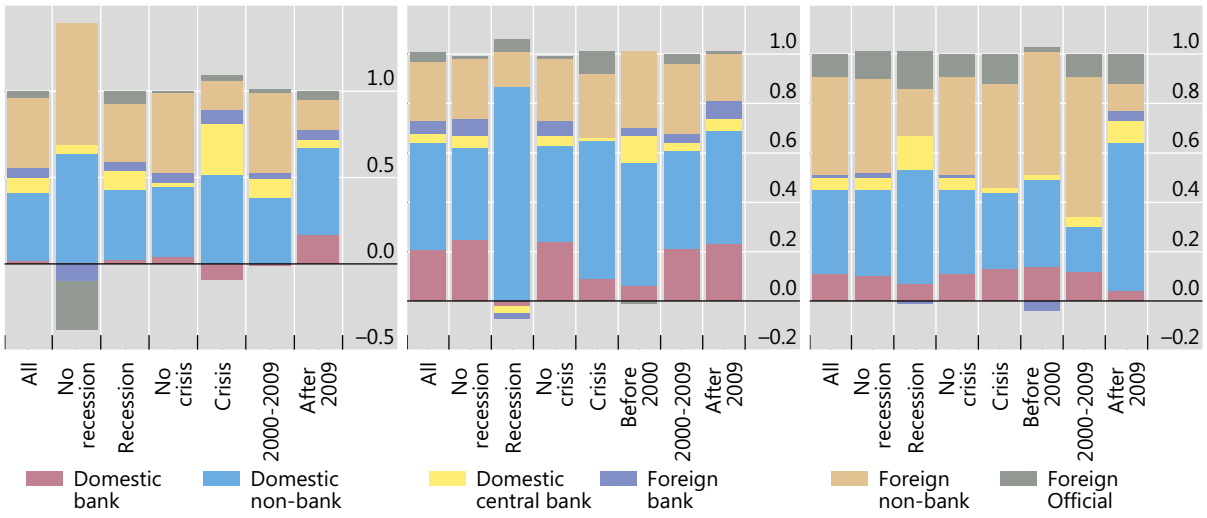
The basic finding that Non-bank investors are important marginal investors continues to hold across these different periods. The next section examines this investor group in more detail.

2.5 The Role of Non-Bank Investors

As we showed above, private investors who are not banks play an important role in the sovereign debt market. The important role of non-bank private investors implied by these results raises the obvious questions: who are these investors and how do they respond to changes in sovereign debt? To shed light on this question, we turn to a more disaggregated data set: the Euro area securities holding statistics produced by the European Central Bank.[14] This source provides data on the holdings of securities by sector of the holder, by the type and sector of the security, and by the residence of the security issuer. Thus, we can observe the holdings of individual government debt for all Euro area investors within

[14] Faia, Salomao, and Veghazy (2022) analyze these data for corporate bonds in the euro-area finding significantly different behavior for mutual funds relative to insurance and pension funds, similar to our results below for sovereign bonds.

Figure 4: Marginal Holders



(a) Advanced economies (b) Emerging markets (c) Developing countries

Note: This figure plots the regression coefficients in Equation (4) under different circumstances for advanced economies, emerging market economies, and developing countries in Panels (a) through (c). A recession is defined by a negative real GDP growth rate. A crisis is identified following Laeven and Valencia (2020), which includes a banking crisis, a currency crisis, and a debt crisis.

a given holder group. Specifically, the non-bank sector in this data has the more granular breakdown: (a) households and non-profits, (b) insurance and pensions, (c) non-financial corporations; and (d) "other financial institutions" which includes entities like hedge funds and mutual funds. As above, we also study the holdings by banks and the official sector. However, in this data source, the official sector is just the government, excluding the central bank. These data are quarterly and span 2013 Quarter 4 to 2020 Quarter 3.

Although these more disaggregated data are useful for examining the responses of investors within the Non-bank category, they require modifications to our aggregate balance sheet approach above for two reasons. First, these Euro Area investors do not represent all of the holdings of the debt of a given country. Therefore, we cannot examine the overall impact on a borrower. As such, our results can only be interpreted as the effects from a segment of the investor population. Second, in contrast to the aggregate data, these data are collected as a group of investors across countries. Therefore, there is no natural counterpart to domestic investors in our primary dataset. Thus, we focus only on holdings by Euro area investors of sovereign debt from countries outside of the Euro area. As a result, our

decomposition only relates to the foreign investor results above. Moreover, since the Euro area investors only hold a portion of total government debt by these countries, we aggregate across debt holdings within the area to measure "total" debt. Thus, the estimates provide a decomposition of overall holdings by Euro area investors only, and do not represent the aggregate debt outstanding.

With these two modifications, we replicate the decomposition of marginal investors in the government debt market. Table 2 shows the results of the regression. Similar to the aggregate data, Columns (1) to (3) show that Non-Bank private investors generally take on additional sovereign debt held in the Euro area. For the base case of all countries, 77% of every additional unit of sovereign debt is held by Non-Banks, while only 23% is held by Banks, and that amount is close to zero for Governments. These general patterns hold for all cases except for Advanced Economies in the baseline estimates in Panel A, where banks seem to absorb the largest share of the increase.

Given the modifications, this decomposition differs from that of Table 1 because the total supply of debt is treated as the total supply within the Euro Area only. Given the importance of the debt from large AE countries such as the US for this group of investors, we also estimate the regressions weighting by the size of country debt.[15] As reported in Panel B, Non-banks are the larger marginal investor in aggregate even for AE countries while results for EM countries are largely unchanged.

More importantly, columns (4) to (7) provide a decomposition within the Non-bank investor group. In the baseline case of All investor groups, Insurance and Pensions take on roughly 14% of the additional debt holdings of non-bank investors. This response is dwarfed by the 85% absorbed by "other financial institutions" such as hedge funds and mutual funds. By contrast, the other two categories of Households and Non-financial companies essentially take on little to none of the additional government debt. This pattern is similar across the debt from both AEs and EMs, and whether the estimates are weighted by

[15] As with the aggregate analysis, we include all countries of the sovereign in the decomposition, including the US. For the Euro area investors, the US provides an important potential Advanced Economy for debt holdings.

Table 2: Marginal Holders of Sovereign Debt - Euro Area

	(1) Gov	(2) Banks	(3) NonBank	(4) HH	(5) InsurPens	(6) NFC	(7) OthFin
Panel A: Equal weighted							
All	0.00***	0.23***	0.77***	0.01	0.14**	0.00*	0.85***
	(0.00)	(0.07)	(0.07)	(0.01)	(0.06)	(0.00)	(0.12)
AE	0.00	0.53***	0.47***	0.02	0.12*	0.01	0.85**
	(0.00)	(0.14)	(0.14)	(0.01)	(0.06)	(0.01)	(0.29)
EM	0.00***	0.10*	0.90***	0.01	0.14*	0.00	0.85***
	(0.00)	(0.05)	(0.05)	(0.01)	(0.07)	(0.00)	(0.12)
Panel B: Weighted by D_{jt-1}							
All	0.01	0.23***	0.77***	0.01	0.07***	0.03	0.89***
	(0.00)	(0.06)	(0.06)	(0.00)	(0.02)	(0.03)	(0.11)
AE	0.01	0.27**	0.73***	0.00	0.06**	0.04	0.89***
	(0.01)	(0.09)	(0.09)	(0.00)	(0.02)	(0.04)	(0.17)
EM	0.01***	0.11**	0.89***	0.02	0.10***	0.00*	0.88***
	(0.00)	(0.04)	(0.04)	(0.01)	(0.03)	(0.00)	(0.06)

Note: This table reports regression coefficients of Equation (4) on sovereign debt issued by non-European countries for different investor groups within Europe. Columns (1) through (3) reports coefficients for government, banks and Nonbank sector. Columns (4) through (7) disaggregates Nonbanks into households (HH), insurance and pension funds (insurPens), non-financial corporations (NFC), and other financial institutioins (OthFin). Standard errors clustered at country and year level are reported in the parentheses.

debt size or not.

Overall, these disaggregated data suggest that the Non-bank investor group is largely driven by the behavior of mutual funds and hedge funds. Of the remaining groups, only the insurance and pension funds have a significant impact on Non-bank responses to debt, and even these institutions contribute much less.

3 Investors and Sovereign Debt Allocations

We showed above how the composition of investor holdings varies when sovereign debt expands on the margin. This section develops a framework to relate these holdings to investor demand. Section 3.1 describes the conceptual framework. Section 3.2 and Section 3.3 then use this framework to identify and estimate the investor demand for the government debt of EM and AE countries, respectively, paying particular attention to their response to the yield. In Section 4, we will combine these estimates with the marginal investor results above to determine the funding exposure of borrowing countries.

3.1 A Conceptual Framework

We summarize next a conceptual framework of investor behavior to be utilized in our empirical analysis below. For this purpose, we describe the behavior of a generic investor group i holdings of the book value of country j debt, previously defined as $H^i_{j,t}$. Appendix C describes the structure for this representative investor in more detail.

Investor holdings of sovereign debt are typically presumed to depend upon both global shocks and country-specific characteristics. To highlight these effects, we consider the investor's decision to hold a given country's debt as the outcome of a two-step decision.[16] In the first step, investors decide their total allocation to sovereign debt as a share of total net worth, defined as: $h^{i,N}_t \equiv H^i_t / N^i_t$ where N^i_t is the net worth of investor group i. Following the literature, we postulate that investors allocate their overall portfolio to sovereign bonds depending upon "global factors" $\mathbf{X}^w_t$.[17] In this case, the desired portfolio share of aggregate sovereign bonds for investor of group i can be written in the form:

$$h^{i,N}_t = h^{i,N}[\mathbf{X}^w_t]. \tag{8}$$

In the second step, investors decide which countries to invest in as a share of total sovereign debt holdings defined as: $h^{i,H}_{jt} \equiv H^i_{jt} / H^i_t$. This decision for holdings of country j gov-

[16] Koijen and Yogo (2020) use a similar two- step decision to summarize investor decisions at the country level across an allocation into total short term debt, long term debt, and equity.

[17] See for example Gabaix and Maggiori (2015), Fang and Liu (2020), and Morelli, Ottonello, and Perez (2020).

ernment debt by that same investor *within* the sovereign allocation depends upon country-specific macro-variables $\mathbf{X}_{j,t}$. One important characteristic that affects investors' demand is the return on holding that debt, typically measured as the yield to maturity. This yield is determined by equating investor demand with the issuer supply of debt, and is therefore endogenous. For expositional clarity, therefore, we separate the yield, defined as $y_{j,t}$, from the other characteristics. In other words, this share can be written as:

$$h_{j,t}^{i,H} = h^{i,H}[\mathbf{X}_{j,t}, y_{j,t}; \mathbf{X}_t^w] \tag{9}$$

Combining the portfolio share decisions in Equations (8) and (9) into the overall portfolio share identity provides the desired holdings by investor groups in terms of country and global variables:

$$H_{jt}^i \equiv h_t^{i,N} h_{j,t}^{i,H} N_t^i = h^{i,N}[\mathbf{X}_t^w] h^{i,H}[\mathbf{X}_{j,t}, y_{j,t}; \mathbf{X}_t^w] N_t^i. \tag{10}$$

That is, the sovereign debt demand depends upon characteristics of the borrower countries $\mathbf{X}_j$ and their bond yields y_j as well as the global factors $\mathbf{X}^w$.

