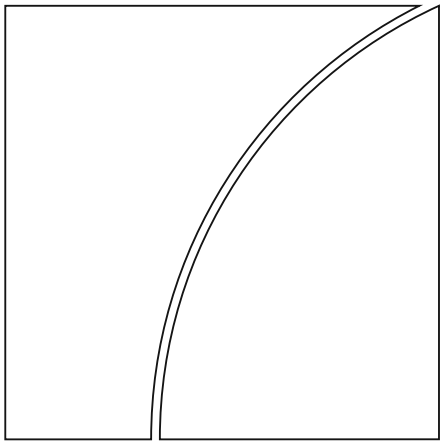

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by Xiang Fang, Bryan Hardy and Karen K Lewis

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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 a data set of sovereign debt holdings by foreign and domestic bank, non-bank private, and official investors for 95 countries over twenty years. Private non-bank investors absorb disproportionately more sovereign debt supply than other investors. Moreover, non-bank investor demand is most responsive to the yield. Counterfactual analysis of emerging market sovereigns shows a 10% increase in debt leads to a 6.7% increase in costs, but an out-sized 9% increase if non-bank investors are absent. We conclude that these sovereigns are vulnerable to losing 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.

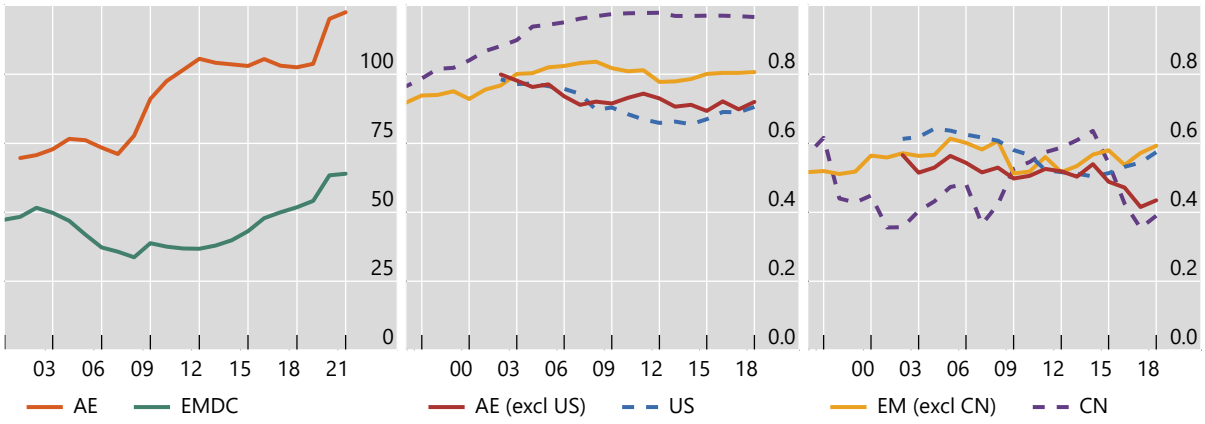
We begin by documenting *who* holds government debt around the world and establishing some new empirical regularities. For this purpose, we first assemble a dataset that distinguishes the holders of each country's sovereign debt into investor groups that have been highlighted in the literature. That is, we disaggregate debt held by foreign and domestic investors and into three subgroups within those categories: 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 varies in our data set. 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 composition of investor shares has changed 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). The share of aggregate debt hold-

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

ings by domestic investors has decreased for AEs while that same share has increased for EMs. The share of debt held by non-bank private investors, shown in Panel (c), shows 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 China (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. Moreover, 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 absorb less than their average holdings of sovereign debt: they hold 28% of the debt on average, but only take up 20% of new debt on the margin. This pattern holds for increases in foreign and domestically held debt as well as in subsamples of AEs and EMs. 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 expansion.

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 more granular data sets. We begin by using data on Euro Area investors to disaggregate the foreign non-bank investor group into non-financial corporations, pensions and insurance companies, households, and a category of other financial institutions, largely representing investment funds. Our analysis indicates that within this group, financial institutions such as investment funds drive the large response of non-banks. We then repeat this analysis for domestic investors who hold US Treasuries and UK Gilts, finding again that non-banks are the most responsive set of investors, and within domestic non-banks that funds are the key players.

Given these findings for *who* holds sovereign debt, we next consider *why* this composition matters to borrowers. To answer this question, we estimate a system of funding equations representing the willingness to extend credit. Since this willingness to fund depends endogenously on the interest paid by the government, we require an instrument for these borrowing costs. For this purpose, we exploit the fact that our data set provides the full breakdown of sovereign debt by investor type for each country. As shown by Koijen and Yogo (2020), such a market clearing condition can be used to provide an instrument that is uncorrelated with unobserved latent factors that drive investors' willingness to extend credit. Accordingly, we use this concept to construct an instrument for the sovereign yield.

Our estimates provide striking results that again point to the importance of non-bank investors. Specifically, for both Emerging Markets and Advanced Economies, non-bank investors are the creditor group most responsive to changes in yields. Moreover, investors of emerging market sovereign debt generally dislike inflation and prefer income growth from the borrowing country.

While these results provide measures of the sovereign's view of each creditor group's willingness to fund, investors will perceive the returns on these investments differently for

two main reasons. First, while governments issue debt and pay interest over time, investors focus upon holding returns per period as measured in the secondary market. Second, since governments primarily issue debt in local currency, foreign investors who hold this debt will incur currency risk in addition to the holding returns.

Although the aggregate data do not contain the identity nor portfolio of holdings by these investor groups, we show that under some additional conditions we can provide investor demand estimates similar to those in Koijen and Yogo (2020) and Jiang, Richmond, and Zhang (2022). First, we focus only on Emerging Markets because the identity of domestic versus foreign investor groups is likely to be more comingled for Advanced Economies. As a second condition, foreign investors are assumed to be US dollar-based. Importantly, as shown by Koijen and Yogo (2020), the demand system under these assumptions allow for substitution across debt issued by different countries. This estimation shows that the elasticity of non-bank investors is again higher than that of banks, and that the elasticity of foreign non-bank investors is the greatest.

To assess what these estimates imply for the sovereign borrower, we ask how much the financing cost would increase for a hypothetical debt increase. Our estimates show that a 10% increase in debt corresponds to a 6.7% increase in yield for the average EM borrower. However, if non-bank investors are not present and borrowers must borrow from banks, the same 10% increase in debt corresponds to a substantially higher 9.1% increase in yield. Thus, EM sovereigns appear highly exposed to the availability of non-bank investor funding. We also study the trade-off between borrowing costs and characteristics. For instance, if inflation increases by 1%, the required yield for the average EM would increase by 2.5%.

The structure of the paper is as follows. We next provide a brief review of the literature. 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, the US Treasuries, and the UK Gilts. Section 3 sets up a framework to explore funding and investor demand in the sovereign debt market and reports estimates of

this demand by investor groups. Section 4 combines the country-level investor demand identification with the marginal absorption estimates to develop a 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), Jiang et al. (2022), Bretscher, Schmid, Sen, and Sharma (2020), and Koijen, Koulischer, Nguyen, and Yogo (2021). 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 portfolio allocation of specific investors as in, for example, Maggiori, Neiman, and Schreger (2020). We instead implement a complementary borrower-focused approach that analyzes the investors of a given country government debt to understand the exposure of issuers.

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 (2022). 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 Bruno and Shin (2015), Gabaix and Maggiori (2015), Fang and Liu (2020), and Miranda-Agrippino and Rey (2021). 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, thereby demonstrating the importance of non-bank investors.

By studying investor types jointly, we also further the defaultable sovereign debt literature that has instead highlighted the importance of individual investor types. For instance, an important part of the EM literature focuses only on the role of foreign investors, particularly foreign banks. See, for example, Eaton and Gersovitz (1981), Arellano (2008), Arellano and Ramanarayanan (2012), Mendoza and Yue (2012), Cruces and Trebesch (2013), and Arellano, Bai, and Mihalache (2020). 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), Bocola (2016), Brunnermeier et al. (2016), Fahri and Tirole (2018), and Chari, Dovis, and Kehoe (2020). A further area focuses on explaining the reserve accumulation behavior of foreign official investors, as can be seen in Wooldridge (2006), Dominguez, Hashimoto, and Ito (2012), Ghosh, Ostry, and Tsangarides (2017), Bianchi, Hatchondo, and Martinez (2018), and Bianchi and Sosa-Padilla (2020), to name a few. We instead evaluate the set of creditors together and thereby contribute to these literatures by showing the relative importance of each investor group.

Lastly, we contribute to the literature by constructing a comprehensive dataset of investor groups' holdings to analyze the impact of investor composition on sovereign financing cost. As noted above, this data decomposition is close to Arslanalp and Tsuda (2012, 2014), and the extension in Arslanalp and Sunder-Plassmann (2022).[3] In order to examine the impact of marginal investors and their demand, however, we construct a dataset that begins earlier spanning all investor types 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. It also complements other studies based upon securities level issuances such as Maggiori, Neiman, and Schreger (2020) and Faia, Salomao, and Veghazy (2022). Relative to these granular data sets, our analysis provides a complete accounting of the investors of a given sovereign and spans both domestic and foreign investors.

[3]The first two of 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 Evolving Composition of Sovereign Debt Investor Groups

We begin by analyzing the holders of sovereign debt and examining who are the marginal investors that purchase new debt. We first describe the structure of the data and the investor group definitions, and highlight the broad trends in sovereign debt holdings. We then analyze the marginal investment in sovereign debt for each group. We finish the section examining non-bank investors in more depth with alternative datasets.

2.1 Investor Group Definitions

We consider three basic types of investors: (1) private banks; (2) non-banks; and (3) official creditors. We describe briefly these three categories below before detailing their construction in the data. We also split these investor groups by their location: foreign vs domestic. This gives us six groups: domestic banks, foreign banks, domestic non-banks, foreign non-banks, domestic central banks, and foreign official.

The first group is private banks. These institutions are often considered primary intermediaries for debt markets including their function as primary dealers (Arnone & Ugolini, 2005). They 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. More broadly, liquidity and capital regulation incentivize domestic banks to hold domestic government debt, potentially creating a bank-sovereign doom loop.[4]

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 pensions and insurance firms, endowments, mutual funds, and hedge funds, as well as non-financial entities like corporations and households.

[4]Bank regulation typically assigns risk-weights to different assets that banks hold for computing the required capital ratios. So, acquiring sovereign debt, which typically carries 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.

Finally, we consider official creditors. "Domestic Official" creditors are simply the "Domestic Central Bank", while the "Foreign Official" group includes foreign central banks, foreign governments, and international organizations such as the World Bank and International Monetary Fund.

This data set is organized around the sovereign issuers of debt, rather than tracking the securities held by investors. Specifically, we are interested in how the holdings of each investor group responds to changes in the sovereign's total debt. To see this decomposition, it will therefore be useful to define the book value of sovereign debt of a given country indexed by n, as $D(n)$ and the amount held by each investor group i, as $H_i(n)$. Then, the investor groups for country n debt can be aggregated across the investor groups to provide a measure of the holdings of each country's creditors as:

$$D(n) \equiv \sum_{i=1}^{I} H_i(n) \tag{1}$$

where I is the number of investor groups. For example, in our aggregate data set above, $I = 6$ since we have three types of investors with domestic and foreign counterparts for each. We will use the decompositions in Equation (1) to uncover the marginal ownership responses to supply changes over time below. 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, relegating a more complete discussion to Appendix A. The general approach follows the work of Arslanalp and Tsuda (2012, 2014), and the recent expansion of their dataset (Arslanalp & Sunder-Plassmann, 2022). We modify their methodology in order to broaden further the time period and sample of countries for which we have data for all investor groups. We point interested researchers to their papers and associated database for a full description of the approach.

We first derive each sovereign's total debt from the IMF Historical Public Debt Database (HPDD), which 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.[5] The total foreign holdings for each sovereign are constructed following the methodology in Avdjiev, Hardy, Şebnem Kalemli-Özcan, and Servén (2022) (hereafter, AHKS), which combines 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 computed as the difference between total debt and foreign debt holdings.

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 for which their debt is less commonly held as reserves, we capture foreign official lending as 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 for banks and foreign official with the total foreign holdings.

Sovereign debt holdings by domestic banks and domestic central banks are taken from the IMF's International Financial Statistics (IFS) dataset, supplemented with data from the official websites of central banks when the data was incomplete. 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.

Overall, this construction provides a sample of 95 countries with a breakdown of debt by investor, with time series spanning 1991 to 2018.[6] For some of the analysis, we split the sovereigns into 3 groups: advanced economies (AEs), emerging markets (EMs), and developing countries (DCs). Details of the country groups can be found in Appendix A.

[5]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.

[6]For a larger sample of 151 countries starting in 1991, partial data are available (i.e. data for some investor groups are missing).

Advantages and limitations of the data. The main advantages of our dataset are that it allocates all of a sovereign's debt to individual investors, and that it spans a large number of countries over a long time period. However, such coverage comes with drawbacks on detail. For instance, our dataset does not include detailed information on the currency or maturity of the debt or the specific location of the foreign investor. It does not have details on the non-sovereign portfolios of these investors. Moreover, the data is annual, and so misses higher frequency dynamics. In the conclusion, we discuss avenues for future research to build on our analysis.