By contrast, the supply of debt depends upon a governments desire to borrow at a given price schedule, as is typical in the defaultable sovereign debt literature (e.g., Arellano (2008)). Our data summarizes this supply as a book value of debt at the end of each year. Defining the Debt-to-GDP ratio for country j as: $d_j \equiv D_j / Y_j$, where Y_j is GDP, Appendix D describes how this relationship can be written as a policy function. In particular, this policy function relates macro and other country-specific variables to the supply of government debt as in:

$$d_{j,t} \equiv d(\mathbf{X}_{j,t}) \tag{11}$$

That is, the share of government debt to output depends upon a vector of country-specific macro-finance variables, $\mathbf{X}_{j,t}$. We assume that investors view these country-specific variables $X_{j,t}$ as exogenous to their own portfolio decisions. Moreover, since government debt supply depends upon these variables, the supply of debt, $d_{j,t}$, is predetermined from the investor perspective within the period. This timing assumption is plausible, as increases in

government borrowing are typically pre-determined by the parliament or law. Therefore, the supply of debt by country j can be written as a function of the other predetermined variables at time t:

$$D_{j,t} \equiv d(\mathbf{X}_{j,t})Y_{j,t} \tag{12}$$

The individual investor group demands for sovereign debt of country j together with its supply implies a market clearing condition that we use below. Specifically, we equate the supply of debt in equations (12) to the sum across all investor groups $i = 1, .., I$ of demand given in equation (10):

$$D_{j,t} \equiv d(\mathbf{X}_{j,t})Y_{j,t} = \sum_{i=1}^{I} h^{i,N}[\mathbf{X}_t^w]h^{i,H}[\mathbf{X}_{j,t};\mathbf{X}_t^w]N_t^i \tag{13}$$

Our analysis in the next section will use pre-determined characteristics of debt and this market clearing condition to construct an instrument for the yield.

3.2 Investor Demand for EM Sovereign Debt

The results above demonstrate who holds sovereign debt, along with important empirical regularities about their holdings. However, understanding why this composition of debt ownership matters for borrower costs requires uncovering investor preferences that are implicit in these aggregate holdings, particularly their response to the yield. For this purpose, we now turn to estimating the investor demand for sovereign debt based on borrowing country characteristics. The approach for both EM and AE countries are the same. Therefore, we start with an analysis of EM sovereign debt here, leaving a description of the results for AE countries to the following Subsection 3.3.

Our identification exploits the full set of investors groups for a given supply of debt by each country. Importantly, this feature contrasts with a common data structure in the literature that focuses upon the portfolio allocation of specific investor groups.[18] Although this investor-focused approach provides important insights into their behavior, each group

[18]See for example, Hau and Rey (2006), Maggiori, Neiman, and Schreger (2020), Coppola, Maggiori, Neiman, and Schreger (2021).

holds only part of the supply of debt. In order to understand the exposure of issuers, we instead choose a borrower-focused approach that analyzes the investors of a given country government debt supply. Clearly, both approaches complement each other.

Equation (10) shows that investor demand depends upon the net worth of each investor group, a breakdown not available on the level of the supply of sovereign debt holdings by country. For estimation purposes, therefore, we operationalize the conceptual framework by treating the behavior of domestic and foreign investor net worth differently. For the domestic investors, we assume that the variation of each investor group's net worth can be proxied by the total GDP of the country, and replace their net worth N_t^i with $Y_{j,t}$ for each country j.[19] By contrast, we treat the net worth of each of the foreign investor groups as a common group time fixed effect. These assumptions lead to a common regression specification of equation across investors below.

$$\frac{H_{j,t}^i}{Y_{j,t}} = \beta_0^i + \beta_1^i \ln y_{j,t} + (\gamma^i)' \mathbf{X}_{j,t} + \gamma_j^i + \theta_t^i + \varepsilon_{j,t}^i, \tag{14}$$

Under this specification, the impact on these investors of variations in global variables $\mathbf{X}_t^w, N_t^i$ are subsumed by the time fixed effects, θ_t^i. However, we return to discuss more directly the effect of global financial variables below. We include the total GDP of the issuance country in the vector of $\mathbf{X}_{j,t}$ to control for net wealth for domestic investors. For expositional convenience, we divide by GDP to scale the holding of sovereign debt.

Equation (14) then has a straighforward interpretation. The book value of country j sovereign debt as a a Share of GDP that is held by group i depends upon investor fixed effects, β_0^i and γ_j^i, time fixed effects, θ_t^i, as well as the yield $y_{j,t}$, and country variables, $\mathbf{X}_{j,t}$. For the analysis below, we use 5-year local currency government bond yield as the relevant price variable.[20]

[19] Alternatively, we can assume that the Net Wealth of domestic investor groups is an affine function of the income level. This specification yields qualitatively similar results to the more parsimonious estimates provided in the text.

[20] We use five-year yields because the coverage of countries is greater than other maturities. Similarly, we use the yields in local currency since EM governments have been increasingly issuing debt in local currency, thereby making the liquidity in these markets greater. For discussion, see for example Du and Schreger (2016) and Table C4 in the BIS Debt Securities Statistics.

In order to determine appropriate country variables, we draw on a large literature on emerging market sovereign debt that has provided a rich set of variables that may impact investor demand. In general, creditors prefer a higher yield, but are concerned about potential default risk. Creditors are more likely to invest in countries with characteristics that they view as correlated with lower default. For example, they are likely to be attracted to countries with higher growth, but dislike currency depreciation.[21] We therefore consider a general demand estimation using a number of characteristics variables, including real GDP growth ("GDP growth"), inflation, the logarithm of the export-to-GDP ratio ("Exp-to-GDP"), the local currency depreciation rate ("Depr. Rate"), and the share of sovereign bonds in the international market that is denominated in local currency ("LC share").

Estimating equation (14) directly is subject to the endogeneity problem that the yield can be correlated with an unobserved demand shock. This problem is standard in the demand estimation literature. Koijen and Yogo (2019) discuss its application in asset pricing and Koijen and Yogo (2020) in global asset pricing, in particular. Following this litearture, we use an identification strategy that exploits the market clearing condition in equation (13). The instrument construction follows three basic steps. First, we calculate the ex post market value of holdings by multiplying the book value times the price-to-book value realized in that period. Thus, the hypothetical market value of holdings by an investor group i becomes: $H^{i,m}_{j,t} = H^{i}_{j,t}/(1+y_{j,t})^{T}$, where T equals the maturity of the debt in years and where the superscript of m indicates "market" value.

Second, using this constructed market value of holdings per investor group, we estimate the demand for holdings as a reduced-form function of country characteristics $\tilde{X}_{j,t}$. The pseudo-demand by investor group i can then be estimated using the regression:

$$\ln \frac{H^{i,m}_{j,t}}{Y_{j,t}} = \alpha_0 + \alpha_1 \tilde{X}_{j,t} + \delta^{i}_{j} + \delta^{i}_{t} + u^{i}_{j,t}. \tag{15}$$

Third, we use the fitted value of this regression, $\ln\left(\frac{\hat{H}^{i,m}_{j,t}}{Y_{j,t}}\right)$, and impose the hypothetical

[21] See for example Arellano (2008) and Aguiar and Gopinath (2007) on output growth; Arellano et al. (2020) and Reinhart and Rogoff (2011) on inflation and depreciation. Aguiar, Chatterjee, Cole, and Stangebye (2020) provides a survey.

market clearing across investors that would hold for a country with these characteristics. This calculation implies:

$$\sum_{i=1}^{I} \exp\left(\ln \frac{\hat{H}_{j,t}^{i,m}}{Y_{j,t}}\right) = \frac{D_{j,t}}{Y_{j,t}(1+\tilde{y}_{j,t})^{T}}. \tag{16}$$

This market clearing condition can then be used to solve for the hypothetical yield $\tilde{y}_{j,t}$ that clears the market given the implicit market demand and ex post market values. The hypothetical yield $\tilde{y}_{j,t}$ is then used as an instrument for the actual yield $y_{j,t}$ in the estimation.

As noted above, this instrument depends upon certain identifying assumptions. Importantly, the country-specific variables included in $\tilde{X}_{j,t}$ and the supply of debt-to-GDP are pre-determined to the investor decision. This assumption seems plausible on economic terms because the current period macroeconomic and financial variables are determined by the fundamentals of the country, rather than from the demand of investors. Moreover, the sovereign decides how much debt to issue to satisfy the government's budget constraint.[22]

In addition, the instrument for the yield needs to be relevant. For this relevancy condition to hold, the instrument must be strongly related to the observed yield $y_{j,t}$ conditional on all the controls in the regression. To determine this relevance, we test our instrument using the weak first-stage IV test of Stock and Yogo (2005). With an F statistic exceeding 20, and thereby a level greater than the critical value of 16.38 at 10% level, we conclude that the relevance condition is satisfied.

Furthermore, to be valid, our instrument must pass the exogeneity condition. In particular, the instrument must be independent of sovereign debt holdings except through the yield and all other controls in the regression. As Equations (15) and (16) show, the constructed instrument is only a function of the set of predetermined characteristics $\tilde{X}_{j,t}$, fixed effects, the book value of debt to GDP, $\frac{D_{j,t}}{Y_{j,t}}$, and the market clearing condition that must always hold. Therefore, the instrument only depends upon variables exogenous to the investor decision,

[22] Increases in sovereign debt are typically pre-determined by slower moving governmental processes, such as approval of spending by a legislative body. Thus, the assumption that the supply of government debt in each period is plausible. One might argue that sovereigns may increase their borrowing in response to a lower rate environment. To the extent that this occurs, it is a slow moving common factor across all sovereign borrowers. We control for such variation with time fixed effects.

and is not affected by any unobserved latent demand variable.

Table 3 in Panel A reports the IV estimation results alone, relegating the raw estimates to the Appendix E.1. As a first pass validity check, the response of investor demand to yield is positive and significant, consistent with standard economic theory. All investor groups increase holdings in response to a higher yield. Moreover, most investor groups increase demand for a country's sovereign debt when GDP grows, inflation declines, and exports increase, although insignificantly so for some groups. However, the impact of currency is more varied across investor groups, particularly for Non-Banks. Specifically, variation in the local currency denomination of internationally issued debt, "LC share", is insignificantly related to demand by domestic private investors, but reflects a decrease in demand by Foreign Non-Banks and Central Banks. Furthermore, in contrast to the other investment groups, Domestic Non-Banks increase holdings of sovereign debt with the currency depreciates. Again, these results point to an important role for Non-Banks as differentiated investor groups than the other creditors.