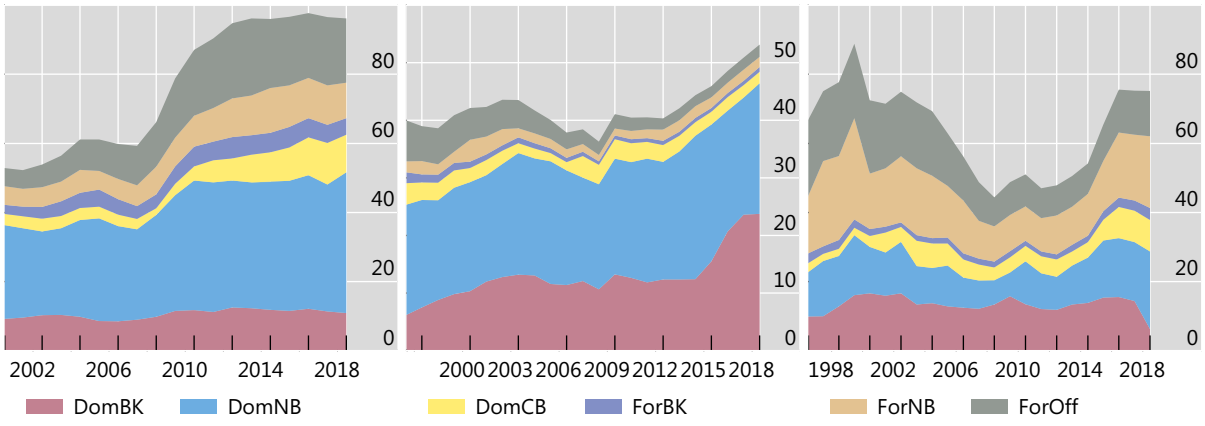
2.3 Investor Trends and Marginal Holders

We next examine some general trends in holdings and the relative behavior of each investor group's holdings as government debt changes. Panels (a), (b), and (c) of Figure 2 shows the average investor holdings-to-GDP shares of advanced economy (AE), emerging market (EM) and developing economies (DC) debt, respectively. These figures show distinctive differences within the groups. For all groups, the foreign bank and non-bank shares have been stable over time.[7] 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 the proportion of foreign official creditors 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, tied to the use of unconventional monetary policies and other programs.

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

[7] Foreign official data for AEs are not available until 2000, so foreign holdings are not fully reported before that point. Coverage for EMs and DCs is broader after 1995.

Figure 2: Trends in Sovereign Debt



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

Note: Aggregate debt by country group detailed in Appendix A divided by the aggregate GDP of the country group. Each panel shows a balanced sample over the given time frame.

group on the change in total debt:

$$\frac{H_{i,t}(n) - H_{i,t-1}(n)}{D_{t-1}(n)} = a_i \frac{D_t(n) - D_{t-1}(n)}{D_{t-1}(n)} + a(n) + a_t + \epsilon_{i,t}(n), \quad \forall i \tag{2}$$

where the subscript t indicates time, and where $a(n)$ and a_t represent country fixed effects and time fixed effects, respectively. Using the identity in Equation (1), the sum of the investor groups add up to the total so that:

$$\frac{D_t(n) - D_{t-1}(n)}{D_{t-1}(n)} = \sum_{i=1}^{I} \frac{H_{i,t}(n) - H_{i,t-1}(n)}{D_{t-1}(n)}. \tag{3}$$

Since all of the debt is absorbed by some investor, the coefficients estimated from this regression will sum to 1: $\sum_{i=1}^{I} a_i = 1$. Each coefficient a_i reflects the marginal holding response of investor group i 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 all 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) ForOff
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 (2) 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 take-up 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). Appendix B illustrates these patterns in panel (a) of Figure B1.

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 simply represent proportional expansions to average holdings. Panel B of Table 1 reports the average holdings by investor group over the period and shows this is not the case. 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 share reported in Panel A are jointly 69% ($0.39 + 0.30$) of the change. This pattern is clearly robust across all the remaining decompositions including AE, EM, and DC.[8]

Appendix B.1 reports an extensive set of results of the same analysis under different scenarios of recessions vs. non-recessions, crisis vs. non-crisis periods, as well as in different subperiods. The general pattern holds in all subsamples.

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)).[9] To consider this possibility, Appendix B.2 repeats the analysis taking into consideration the currency valuation effect. The results are largely unchanged: non-banks have a larger response to increased

[8]The most recent shares in the sample are essentially the same as the averages, which rules out the possibility that non-banks' average shares have an upward trend.

[9]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.

debt supply than other investor groups.

2.4 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. This finding 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 other more disaggregated data sets: (i) the Euro area securities holding statistics (SHS) produced by the European Central Bank; (ii) US TIC data; and (iii) UK Gilt Holders data.[10] We utilise the Euro area data to shed light on the foreign non-bank segment, and the US and UK data to examine the domestic non-bank segment.

We first examine the Euro Area SHS data. The SHS provides data on the holdings of securities for all investors located in the Euro Area, split by sector of the holder/investor, the type (e.g., equity vs debt) of security, the sector of the issuer, and the residence of the issuer. Thus, we can observe the holdings of government debt issued by specific countries for all Euro area investors, disaggregated by investor type. 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 the government, excluding the central bank. These data are quarterly, with sample taken over 2013 Q4 to 2020 Q3.

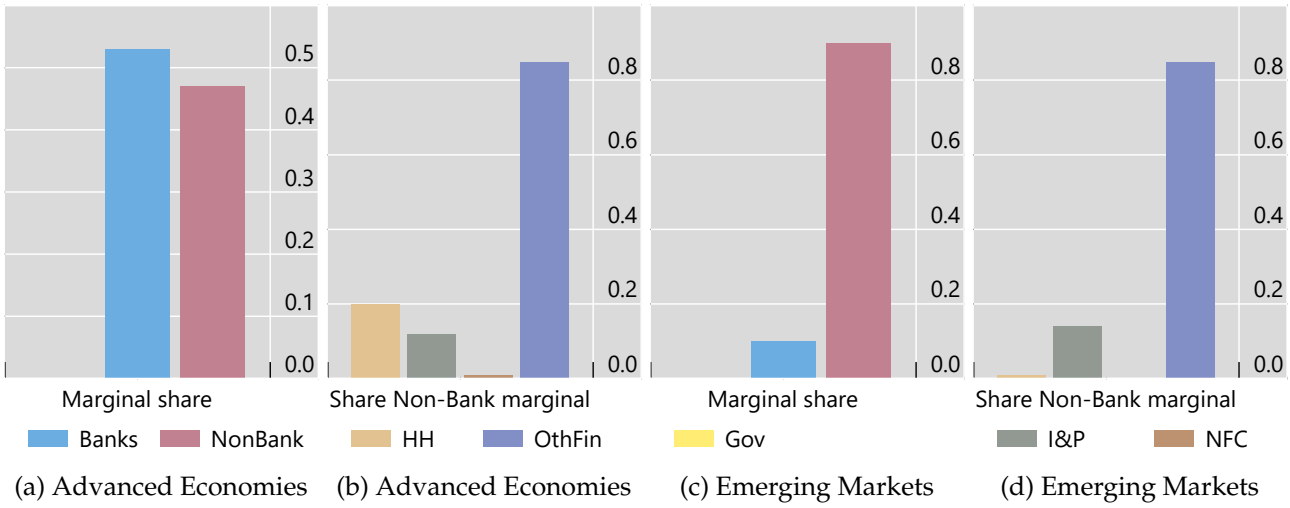
This setup allows us to examine how Euro Area non-bank investors behave relative to each other and relative to other Euro area investors in regards to their holdings of foreign sovereign debt (i.e. outside the Euro Area). Since Euro Area investors do not account for the full set of foreign investors for a given government, we cannot replicate our previous analysis. Nevertheless, we can adapt that approach to establish which types of non-bank

[10] Faia, Salomao, and Veghazy (2022) analyze the underlying data for the Euro Area SHS, focusing on corporate bonds in the euro-area, and find significantly different behavior for mutual funds relative to insurance and pension funds, similar to our results below for sovereign bonds.

investors in the Euro Area drive the overall behavior of Euro Area non-bank investors in foreign sovereign debt markets. We therefore modify our regression in Equation (2) so that the denominator is the total holdings of foreign sovereign debt by Euro Area investors, rather than total debt. When we examine within the non-bank group, we replace the denominator with the total holdings of sovereign n's debt by Euro Area non-bank investors.

The coefficient results are summarized in Figure 3 while the regression results are relegated to Table B8 in Appendix B. Similar to the aggregate data, the non-bank private investors are the most marginal group within the set of Euro Area investors (excluding central banks). For the base case of all non-Euro Area countries, 77% of every additional unit of sovereign debt picked up by these investors is held by Non-Banks, while only 23% is held by Banks. These general patterns hold for all cases except for Advanced Economies in the baseline estimates shown in Figure 3 panel (a), where banks seem to absorb the largest share of the increase.[11]

Figure 3: Foreign Non-bank Marginal Holders: Euro Area Investors



(a) Advanced Economies (b) Advanced Economies (c) Emerging Markets (d) Emerging Markets

Note: This figure plots the regression coefficients in Equation (2) for euro area investors' holdings of non-euro area government debt. Panels (a) and (c) report the coefficients for regressions of EA investor holdings of non-EU government debt for AE governments and EM governments, respectively, reported in columns (1), (2), and (3) in Table B8. These groups are private Banks, Non-Banks, and other governments "Gov". Panels (b) and (d) report the coefficients for regressions of disaggregated Non-bank EA investor groups based upon columns (4), (5), (6), and (7) of Table B8) for Households, Insurance and Pensions (IP), Nonfinancial Corporations (NFC), and Other Financial Institutions (OthFin). The results use the total EA investor holdings of non-EA debt by AE and by EM separately as the total denominator in Equation (2).

[11]Debt from large AE countries such as the US are important for this group of investors, but are weighted equally with other countries. If we weight this regression by the size of the total holdings of that sovereign's debt by European investors, then non-banks are again the most marginal investor in foreign AE sovereign debt.

More importantly, panels (b) and (d) in Figure 3 provide a decomposition within the Non-bank investor group. Insurance and pension (IP) account for 12 to 14% of the additional sovereign debt picked up by foreign non-banks in both (non-Euro Area) advanced and emerging markets. This is dwarfed by "other financial institutions" (OthFin) such as hedge funds and mutual funds, which picked up 85%. By contrast, the other two categories of households (HH) and non-financial companies (NFC) essentially take on little to none of the additional foreign government debt.

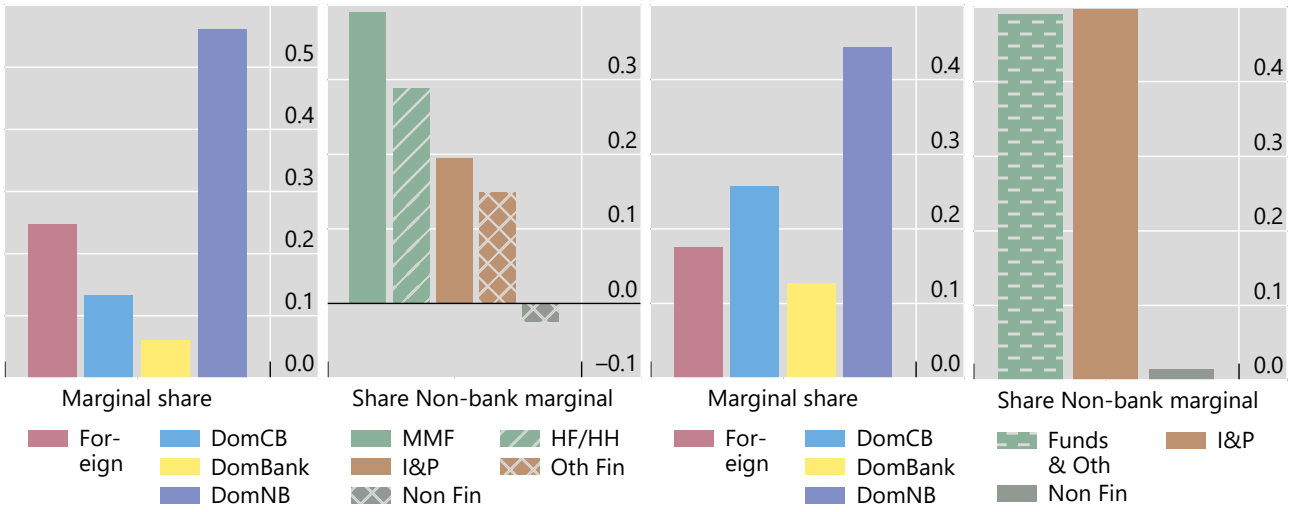
We next turn to the US and UK data to examine the domestic non-bank group. These data breakout the total debt issuance by the central government by who is holding the debt. Thus, we apply our standard approach in Equation (2), dropping the time and country fixed effects, as we are considering a single country. These datasets provide a detailed breakdown of domestic holders of these securities, but provide little or no sector breakdown of the foreign holders. We utilize data over 1995 Q1 to 2020 Q4 for comparability with the other data. While we note that the US and UK are not typical countries, so results may not be fully generalizable, they nevertheless provide a useful window into domestic non-banks' holdings of government debt.

The coefficients from these regressions are plotted in Figure 4 while the details are reported in Tables B9 and B10 in Appendix B. For US Treasuries and UK Gilts, respectively, Panels (a) and (c) depict the regression coefficients for the aggregated groups of total foreign investors, domestic central banks, and domestic non-banks. As shown there, domestic non-banks are the most marginal investors in these markets, accounting for nearly half of the variation. Panels (b) and (d) break out the non-bank marginal share by underlying sector for holdings of US Treasuries and UK Gilts, respectively. In the US, we see that investment funds, including hedge funds and Money Market Funds (MMFs), are the most important group, accounting for over half of the non-bank marginal variation (despite making up only 26% of non-bank holdings on average).[12] The Insurance and Pension (I&P) sector accounts for about 15%. In the UK, the I&P sector plays a much larger role for non-bank holdings,

[12]The "household" sector includes hedge funds, private funds, and private trusts.

accounting for nearly half of the marginal absorption. Funds and other non-bank financial institutions account for the other half. The large presence of I&P is notable especially in light of the Sept 2022 turmoil in the Gilt market regarding pension funds.[13]

Figure 4: Domestic Non-bank Marginal Holders: US and UK



(a) US Treasuries (b) US Treasuries (c) UK Gilts (d) UK Gilts

Note: This figure plots the regression coefficients in Equation (2) for the holders of US Treasuries and the holders of UK Gilts over 1995q1-2020q4. The regression results are reported in Tables B9 and B10, for US Treasuries and UK Gilt, respectively. Panels (a) and (c) give the aggregate breakdown for all foreign (Foreign), domestic central bank (DomCB), domestic bank (DomBank), and domestic non-bank (DomNB). In panel (b), "HF/HH" includes Hedge funds, private equity, private trusts, and direct household holdings. "Non Fin" is all non-financial holders excluding households. "Oth Fin" is all other financial institutions apart from funds and Insurance and Pension (I&P). In panel (d), "Funds & Oth" comprises all funds and financial institutions except for I&P. "Non Fin" includes all non-financial holders.

Overall, these disaggregated data suggest that the foreign non-bank investor group is largely driven by the behavior of investment funds, with modest participation from the I&P sector. For the domestic non-bank investor group, the I&P sector likely plays a larger role alongside funds. Other domestic players may be context specific (e.g., the large role of MMFs in the US may be unique), but the results suggest that investment and other funds are the primary non-bank players in the market.

[13]The higher marginal participation of this sector is driven by their large average holdings, rather than I&P being quite active traders. In the US, this sector makes up 43% of domestic non-bank holdings, while in the UK it accounts for 81%. This fits with the perception that this sector is more stable in their holdings.

3 Sovereign Debt, Investor Holdings, and Yields

We showed above who holds sovereign debt and how the composition of investor holdings varies when that debt expands on the margin. In this section, we describe a framework to study the behavior of creditors, allowing us to consider why that composition matters. Section 3.1 begins by considering how a sovereign may view the propensity for its investors to provide credit as it varies debt and the yield on that debt. Although this framework could in principle be used for any country, we study debt issued by AE and EM countries separately because investors view these two types of assets differently. Investors hold AE debt (for example, US Treasuries) mainly for its safety and liquidity, but investors primarily hold EM debt for its yield. Therefore, in Sections 3.2 and 3.4 we estimate the funding propensities from the point of view of EM and AE sovereigns, respectively. Section 3.3 then shows that under some additional assumptions, this framework may be used to identify and estimate the investor demand similarly to the approach in Koijen and Yogo (2020). In Section 4, we combine these estimates with the marginal investor results above to determine the sensitivity of financing cost in borrowing countries.

3.1 Sovereign Funding

We now describe a framework to relate the debt funding of a sovereign to its creditor holdings and to study how those creditors respond to the yield. Clearly, the sovereign debt market is characterized by both supply and demand, as we describe in turn.

The supply of debt depends upon factors that impact the desire to borrow along with the cost of doing so. Specifically, a long literature has related government financing needs with economic downturns and macroeconomic variables such as inflation (e.g. Aguiar, Chatterjee, Cole, and Stangebye (2020); Reinhart and Rogoff (2011)). Moreover, a government's ability to borrow depends upon its perceived riskiness. For example, in the defaultable sovereign debt literature, debt levels depend upon the country's income level and its default probability (e.g., Arellano (2008)). We summarize this relationship by treating the debt

supply-to-GDP as dependent on a vector of country-specific variables that impact the borrowing decision, defined as $\mathbf{x}_t(n)$ for a given country n, as well as its own lag. Thus, defining the book value of country n's debt as a share of GDP to be $d(n) \equiv D(n)/Y(n)$, where $Y(n)$ is country n's GDP level, we can write the debt supply function as: $d_t(n) = d\left(\mathbf{x}_t(n), d_{t-1}\right)$. Our analysis below uses the functional form for this process given by:

$$\frac{D_t(n) - \gamma_0 D_{t-1}(n)}{Y_t(n)} \equiv d_t(n) - \gamma_0 d_{t-1}(n) g_t(n)^{-1} = g(\mathbf{x}_t(n)), \tag{4}$$

where γ_0 is the legacy debt that has not matured and $g_t(n) = Y_t(n)/Y_{t-1}(n)$ is country n's GDP growth rate. Governments mostly borrow long-term so that $(1-\gamma_0)^{-1}$ is approximately the maturity of country n's debt. The newly issued debt depends on the set characteristics $\mathbf{x}_t(n)$. Below, we will assume that investors and governments view the same country-specific variables $\mathbf{x}_t(n)$ as exogenous to their own decisions. An interesting question for future research is to ask whether they differ.

Given a desired supply of book value for this debt, a government then raises the debt according to the willingness to fund by a set of creditors. To examine the funding provided by these investors, we define $P_t(n)$ as the price of debt of government n at time t and the share of holdings of that country's debt-to-GDP held by investor i at time t as:

$$h_{i,t}(n) \equiv \left(\frac{H_{i,t}(n)}{D_t(n)}\right) d_t(n), \tag{5}$$

Then the market value of this share can be written as: $h^m_{i,t}(n) \equiv P_t(n) h_{i,t}(n)$. Investor i's holdings of country n's debt are assumed to depend on the price of debt $P_t(n)$ and other country characteristics $\mathbf{x}_t(n)$. We capture this relation as a funding function: $h^m_{i,t}(n) = h_i(P_t(n), \mathbf{x}_t(n))$. The market clearing condition in Equation (1) can then be rewritten as:

$$P_t(n) d_t(n) = \sum_{i=1}^{I} h_i(P_t(n), \mathbf{x}_t(n)). \tag{6}$$

This condition implies an equilibrium price level of country n's debt, $P_t(n)$, as a function of the book value of debt-to-GDP, $d_t(n)$, and the propensity for investors to fund debt depending on the characteristics of country n, $\mathbf{x}_t(n)$.

The ability for the government to sustain debt will depend upon its borrowing costs, captured by the price of debt. In general, the price of debt depends upon the interest rate, debt maturity and coupon repayment schedule. While this information may be available for some individual bond issuances, the debt maturity and payment schedules for total debt are not available. Therefore, we assume that the annualized interest cost per period is proxied by the yield-to-maturity on pure discount government bonds. In this case, the price of debt is: $P_t(n) = (1 + y_t(n))^{-T}$, where $y(n)$ is the yield of T-year debt issued by government n.

We now use this framework to estimate the investor willingness to fund debt viewed from the point of view of the borrowing government. We specify this function $h^m_{i,t}(n)$ as a log-linear function of yield $y_t(n)$ and exogenous characteristics $\mathbf{x}_t(n)$.[14] The empirical regression model of investor i's holding shares of country n's debt-to-income is then:

$$\ln h^m_{i,t}(n) = \theta_{0,i} y_t(n) + \theta'_{1,i} \mathbf{x}_t(n) + \theta_i(n) + \theta_{i,t} + \varepsilon_{i,t}(n) \tag{7}$$

As Equation (7) shows, the willingness to fund by investor group i depends not only on the yield and country-specific characteristics $\mathbf{x}(n)$, but also on country and year fixed effects. Country fixed effects $\theta_i(n)$ are included to capture the time-invariant characteristics of countries that affect the overall ability to fund from a given investor group.[15] Year fixed effects $\theta_{i,t}$ are included to capture worldwide economic shocks that are common to all countries. Finally, $\varepsilon_{i,t}(n)$ captures investor i's latent demand for country n's debt.

Estimating holdings shares as in Equation (7) presents two identification issues. First, since the yield of debt is determined in equilibrium by equating demand to supply, it is likely to be correlated with latent demand $\varepsilon_{i,t}(n)$. To address this problem, we construct an instrument for yield $y_t(n)$ based on the insight of Koijen and Yogo (2020) that utilizes

[14] Since $P_t(n)$ is a monotonic transformation of $y_t(n)$, we replace $P_t(n)$ in the H_i function with $y_t(n)$.

[15] The inclusion of fixed effects is a departure from Koijen and Yogo (2019, 2020). It is motivated by the different structure of our data: allocating all of a borrower's debt by the investors, rather than allocating all of the investors' assets to the borrowers or equity issuers. Foreign investors in our data are composed of different entities for each country. The identifying assumption of our approach is that all countries face a common willingness to fund debt by a given foreign investor group based on their exogenous characteristics, $\mathbf{x}(n)$, and yield. Including a sovereign country fixed effect within the vector of characteristics better captures constant funding differences across sovereigns for a given investor type that are not captured by the other characteristics. Moreover, domestic investors operate in very different contexts within their own countries. Thus, including fixed effects also help to make domestic investor behavior more comparable across borrowers by controlling for time-invariant differences of each country within each domestic investor group.

the market clearing condition to construct an implied yield that is orthogonal to the latent demand and correlated with the observed yield. Our dataset includes a full set of creditors for a particular sovereign, which enables us to construct the instrument using this insight.

Specifically, we begin by estimating the market value of holdings per investor group as a reduced-form function of country characteristics $\mathbf{x}_t(n)$ using the regression:

$$\ln h^m_{i,t}(n) = \alpha_i' \mathbf{x}_t(n) + \alpha_i(n) + \alpha_{i,t} + u_{i,t}(n). \tag{8}$$

The fitted values of this regression for each investor defined as $\hat{h}^m_{i,t}(n) = \exp(\hat{\alpha}_i' \mathbf{x}_t(n) + \hat{\alpha}_i(n) + \hat{\alpha}_{i,t})$ provides an exogenous measure of the right-hand side of the market clearing condition in Equation (6), which only depends on exogenous characteristics $\mathbf{x}_t(n)$.

The second identification issue concerns the endogeneity of the supply of debt. Therefore, according to Equation (4), we project current debt-to-GDP on the characteristics and lagged debt as in the following equation:

$$d_t(n) = \gamma_0 d_{t-1}(n) g_t(n)^{-1} + \gamma_1 \mathbf{x}_t(n) + \gamma(n) + \gamma_t + e_t(n) \tag{9}$$

Substituting the fitted values of Equation (9), defined as $\hat{d}_t(n)$, for the realized debt along with the fitted values from the market value of holding shares, $\hat{h}^m_{i,t}(n)$, into the market clearing in Equation (6) implies:

$$\hat{d}_t(n)(1 + \tilde{y}_t(n))^{-T} = \sum_{i=1}^{I} \hat{h}^m_{i,t}(n) \tag{10}$$

where the fitted value is: $\hat{d}_t(n) = \hat{\gamma}_0 d_{t-1}(n) g_t(n)^{-1} + \hat{\gamma}_1 x_t(n) + \hat{\gamma}(n) + \hat{\gamma}_t$. Based upon this condition, we then solve for the hypothetical yield $\tilde{y}_{j,t}$ that clears the market given the exogenous variables. The hypothetical yield $\tilde{y}_{j,t}$ is then used as an instrument for the actual yield $y_{j,t}$ in the estimation of Equation (7).

3.2 Funding Emerging Market Sovereign Debt

We now use this framework above to estimate the investor funding shares for EM sovereigns. Note that estimating Equation (7) requires specifying a set of country-specific characteristics, $\mathbf{x}_t(n)$. For this purpose, 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. Thus, 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 inflation.[16] In light of the literature on sovereign debt and following Koijen and Yogo (2020) that estimates asset demand across countries, we include real GDP growth ("GDP growth"), inflation, the logarithm of the export-to-GDP ratio ("Exp-to-GDP"), the logarithm of the nominal GDP ("GDP") and sovereign credit ratings ("Ratings").[17] We use the five-year local currency government bond yield ("Bond Yield") as the relevant price variable.[18]

Table 2 reports the IV estimation results, relegating the reduced form holding estimates of Equation (8) and the debt-to-GDP estimates of Equation (9) to the Appendix Section C.1 and C.2, respectively. As would be expected on economic grounds, 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 and inflation declines, although insignificantly so for some groups. Exports-to-GDP and Ratings are relatively insignificant across groups.

The responsiveness of the holdings to yield provide an important first look at the relevance of different investor groups for the sovereign, as reported in the first row of Table 2. Within domestic investors, both banks and non-banks have a significant response to yield, but the non-bank group is almost twice as responsive. That is, in response to a 1 percent increase in yield, domestic non-banks increase their debt holding by 23% while domestic banks do so by 12%. Similarly, among the foreign investors, foreign non-banks are the most responsive as they increase holdings by 38% for a 1 percent increase of yield. Thus, non-banks appear to vary their sovereign debt holdings by more than other investor groups in

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

[17] Using a data base of bilateral holdings across countries with a larger number of observations, Koijen and Yogo (2020) also include some other variables such as imports-to-GDP, real GDP per capita, and equity volatility. Using our much smaller data base of holdings by country, we found that these variables were generally insignificant

[18] We use five-year yields because the coverage of countries is greater than that of other maturities. Similarly, we use the yields in local currency since EM governments primarily borrow in their local currency, and have been increasingly borrowing from abroad in local currency, thereby making the liquidity in these markets greater. For discussion, see for example Du and Schreger (2016) and Onen, Shin, and von Peter (2023), as well as Table C4 in the BIS Debt Securities Statistics.

response to yield changes.

Table 2: Emerging Market Funding

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
Bond yield	12.073*	22.914***	27.368	28.167**	38.410*	24.890*
	(6.833)	(8.754)	(17.226)	(13.689)	(19.704)	(14.538)
GDP	-0.257	0.039	-0.716	-0.403	-1.156*	-1.692**
	(0.164)	(0.276)	(0.476)	(0.329)	(0.658)	(0.307)
GDP growth	3.554*	3.949	8.568	3.325	16.068**	6.728
	(2.019)	(2.687)	(5.413)	(4.045)	(6.307)	(4.221)
Inflation	-3.486***	-3.471***	-4.424*	-6.013***	-3.967	-4.068**
	(0.946)	(1.304)	(2.322)	(1.896)	(2.619)	(1.976)
Exp-to-GDP	-0.249	-0.266	-0.689	-0.536	-0.094	-0.362
	(0.193)	(0.298)	(0.565)	(0.387)	(0.650)	(0.369)
Rating	0.018	-0.001	0.049	-0.023	0.012	0.025
	(0.013)	(0.020)	(0.035)	(0.026)	(0.040)	(0.025)
Observations	350	323	288	350	305	342

Note: This table reports the IV estimates of the funding shares in Equation (7), with 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 levels are reported in the parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

These results provide insights from the sovereign's perspective about how funding varies across investor groups in response to changes in borrowing costs, captured by the local currency yield. However, given that the data do not include information about the identity of the investor, this analysis presumes governments do not have separate information about the investor demand in the funding market. Nevertheless, in the next subsection, we show that under some additional assumptions, our framework can be viewed as consistent with the literature of demand system asset pricing as described in Koijen and Yogo (2019, 2020) and our estimated demand elasticities are similar to those reported in the literature.