Table 3: Emerging Market Sovereign Debt Demand by Country Characteristics

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
Panel A: IV Estimates						
Bond yield	0.082***	0.094***	0.024**	0.010*	0.114***	0.057***
	(0.023)	(0.029)	(0.012)	(0.005)	(0.030)	(0.018)
GDP growth	0.202	0.221	0.147**	-0.020	0.588***	0.117
	(0.139)	(0.171)	(0.071)	(0.032)	(0.177)	(0.109)
Inflation	-0.010	-0.128*	0.050*	-0.012	-0.058	-0.108**
	(0.058)	(0.071)	(0.030)	(0.013)	(0.074)	(0.046)
Exp-to-GDP	0.012	-0.012	0.005	0.002	0.082***	0.082***
	(0.022)	(0.027)	(0.011)	(0.005)	(0.028)	(0.017)
Depr. Rate	-0.077***	0.127***	-0.038***	-0.004	-0.031	-0.010
	(0.018)	(0.022)	(0.009)	(0.004)	(0.023)	(0.014)
LC share	-0.048	-0.029	-0.071***	-0.003	-0.169***	-0.070**
	(0.037)	(0.045)	(0.019)	(0.008)	(0.046)	(0.029)
Obs	339	339	339	339	339	339
Panel B: Shares and Demand Elasticity						
Mean $\frac{H^i_{j,t}}{Y_{j,t}}$	0.128	0.156	0.029	0.020	0.068	0.070
Elasticity	0.641	0.603	0.826	0.50	1.676	0.814

Note: This table reports the IV estimates of the demand function in Equation (14), with the control of country and year fixed effects for the EM sovereign debt. The sample spans 1996-2018 at annual frequency. The dependent variable is holding of the group indicated in the column title to GDP. The standard errors clustered at country and year level are reported in the parentheses. Panel A reports the instrumental variable estimates. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Panel B gives the shares and implied demand elasticities.

The coefficient estimate for log yield in Panel A represents the slope of the "demand function" by capturing how desired investor holdings vary with the yield; that is, the inverse price. It will be useful in our borrowing exposure counterfactuals below to convert these estimates into a demand elasticity. For this purpose, we construct the sovereign debt

demand elasticities by investor group as reported in the Panel B.[23]

As the estimates show, the foreign Non-banks have the highest elasticity among the private investors at a value of 1.676, followed by domestic banks and non-banks, while foreign banks' elasticity of demand is the smallest. The official sector's demand elasticity lies between domestic private investors and Foreign Non-banks. The impact of each of these respective investor groups on total demand have strong implications for the vulnerability of sovereign borrowers, a point we discuss in the next section.

Since the global variables are common to all investors, their impacts are absorbed by the year fixed effects. In order to analyze more specifically the effects of these global variables, Appendix E.3 reports the regression results including two global financial variables: log VIX and the log of the broad dollar index. As articulated in a number of papers including Miranda-Agrippino and Rey (2021), the VIX may capture global risk aversion or investor sentiment. Moreoever, rises in the dollar value may generate binding financial constraints for global intermediaries exposed to many different currencies as describe in Bruno and Shin (2015), for example. Including these global effects in the regressions show that investor responses to yield changes are similar to the results in Table 3. Particularly, foreign nonbanks respond the most and foreign banks respond the least. In addition, however, a rise in VIX reduces all investor groups' holding of the EM sovereign debt while a stronger dollar is associated with an increase of EM debt holding for all investor groups. Overall, therefore, these findings are consistent with the general framework provided above.

3.3 Investor Demand for AE Sovereign Debt

We next apply this same demand analysis to investors in the advanced economy sovereign debt market. The methodology of estimating AE sovereign debt demand function is similar to EMs with two modifications. First, since AE sovereign debt is almost entirely issued in local currency, we drop the variable "LC share" from the country characteristics list of

[23]Specifically, the elasticity is defined as: $\eta^i = \frac{d\left(H_j^i/Y_j\right)}{dy_j}\frac{y_j}{\left(H_j^i/Y_j\right)}$. For y_j and H_j^i/Y_j, we use the averages over time and country in the sample, as reported in the table.

regressors.[24] Second, given the special status of the US Treasury Market, we exclude the U.S. sovereign debt from the AE sample. Indeed, as is well recognized in the literature, US Treasuries are often treated as special safe assets in the international financial market.[25] This safe asset status has been described as an "exorbitant privilege."[26] Moreover, we exclude Greece for the period of 2009 to 2015, when Greece was experiencing a debt crisis and its yield was spiked to an excessively high level.

Table 4 reports the IV estimation results for AEs. The first-step regression for the instrument and the raw estimates are reported in Appendix E.4 and E.5.

Table 4: Advanced Economies Sovereign Debt Demand by Country Characteristics

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
Bond yield	0.016	0.179***	-0.009	0.000	0.139**	0.019
	(0.024)	(0.054)	(0.015)	(0.013)	(0.056)	(0.033)
GDP growth	-0.357*	0.383	0.158	-0.057	0.600	0.016
	(0.204)	(0.462)	(0.125)	(0.110)	(0.479)	(0.279)
Inflation	-0.041	0.325	0.345**	0.411***	-0.675	0.556
	(0.268)	(0.608)	(0.165)	(0.145)	(0.631)	(0.368)
Exp-to-GDP	0.151***	0.291***	0.140***	-0.066***	0.256***	0.135***
	(0.034)	(0.077)	(0.021)	(0.018)	(0.080)	(0.046)
Depr. Rate	0.004	0.139	0.040	0.006	0.080	0.009
	(0.041)	(0.094)	(0.025)	(0.022)	(0.097)	(0.057)
Obs	266	266	266	266	266	266
Panel B: Shares and Demand Elasticity						
Mean $\frac{H^i_{j,t}}{Y_{j,t}}$	0.154	0.227	0.040	0.066	0.151	0.098
Elasticity	NA	0.789	NA	NA	0.920	NA

Note: This table reports the IV estimates of the demand function in Equation (14), with the control of country and year fixed effects. The sample spans 2000-2018 at annual frequency. The dependent variable is holding of the group indicated in the column title to GDP. The standard errors clustered at country and year level are reported in the parentheses. Panel A reports the instrumental variable estimates. * p $<$ 0.10, ** p $<$ 0.05, *** p $<$ 0.01. Panel B gives the shares and implied demand elasticities with "NA" when estimates are insignificant.

[24] Unlike EM countries, this pattern has held for AE countries for several decades. For example, see the discussion in Eichengreen, Hausmann, and Panizza (2003).

[25] See for example, Jiang, Krishnamurthy, and Lustig (2018).

[26] See for example the discussion in Gourinchas, Rey, and Govillot (2017).

As the first row shows, the response of investor groups' holding to yield changes are mostly positive, except for the domestic central bank. However, unlike for the holdings of EM debt, only two out of six coefficients are statistically significant. These findings are consistent with the common view that the demand for AE sovereign debt is primarily for purposes related to liquidity and capital market regulation purposes. Indeed, a lower real GDP growth of the country depresses both domestic and foreign banking sectors' holdings. Domestic central banks and foreign banks increase holdings of debt issued by countries with higher inflation, although the major advanced economies have experienced relatively low inflation during the past three decades. A higher export-to-GDP ratio attracts all investors groups. Unlike for EM debt, investor demand for AE debt appears relatively insensitive to currency depreciation.

In Panel B of the Table, we report the sample average of holdings-to-GDP by different investor groups, and the implied price elasticity of different investor groups. Similar to the EM sovereign debt, the Foreign Non-bank sector has the highest elasticity with respect to yield. But the Domestic Non-bank sector's demand elasticity is also much higher than investor groups. In general, the banking sector holds advanced economies' sovereign debt as safe and liquid assets to satisfy the liquidity requirement and the central banks hold these debt as foreign reserves. These narratives are consistent with our results that Banks and Central Bank holdings are insensitive to yield changes.

4 Borrower Country Exposure and Counterfactuals

Above, we have estimated demand functions of sovereign debt by investor groups. We now use these estimates to ask what they imply about the exposure of countries' cost of borrowing to rising debt. This question is clearly an important one given the projected rise of debt-to-GDP in the next few years.

4.1 Borrowing Exposure Measure "Delta"

One way to characterize the vulnerability of a sovereign's borrowing cost is to consider its exposure to a given funding source. Thus, according to this approach, one would simply look at the size of a sovereign's funding provided by a particular lender. However, such an exposure measure does not represent the true cost to the borrower because it does not incorporate the risk faced from changes in investor groups. Specifically, a simple measure of the amount of funding by investor groups ignores the impact of the cost required by these investors in order to absorb any increases.

For these reasons, a standard interpretation of true economic exposure to risks faced by an economic entity is to consider the sensitivity of the economic outcome to variations in the risky variable. Thus, this economic exposure measure can be measured as simply the percentage change in an outcome of concern as a result of a percentage change in the risky variable. For example, for a firm facing currency risk, this exposure measure is the percentage change in profits (or firm value) that would result from a percentage change in the exchange rate. Therefore, this measure has been used in a literature studying the risk faced by companies involved in international investment and trade. For example, Bartov and Bodnar (1994), Bodnar, Dumas, and Marston (2002), and, more recently, Adams and Verdelhan (2021) study the exposure of firm profitability to currency.