3.3 Investor Demand Estimation for Emerging Market Debt

As noted above, our data set does not provide the identity of the investor other than whether it is domestic or foreign and its sectoral classification. Therefore, it does not provide information about what the other holdings of these investors are. This omission is important because, in reality, investors substitute between debt issued by different countries. Moreover, foreign investors care about returns denominated in their own currency, while domestic investors care about returns denominated in local currency. In principle, these issues could be addressed with a more granular data set that included the identity of these investors and their portfolios. We leave this important question for future research.

Despite these issues, under two additional assumptions, our data can be used to estimate a demand system model of EM debt by different investor groups following Koijen and Yogo (2019, 2020). We summarize these assumption below, although Appendix D provides more details. First, we assume that all foreign investors within a specific investment group can be treated as a single investor. This assumption requires, for instance, that a foreign bank does not become a domestic bank within the sample. This assumption appears more reasonable for EM sovereign debt since many of their foreign investors are from advanced economies. Second, since we do not know the identity of the foreign investors, we assume that these investors are all US dollar-based investors. As such, they face foreign exchange risk in holdings of non-US dollar denominated debt and base their risk-free rate on US Treasuries. Although this assumption is inaccurate for some foreign investors, the continued importance of the US dollar in the global market suggests that it provides a useful benchmark. We assume domestic investors are local-currency-based.

Under these assumptions, we then treat the six creditor groups as distinct investor types with desired portfolio shares of an unobserved wealth. As in Koijen and Yogo (2020), we model investor i's portfolio share of country n's debt as a logistic function of expected returns and the set of country characteristics $\mathbf{x}_t(n)$.[19] That is, we denote the portfolio holdings

[19]Unlike Koijen and Yogo (2020), we do not have a breakdown of total debt holdings to wealth by investor group and therefore we collapse the two-step decision process within and across asset classes in that paper into one single step.

of investor i of sovereign debt holdings of country n as: $H^m_{i,t}(n) = \omega_{i,t}(n)A_{i,t}$ where $A_{i,t}$ is the wealth of investor i in US dollars and $\omega_{i,t}(n)$ is the share of country n's sovereign debt in investor i's portfolio. Similarly, $H_{i,t}(0) = A_{i,t}\omega_{i,t}(0)$ is the amount of investor i outside asset holdings in US dollars and $\omega_{i,t}(0)$ is the portfolio share of that asset. The regression model is then given as:

$$\delta_{i,t}(n) \equiv \ln\left(\frac{\omega_{i,t}(n)}{\omega_{i,t}(0)}\right) = \ln\left(\frac{H^m_{i,t}(n)}{H_{i,t}(0)}\right) = \lambda_{0,i}\mu_{i,t}(n) + \lambda'_{1,i}\mathbf{x}_t(n) + \lambda_{i,t} + \lambda_i(n) + \varepsilon_{i,t}(n) \quad (11)$$

where $\lambda_{i,t}$ and $\lambda_i(n)$ are year and country fixed effects and $\mu_{i,t}(n)$ is the expected excess return of country n's sovereign debt faced by investor i. Similar to our analysis in Section 3.2, country fixed effects are included to capture time-invariant country characteristics while time fixed effects are included to capture global-wide shocks that are common to all countries.

Estimating Equation (11) poses two challenges. First, we do not observe the net worth or the outside asset held by investor i. Second, the expected excess return faced by domestic and foreign investors differ according to their base currency. Therefore, we next discuss how we approach these two challenges.

Outside Assets We first describe our approach to the outside asset for the foreign investors and the domestic investors, in turn. As noted above, we treat foreign investors as representative investors in the global economy who make debt allocation decisions across all the EM countries. Given that we do not observe the wealth or outside asset holding of such investors, we assume that their outside asset holding can be absorbed by the time fixed effect and thus not affect our parameter estimation. Clearly, this treatment requires the foreign investor group composition to be relatively constant for all EM borrowing countries.

Domestic investors are different from foreign investors, however, as they differ by country. For example, for a particular investor group such as "banks", we have N distinct domestic banks in this investor group, one for each country. As such, we do not have a sufficient number of observations for a given domestic investor to identify a separate response per

country. Therefore, we instead treat the responses of the domestic investors jointly across countries but condition on a proxy for the outside asset, defined for a particular domestic investor group as $H_{i,t}(o,n)$. Thus, Equation (11) can be rewritten for domestic investors as:

$$\ln\left(\frac{H^m_{i,t}(n)}{H_{i,t}(o,n)}\right) = \lambda_{0,i}\mu_{i,t}(n) + \lambda'_{1,i}\mathbf{x}_t(n) + \lambda_{i,t} + \lambda_i(n) + \varepsilon_{i,t}(n) \tag{12}$$

In our baseline results below, we consider the level of GDP as a proxy of the outside asset held by investor i of country n, allowing comparability to the foreign investor results. Our results are qualitatively similar based on measures such as bank credit and the equity market cap.

Expected Excess Returns We next discuss our treatment of excess returns for foreign and domestic investor groups. All foreign investors are assumed to be US dollar-based, as noted earlier. Thus, for foreign investors, we follow Koijen and Yogo (2020) in treating the expected excess return for a US dollar-based investor as the fitted value of a predictive regression of holding period return of debt plus the exchange rate change given by:

$$r_{t+1}(n) + s_{t+1}(n) - s_t(n) - y_t(US) = \phi_f p_t(n) + \psi_f(s_t(n) - z_t(n)) + \chi_f(n) + \nu_{f,t+1}(n) \tag{13}$$

where $r_{t+1}(n)$ is the holding return of sovereign debt of country n in local currency, $s_t(n)$ is the log of exchange rate $S_t(n)$, and $y_t(US)$ is the short-term yield of US Treasuries. The predictive variables are the log of the bond price, $p_t(n)$, and the log of the real exchange rate given by the difference between the log nominal exchange rate, $s_t(n)$, and the difference of price levels between country n and the US, $z_t(n)$. A country fixed effect $\chi_f(n)$ is included to capture time-invariant characteristics of country n. Constructed expected excess returns are then:

$$\mu_{f,t}(n) = \hat{\phi}_f p_t(n) + \hat{\psi}_f(s_t(n) - z_t(n)) + \hat{\chi}_f(n) \tag{14}$$

By contrast, domestic investors are local-currency based and view the realized returns in excess of their own short term rate given by predictive regressions for each currency n:

$$r_{t+1}(n) - y_t(n) = \phi_d p_t(n) + \chi_d(n) + \nu_{d,t+1}(n) \tag{15}$$

where $y_t(n)$ is the short term rate in local currency of country n. The constructed expected returns for domestic investors are then:

$$\mu_{d,t}(n) = \hat{\phi}_d p_t(n) + \hat{\chi}_d(n) \tag{16}$$

Appendix D.2 provides the estimation results of the return system as well as a description of their connection to investor demand elasticities with respect to yield.

Estimation Results Based upon these modifications for outside assets and expected returns, we can now turn to estimating the investor demand equations. To address the endogeneity of the expected excess return $\mu_{i,t}(n)$ for each investor group i, we first construct an instrument following the same steps as in Section 3.2. These instruments are then used to estimate the foreign and domestic investor demand in Equation (11) and Equation (12).

Table 3 provides the results of this baseline estimation in Panel A. The first two rows again show the importance of non-bank investors, with the first row showing the dependence on domestic excess returns and the second on foreign excess returns. Among the foreign investors, foreign non-banks are the most sensitive as a 1% change in expected excess returns corresponds to a 10% change in debt holdings of a particular country. Among the domestic private investors, domestic non-banks are more responsive than domestic banks at 7.7% and 4.2%, respectively. Domestic central banks are more responsive, although this response is likely motivated by policy decisions and not by the desire for a return. Across investor groups, higher inflation leads to a decline in holdings while higher GDP growth generally increases these holdings.

The estimates of expected return responses can further be used to obtain implied investor demand elasticities. Investors who increase their holdings of a particular country's sovereign debt in response to an increased yield would necessarily have to reduce portfolio shares in another asset. This feature of the asset demand system allows for substitution across debt issued by different countries and different assets more generally. As shown in Koijen and Yogo (2019) and detailed in Appendix D.2, investor group i's elasticity of de-

Table 3: Investor Demand: Emerging Markets

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
Panel A: IV Estimates						
Return- Domestic	4.150*	7.753***	10.347*			
	(2.190)	(2.770)	(6.021)			
Return- Foreign				8.034**	10.056*	6.428*
				(3.924)	(5.199)	(3.844)
GDP	0.767***	1.099***	0.330	1.718***	1.299	0.203
	(0.152)	(0.252)	(0.467)	(0.610)	(1.251)	(0.587)
GDP Growth	3.739*	4.264	10.080*	5.124	17.428**	7.543
	(1.968)	(2.590)	(5.850)	(4.892)	(6.982)	(4.761)
Inflation	-3.542***	-3.526***	-4.894**	-7.217***	-5.071	-4.734**
	(0.910)	(1.235)	(2.424)	(2.468)	(3.171)	(2.398)
Exp-to-GDP	-0.222	-0.216	-0.662	-0.502	-0.167	-0.304
	(0.175)	(0.271)	(0.542)	(0.400)	(0.642)	(0.363)
Ratings	0.016	-0.005	0.046	-0.016	0.008	0.028
	(0.012)	(0.018)	(0.033)	(0.029)	(0.039)	(0.026)
Panel B: Shares and Elasticities						
Mean $\omega_i(n)$	0.140	0.340	NA	0.01	0.015	NA
Elasticity	10.64	14.89	NA	29.05	35.45	NA

Note: This table reports the EM sovereign debt IV estimates of the demand function in Equation (12) for the first three columns and in Equation (11) for the last three columns, including country and year fixed effects. 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.

mand with respect to expected excess return equals $\lambda_{0,i}(1 - \omega_{i,t}(n))$. Therefore, calculating the elasticities requires adjusting the investors' yield coefficients by their portfolio share of country n debt holdings, $\omega_{i,t}(n)$. Although we do not have measures of portfolio shares of each investor groups, we can get estimates of domestic and foreign shares. For domestic banks and domestic non-banks, we proxy for this share using the average ratio across emerging markets of investor group holdings of own government bonds to assets. Taken

from the IMF Financial Soundness Indicators, these ratios are 0.14 for banks and 0.34 for non-banks. For foreign investors, we take the data from the Euro area SHS data and BIS banking statistics to compute proxies. In particular, holdings of EM sovereign debt by euro area non-bank investors is about 1.5% of their portfolio. From the BIS banking statistics, foreign banks have roughly 1% of claims on foreign sovereigns (Hardy and Zhu (2023)).

Panel B of Table 3 reports these shares and their implied elasticities with respect to yield. These elasticities vary from 10 for domestic banks to around 35 for foreign non-banks. Although much of the comparable elasticities in the literature relate to private assets instead of sovereign debt, the estimates are consistent with other debt instruments. For example, for ten year bonds, Jiang et al. (2022) find a range of 13 to 44, while the estimates in Koijen et al. (2021) vary between 12 to 30 but reach 72 for foreigners. The similarity between these elasticity estimates suggests that there may be a high degree of substitutability between private and sovereign debt, an interesting question that we leave on the agenda for future research.

3.4 Funding Advanced Economy Sovereign Debt

We now return to consider the funding of Advanced Economy debt based upon the framework described in Section 3.2. The approach to estimating AE sovereign debt funding is similar to that of EM sovereigns with two modifications. First, since variations in yields are much lower for these countries, we regress the holdings on the logarithm of the yield.[20] Second, we omit some countries. In particular, 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, a status has been described as an "exorbitant privilege."[21] Moreover, we exclude Greece for the period of 2009 to 2015 when Greece was experiencing a debt crisis and its yield spiked to an excessively high level.

Table 4 reports the IV estimation results for AEs. The results for the first-step regressions

[20] For some countries, the yields are very low during the Zero Lower Bound period implying implausibly out-sized responses.

[21] On the safe asset status, see for example, Jiang, Krishnamurthy, and Lustig (2018)and the discussion in Gourinchas, Rey, and Govillot (2017).

Table 4: Advanced Economy Funding: Instrumental Variable Estimates

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
Bond yield	1.377***	2.179**	1.790**	0.979**	3.111**	0.686**
	(0.497)	(0.865)	(0.782)	(0.391)	(1.373)	(0.301)
GDP growth	6.990*	4.897	15.057**	1.915	11.634	5.246**
	(3.726)	(6.659)	(6.723)	(3.039)	(9.600)	(2.338)
GDP	-0.742	-2.161*	-1.482	0.705	0.021	0.915**
	(0.595)	(1.130)	(1.086)	(0.494)	(1.510)	(0.380)
Exp-to-GDP	4.363***	5.103**	6.124**	2.957**	8.735**	1.384
	(1.536)	(2.408)	(2.540)	(1.203)	(3.938)	(0.926)
Rating	-0.469*	-1.128**	-0.110	-0.560**	-1.358*	-0.013
	(0.279)	(0.498)	(0.462)	(0.221)	(0.724)	(0.170)
Inflation	3.705	4.007	20.007*	9.769**	8.820	11.810***
	(5.994)	(9.532)	(11.488)	(4.940)	(14.611)	(3.801)
Observations	274	264	249	275	267	275

Note: This table reports the IV estimates of the funding function in Equation (7), with 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.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

for the instrument and results for the projected debt are reported in Appendices C.3 and C.4, respectively. As the first row shows, the responses of each investor group's holdings to yield changes are all positive. Moreover, as with the holdings of EM debt, the non-banks are the most responsive to changes in yields within the domestic and foreign investor groups. In particular, a one percent change in the local currency yield leads to a 2.2% change in holding shares by domestic non-banks compared to a 1.4% change in domestic banks. Similarly, foreign non-banks respond to the same change with a 3.1% change in holdings compared to a 0.98% change by foreign banks. Overall, the pattern that non-banks are more responsive as found among emerging markets appears robust to advanced economies as well.

It would be useful to estimate these holdings as a demand system based upon the investors in the AE country government debt as we did for EM sovereigns. However, as

noted earlier, in our data set foreigners are only identified as living outside the given country. Thus, we cannot cleanly identify which investors are foreign for a given sovereign. For example, German banks will be in the "Domestic bank" group for German debt but in the "Foreign bank" group for French debt. Thus, we cannot estimate realistic investor demand systems for AE governments with this data set. A more granular data set of portfolio holdings of sovereign debt and other securities would be required for the estimation of the demand system for AE sovereign debt, an important study that we leave for future research.

4 Cost of Financing Sensitivity and Counterfactual Analysis

Section 3 reported estimates of the demand response of different investors to, alternatively, changes in the yield or the expected excess return of debt and to other country characteristics. This section illustrates *why* the investor composition of sovereign debt holdings matters. For this purpose, we develop a measure of financing costs and show how it depends upon the investor elasticity to yield. We then consider how this financing cost differs according to the characteristics preferred by the various investor groups. All of the analysis in this section is based upon the Emerging Market sample using estimates from the demand system approach in Section 3.3. Using the estimates in Section 3.2 leads to similar results.

In this section, we conduct counterfactual analyses for private investors only. Despite that official lenders' holdings respond to the price of debt and other characteristics changes, we treat official lenders' holding as policy choices instead of market behaviors. The marginal or average shares of official lenders are redistributed proportionally to private bank and non-bank sectors.

4.1 Debt Increase

We begin by asking the question: how much will the cost of financing increase if the government wants to increase the debt by one percent? This question is clearly an important one given the projected rise of debt-to-GDP in the next few years. To calculate this measure, we first note that the present value of the cost of borrowing to the country is equal to the

present value of debt to the creditors according to the market-clearing condition in Equation (6). For expositional parsimony, we also define the market-value of debt as: $D_t^m \equiv D_t P_t$ and subsume the dependence upon country n. Then, Appendix E.1 shows that the overall response in the yield for a percentage increase in debt is:

$$\xi \equiv \frac{dy}{d \ln D^m} = \frac{\sum_{i=1}^{I} a_i/(T+\eta_i)}{\sum_{i=1}^{I} a_i \eta_i/(T+\eta_i)} \tag{17}$$

where η_i is the yield elasticity of demand by investor group i and a_i is the change in book value holdings by investor group i in response to changes in debt as estimated in Section 2. We call this measure ξ the "financing cost sensitivity." This calculation is a partial equilibrium calculation as it does not account for substitution effects that arise from investors adjusting their portfolios towards or away from non-EM sovereign debt assets in response to prices.

The interpretation of this measure is straightforward. The numerator is the sensitivity of cost of financing in response to a one percent change in the book value of debt. This sensitivity equals the marginal absorption-weighted average of the inverse demand elasticities. Intuitively, if the sovereign issues one percent more debt, a_i percent is absorbed by investor group i. To induce investor group i to absorb this amount of debt, the yield must rise by $a_i/(\eta_i + T)$. By contrast, the denominator shows how much debt should be issued at book value in order to collect one more percent in market value. Since demand is downward-sloping, the price of debt will in general decrease when the debt level increases. Thus, the increase in market value of debt will be lower than the increase in book value of debt. If the aggregate elasticity is relatively high, the price change is mild so that the increase in debt revenue will be close to the increase in book value. We use our estimates to study the relative importance of these effects.

Panel A of Table 5 reports these financing cost sensitivities calculated from Equation (17) using the marginal responses a from Table 1 and elasticities η from Table 3. For convenience, Panel D repeats the estimates used in this calculation. The first row of Panel A shows the financing sensitivity using the total composition of investors in our sample estimates. Specif-

ically, if a government increases debt by 10 percent, the cost of financing given by the debt yield, will increase by 59 basis points. The average 5-year yield of EM debt in our sample is 8.8%, so that an increase of 59 basis points represents a 6.7% increase in cost of financing.

Next, we consider how a change in the investor base would impact this financing sensitivity. These counterfactuals evaluate how the financing costs are affected if the absorption shares of a given investor group is set to zero while the remaining shares are distributed proportionately across the remaining investors according to their marginal absorption levels. As Table 5 Panel A shows in the row labeled "No Bank", excluding the bank investor groups as a whole would move the cost of financing sensitivity from 59 basis points to 52 basis points in response to a 10% increase in debt revenue. By contrast, the next row labeled "No Non-bank" illustrates how excluding the non-bank investor groups (domestic and foreign) would impact financing. As reported, eliminating non-banks would significantly increase the overall financing cost sensitivity to 80 basis points, representing a 9% increase for the average emerging market. This greater sensitivity is due to the higher elasticities of non-bank investors as reported in Panel D. Thus, when the investor base has more non-banks, the required increase in yield for the sovereign is less.

4.2 Changes of Characteristics

We next consider how a change in the characteristics of the borrower would impact the government's financing costs. Specifically, in this second set of illustrations, we ask the question: how much would the yield have to change in response to changes in characteristics in order to keep the market value of debt unchanged? This counterfactual provides information about the investor substitutability between the borrowing costs and characteristics.

For this purpose, we define ζ as the change of yield in response to a unit change in one of the characteristics, $X_t(n)$, given the market value debt. Then, Appendix E.2 shows that ζ can be expressed as:

$$\zeta \equiv \frac{dy_t(n)}{dX_t(n)} = \frac{\tilde{\zeta}}{1 - T\tilde{\xi}} \tag{18}$$

where

$$\tilde{\zeta} = -\frac{1}{T}\left(\sum_{i=1}^{I}\frac{\partial \ln H_{i,t}^{m}(n))}{\partial X_t(n)}\psi_i\right) \div \left(1 - \sum_{i=1}^{I}\frac{\partial \ln H_{i,t}^{m}(n)}{\partial P_t(n)}\psi_i\right)$$

and where ψ_i is the average share of emerging market debt held by investor group i, as given in Table 1. The numerator $\tilde{\zeta}$ is the response of yield to a unit change of characteristic $X_t(n)$ for a given book value of debt $D_t(n)$. However, if the yield of debt changes in response to changes in X, the market value of debt will move accordingly. Therefore, the book value of debt should adjust to offset the yield change as captured by dividing by $(1 - T\zeta)$.

To analyze this relationships, we focus on two characteristics: real GDP growth and the inflation rate. Panel B of Table 5 reports the response of yield to a one percent decrease in real GDP growth. As shown in Table 3 (repeated in Table 5 Panel D), a decrease of real GDP growth induces investors to reduce their demand of debt, so that the yield increases. In response to a one percentage point decrease of real GDP growth, the yield increases by 36 basis points, which is equal to a 4.1% rise in the average yield to EM debt. Similarly, if inflation increases by one percent, the yield would have to increase by 22 basis points, which is equal to 2.5% of the average yield to EM debt. The reason is that, other things equal, all investors dislike investing in the debt of countries with low GDP growth and high inflation.

To evaluate how investors differ according to their view of these attributes and their impact on funding, we next consider how the the cost of financing sensitivity changes with different investor bases. Table 5 Panel B shows the results of this analysis under the rows labeled "No Bank" and "No Non-bank."[22] Excluding the bank investor groups as a whole, yield will increase by 41 basis points in response to a one-percent real GDP growth decrease and 19 basis points in response to a one-percent inflation increase. By contrast, excluding the non-bank investor groups implies that the yield would have to increase by 29 basis points to a one percent decrease in real GDP growth but a significantly higher 28 basis points to an increase in inflation. As Panel D shows, the reason is that foreign non-banks' holdings of debt have the strongest response to GDP growth and foreign banks' holdings of debt have

[22] As before, 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.

the strongest response to inflation among all investors. Thus, excluding investor groups with strongest responses reduces the yield pressure from these changes. Overall, these results highlight the importance of non-banks not only for their sensitivity to yield, but to characteristics as well.

4.3 Changes of Investors' Latent Demand

Finally, we analyze the impact of changes in investor group latent demand on the borrowing costs. In particular, we ask: how much would yield change in response to a one percent increase in a given investor group's latent demand given the market value of debt? Intuitively, if investors in a particular group, k, increase their latent demand, the price of debt will increase. Thus, the government can issue less book value of debt to maintain the same market value. The reduced debt issuance will further lower debt yield. Appendix E.3 shows that this sensitivity of financing costs to latent demand can be expressed as:

$$\varphi \equiv \frac{dy_t(n)}{d\epsilon_{k,t}(n)} = \frac{\tilde{\varphi}}{1 - T\bar{\xi}} \tag{19}$$

where $\tilde{\varphi} = \psi_k / T \div \left(1 + \frac{1}{T}\sum_{i=1}^{I} \psi_i \eta_i\right)$. Table 5 Panel C reports the results of this analysis. Since domestic investors are in general less elastic than foreign investors and also hold more debt, a demand increase leads to the larger yield reduction for domestic investors than foreign investors. An increase in demand by foreign non-banks generates a sizable shift in costs despite holding a lower share.

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 fi-

Table 5: Borrowing Cost Sensitivity and Counterfactuals

Panel A: Borrowing Cost Sensitivity to Debt Increase		
Investor Composition	Sensitivity [a]	% Yield change [b]
Actual	0.59	6.70%
No Bank	0.52	5.91%
No Non-bank	0.80	9.09%

Panel B: Borrowing Cost Sensitivity to Characteristics				
Investor Composition	Real GDP growth		Inflation	
	Sensitivity	% Yield change [b]	Sensitivity	% Yield change [b]
Actual	0.36	4.09%	0.22	2.50%
No Bank	0.41	4.66%	0.19	2.16%
No Non-bank	0.29	3.30%	0.28	3.18%

Panel C: Borrowing Cost Sensitivity to Latent Demand				
Investor Group	Domestic Bank	Domestic Non-bank	Foreign Bank	Foreign Non-bank
Sensitivity	-1.32	-1.42	-0.30	-0.86

Panel D: Components from Estimates				
Component	Domestic Bank	Domestic Non-bank	Foreign Bank	Foreign Non-bank
Elasticity η	10.64	14.89	29.05	35.45
Marginal Shares a	0.21	0.43	0.05	0.24
Average Shares ψ	0.26	0.28	0.06	0.17
GDP growth: $\partial H/\partial X$	3.74	4.26	5.12	17.43
Inflation: $\partial H/\partial X$	-3.54	-3.53	-7.22	-5.07

Panel A reports calculations of the borrowing cost sensitivity in Equation (17). Panel B gives the effects on borrowing costs due to the characteristics as in Equation (18). Panel C provides the effects of latent demand by investor group given in Equation (18). Panel D provides the measures used in the counterfactual calculations. The marginal shares a and average shares ψ are from Table 1 while the semi-elasticities η, and coefficients for GDP growth and inflation are from Table 3. Footnotes: [a] scaled by 10% ; [b] based upon average EM five-year yield in our sample of 8.8%

nancial institutions that are not banks absorb substantially more of the variation in outstanding government debt than other investor groups. Further decomposing this non-bank investment group using country/region specific data, we find that investment funds are the primary drivers of this larger group. Next, we identify the propensity to provide funding across investor groups by exploiting the market clearing condition provided by the full set of creditors in our data. Using these estimates, we find that the elasticity of demand by non-bank investors is higher than other groups. Finally, we use both the marginal increase of holdings together with EM investor demand estimates to calculate the financing cost sensitivities. An average EM country faces significant financing cost sensitivity since a 10% increase would lead to a nearly 7% increase in borrowing costs. These countries face the greatest sensitivity of financing cost against losing non-bank investors compared to any other investment groups, as removing them from the investor pool increases the borrowing cost response from 7% to 9%. We conclude that EM sovereign investors are highly vulnerable to the presence or absence of non-bank investors. Thus, the behavior of non-bank investors is crucial for understanding sovereign debt sustainability.

Our analysis opens up several avenues for future research, particularly given the limitations of our data. For example, our data is annual and lacks detailed data on the currency and maturity structure of sovereign debt. It also does not report the location of foreign investors, identities of investors, or the non-sovereign portion of investor portfolios. Data built from the investor side, such as fund level data or granular data underlying the euro area SHS data, would allow researchers to dig further into the aspects of the data missing from our study and provide greater analysis from the investors' perspectives. They would allow a deeper understanding of how investors trade off their holdings of sovereign debt with other assets, how they respond differently to local currency versus foreign currency debt of emerging market sovereigns, how the yield elasticity varies by maturity, or how interventions by AE central banks affect their presence in the market. They would also allow for greater analysis of the heterogeneity of this very diverse group of investors. We leave these important questions on the agenda for future research.

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Online Appendix

A Data construction

A.1 Debt and Investor Holdings

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.[1] 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.[2] 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. (2022). We start by obtaining outstanding external liabilities of the general government sector from the International Investment Position (IIP) data. This consists of adding together liability positions from both portfolio debt securities (bonds) and other investment debt (loans). However, coverage of IIP data by sector can be sparse, especially for recent years (Avdjiev et al., 2022). So, we fill in missing values from a number of sources. First, if only data for the government sector is missing, but other sectors are reported, we fill the missing government sector internally from the IIP by subtracting the reporting sectors from the total. Then, the Quarterly External Debt Statistics (QEDS), when available (for a limited set of countries starting from 2005). To fill in remaining values, we utilize data from the Bank for International Settlements (BIS).

[1] 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

[2] 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.

To fill in missing values for outstanding amounts of externally held government bonds, we use the BIS International Debt Securities (IDS) data. The IDS consists of all debt securities issued in international markets, which target foreign investors.[3] These data are available for a wide range of countries and time periods, and include granular splits by issuer country and sector, as well as other details not utilized in this paper. Internationally issued bonds serve as a good proxy for bonds held by foreign investors, especially in the case of emerging markets.[4]

To fill in missing values for outstanding amounts of non-bond external sovereign liabilities, we use the BIS International Banking Statistics, to capture lending from foreign banks, as well as IMF credit from the IIP, which captures official lending. The foreign bank estimation is described below.