In this paper, we are interested in the borrowing costs of the sovereign of a given country as the outcome of interest. Clearly then, the analysis above has shown that these borrowers face risks to their borrowing costs from the investor set. Thus, we can use the same approach to calculate the exposure a country faces to its borrowing costs. In this case, the exposure measure is the percentage change in borrowing costs due to a percentage change in shocks that would impact the country's need to borrow. Following the literature, we call this measure the Exposure Delta and for our application, more specifically, the Borrowing Exposure Delta. To see this exposure calculation, note that the present value of the cost of borrowing to the country is equal to the present value of debt to the creditors. Subsuming the depen-

dence on characteristic variables for expositional simplicity, we can write the holdings of country j for each investor group i generally as $H^i_{j,t}$ and the price determined by the inverse demand function of these holdings as $q^i_j(H^i_{j,t})$. Then the accounting identity under market clearing implies:

$$D_{j,t}q_{j,t} = \sum_{i=1}^{I} H^i_{j,t} q^i_j(H^i_{j,t}) \tag{17}$$

We next use the fact that the price of debt is the discounted yield. As an approximation, we denote the yield corresponding to the inverse demand as $y^i_{j,t}$ in the the identity $q^i_{j,t} = 1/(1+y_{j,t})^T$, where $y^i_{j,t}$ is the yield faced by investor group i. Appendix F shows that the borrowing cost exposure, Exposure Delta, faced by country j is measured by:

$$\begin{aligned} \delta_{j,t} \equiv \frac{\partial y_{j,t}/y_{j,t}}{\partial d_{j,t}/d_{j,t}} &= \sum_{i=1}^{I} \left(\frac{\partial y^i_{j,t}/y^i_{j,t}}{\partial d_{j,t}/d_{j,t}} \right) \frac{dH^i_j}{dD_j} \\ &= \sum_{i=1}^{I} \left(\frac{a^i_j}{\eta^i_j} \right) \end{aligned} \tag{18}$$

where η^i_j is the elasticity of demand by investor group i for sovereign debt for a country with the characteristics of country j and where a^i_j is the change in holdings by investor group i in response to changes in debt of country j. Thus, a country's financing exposure is a weighted average of inverse demand elasticities η^i_j for each investor group, where the weights are the marginal financing-shares, $a^i_j \equiv \frac{dH^i_j}{dD_j}$. Therefore, the exposure measure can be constructed by combining the marginal investor responses in Section 2 with the investor elasticities from Section 3.

4.2 "Borrower Exposure Delta" and Counterfactuals: EM

The Exposure Delta measure provides a useful benchmark for understanding the underlying risk. For countries such as the U.S. with sovereign debt that is viewed by investors as a safe haven asset, the borrowing costs may be essentially unrelated to the size of borrowing deflated by GDP. Indeed, as we saw in Table 4, investors in AE debt are essentially

unresponsive to yield, with the possible exception of the Non-banks. Therefore, these "safe asset" countries are likely to be relatively unexposed to higher costs due to expanding debt-to-GDP and thus $\delta_j = 0$. We therefore exclude AE country debt in these counterfactuals and focus instead on EM country debt. For countries with more risky debt, $\delta_j > 0$ since expanding debt creates a greater perception of default by investors, thereby requiring a higher yield to compensate. Nevertheless, if δ_j is less than one, then an increase in borrowing is related to an increase than is less than proportionate to that increase. However, if δ_j is greater than one a country faces an out-sized increase in borrowing costs in response to higher borrowing. Therefore, $\delta_j = 1$ provides a useful benchmark for the stability of a government's ability to respond to borrowing needs.

Table 5 shows these exposures using the Exposure Delta measure in equation (19). Panel A gives the measure for the total set of investor groups. The first two rows provide two useful Benchmarks. The first row notes that for a Safe Asset country, the Exposure Delta is likely near zero since the country can typically expand debt without meaningfully raising financing costs. By contrast, the second row highlights the knife-edge level of one as the Exposure Delta for which countries can expand debt without more than proportionally increasing costs.

Table 5: Emerging Market Borrowing Exposures

Panel A: Total Borrowing Cost Exposure and Counterfactuals

		Delta
Benchmarks:		
	Safe asset	0.00
	Knife-edge high	1.00
Using Estimates:		
	Delta	1.38
	Without Domestic	0.89
	Without Official	1.38
	Without Non-banks	1.54

Panel B: Individual Investor Exposures

Exposures:	DomBank	Dom NonBnk	Dom Cen	ForBank	For NonBnk	For Cen
Only this group	1.56	1.66	1.21	2.00	0.60	1.23
Excluding Group	1.32	1.15	1.37	1.33	1.61	1.37
Absorption	0.21	0.43	0.04	0.05	0.24	0.04

Note: This table shows the exposure of the sovereign's financing cost to the increase in government debt. Delta corresponds to the exposure measure δ in Equation (19). Each row represents one counterfactual scenario.

The next row of Panel A provides the overall Borrowing Cost Exposure Delta estimates using the absorption shares reported in Table 1. The following rows illustrate the vulnerabilities of these countries to the presence of different investor groups. For these counterfactuals, the absorption shares of different investor groups are set to zero with the remaining shares distributed proportionately across the remaining investors according to their marginal absorption. As the counterfactuals show, excluding Domestic investors as a whole would move the Exposure Delta below one. By contrast, excluding the Non-bank investor groups

would significantly increase overall Exposure Delta above its base level to 1.5, even higher than when we exclude official creditors.

Panel B of Table 5 explores the contribution of each investor group. For each of the six investor groups, the table first reports both the Marginal "Exposures" given by investor i as $1/\eta_j^i$. These numbers provide estimates for how sensitive the borrowing costs for EM governments would be if only one investor group provided the credit. The next row measures the Exposure Delta under the counterfactual experiment that a given investor group absorbs no additional debt so that the remaining investors take the debt on. The last line shows the Marginal "Absorption" numbers, which incorporates how much debt each investor group takes on as a country's debt expands: $a_j^i \equiv \frac{dH_j^i}{dD_j}$.

As these numbers show, the EM borrowers' exposure to losing Foreign Non-Bank investors is the largest at 1.61. Indeed, in the case of Foreign Non-Banks, the high demand elasticity implies that having only these investors would generate a lower impact on borrowing cost exposure of only 0.60. Therefore, excluding these investors clearly leads to a higher overall exposure, 1.61, as more inelastic investors are left to pick up the debt. This contributes to the overall sensitivity to Non-bank investors reported in Panel A. In general, if the Non-bank investor group were absent, the countries would face considerably more volatility in borrowing costs in response to changes in debt-to-GDP. Therefore, these counterfactuals suggest significant exposure by Emerging Market sovereigns to the existing set of creditors, particularly Non-banks.

By contrast, EM borrower's exposure to Foreign Banks have the opposite pattern. If these sovereigns relied solely on foreign banks, they would face the highest increase in borrowing costs when they increase debt. As Panel B shows, the exposure from "Only this group" would imply an Exposure Delta of 2, clearly much higher than the same measure of 0.6 for Foreign Nonbanks. Hence from this perspective, sovereigns that are dependent only on Foreign Banks have the highest borrowing cost exposure.

5 Concluding Remarks

The rising levels of government debt worldwide in the wake of the Covid-crisis have made urgent the answers to questions about their repayment. At the front of those questions is: who holds this debt and does it matter to borrowers in this market? In this paper, we address these questions by analyzing a unique data set that decomposes sovereign debt into investor holding groups for a large number of countries over almost three decades.

Based upon our analysis, the answers to these questions are striking. First, private financial institutions that are not banks absorb substantially more of the variation in outstanding government debt than other investor groups. Across all countries, they take up 69% on the margin of increases in the debt, although they only hold 46% on average. Further decomposing this Non-bank investment group using Euro Area data, we find that investment funds are the drivers of this larger group.

Next, we identify a demand function for EM investor groups by exploiting a feature of our data. In particular, our data provides the full set of investor groups by country allowing us to solve for the market clearing condition. Using these estimates, we find that the elasticity of demand by Non-bank foreign investors is higher than other groups.

Finally, we use both the marginal increase of holdings together with the investor demand estimations to calculate the implied government debt exposure. An average EM country faces significant borrowing exposure since a percentage increase in debt-to-GDP leads to a greater than proportional cost across existing investor groups. Even more remarkable, these countries face the greatest exposure against losing foreign Non-bank investors compared to any other investment groups, while they have the greatest exposure from relying only on foreign banks. We conclude that EM sovereign investors are highly vulnerable to the presence or absence of foreign Non-bank investors. Thus, the behavior of non-bank investors, particularly foreign non-banks, is crucial to account for when evaluating questinos relating to sovereign debt.

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A Data construction

The series in the aggregate dataset are sampled at an annual frequency, covering the years between 1990 and 2018. The series are denominated in US dollars.[27] Debt for each category refers to general government debt, which consists of state, local, and central government debt.

Total Total debt holdings are measured by combining the data from the IMF Historical Public Debt Database (debt-to-GDP) and GDP series from The World Bank. While a full data series over time are available for some, there are 96 countries for which the debt-to-GDP series ends in 2015.[28] For these countries, we forecast the total debt level using the forward-looking growth rates from QPSD total debt series in years 2016-2018.

Foreign Total The methodology for calculating foreign total holdings is based on that in Avdjiev et al. (2018). As a first step, these series are collected from the international investment position (IIP) dataset giving the sum of external portfolio debt liabilities and external other investment debt liabilities for the general government sector. When missing, these series are complemented with data from the Quarterly External Debt Statistics (QEDS) that provides the external debt of general government. The remaining missing values are filled by estimates derived from the BIS international banking statistics (IBS) and BIS international debt securities (IDS) datasets.

Foreign Official Foreign official holdings for advanced economies and China are taken from Arslanalp and Tsuda (2012) and Arslanalp and Tsuda (2014), consisting mostly of foreign official reserves held abroad. The remaining countries are populated with the data from the

[27] Series that are originally reported in local currency are converted to US dollars using the end of period exchange rate from the IMF. Robustness to currency value effects are described in Section B.2

[28] Afghanistan, Algeria, Angola, Anguilla, Antigua and Barbuda, Argentina, Armenia, Aruba, Azerbaijan, Bahamas, Bahrain, Belize, Benin, Bermuda, Bhutan, Bolivia, Botswana, Brunei Darussalam, Burkina Faso, Burundi, Cabo Verde, Cameroon, Cayman Islands, Central African Republic, Chad, Comoros, Republic of Congo, Cote d'Ivoire, Curacao, Djibouti, Dominica, Ecuador, Republic of Equatorial Guinea, Eritrea, Eswatini, Gabon, Gambia, Ghana, Grenada, Guinea, Guinea-Bissau, Guyana, Haiti, Hong Kong SAR, Iran, Iraq, Jamaica, Jordan, Kenya, Kuwait, Lao People's Democratic Republic, Lesotho, Liberia, Libya, Liechtenstein, Macao SAR, Madagascar, Malawi, Maldives, Mali, Mauritania, Morocco, Mozambique, Myanmar, Namibia, Nepal, New Zealand, Niger, Oman, Pakistan, Papua New Guinea, Qatar, Rwanda, Samoa, San Marino, São Tomé and Príncipe, Saudi Arabia, Senegal, Sierra Leone, Singapore, Solomon Islands, South Africa, Sri Lanka, Sudan, Suriname, Syrian Arab Rep., Togo, Tonga, Trinidad and Tobago, Tunisia, Uganda, Uruguay, Vanuatu, Venezuela, Zambia, Zimbabwe.

World Bank debtor reporting system (DRS) data on bilateral and multilateral official lending to emerging and developing economy governments.

Foreign Bank The methodology for estimating foreign bank holdings is based on Avdjiev et al. (2018). We compute estimates for share of official holdings from international claims in the Consolidated Banking Statistics (CBS) and apply that share to cross-border bank lending from the Locational Banking Statistics (LBS). In addition, we make a correction for Switzerland where holdings by external banks are significantly overestimated with our methodology.[29]

Foreign Nonbank The Foreign Nonbank series is computed by subtracting Foreign Official and Foreign Bank series from the Foreign Total.