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 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. (2022). It leverages two datasets on international banking activity compiled by the BIS.

The Locational Banking Statistics (LBS) capture outstanding claims and liabilities of internationally active banks located in 44 reporting countries against counterparties residing in more than 200 countries. Banks record their positions on an unconsolidated basis, including intragroup positions between offices of the same banking group. The data are compiled based on the residency principle (as done for IIP or QEDS). The LBS capture the overwhelming majority of cross-border banking activity. The historical LBS data break down counterparties in each country into banks (bank and central bank sectors) and non-banks (corporate and government sectors).[5]

The second set of banking data is the Consolidated Banking Statistics (CBS). This differs from the LBS in that the positions of banks reporting to the BIS are aggregated by the nationality (rather than by

[3] A bond is flagged as international if the registration of the bond, the governing law of the bond, or the listing location of the bond are not the same as the bond issuer's country of residence. This classifies in essence any bond whose issuance targets investors outside of its local market.

[4] For US government bonds, when missing from IIP or QEDS, we utilize TIC data to fill in missing values, since US government bonds are issued domestically and frequently bought by foreigners.

[5] Data on total cross border claims by BIS reporting banks separated by bank and non-bank counterparties are available going back to 1978. More recent enhancements to the BIS LBS data (since 2013) provide more granular counterparty sector splits, dividing the non-bank sector into the non-bank private sector and the public sector (ie government) (Garcia Luna & Hardy, 2019).

the residence) of the reporting bank.[6] We use the CBS on an immediate counterparty basis (CBS/IC).[7] The CBS data historically provide a borrower breakdown of the Non-Bank Sector into Public and Private.

While we maintain a residence perspective when identifying holders of government debt, consistent with the LBS and IIP, the CBS have a longer time series of the breakdown between public and private borrowers, which allow for a larger and longer sample of estimates for foreign banks' lending to governments. We use the share of international bank debt for each sector from the CBS to estimate the split of the Non-Bank LBS data into Public and Private components.[8] We calculate the public sector borrowing from cross-border banks as follows:

$$\widehat{XBS}_{pub,n,t} = XBC_{nb,n,t} \frac{INTC_{pub,n,t}}{INTC_{nbp,n,t} + INTC_{pub,n,t}} \tag{A.1}$$

where npb indicates Non-Bank Private, nb indicates Non-Bank, pub indicates Public, n denotes the borrowing country, and t denotes the time period. $\widehat{XBS}$ is our estimated cross border bank holdings of debt, XBC denotes the cross border claims (from the LBS) of BIS reporting banks, and $INTC$ is international claims (from the CBS on immediate counterparty basis). The CBS international claims are defined as the sum of XBC and the local claims by foreign affiliates of these banks that are denominated in foreign currencies (LCFC).The sector breakdown in the CBS is not available for cross-border claims, only for international claims.

This construction of the split of bank debt makes the following assumptions: First, the sectoral shares for $INTC$ are the same as the sectoral shares for XBC. This is reasonable since for most countries, LCFC tends to be small relative to XBC.[9] Second, the sectoral shares for the set of banks that report LBS data (44 countries) are the same as the sectoral shares for the set of banks that report CBS data (31 countries). The 31 CBS reporting countries account for about 90% of the XBC in the LBS, and the CBS captures the activities of the subsidiaries of banks from these 31 countries worldwide. As a result, the CBS data are sufficiently representative to make the above assumption a reasonable one. Third, data

[6] For example, the positions of a French bank's subsidiary located in New York - which in the LBS are included in the positions of banks in the United States - are consolidated in the CBS with those of its parent and are included in the positions of French banks.

[7] The CBS are compiled in two different ways: by immediate counterparty and by ultimate risk. The immediate counterparty is the entity with whom the bank contracts to lend or borrow. Ultimate risk takes account of credit risk mitigants, such as collateral, guarantees and credit protection bought, which transfer the bank's credit exposure from one counterparty to another.

[8] This general approach is also used in Arslanalp and Tsuda (2012) and Arslanalp and Tsuda (2014)

[9] While for most countries, LCFC tends to be small relative to XBC, there are a small number of exceptions. For example, this is not the case in dollarized economies (e.g. Ecuador) and some emerging European economies (e.g. Hungary and Poland), where lending denominated in euro and in Swiss francs has been non-negligible.

for the CBS that allow us to estimate the split of Non-Bank into Public and Private are not available for advanced economies before 2000, and are only available on a semiannual basis for EM for the period before 2000. We linearly extrapolate the semiannual shares to Public and Private into a quarterly series for EM. For advanced economies, we assume constant shares from 2000 backwards.[10]

Recently, the BIS has released its enhanced banking data, starting in 2013. These data contain more granular borrowing sector splits - Bank, Public, and Non-Bank Private (Garcia Luna & Hardy, 2019). Avdjiev et al. (2022) use this short, recent series to establish that this methodology for estimating borrowing sector splits generates estimates that are very close to the actual (reported) figures.[11] In addition, we make a correction for Switzerland where holdings by external banks are significantly overestimated with our methodology.[12]

Foreign Non-bank The Foreign Non-bank 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 were incomplete, additional data were taken from the official websites of respective central banks.[13] For these cases, the IFS data were supplemented using the backward-looking growth rates taken from central banks' websites.

Domestic Bank These holdings were compiled using the same procedure as for the Domestic Central Bank.[14]

[10] The assumption of constant shares for advanced economies before 2000 is not too concerning, as we only extend back 4 years.

[11] Since not all LBS reporting countries have started providing the enhanced borrowing sector splits, these comparisons are based on the set of LBS reporting countries which had started reporting enhanced LBS data as of March 2016.

[12] 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%. We therefore use a ratio of 15% to compute foreign bank holdings of Swiss government debt.

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

[14] 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 Non-bank The Domestic Non-bank 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 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.

A.2 Country Groups

The final sample consists of the following 95 countries:

Advanced economies (23): Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom, and the United States.

Emerging markets (45): Argentina, Bahrain, Bangladesh, Belarus, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Cyprus, Czech Republic, Estonia, Egypt, Hungary, India, Indonesia, Israel, Jordan, Latvia, Lithuania, Kuwait, Malaysia, Mexico, Morocco, Nigeria, Oman, Pakistan, Peru, Philippines,

Poland, Qatar, Romania, Russia, Serbia, Slovak Republic, Slovenia, South Africa, South Korea, Thailand, Turkey, Uruguay, Ukraine, Venezuela, and Vietnam.

Developing economies (27): Jamaica, Paraguay, Sudan, Angola, St. Lucia, Lebanon, Bolivia, Tunisia, Papua New Guinea, Panama, Kenya, Sri Lanka, El Salvador, Ecuador, Dominican Republic, Malta, Albania, Montenegro, Costa Rica, Namibia, Gabon, Kazakhstan, Liberia, Mongolia, Guatemala, Bahamas, and Cote d'Ivoire.

A.3 Financial, Price, and Characteristics Data

We now describe the data sources for the financial data used in Section 3. The 5-year bond yields are the corresponding zero coupon yields provided by the Global Financial Data. Countries with available yields are Korea, United Kingdom, Venezuela, Sri Lanka, Iceland, Norway, Sweden, Australia, Germany, Singapore, Denmark, Japan, United States, France, Belgium, New Zealand, Canada, Spain, Finland, Hong Kong, Hungary, Portugal, Malaysia, Switzerland, Italy, India, Morocco, Philippines, Netherlands, Thailand, Ireland, Austria, Greece, South Africa, Mexico, Poland, Mauritius, Armenia, Fiji, Pakistan, Tunisia, Zambia, Belarus, Bulgaria, Bangladesh, Malta, Brazil, China, Indonesia, Vietnam, Angola, Colombia, Croatia, Israel, Peru, Qatar, Romania, Russia, Slovenia, Turkey, Egypt, Lithuania, Latvia, Uganda.

For relevant short term rates by currency, we try to obtain 3-month government bond yields where possible and, if unavailable, we use instead short term deposit rates in local currency. In particular, we implement the following procedure. First, we take the 3-month bond yields if available from Global Financial Data. Next, if missing, we use instead the short-term (most of them are 3-month) deposit rate from the Global Financial Data. Then, if short term rates are still missing, we use the deposit rate available from the World Bank (World Development Indicators, FR.INR.DPST). Finally, for the few countries where no short rates are available from these other sources, we fill in the missing data with the 1-year yield downloadable from the Global Financial Data.

Exchange rates are obtained from the World Bank (Global Economic Monitor, DPANUSSPF). Prices used for the real exchange rates are downloaded from World Bank. We use the 4th quarter Headline Consumer Price Index as the inflation of each year.

The characteristics data used are described next. We obtained real GDP growth, inflation, exports, and the GDP level from the IMF World Economic Outlook. In particular, GDP growth is from series $NGDP_RPCH$, the inflation is series PCPIEPCH, and the GDP level is from series NGDPD. The

Sovereign Ratings measure is a combination of SP Sovereign Rating and Fitch Sovereign Rating. In order to convert the discrete series to numerical levels, we follow the procedure described in Koijen and Yogo (2020).

B Marginal Investor Analysis: Additional Results

This appendix provides more detailed results for the analysis in Section 2.

B.1 Marginal investors during different circumstances

In this appendix subsection, we report robustness checks for the analysis in Section 2.3. For example, the analysis in the text treats the investor composition as constant. However, in reality, 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 (2) 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.[15] We consolidate the results of these regressions into Figures B1 (panels (b) and (c)) and Figures B2, relegating detailed reporting of the regression coefficients to Tables B1, B2, and B3.

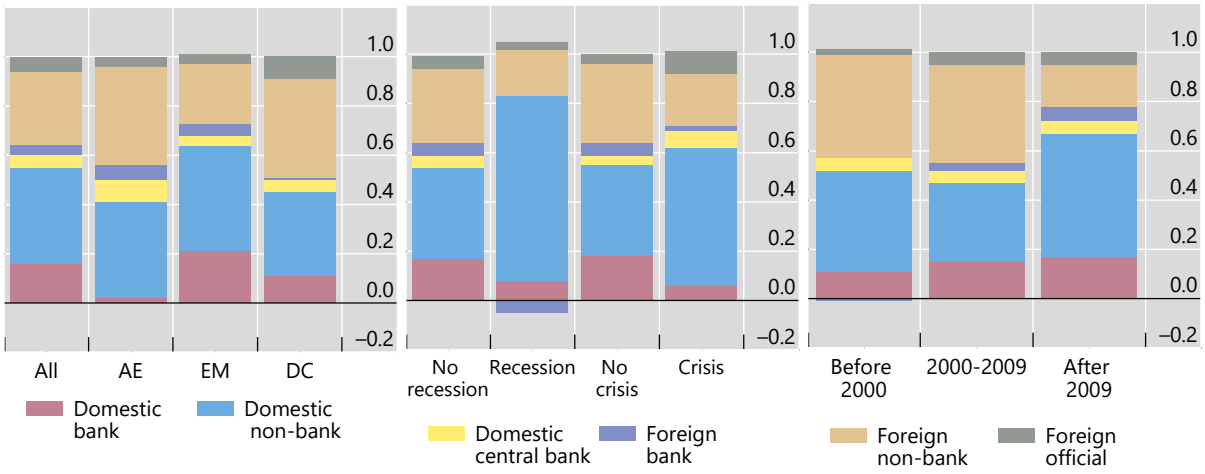
The figures highlight important patterns across geographic groups. Both Advanced Economies and Emerging Market sovereign debt show marked differences in their marginal investors across different circumstances. For example, domestic non-banks absorb more emerging market debt during recessions or banking 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

[15] 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.

holdings of debt in the form of reserves by foreign central banks, particularly those in EM countries.[16]

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.

Figure B1: Marginal Holders



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

Note: This figure plots the regression coefficients in Equation (2) for all countries under different circumstances. Panel (a) depicts the coefficients for each investor group by country group as reported in Table 1 in the text. Panel (b) 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 (c) shows the coefficients for each investor group in three subsamples: pre-2000, 2000-2009, and post-2009.

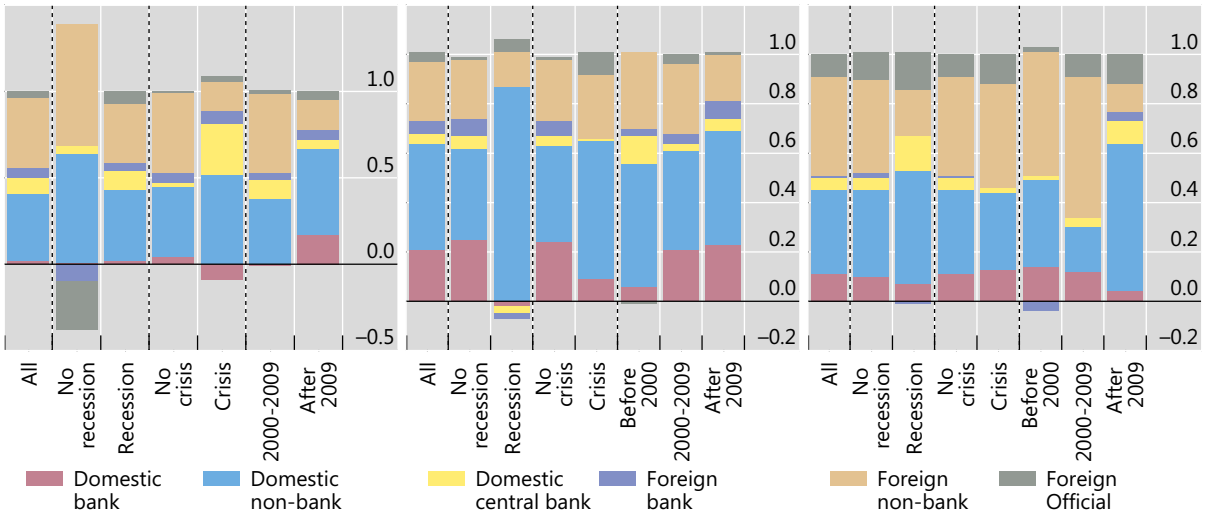
The basic finding that Non-bank investors are important marginal investors continues to hold across these different periods. The next subsections examine these relationships in more detail across investor groups.

B.1.1 Recessions and Non Recessions

Table B1 reports the regression results depicted in Figures 2 for recessions and non-recessions.

[16] 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 B2: Marginal Holders



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

Note: This figure plots the regression coefficients in Equation (2) under different circumstances for advanced economies, emerging market economies, and developing countries in Panels (a), (b) and (c), respectively. 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. The regression estimates are in Tables B1, Table B2, and Table B3.

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 (2) for each investor group 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 described in the text.

B.1.2 Banking Crisis and No Banking Crisis

Table B2 reports the regression results depicted in Figures 2 for banking crises.

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 (2) for each investor group during times with banking crises (Panel A) and without banking crisis (Panel B). A country-year (n, t) observation is defined as if country n 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 described in the text.

B.1.3 Different Subperiods

Table B3 reports the regression results depicted in Figures 2 for different subperiods.

B.2 Marginal Investors Considering Currency Valuation Effects

This section provides an analysis of the marginal holders of sovereign debt taking the currency valuation effect into consideration.

To see the potential impact of currency, we define the impact of currency valuation on holdings of sovereign debt n by investor group i as $CV_{i,t}(n)$. Then we can rewrite the general relationship for holdings as:

$$H_{i,t}(n) - H_{i,t-1}(n) = \Delta\tilde{H}_{i,t}(n) - CV_{i,t}(n) \tag{B.1}$$

where $\Delta\tilde{H}_{i,t}(n)$ is the change in holdings excluding currency valuation effects.

To compute $\Delta\tilde{H}_{i,t}(n)$, we make two assumptions. First, all domestic investors holdings of their own sovereign debt is denominated in local currency. Second, the local currency share of foreign investors may be proxied by the share of local currency among bonds issued in international financial markets, derived from the BIS international debt securities statistics. 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:

$$CV_{i,t}(n) = H_{i,t-1}(n) \times LC_{i,t-1}(n) \times \frac{S_t(n) - S_{t-1}(n)}{S_{t-1}(n)}$$

where $LC_{i,t}(n)$ is country n local currency share of debt investor group i's holding of country n's debt, and $S_t(n)$ is the price of currency n in terms of dollar, both at time t. We define the currency valuation adjusted change in total debt as $\Delta\tilde{D}_t(n) = \sum_{i=1}^{I} \Delta\tilde{H}_{i,t}(n)$. The regression Equation (2) is in turn written as

$$\frac{\Delta\tilde{H}_{i,t}(n)}{D_{t-1}(n)} = \tilde{a}_i \frac{\Delta\tilde{D}_t(n)}{D_{t-1}(n)} + \tilde{a}(n) + \tilde{a}_t + \epsilon_{i,t}(n), \quad \forall i \tag{B.2}$$

B.2.1 Unconditional Estimates

We first report the results using the Currency Valuation (CV) measure over all periods. These are reported in Table B4 below. As the results show, Non-banks continue to absorb the largest proportion of debt on the margin. Moreover, the following subsections show that these patterns continue to hold when decomposed by recessions and non-recessions in Table B5, by banking crisis in Table B6, and by different subperiods in Table B7.

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 (2) for each investor group 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 described in the text.

Table B4: Marginal Holders of Sovereign Debt Conditioning on Currency

	(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 (B.2) 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 with Currency Valuation

Table B5 report the results of estimating Equation (B.2) conditioned on recessions or no recessions.

Table B5: Marginal Holders Conditioning on Currency: 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 (B.2) for each investor group 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 with Currency Valuation

Table B6 reports the results of estimating Equation (B.2) conditioned on banking crisis or no banking crisis.

Table B6: Marginal Holders Conditioning on Currency: 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)
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 (B.2) for each investor group with during times with banking crises (Panel A) and without banking crisis (Panel B). A country-year n, t observation is defined as if country n 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 in the text.

B.2.4 Different Subperiods with Currency Valuation

Table B7 reports the results of estimating Equation (B.2) over different subperiods.

Table B7: Marginal Holders Conditioning on Currency: Different Subperiods

	Dom	For	DomBK	DomNB	DomCB	ForBK	ForNB	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 (B.2) for each investor group 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.3 Non-bank Regressions: Euro Area SHS, US Treasuries, and UK Gilts

In this subsection, we report the results of estimating the marginal investor decomposition Equation (2) for a disaggregated data set of Euro Area investors, US Treasuries, and UK Gilts.

B.3.1 Euro Area Data

Table B8 reports the estimates of the share of marginal Euro Area investor holdings of non-Euro Area sovereign investments, as depicted in Figure 3 in the text.

Table B8: Marginal Foreign Non-bank Investors - Euro Area

	(1) Gov	(2) Banks	(3) non-bank	(4) HH	(5) InsurPens	(6) NFC	(7) OthFin
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)

Note: This table reports regression coefficients of Equation (2) on sovereign debt issued by non-European countries for different investor groups within Europe. Columns (1) through (3) report coefficients for governments, banks and the non-bank sector. Columns (4) through (7) disaggregates non-banks into households (HH), insurance and pension funds (insurPens), non-financial corporations (NFC), and other financial institutions (OthFin). Standard errors clustered at country and year level are reported in the parentheses.

In particular, in the row labeled "All", this table reports the estimates of Equation (2) treating the denominator as the total holdings of Non-Euro Area sovereign debt by Euro Area investors. Similarly, in the rows labeled "AE" and "EM", this denominator and related holdings breakdowns are based on total holdings by EA investors of AE and EM debt, respectively.

B.3.2 US Treasuries

Table B9 gives the estimates of Equation (2) for the US Treasuries using TIC data. In this case, for the "All" row, the denominator is given by total holdings of US Treasuries while the numerator corresponds to holdings by the reported investor groups. In the row labeled "Non-bank", the denominator is the total holdings of Nonbank investors while the numerator is the subgroup of Nonbank investors given by Money Market Funds (MMFs), Hedge Funds and Households (HF/HH), Insurance and Pensions (IP), Other Financials (OthFin) and Non Financials (NonFin).As the table shows, non-bank investors

are particularly important within the domestic investor group. Taken together, Money Market funds and Hedge funds/households comprise that largest component of domestic nonbanks.

Table B9: Marginal Investors in US Treasuries

	Marginal Share				Marginal Non-Bank Share				
	(1) Foreign	(2) DomCB	(3) DomBank	(4) DomNB	(5) MMFs	(6) HF/HH	(7) I&P	(8) OthFin	(9) NonFin
All	0.247***	0.132***	0.061***	0.560***					
	(0.039)	(0.040)	(0.012)	(0.049)					
Non-Bank					0.241***	0.314***	0.150***	0.122***	0.173***
					(0.037)	(0.051)	(0.034)	(0.031)	(0.058)
Constant	0.004***	0.001	-0.001**	-0.004***	0.000	-0.002**	0.001**	0.001*	-0.001
	(0.001)	(0.001)	(0.000)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	104	104	104	104	104	104	104	104	104

Note: This table reports estimates from Equation (2) for the holders of US Treasuries over 1995q1-2020q4. "HF/HH" includes Hedge funds, private equity, private trusts, and direct household holdings. "NonFin" is all non-financial holders excluding households. "OthFin" is all other financial institutions apart from funds and Insurance and Pension (I&P). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B.3.3 UK Gilts

Table B10 reports estimates for Equation (2) where the holdings are the shares of UK Gilts.

Table B10: Marginal Investors in UK Gilts

	Marginal Share				Marginal Non-Bank Share		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Foreign	DomCB	DomBank	DomNB	Funds & Oth	I&P	NonFin
All	0.174***	0.256***	0.126***	0.443***			
	(0.029)	(0.047)	(0.025)	(0.047)			
Non-Bank					0.510***	0.481***	0.0085*
					(0.055)	(0.054)	(0.004)
Constant	0.003**	-0.000	-0.002**	-0.001	-0.003**	0.003**	-0.000
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.000)
Observations	104	104	104	104	104	104	104

Note: This table reports estimates from Equation (2) for the holders of UK Gilts over 1995q1-2020q4. "Funds & Oth" includes all financial firms besides banks, and insurance companies and pension funds (I&P). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B10 gives the estimates of Equation (2) for the UK Gilts. In the row labeled "All", the denominator is given by total holdings of UK Gilts while the numerator corresponds to holdings by the reported investor groups. In the row labeled "Non-bank", the denominator is the total holdings of Non-bank investors while the numerator is the subgroup of Nonbank investors given by "Funds and Other", Insurance and Pensions (IP), and Non Financials (NonFin). As the table shows, non-bank investors are particularly important within the domestic investor group.

C Supplemental Results for Instrument Construction

This appendix provides supplementary information for the instruments used in Section 3 of the text.

C.1 Reduced-form Estimates of IV Construction: EMs and Yields

This section reports the regression coefficients for the first-stage regression that constructs the instruments. The following Table C11 gives the results for Equation (8) for Emerging Market countries.

Table C11: Reduced-form Holding Regression: EM

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
GDP	-0.18**	0.28***	-0.71***	-0.28*	-1.74***	-1.54***
	(0.09)	(0.17)	(0.32)	(0.18)	(0.29)	(0.18)
GDP Growth	-0.35	-2.22**	2.49	-3.85***	1.88	-1.32
	(0.62)	(1.12)	(2.36)	(1.18)	(1.73)	(1.20)
Inflation	-2.12***	-0.15	-1.25	-2.05***	1.12*	-0.52
	(0.24)	(0.41)	(0.78)	(0.46)	(0.64)	(0.47)
Exp-to-GDP	-0.00	-0.01	-0.43	-0.20	-0.22	0.00
	(0.10)	(0.18)	(0.34)	(0.19)	(0.35)	(0.20)
Observations	391	356	324	391	340	380
R2	0.98	0.95	0.88	0.92	0.88	0.90

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

C.2 Projected Debt-to-GDP Estimates: EMs

Table C12 reports the projections of debt-to-GDP, $d_t(n)$ for EM countries using Equation (9). As described in the text, this variable is projected on exogenous characteristics and its lag modified by the gross GDP growth. A coefficient of 0.72 indicates about a 28% of mean reversion in the level of debt-to-GDP. As described in the text, this finding may be interpreted as an average maturity of 3.6 years, which is close to the 5-year bond yield we choose in the main analysis.

Table C12: Projected Debt-to-GDP Supply: EMs

	Debt-to-GDP
Lag Debt-to-GDP	0.72***
	(0.03)
GDP Growth	-0.09
	(0.11)
Inflation	0.11***
	(0.04)
Exp-to-GDP	-0.03*
	(0.02)
Observations	362
R2	0.96

Note: This table reports the estimates of Equation (9) for emerging market economies. The sample spans 1996-2018 at annual frequency. The standard errors are reported in the parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

C.3 IV Construction: AE

This section reports the estimates used to construct the Advanced Economy instruments for Table 4 in the text. The following table gives the results of Equation (8) for Advanced Economies.

C.4 Projected Debt-to-GDP Estimates: AEs

Table C14 reports the projections of debt-to-GDP, $d_t(n)$ for AE countries using Equation (9). As described in the text, this variable is projected on exogenous characteristics and its lag modified by the gross GDP growth.

Table C13: Reduced-form holding regressions: AEs

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
GDP	-0.30***	-0.92***	-2.10**	0.74***	0.66	1.09***
	(0.22)	(0.31)	(0.83)	(0.21)	(0.41)	(0.22)
GDP growth	1.76	-5.90***	3.92	-2.15*	-2.63	2.74**
	(1.23)	(1.73)	(4.43)	(1.16)	(2.19)	(1.23)
Inflation	-4.29*	-1.91	-0.13	10.16***	0.08	5.50**
	(2.43)	(3.44)	(9.11)	(2.29)	(4.32)	(2.43)
Exp-to-GDP	0.44	-0.37	2.72**	0.21	0.97*	-0.20
	(0.29)	(0.43)	(1.14)	(0.28)	(0.54)	(0.29)
Observations	341	322	312	342	326	341
R2	0.99	0.93	0.82	0.95	0.86	0.96

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

Table C14: Projected Debt-to-GDP Supply: AEs

Lag Debt-to-GDP	0.72***
	(0.03)
GDP Growth	-0.71***
	(0.23)
Inflation	-0.98**
	(0.45)
Exp-to-GDP	0.15***
	(0.05)
Observations	323
R2	0.98

Note: This table reports the estimates of Equation (9) for advanced economies. The sample spans 1996-2018 at the annual frequency. The standard errors are reported in the parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

D Supplemental Results for Demand System Estimation

In this appendix, we provide more detailed results about the demand system approach of estimation in Section 3.3 of the paper.

D.1 Predictive Regression Results

Table D15 reports the return predictive regression results for Equation (15) and (13) in the main text.

Table D15: Bond Return Predictive Regression

	(1) Domestic Excess Return	(2) Foreign Excess Return
$p_t(n)$	-0.59***	-0.75***
	(0.05)	(0.08)
$q_t(n)$		0.23***
		(0.06)
Observations	367	367
R2	0.34	0.27

As described there, $p_t(n)$ is the logarithm of the price of a 5 year zero coupon bond in local currency for country n and $q_t(n)$ is the logarithm of its real exchange rate relative to the U.S. dollar. In particular, $q_t(n) \equiv s_t(n) - z_t(n)$ where $s_t(n)$ is the logarithm of the US dollar price of currency n and $z_t(n)$ is the logarithm of the ratio of the price index of country n to the US price index.

D.2 Yield Elasticity

We next describe the derivation of the investor demand elasticity following the literature of Koijen and Yogo (2019) and Jiang et al. (2022).