Domestic Total Domestic Total series is computed by subtracting Foreign Total from the Total.

Domestic Central Bank For the most part, domestic central bank holdings are taken from the IMF's International Financial Statistics (IFS) data set. This data base provides the debt holdings levels from the Standardized Reporting Form (SRF) only from 2001 onwards. Therefore, debt holding levels prior to 2001 are backcasted with annual growth rate taken from the non-standardized reporting form (non-SRF) in the same dataset. For the countries where the IFS data was incomplete, additional data was taken from the official websites of respective central banks.[30] For these cases, the IFS data was supplemented using the backward-looking growth rates taken from central banks' websites.[31]

Domestic Bank These holdings were compiled using the same procedure as for Domestic Central Bank.

[29] Specifically, the ratio from consolidated banking statistics (CBS) is close to 30% around 2014, while updated data from the locational banking statistics (LBS), which includes a sector breakdown for government lending in recent years, suggests the true ratio is closer to 10%, but not more than 20%.

[30] Austria, Belgium, Bulgaria, Finland, France, Germany, Greece, Iceland, Ireland, Korea, Latvia, Portugal, Spain, Sweden, UK.

[31] The list of countries for which additional data from the official Central Bank websites was used: Belgium, Finland, France, Germany, Korea, Luxembourg, Mexico, Netherlands, Portugal, Serbia, Spain, Sweden.

Domestic Nonbank The Domestic Nonbank series were computed by subtracting the Domestic Central Bank and Domestic Bank series from the Domestic Total.

Inconsistencies and Cleaning When combining data across different sources, inconsistencies are inevitable. While most of the dataset fits together, there are some cases where the sum of some of the components (e.g. domestic central bank and domestic bank) add to more than the total (e.g. domestic total). In these cases, the procedure produces some negative observations for residually computed groups (e.g. domestic non-banks). In general, we used the following procedures to maintain internal consistency in the dataset (i.e. the sum of the parts add up to the whole) for these special cases.

If the Foreign Official plus Foreign Bank is greater than the Foreign Total, we replaced the Foreign Total as the sum of the Foreign Bank plus the Foreign Official; that is, replace Foreign = max(Foreign total, foreign official + foreign bank).

If the sum of the Foreign total and the Domestic bank and the Domestic Central Bank is greater than the total debt, we replace total debt as this sum; that is, replace Total debt = max(Total debt, foreign total + domestic bank + domestic Central Bank)

Given these updated variables, we compute any residual categories as needed; that is, we would subtract the other variables from the updated totals to measure the Foreign Non-bank, the Domestic Total, and the Domestic Non-bank.

After following this process, all of the generated data series are greater than or equal to zero, and the data are internally consistent. Further, we manually examine cases where the negative values were large to make sure that this procedure made sense. In a few cases where it appears driven by low data quality, we replace the observation with linear interpolation.

B Additional Results

This appendix provides more detailed results and robustness checks for the analysis in Section 2.3.

B.1 Marginal Holders under Different Circumstances

B.1.1 Recessions and Non Recessions

This subsection reports the regression results depicted in Figures 2.

Table B1: Marginal Holders of Sovereign Debt: Recession and No Recession

	(1) Dom	(2) For	(3) DomBK	(4) DomNB	(5) DomCB	(6) ForBK	(7) ForNB	(8) ForCB
				Panel A: Recessions				
All	0.83***	0.17***	0.08	0.75***	0.00	-0.05	0.19**	0.03
	(0.05)	(0.05)	(0.05)	(0.09)	(0.01)	(0.04)	(0.09)	(0.03)
AE	0.68**	0.32	0.01	0.63**	0.05*	-0.10	0.70***	-0.28
	(0.26)	(0.26)	(0.09)	(0.23)	(0.02)	(0.11)	(0.21)	(0.20)
EM	0.82***	0.18	-0.02	0.87***	-0.03	-0.02	0.14	0.05
	(0.13)	(0.13)	(0.06)	(0.16)	(0.02)	(0.04)	(0.14)	(0.05)
DC	0.67***	0.33*	0.07	0.46*	0.14	-0.01	0.19**	0.15**
	(0.18)	(0.18)	(0.10)	(0.22)	(0.09)	(0.08)	(0.08)	(0.06)
				Panel B: Non Recessions				
All	0.60***	0.40***	0.17***	0.37***	0.05***	0.05***	0.30***	0.05***
	(0.05)	(0.05)	(0.04)	(0.06)	(0.02)	(0.02)	(0.05)	(0.01)
AE	0.54***	0.46***	0.02	0.41***	0.11	0.05**	0.34***	0.07**
	(0.11)	(0.11)	(0.03)	(0.09)	(0.07)	(0.02)	(0.10)	(0.03)
EM	0.67***	0.33***	0.25***	0.37***	0.05**	0.07***	0.24***	0.01
	(0.05)	(0.05)	(0.05)	(0.08)	(0.02)	(0.02)	(0.06)	(0.01)
DC	0.50***	0.50***	0.10***	0.35***	0.05***	0.02	0.38***	0.11***
	(0.09)	(0.09)	(0.02)	(0.08)	(0.02)	(0.02)	(0.09)	(0.03)

Note: This table reports the regression coefficients for Equation (4) for each investor group with a balanced sample during recessions (Panel A) and non recessions (Panel B). A recession is defined as a negative real GDP growth rate. Country and year FEs are included, and standard errors are clustered at the country level and reported in the parentheses. Columns (1) and (2) represent domestic and foreign investors, respectively. Columns (3) through (8) correspond to the six investor groups.

B.1.2 Banking Crisis and No Banking Crisis

Table B2: Marginal Holders of Sovereign Debt: Banking Crisis and No Banking Crisis

	(1) Dom	(2) For	(3) DomBK	(4) DomNB	(5) DomCB	(6) ForBK	(7) ForNB	(8) ForCB
				Panel A: Banking Crisis				
All	0.69***	0.31***	0.06	0.56***	0.07	0.02	0.21**	0.09
	(0.05)	(0.05)	(0.05)	(0.07)	(0.06)	(0.02)	(0.09)	(0.06)
AE	0.72***	0.28	-0.09*	0.52***	0.29**	0.08*	0.17	0.03
	(0.19)	(0.19)	(0.05)	(0.12)	(0.11)	(0.04)	(0.25)	(0.05)
EM	0.65***	0.35***	0.09*	0.56***	0.01	0.00	0.26**	0.09
	(0.07)	(0.07)	(0.04)	(0.07)	(0.01)	(0.02)	(0.10)	(0.07)
DC	0.46***	0.54***	0.13*	0.31**	0.02	-0.00	0.42**	0.12*
	(0.12)	(0.12)	(0.06)	(0.13)	(0.02)	(0.01)	(0.17)	(0.07)
				Panel B: No Banking Crisis				
All	0.59***	0.41***	0.18***	0.37***	0.04***	0.05***	0.32***	0.04***
	(0.05)	(0.05)	(0.04)	(0.06)	(0.01)	(0.01)	(0.05)	(0.01)
AE	0.47***	0.53***	0.04*	0.41***	0.02**	0.06*	0.46***	0.01
	(0.12)	(0.12)	(0.02)	(0.11)	(0.01)	(0.03)	(0.11)	(0.03)
EM	0.67***	0.33***	0.24***	0.39***	0.04**	0.06***	0.25***	0.01
	(0.06)	(0.06)	(0.05)	(0.08)	(0.02)	(0.02)	(0.05)	(0.01)
DC	0.49***	0.51***	0.11***	0.34***	0.05**	0.01	0.40***	0.09***
	(0.11)	(0.11)	(0.04)	(0.10)	(0.02)	(0.02)	(0.11)	(0.02)

Note: This table reports the regression coefficients for Equation (4) for each investor group with a balanced sample during times with banking crises (Panel A) and without banking crisis (Panel B). A country-year i, t observation is defined as if country i experienced a banking crisis in either of year $t, t-1, t-2, t-3$. Banking crisis definitions follow Laeven and Valencia (2020). For the developing countries, the definition of crisis includes not only banking crisis, but also debt crisis and currency crisis. Country and year FEs are included, and standard errors are clustered at the country level and reported in the parentheses. Columns (1) and (2) represent domestic and foreign investors, respectively. Columns (3) through (8) correspond to the six investor groups.

B.1.3 Different Subperiods

Table B3: Marginal Holders of Sovereign Debt: Different Subperiods

	(1) Dom	(2) For	(3) DomBK	(4) DomNB	(5) DomCB	(6) ForBK	(7) ForNB	(8) ForCB
				Panel A: Before 2000				
All	0.57***	0.43**	0.11*	0.41**	0.05*	-0.01	0.42**	0.02
	(0.18)	(0.18)	(0.06)	(0.18)	(0.02)	(0.03)	(0.16)	(0.01)
EM	0.66**	0.34	0.06	0.50*	0.11***	0.03	0.31	-0.01
	(0.25)	(0.25)	(0.04)	(0.25)	(0.03)	(0.04)	(0.27)	(0.02)
DC	0.52*	0.48*	0.14*	0.35	0.02	-0.04	0.50**	0.02*
	(0.25)	(0.25)	(0.08)	(0.25)	(0.02)	(0.04)	(0.22)	(0.01)
				Panel B: 2000-2009				
All	0.52***	0.48***	0.15**	0.32***	0.05***	0.03	0.40***	0.05**
	(0.07)	(0.07)	(0.06)	(0.08)	(0.02)	(0.02)	(0.08)	(0.02)
AE	0.48***	0.52***	-0.01	0.38***	0.11	0.04*	0.46**	0.02
	(0.17)	(0.17)	(0.03)	(0.13)	(0.08)	(0.02)	(0.18)	(0.01)
EM	0.64***	0.36***	0.21**	0.40***	0.03*	0.04	0.28***	0.04
	(0.08)	(0.08)	(0.08)	(0.12)	(0.02)	(0.04)	(0.08)	(0.03)
DC	0.34**	0.66***	0.12	0.18*	0.04*	0.00	0.57***	0.09**
	(0.12)	(0.12)	(0.07)	(0.10)	(0.02)	(0.01)	(0.15)	(0.04)
				Panel C: After 2009				
All	0.72***	0.28***	0.17***	0.50***	0.05*	0.06***	0.17***	0.05**
	(0.04)	(0.04)	(0.04)	(0.08)	(0.03)	(0.01)	(0.03)	(0.02)
AE	0.61***	0.39***	0.11*	0.47***	0.03	0.06*	0.22**	0.11
	(0.10)	(0.10)	(0.05)	(0.09)	(0.02)	(0.03)	(0.08)	(0.09)
EM	0.73***	0.27***	0.23***	0.46***	0.05	0.07***	0.19***	0.01
	(0.05)	(0.05)	(0.05)	(0.10)	(0.03)	(0.01)	(0.05)	(0.01)
DC	0.73***	0.27**	0.04	0.60***	0.09	0.04	0.11*	0.12**
	(0.10)	(0.10)	(0.04)	(0.16)	(0.06)	(0.04)	(0.06)	(0.05)

Note: This table reports the regression coefficients for Equation (4) for each investor group with a balanced sample before 2000 (Panel A), 2000-2009 (Panel B), and after 2009 (Panel C). Country and year FEs are included, and standard errors are clustered at the country level and reported in the parentheses. Columns (1) and (2) represent domestic and foreign investors, respectively. Columns (3) through (8) correspond to the six investor groups.

B.2 Marginal Investors Considering Currency Valuation Effect

This section reports regression results of Equation (7). As described in the text, these estimates incorporate the currency valuation effect on sovereign debt holdings by foreigners. As the estimates show, Domestic and Foreign Nonbanks continue to respond the most to variations in the supply of debt.

B.2.1 Unconditional Estimates

Table B4: Marginal Holders of Sovereign Debt

	(1) Dom	(2) For	(3) DomBK	(4) DomNB	(5) DomCB	(6) ForBK	(7) ForNB	(8) ForCB
All	0.70***	0.30***	0.17***	0.46***	0.07***	0.03***	0.23***	0.04***
	(0.05)	(0.05)	(0.03)	(0.05)	(0.02)	(0.01)	(0.04)	(0.01)
AE	0.60***	0.40***	0.05**	0.46***	0.09	0.06**	0.31**	0.03
	(0.12)	(0.12)	(0.02)	(0.10)	(0.06)	(0.02)	(0.12)	(0.02)
EM	0.76***	0.24***	0.21***	0.47***	0.07***	0.04**	0.18***	0.03
	(0.05)	(0.05)	(0.04)	(0.06)	(0.02)	(0.01)	(0.04)	(0.02)
DC	0.60***	0.40***	0.11***	0.43***	0.05***	0.01	0.31***	0.07***
	(0.10)	(0.10)	(0.04)	(0.09)	(0.01)	(0.01)	(0.10)	(0.02)

Note: Panel A of the table reports the regression coefficients for Equation (7) for each investor group. The first two columns represent domestic and foreign investors, respectively. Columns (3) through (8) correspond to the six investor groups. Standard errors clustered at the country level are reported in the parentheses. Panel B of the table reports the average share of holding by each investor group.

B.2.2 Recessions and Non-Recessions

Table B5: Marginal Holders of Sovereign Debt: Recession and Non Recession

	(1) Dom	(2) For	(3) DomBK	(4) DomNB	(5) DomCB	(6) ForBK	(7) ForNB	(8) ForCB
				Panel A: Recessions				
All	0.89***	0.11**	0.17***	0.63***	0.09***	-0.01	0.11**	0.01
	(0.05)	(0.05)	(0.04)	(0.05)	(0.03)	(0.02)	(0.05)	(0.02)
AE	0.86***	0.14	0.01	0.81***	0.04	-0.08	0.40	-0.18
	(0.25)	(0.25)	(0.08)	(0.24)	(0.02)	(0.08)	(0.27)	(0.15)
EM	0.85***	0.15*	0.16***	0.56***	0.13**	0.02	0.09	0.03
	(0.07)	(0.07)	(0.04)	(0.07)	(0.04)	(0.02)	(0.07)	(0.03)
DC	0.82***	0.18	-0.07	0.78***	0.10	-0.03	0.13	0.08
	(0.17)	(0.17)	(0.09)	(0.23)	(0.07)	(0.08)	(0.10)	(0.08)
				Panel B: Non Recessions				
All	0.67***	0.33***	0.17***	0.44***	0.06***	0.05***	0.24***	0.04***
	(0.05)	(0.05)	(0.03)	(0.06)	(0.01)	(0.01)	(0.05)	(0.01)
AE	0.62***	0.38***	0.07***	0.45***	0.10	0.05**	0.28**	0.05*
	(0.11)	(0.11)	(0.02)	(0.09)	(0.07)	(0.02)	(0.10)	(0.03)
EM	0.73***	0.27***	0.22***	0.45***	0.06***	0.06***	0.19***	0.01*
	(0.06)	(0.06)	(0.05)	(0.09)	(0.02)	(0.02)	(0.05)	(0.01)
DC	0.60***	0.40***	0.12***	0.42***	0.05***	0.02	0.30***	0.08***
	(0.10)	(0.10)	(0.04)	(0.08)	(0.02)	(0.01)	(0.09)	(0.02)

Note: This table reports the regression coefficients for Equation (7) for each investor group with a balanced sample during recessions (Panel A) and non recessions (Panel B). A recession is defined as a negative real GDP growth rate. Country and year FEs are included, and standard errors are clustered at the country level and reported in the parentheses. Columns (1) and (2) represent domestic and foreign investors, respectively. Columns (3) through (8) correspond to the six investor groups.

B.2.3 Banking Crisis and No Banking Crisis

Table B6: Marginal Holders of Sovereign Debt: Banking Crisis and No Banking Crisis

	(1) Dom	(2) For	(3) DomBK	(4) DomNB	(5) DomCB	(6) ForBK	(7) ForNB	(8) ForCB
				Panel A: Banking Crisis				
All	0.83***	0.17**	0.13***	0.58***	0.12***	0.00	0.12*	0.05
	(0.07)	(0.07)	(0.04)	(0.04)	(0.04)	(0.02)	(0.07)	(0.04)
AE	0.85***	0.15	0.06**	0.53***	0.26***	0.07**	0.04	0.03
	(0.13)	(0.13)	(0.03)	(0.07)	(0.07)	(0.03)	(0.16)	(0.03)
Obs	64	64	64	64	64	64	64	64
r2	0.88	0.55	0.38	0.87	0.77	0.44	0.33	0.40
EM	0.82***	0.18	0.16**	0.54***	0.13***	-0.01	0.15	0.04
	(0.11)	(0.11)	(0.06)	(0.06)	(0.04)	(0.01)	(0.10)	(0.04)
DC	0.65***	0.35**	0.05***	0.59***	0.02	0.01	0.25*	0.08**
	(0.12)	(0.12)	(0.01)	(0.12)	(0.02)	(0.01)	(0.13)	(0.04)
				Panel B: No Banking Crisis				
All	0.67***	0.33***	0.18***	0.44***	0.05***	0.04***	0.25***	0.03***
	(0.05)	(0.05)	(0.03)	(0.06)	(0.01)	(0.01)	(0.05)	(0.01)
AE	0.53***	0.47***	0.03	0.48***	0.01*	0.07**	0.40***	0.01
	(0.12)	(0.12)	(0.02)	(0.12)	(0.01)	(0.03)	(0.11)	(0.03)
EM	0.73***	0.27***	0.22***	0.45***	0.06***	0.05***	0.20***	0.02*
	(0.05)	(0.05)	(0.04)	(0.08)	(0.02)	(0.02)	(0.05)	(0.01)
DC	0.57***	0.43***	0.13**	0.39***	0.05***	0.01	0.34***	0.08***
	(0.12)	(0.12)	(0.05)	(0.10)	(0.01)	(0.02)	(0.12)	(0.02)

Note: This table reports the regression coefficients for Equation (7) for each investor group with a balanced sample during times with banking crises (Panel A) and without banking crisis (Panel B). A country-year i, t observation is defined as if country i experienced a banking crisis in either of year $t, t-1, t-2, t-3$. Banking crisis definitions follow Laeven and Valencia (2020). For the developing countries, the definition of crisis includes not only banking crisis, but also debt crisis and currency crisis. Country and year FEs are included, and standard errors are clustered at the country level and reported in the parentheses. Columns (1) and (2) represent domestic and foreign investors, respectively. Columns (3) through (8) correspond to the six investor groups.

B.2.4 Different Subperiods

Table B7: The Marginal Holder of Sovereign Debt: Different Subperiods

	(1) Dom	(2) For	(3) DomBK	(4) DomNB	(5) DomCB	(6) ForBK	(7) ForNB	(8) ForCB
				Panel A: Before 2000				
All	0.60***	0.40**	0.07**	0.47***	0.06*	-0.01	0.41**	0.01
	(0.16)	(0.16)	(0.03)	(0.17)	(0.03)	(0.03)	(0.15)	(0.01)
EM	0.63**	0.37	0.10*	0.42*	0.11***	0.03	0.36	-0.01
	(0.22)	(0.22)	(0.05)	(0.24)	(0.04)	(0.03)	(0.24)	(0.02)
DC	0.57**	0.43*	0.06*	0.48*	0.02	-0.04	0.44*	0.03*
	(0.24)	(0.24)	(0.03)	(0.23)	(0.02)	(0.03)	(0.21)	(0.01)
				Panel B: 2000-2009				
All	0.65***	0.35***	0.18***	0.41***	0.06***	0.03*	0.28***	0.04**
	(0.07)	(0.07)	(0.04)	(0.07)	(0.02)	(0.02)	(0.07)	(0.02)
AE	0.58***	0.42**	0.03	0.46***	0.10	0.05**	0.36**	0.01
	(0.16)	(0.16)	(0.02)	(0.11)	(0.07)	(0.02)	(0.17)	(0.01)
EM	0.73***	0.27***	0.23***	0.44***	0.06**	0.03	0.20***	0.03
	(0.08)	(0.08)	(0.06)	(0.09)	(0.03)	(0.03)	(0.07)	(0.02)
DC	0.52***	0.48***	0.15**	0.33***	0.04**	0.01	0.41**	0.07*
	(0.16)	(0.16)	(0.06)	(0.11)	(0.01)	(0.01)	(0.17)	(0.03)
				Panel C: After 2009				
All	0.80***	0.20***	0.16***	0.56***	0.07***	0.04***	0.13***	0.03**
	(0.05)	(0.05)	(0.04)	(0.07)	(0.02)	(0.01)	(0.03)	(0.01)
AE	0.68***	0.32***	0.13*	0.55***	0.01	0.05	0.17*	0.10
	(0.11)	(0.11)	(0.07)	(0.11)	(0.02)	(0.03)	(0.09)	(0.08)
EM	0.82***	0.18***	0.20***	0.54***	0.08***	0.04***	0.13***	0.01
	(0.06)	(0.06)	(0.04)	(0.09)	(0.03)	(0.02)	(0.05)	(0.01)
DC	0.76***	0.24**	0.04	0.64***	0.08	0.05	0.10*	0.09*
	(0.09)	(0.09)	(0.03)	(0.14)	(0.05)	(0.03)	(0.06)	(0.05)

Note: This table reports the regression coefficients for Equation (7) for each investor group with a balanced sample before 2000 (Panel A), 2000-2009 (Panel B), and after 2009 (Panel C). Country and year FEs are included, and standard errors are clustered at the country level and reported in the parentheses. Columns (1) and (2) represent domestic and foreign investors, respectively. Columns (3) through (8) correspond to the six investor groups.

C The Investor Framework

This appendix describes the general investor framework used to motivate the demand regression equations in the text, in particular Equation (14).

C.1 General Market Set-up and Timing

Investors enter a period t taking as given the supply of debt of a particular country j, given as D_t^j. The next appendix shows how this supply may be determined as a policy function of governments that depends upon country-specific variables X_t^j. These macro-financial variables likely impact the willingness of investors to extend credit to these governments. However, investors view these variables as exogenous to their own decisions. Thus, from the investor perspective, the supply of debt is predetermined.

Given the total set of countries with sovereign debt supplies, these investors choose the allocation of their holdings of sovereign debt in their portfolio. Specifically, they choose the total sovereign debt portfolio share given as:

$$h_{N,t}^i \equiv H_t^i / N_t^i \tag{19}$$

where N_t^i is investor i's "Net Wealth" and where $H_t^i = \sum_{j=1}^{J} H_{j,t}^i$, the total holdings by i of sovereign debt across countries. Clearly the total share of sovereign debt holdings in Equation (19) can also be written equivalently as:

$$h_{N,t}^i \equiv \sum_{j=1}^{J} H_{j,t}^i / N_t^i \tag{20}$$

Therefore, we may look at the portfolio allocation for sovereign debt as an aggregate decision as in Equation (19) or as the sum of the portfolio allocation into each individual country debt as in Equation (20).

For our empirical estimation, it proves convenient to consider the total holdings separate from the country-specific decisions for two reasons. First, the aggregate holdings of some

investor groups are often impacted by common global factors, as described in the text. Therefore, we may consider the total demand for sovereign debt to depend upon these time varying global factors, X_t^w. Second, demand for individual country j debt holdings depends only upon cross-sectional country-specific variables X_t^j, variables that are distinct from the common allocation. Therefore, we next describe a two step investor decision that helps inform our regression results.

We follow that discussion with an alternative interpretation of the same regression equation, but in the format of a sum of individual demand regressions as in Equation (20).

C.2 Allocation to total govt debt holdings

In this step, investors choose their overall holdings of sovereign debt allocations as defined in Equation (19). One way to motivate this decision is to consider the standard mean-variance portfolio optimization problem for a general intertemporal objective function $V(N, u_N)$ for N denoting "Net Wealth" as above and u_N allowing for current investor preferences. Then the optimization can be written generally as a choice of allocation into sovereign debt holdings relative to other assets as in:

$$\underset{\{h^i_{N,t}\}}{Max}\, E_t V(N^i_{t+1}, u^i_{N,t}) \tag{21}$$

subject to the net wealth constraint:

$$N^i_{t+1} = [R_{H,t+1} h^i_{N,t} + E_t R_{0,t+1}(1 - h^i_{N,t})] N^i_t \tag{22}$$

where $R_{H,t} = R_H(\mathbf{X_t^w})$ is the return on total holdings of sovereign debt, specified as a function of X_t^w, the vector of global variables. Similarly, $R_{0,t}$ is the return on all other assets in the portfolio. As shown by Koijen and Yogo (2020), a convenient form of this objective function is provided by Constant Absolute Risk Aversion utility.

This problem implies a portfolio share solution of total sovereign debt in the form of:

$$h^{i,*}_{N,t} = h_N(X^w_t, u^i_{N,t}) \tag{23}$$

where $u^i_{N,t}$ is a variable that summarizes the difference is aggregate sovereign debt portfolio allocation of investor i from the other investors.

C.3 Allocation to specific country debt

Given the decision about how much to hold of the total share of sovereign debt in Equation (23), investors decide how much to allocation to an individual country. It is therefore useful to define the holdings in country j debt as a share of total sovereign debt holdings:

$$h^i_{j,t} \equiv H^i_{j,t} / H^i_t \tag{24}$$

Given the same objective function above, this problem can be summarized as a nested optimization over components in the total sovereign debt holdings. In particular, this optimization is:

$$\underset{\left\{h^i_{j,t}\right\}}{Max} E_t V(N^i_{t+1}, u^i_{j,t}) \tag{25}$$

given the portfolio return on the country-specific debt:

$$R_j(X_{j,t}; X^w_t) h^i_{j,t} \tag{26}$$

since $h^{i,*}_{N,t} N^i_t = H^{i,*}_t$. These returns depend upon country-specific variables $X_{j,t}$ that impact perceived default risk and other characteristics on behalf of creditors. In the analysis, we use the yield on sovereign debt y^j_t to measure this return. This optimization implies the general solution:

$$h^{i,*}_{j,t} = h^i(X_{j,t}; X^w_t) \tag{27}$$

C.4 Connection to Regression Framework

We now use this framework to connect the investor decision to the regression equation (14), repeated here for convenience:

$$\frac{H^i_{j,t}}{Y_{j,t}} = \beta^i_0 + \beta^i_1 \ln y_{j,t} + (\gamma^i)' \mathbf{X}_{j,t} + \gamma^i_j + \theta^i_t + \varepsilon^i_{j,t},$$

Combining the demand for total sovereign debt and individual country sovereign debt shares implies as share of net wealth given by:

$$H^i_{jt} \equiv h^{i,N}_t h^{i,H}_{j,t} N^i_t = h^{i,N}[\mathbf{X}^w_t] h^{i,H}[\mathbf{X}_{j,t}, y_{j,t}; \mathbf{X}^w_t] N^i_t.$$

Thus Equation (14) specifies this same demand as a linear function of two basic relationships. First, it includes time fixed effects capturing the global variables impacting total sovereign holdings through $\mathbf{X}^w_t$. The effects of the investor-specific demand as in $u^i_{N,t}$ in the optimization is captured by the investor fixed effect, $beta^i_0$. We also describe analysis using direct measures of global variables such as the VIX and the broad dollar index in the appendices.

Second, this specification captures the impact of country-specific risk through these characteristics in $\mathbf{X}_{j,t}$. The investor-specific preferences for individual country j debt given in the optimization as $u^i_{j,t}$ is captured in the regression by γ^i_j over time and by $\varepsilon^i_{j,t}$ at a point in time. Moreover, this country-specific demand depends importantly in the yield which captures the return to the investor R_j.

D The Supply Function of Debt

Government borrowers provide the "supply" of sovereign debt. Although this statement is clearly true in general, it will prove convenient to illustrate the relationship in the context of the emerging market debt literature. In this literature beginning with Eaton and Gersovitz (1981) and adapted by Arellano (2008), the government conducts all borrowing for the economy. Under the additional assumption that all debt is one period, the government solves the

optimization problem taking the debt pricing schedule $q_j(B_{j,t})$as given:

$$\max_{C_{j,t},B_{j,t}} \sum_{t=0}^{\infty} \beta^t E u(c_{j,t}) \tag{28}$$

$$C_{j,t} + B_{j,t-1} = Y_{j,t} + q_j(B_{j,t})B_{j,t} \tag{29}$$

where for country j, $C_{j,t}$ and $Y_{j,t}$ are consumption and output, respectively, and where $B_{j,t}$ is an internationally traded pure discount bond and $q_j(B_{j,t})$ is the price schedule of the bond. Although this relationship holds generally, we assume that the price schedule is independent of investors' demand shocks for our empirical implementation. As in Arellano and Ramanarayanan (2012), we can also extend this framework to allow for longer term coupon debt. For example, Bai, Kehoe, and Perri (2019) generalize this relationship by specifying that the government pays out existing debt as a coupon payment given by: ϕB_t for the first period, $\phi(1-\phi)B_t$ for the second period, $\phi(1-\phi)^2 B_t$ for the third period, etc. This stylized approach includes as special cases the one period debt above as $\phi = 1$ and, on the other extreme, a perpetuity as $\phi = 0$. In this case, the budget constraint becomes:

$$C_{j,t} = Y_{j,t} + q_j(B_{j,t})B_{j,t} - [q_j(B_{j,t})(1-\phi_j) + \phi_j]B_{j,t-1} \tag{30}$$

Thus, consumption is income $Y_{j,t}$ net of paying current borrowing obligations from the prior period $\phi_j B^j_{t-1}$ and rolling over next period debt with new borrowings, $B_{j,t} - (1-\phi_j)B_{j.t-1}$ at price $q_j(B_{j,t})$. More generally, allowing for investment, government spending, and net exports, the basic balance of payments identity in equation (30) can be generalized to include investment and government spending. For this more general aggregate budget constraint, we can redefine C as domestic absorption and recognize that net current account balances equal the change in the value of bond holdings. We use Export-to-GDP as a proxy for this relationship in our empirical estimates.

The solution to the government's optimization problem implies that the supply of sovereign debt depends upon a number of country-specific macroeconomic variables that we define as a vector process at time t as: $\mathbf{X}_{j,t}$. In particular, this set of variables is a vector of country-specific

characteristics that may impact the desire to borrow, including the growth rate of the economy, η_t, and prior sovereign debt-to-output share d_{t-1}.

Another set of variables that impact sovereign debt supply relates to the price of borrowing and the characteristics of these obligations. Clearly, the supply of debt depends negatively upon the direct cost of borrowing. To make clear the special role of borrowing costs, we separate out yield $y_{j,t}$ from the characteristic vector $X_{j,t}$ in the text.

In addition, however, borrowing may entail indirect costs if the debt must be repaid in foreign currency or at undesirable maturity durations. Indeed, recent literature has argued that domestic sovereigns preferred to borrow in their own local currencies rather than foreign currency borrowing that entails greater exchange rate risk.[32] Similarly, countries may face a trade-off of lower borrowing costs in short term maturities that incur greater roll-over risk versus a higher cost of borrowing long term.[33] We could combine these direct and indirect costs of borrowing in a vector of debt characteristics to include along with the country characteristics. Thus, this vector would include, indirect costs such as a disadvantageous maturity of debt $\phi_{j,t}$, a higher share of debt denominated in foreign currency, and a higher value of foreign currency that impacts that share.

Overall these basic relationships can be then summarized in a general supply of debt-to-GDP relationship given by equation (11) in the paper and repeated here for convenience:

$$d_t \equiv d(\mathbf{X}_{j,t})$$

That is, the share of government debt to output depends upon a vector of country-specific macro-finance variables, $\mathbf{X}_{j,t}$. Then, the supply of debt by country can be written as in equation (12) of the paper as in:

$$D_{j,t} \equiv d(\mathbf{X}_{j,t})Y_{j,t}$$

Clearly, these relationships reflect basic borrowing functions that map the country-specific variables and their debt characteristics into the supply of debt. In our analysis, we plausi-

[32] See for example Ottonello and Perez (2019), Arellano et al. (2020), and Du, Pflueger, and Schreger (2020).
[33] See Arellano and Ramanarayanan (2012) for a development of this argument.

bly assume that the supply of debt is predetermined in the beginning of the period in which investors extend credit.

E Additional Results for Investor Demand

E.1 Reduced-form Estimates of IV Construction: EMs

This section reports the regression coefficients for the first-stage regression that constructs the instrument.

Table E8: Reduced-form regression for the instrument: EM

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
GDP Growth	0.56	-3.86	2.96	-2.75	1.92	-1.82
	(1.04)	(2.27)	(2.77)	(1.92)	(2.12)	(1.97)
Inflation	-1.65***	0.26	-0.44	-2.19***	0.93**	-0.56
	(0.49)	(0.44)	(1.14)	(0.37)	(0.35)	(0.36)
Exp-to-GDP	0.11	-0.16	-0.37	0.11	0.98*	0.68*
	(0.22)	(0.25)	(0.56)	(0.37)	(0.54)	(0.40)
Obs	406	367	339	406	353	396
R2	0.86	0.82	0.71	0.84	0.78	0.88

Note: This table reports the reduced-form estimates of the first-stage regression of instrument construction for EMs, with the control of country and year fixed effects. The sample expands 1996-2018 at annual frequency. The dependent variable is holding of the group indicated in the column title to GDP. The standard errors clustered at country and year level are reported in the parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

E.2 Raw Estimates of Demand Estimation: EM

Table 3 in the text provides the IV estimates of demand for investors in EM sovereign debt. Below we report the raw estimates of investor holding on log yield and other controls. As these estimates show, the responses of yield generally have the wrong signs are and mostly insignificant, which reflects the potential omitted variable bias and the necessity of employing the instrumental variable strategy..

Table E9: Raw Estimates of Investor Demand: EM

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
Bond yield	-0.017***	-0.001	-0.002	0.003	-0.006	0.012
	(0.005)	(0.007)	(0.007)	(0.003)	(0.014)	(0.012)
GDP_growth	-0.183***	-0.057	0.003	-0.022	0.081	-0.119
	(0.061)	(0.108)	(0.049)	(0.016)	(0.140)	(0.090)
Inflation	0.052	-0.024	0.071**	0.004	0.018	-0.043
	(0.048)	(0.048)	(0.028)	(0.014)	(0.045)	(0.044)
Exp-to-GDP	-0.007	-0.028	-0.012	-0.005	0.035	0.040
	(0.031)	(0.039)	(0.020)	(0.008)	(0.032)	(0.036)
Depr. Rate	-0.052**	0.144***	-0.028***	-0.008*	-0.003	-0.010
	(0.020)	(0.024)	(0.008)	(0.004)	(0.018)	(0.009)
LC share	0.010	0.045***	-0.073**	-0.010	-0.131	-0.083
	(0.043)	(0.016)	(0.030)	(0.006)	(0.102)	(0.057)
Observations	363	363	363	363	363	363

Note: This table reports the reduced-form estimates of equation (14). The sample expands 1996-2018 at annual frequency. The dependent variable is holding of the group indicated in the column title to GDP. Standard errors clustered at the country and year level are reported in the parenthese. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

E.3 Including Global Financial Variables: EM

Table E10: IV Estimates Book Value

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
Bond yield	0.093***	0.070**	0.037***	0.010*	0.191***	0.101***
	(0.031)	(0.028)	(0.014)	(0.005)	(0.051)	(0.027)
GDP growth	0.044	0.081	0.096	-0.012	0.499**	0.076
	(0.132)	(0.119)	(0.061)	(0.023)	(0.217)	(0.113)
Inflation	-0.110	-0.129*	0.010	-0.005	-0.308**	-0.179**
	(0.084)	(0.076)	(0.038)	(0.015)	(0.138)	(0.072)
Exp-to-GDP	0.084**	0.038	0.019	-0.001	0.189***	0.110***
	(0.034)	(0.031)	(0.016)	(0.006)	(0.056)	(0.029)
Depr. Rate	-0.060***	0.142***	-0.035***	-0.009**	-0.009	-0.019
	(0.021)	(0.019)	(0.010)	(0.004)	(0.035)	(0.018)
LC share	-0.004	0.023	-0.084***	-0.006	-0.153**	-0.109***
	(0.047)	(0.042)	(0.021)	(0.008)	(0.077)	(0.040)
VIX	-0.048***	-0.041***	-0.005	-0.005**	-0.070***	-0.025**
	(0.014)	(0.012)	(0.006)	(0.002)	(0.022)	(0.012)
Dollar	0.222***	0.143***	0.084***	0.019**	0.328***	0.186***
	(0.053)	(0.048)	(0.025)	(0.009)	(0.088)	(0.046)
Obs	342	342	342	342	342	342

Note: This table reports the instrumental variable estimates of equation (14) with the inclusion of the two global financial variables, log VIX and log broad dollar index with country fixed effect. The sample expands 1996-2018 at annual frequency. The dependent variable is holding of the group indicated in the column title to GDP. Standard errors clustered at the country and year level are reported in the parentheses. * p $<$ 0.10, ** p $<$ 0.05, *** p $<$ 0.01.

E.4 IV Construction: AE

Table E11: Reduced-form regression for the instrument in log: without global variables

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
GDP growth	-1.13	-7.48***	-3.35	-0.43	-2.13	1.08
	(1.28)	(1.48)	(3.94)	(1.18)	(1.87)	(1.27)
Inflation	-0.78	-0.06	13.97**	8.24***	-1.72	1.53
	(2.06)	(2.38)	(6.42)	(1.89)	(2.98)	(2.61)
Exp-to-GDP	1.33***	0.66**	5.89***	-0.81***	0.71*	-0.41
	(0.25)	(0.30)	(0.80)	(0.23)	(0.37)	(0.25)
Obs	374	355	344	375	357	350
r2	0.99	0.81	0.75	0.80	0.71	0.87

Note: This table reports the reduced-form estimates of the first-stage regression of instrument construction for AEs, with the control of country and year fixed effects. The sample expands 1996-2018 at annual frequency. The dependent variable is holding of the group indicated in the column title to GDP. The standard errors clustered at country and year level are reported in the parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

E.5 Raw Estimates: AE

Table E12: Raw Estimates Book Value: Level without global variables

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
Bond yield	0.015*	0.023***	-0.012*	-0.015***	-0.020	0.047*
	(0.008)	(0.006)	(0.006)	(0.005)	(0.013)	(0.027)
GDP growth	-0.218*	-0.450**	0.064	-0.083	-0.209	-0.369
	(0.108)	(0.171)	(0.120)	(0.083)	(0.189)	(0.391)
Inflation	-0.090	0.514	0.572	0.383**	-0.425	-0.011
	(0.280)	(0.573)	(0.358)	(0.144)	(0.410)	(0.318)
Exp-to-ratio	0.104**	0.126**	0.137***	-0.093**	0.067	0.387
	(0.048)	(0.057)	(0.025)	(0.038)	(0.117)	(0.239)
Depr. Rate	-0.011	0.101*	0.013	-0.014	-0.038	0.108
	(0.027)	(0.057)	(0.024)	(0.021)	(0.045)	(0.070)
Obs	337	337	337	337	337	337

Note: This table reports the reduced-form estimates of equation (14). The sample expands 1996-2018 at annual frequency. The dependent variable is holding of the group indicated in the column title to GDP. Standard errors clustered at the country and year level are reported in the parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

F Exposure

This section provides the detailed algebra that yields Equation (19) in the main text.

The exposure analysis is based on the following equation:

$$P_{j,t}D_{j,t} = \sum_{i=1}^{6} P_{j,t}^{i} H_{j,t}^{i}$$

where $P_{j,t}^{i}$ is the price faced by investor i. In equilibrium $P_{j,t} = P_{j,t}^{i}$ for all i. For ease of notation, we write $P_{j,t} = \exp(-y_{j,t})$ and $P_{j,t}^{i} = \exp(-y_{j,t}^{i})$ and abstract away the maturity. Therefore,

$$y_{j,t} = -\ln D_{j,t}^{-1} - \ln \sum_{i=1}^{6} \exp(-y_{j,t}^{i}) H_{j,t}^{i}$$

Thus:

$$\frac{dy_{j,t}}{dD_{j,t}} = \frac{1}{D_{j,t}} - \frac{1}{\sum_{i=1}^{6} \exp(-y_{j,t}^{i}) H_{j,t}^{i}} \left[\sum_{i=1}^{6} \frac{d\left(\exp(-y_{j,t}^{i}) H_{j,t}^{i}\right)}{dH_{j,t}^{i}} \frac{dH_{j,t}^{i}}{dD_{j,t}} \right]$$

Let investor group i's marginal financing share $\frac{dH_{j,t}^{i}}{dD_{j,t}} = a_{j}^{i}$ and $\frac{dH_{j,t}^{i}}{dy_{j,t}^{i}} \frac{y_{j,t}^{i}}{H_{j,t}^{i}} = \eta_{j}^{i}$.

$$\frac{dy_{j,t}}{dD_{j,t}} = \frac{1}{D_{j,t}} - \frac{1}{\sum_{i=1}^{6} \exp(-y_{j,t}^{i}) H_{j,t}^{i}} \left[\sum_{i=1}^{6} a_{j}^{i} \left(\exp(-y_{j,t}^{i}) - H_{j,t}^{i} \exp(-y_{j,t}^{i}) \frac{1}{\eta_{j}^{i}} \frac{y_{j,t}^{i}}{H_{j,t}^{i}} \right) \right]$$

We define exposure δ_{j} as

$$\delta_{j} = \frac{dy_{j,t}}{dD_{j,t}} \frac{D_{j,t}}{y_{j,t}} = \frac{1}{y_{j,t}} - \frac{1}{y_{j,t} \sum_{i=1}^{6} \exp(-y_{j,t}^{i}) \frac{H_{j,t}^{i}}{D_{j,t}}} \left[\sum_{i=1}^{6} a_{j}^{i} \exp(-y_{j,t}^{i}) - a_{j}^{i} \exp(-y_{j,t}^{i}) y_{j,t}^{i} \frac{1}{\eta_{j}^{i}} \right]$$

Plug in $y_{j,t}^{i} = y_{j,t}$, $\sum_{i=1}^{6} a_{j}^{i} = 1$, and $\sum_{i=1}^{6} H_{j,t}^{i} = D_{j,t}$, we obtain Equation (19).

$$\delta_{j} = \frac{dy_{j,t}}{dD_{j,t}} \frac{D_{j,t}}{y_{j,t}} = \sum_{i=1}^{6} \frac{a_{j}^{i}}{\eta_{j}^{i}}.$$