D.2.1 Foreign Investors

As described above, foreign non-EM investors hold the sovereign debt of all EM countries plus an outside asset that does not include this debt. To calculate the demand elasticity relative to expected returns μ, differentiate with respect to expected returns the ratio of shares for a given country n given

in Equation (11) in the text. This implies:

$$\frac{d\delta_{i,t}(n)}{d\mu_{i,t}(n)} = \frac{d(\ln \omega_{i,t}(n) - \ln(1 - \sum_{k=1}^{N} \omega_{i,t}(k)))}{d\mu_{i,t}(n)} = \frac{d \ln w_{i,t}(n)}{d\mu_{i,t}(n)} + \sum_{k} \frac{w_{i,t}(k)}{w_{i,t}(0)} \frac{d \ln w_{i,t}(k)}{d\mu_{i,t}(n)} = \lambda_{0,i} \tag{D.1}$$

Without loss of generality, consider $n = 1$ and denote $\kappa_{n,j} \equiv (d \ln w_{i,t}(n)/d\mu_{i,t}(j))$. Suppressing the investor indicator i for parsimony, the relationship can be rewritten,

$$\kappa_{11} + \frac{\omega(1)}{\omega(0)}\kappa_{11} + \sum_{k=2}^{N} \frac{\omega(k)}{\omega(0)}\kappa_{k,1} = \lambda_0 \tag{D.2}$$

Multiplying both sides by $\omega(0)$, implies:

$$(\omega(0) + \omega(1))\kappa_{1,1} + \sum_{k=2}^{N} \omega(k)\kappa_{k,1} = \lambda_0\, \omega(0) \tag{D.3}$$

Furthermore, note that for $j \neq 1$,

$$\kappa_{j,1} + \frac{\omega(1)}{\omega(0)}\kappa_{1,1} + \sum_{k=2}^{N} \frac{\omega(k)}{\omega(0)}\kappa_{k,1} = 0 \tag{D.4}$$

Multiplying both sides by $\omega(0)$, we get

$$\omega(0)\kappa_{j,1} + \omega(1)\kappa_{1,1} + \sum_{k=2}^{N} \omega(k)\kappa_{k,1} = 0 \tag{D.5}$$

From the equation above, we see that $\kappa_{j,1}$ for $j \neq 1$ does not depend on j. Therefore,

$$\kappa_{j,1} = -\frac{\omega(1)}{1 - \omega(1)}\kappa_{1,1} \text{ for } j \neq 1 \tag{D.6}$$

Substituting this variable into the above Equation (D.3) and solving for κ_{11} implies:

$$\kappa_{1,1} = \lambda_0(1 - \omega(1)) \tag{D.7}$$

Since this relationship holds for any arbitrary country n and individual investor i, then clearly the demand elasticity for foreign investors can be written more generally as:

$$\frac{d \ln H_{i,t}(n)}{d\mu_{i,t}(n)} = \frac{d \ln w_{i,t}(n)}{d\mu_{i,t}(n)} = \lambda_{0,i}(1 - \omega_{i,t}(n)) \tag{D.8}$$

D.2.2 Domestic Investors

We derive the elasticity of demand with respect to expected excess returns for domestic investors by differentiating Equation (12) in the text. In particular, we differentiate this share as in:

$$\frac{d\ln(H_{i,t}(n))}{d\mu_{i,t}(n)} = \frac{d\ln\omega_{i,t}(n)}{d\mu_{i,t}(n)} \tag{D.9}$$

subject to the constraint that the shares of wealth sum to one. In the case of domestic investors, we assume they hold no other sovereign debt so that the share for domestic investors plus the share of outside assets sum to one; that is, $\omega_{i,t}(n) = 1 - \omega_{i,t}(0,n)$. Thus, differentiating the ratio of portfolio shares in Equation (12) with respect to expected returns implies:

$$\frac{d(\ln\omega_{i,t}(n) - \ln(1-\omega_{i,t}(n))}{d\mu_{i,t}(n)} == \frac{1}{1-\omega_{i,t}}\frac{d\ln\omega_{i,t}(n)}{d\mu_{i,t}(n)} = \lambda_{0,i}$$

Therefore,

$$\frac{d\ln\omega_{i,t}(n)}{d\mu_{i,t}(n)} = \lambda_{0,i}(1-\omega_{i,t}(n)) \tag{D.10}$$

Comparing this equation with Equation (D.8) makes clear that the form of the demand elasticities are the same between foreign and domestic investors. Moreover, these demand elasticity measures are the same as Koijen and Yogo (2019) and Jiang et al. (2022).

Price elasticity. Bond price and expected excess return are linked through the predictive regression of excess returns described above. Using this relationships implies:

$$\frac{d\ln H^m_{i,t}(n)}{d\ln P_t(n)} = \lambda_{0,i}(1-\omega_{i,t}(n))\phi^i_0 \tag{D.11}$$

We lack the data to assess the response of exchange rate in response to bond price change, thus we must indirectly assume that the change of bond price does not affect demand of debt through changing exchange rate.

Yield elasticity.

$$\frac{d\ln H^m_{i,t}(n)}{dy_t(n)} = -\frac{1}{T}\lambda_{0,i}(1-\omega_{i,t}(n))\phi^i_0 \tag{D.12}$$

E Counterfactual Derivation

This section provides the detailed algebra for the calculation of counterfactual measures.

E.1 Borrowing Cost Sensitivity

We are interested in the following question: if the government wants to increase debt by one percent, how much will yield increase? To derive this measure, we start from the following equation:

$$P_t(n)D_t(n) = \sum_{i=1}^{6} P_{i,t}(n)H_{i,t}(n) \tag{E.1}$$

where $P_t(n)$ is the price of debt issued by country n and $P_{i,t}(n)$ is the price faced by investor group i. In equilibrium, $P_{i,t}(n) = P_t(n)$. Thus, the question above can be restated as: what will happen to the yield if the government issues one more percent of (market value) debt? This question can be answered by calculating the change in yield for a percentage change in the market value of debt; that is, $\xi \equiv \frac{dy_t(n)}{d\ln(P_t(n)D_t(n))}$.

To calculate this measure, note that $P_t(n) = \exp(-Ty_t(n))$. Therefore, we can rewrite this measure as:

$$\xi \equiv \frac{dy_t(n)}{d\ln\left(P_t(n)D_t(n)\right)} = \frac{dy_t(n)}{-Tdy_t(n) + d\ln D_t(n)} \tag{E.2}$$

From the market clearing condition, we can express the yield as:

$$y_t(n) = \frac{1}{T}\left(\ln D_t(n) - \ln \sum_{i=1}^{6} P_t^i(n)H_i(n)\right) \tag{E.3}$$

Differentiating with respect to the logarithm of debt then implies:

$$\frac{dy_t(n)}{d\ln D_t(n)} = \frac{1}{T} - \frac{1}{T}\left(\frac{\sum_{i=1}^{I} \frac{d\left(P_t^i(n)H_{i,t}(n)\right)}{dH_{i,t}(n)} \frac{dH_{i,t}(n)}{dD_t(n)} D_t(n)}{\sum_{i=1}^{I} P_t^i(n)H_{i,t}(n)}\right) \tag{E.4}$$

Recall that from Section 2, the investor group i's marginal financing share $\frac{dH_{i,t}(n)}{dD_t(n)} = a_i$. Moreover, define the inverse demand elasticity as $\frac{\partial y_t(n)}{\partial \ln H_{i,t}^m(n)} = \frac{1}{\tilde{\eta}_i}$. Then with these definitions, we can re-express $\frac{dy_t(n)}{d\ln D_t(n)}$ in Equation (E.4) as:

$$\tilde{\xi} \equiv \frac{dy_t(n)}{d\ln D_t(n)} = \frac{1}{T} - \frac{1}{T}\left(1 - T\sum_{i=1}^{I}\frac{a_i}{\tilde{\eta}_i}\right) = \sum_{i=1}^{I}\frac{a_i}{\tilde{\eta}_i} \tag{E.5}$$

Empirically, our estimates in Table 3 in Panel B provide the semi-elasticity of market value of holding

with respect to yield. That is, we can denote our empirical estimates as:

$$\frac{1}{\eta_i} \equiv \frac{dy_t(n)}{d\ln H^m_{i,t}(n)} = \frac{dy_t(n)}{-Tdy_t(n) + d\ln H_{i,t}(n)} = \frac{1/\tilde{\eta}_i}{-T/\tilde{\eta}_i + 1}$$

Therefore, substituting these estimates into Equation (E.2) implies:

$$\xi = \frac{dy_t(n)}{d\ln\left(P_t(n)D_t(n)\right)} = \frac{dy_t(n)/d\ln D_t(n)}{-Tdy_t(n)/d\ln D_t(n) + 1} = \frac{\sum_{i=1}^{I} \frac{a_i}{\eta_i + T}}{\sum_{i=1}^{I} \frac{a_i \eta_i}{T + \eta_i}} \tag{E.6}$$

as given in equation (17) in the text. ξ is the inverse of the aggregate demand semi-elasticity with respect to yield in the EM sovereign debt market.

E.2 Sensitivity to Characteristics Changes

In this section, we derive the impact on yield implied by a change in one of the characteristics that we denote X_t. Again we start with the market clearing condition of Equation (E.1). The market clearing condition implicitly defines a function of $P_t(n) = P(X_t(n), D_t(n))$.

We first calculate how much the price of debt would change in response to a unit change in $X_t(n)$ given the book value of debt. Taking the first-derivative with respect to X_t implies:

$$D_t(n)P_t(n)\frac{d\ln P_t(n)}{dX_t(n)} = \sum_{i=1}^{I} \frac{\partial H^m_{i,t}(n)}{\partial \ln P_t(n)} \frac{d\ln P_t(n)}{dX_t(n)} + \frac{\partial H^m_{i,t}(n)}{\partial X_t(n)} \tag{E.7}$$

Rearranging terms yields:

$$\frac{d\ln P_t(n)}{dX_t(n)} = \frac{\sum_{i=1}^{I} \frac{\partial \ln H^m_{i,t}(n)}{\partial X_t(n)} \psi_i}{1 - \sum_{i=1}^{I} \frac{\partial \ln H^m_{i,t}(n)}{\partial \ln P_t(n)} \psi_i} \tag{E.8}$$

where ψ_i is the average share of debt held by investor i. We can then write the yield response to a change in a given characteristic $X_t(n)$ as:

$$\tilde{\zeta} = \frac{dy_t(n)}{dX_t(n)} = -\frac{1}{T} \frac{\sum_{i=1}^{I} \frac{\partial \ln H^m_{i,t}(n)}{\partial X_t(n)} \psi_i}{1 - \sum_{i=1}^{I} \frac{\partial \ln H^m_{i,t}(n)}{\partial \ln P_t(n)} \psi_i} \tag{E.9}$$

Clearly, $\tilde{\zeta}$ is the yield response to a unit change in $X_t(n)$ given the book value of debt. But the market value will change with the price response. Therefore, as above, we calculate how much the book value of debt would have to change for a given market value.

Recall that the price of debt can be written as a function of $D_t(n)$ and $X_t(n)$ as $P(D_t(n), X_t(n))$. We can rewrite the change of market value in response to a unit change in $X_t(n)$ as

$$\frac{d(\ln P(D_t(n), X_t(n)) + d\ln D_t(n)}{dX_t(n)} = \frac{\partial \ln P_t(n)}{\partial \ln D_t(n)} \frac{d\ln D_t(n)}{dX_t(n)} + \frac{\partial \ln P_t(n)}{\partial X_t(n)} + \frac{d\ln D_t(n)}{dX_t(n)} = 0 \tag{E.10}$$

We then solve for the percentage change in the book value of debt due to a change in the given characteristic as:

$$\frac{d\ln D_t(n)}{dX_t(n)} = -\frac{\partial \ln P_t(n)/\partial X_t(n)}{1 + \partial \ln P_t(n)/\partial \ln D_t(n)} = \frac{T\tilde{\zeta}}{1 - T\tilde{\xi}} \tag{E.11}$$

where ξ is the inverse of aggregate demand elasticity derived in section E.1. Then defining the yield response to a unit change in characteristics $X_t(n)$ while keeping the market value of debt unchanged as ζ, this variable can be expressed as:

$$\zeta = \tilde{\zeta} + \frac{dy_t(n)}{d\ln D_t(n)} \frac{T\tilde{\zeta}}{1 - T\tilde{\xi}} = \frac{\tilde{\zeta}}{1 - T\tilde{\xi}} \tag{E.12}$$

This expression verifies Equation (18) in the text.

E.3 Spillover of Individual Holding

In this section, we derive the impact on the yield if investor i's latent demand increases by one percent. We also consider how much each investor's holdings will change. We start from the market clearing condition of Equation (E.1). The market clearing condition implicitly defines a function of $P_t(n) = P(X_t(n), D_t(n), \varepsilon_t(n))$ where $\varepsilon_t(n)$ is the vector of each investor's latent demand for debt issued by country n.

Again, we first fix the book value of debt $D_t(n)$ and take the first-derivative with respect to investor k's latent demand $\varepsilon_{k,t}(n)$, obtaining:

$$D_t(n)P_t(n)\frac{d\ln P_t(n)}{d\varepsilon_{k,t}(n)} = \sum_{i=1}^{I} \frac{\partial H^m_{i,t}(n)}{\partial \ln P_t} \frac{d\ln P_t}{d\varepsilon_{k,t}(n)} + \frac{\partial H^m_{k,t}(n)}{\partial \varepsilon_{k,t}(n)} \tag{E.13}$$

Thus, the response of price to the change in latent demand is:

$$\frac{d\ln P_t(n)}{d\varepsilon_{k,t}(n)} = \frac{\partial H^m_{k,t}(n)/\partial \varepsilon_{k,t}(n)}{D_t(n)P_t(n) - \sum_{i=1}^{I} \frac{\partial H^m_{i,t}(n)}{\partial \ln P_t(n)}} = \frac{\psi_k}{1 - \sum_{i=1}^{I} \psi_i \frac{\partial \ln H^m_{i,t}(n)}{\partial \ln P_t(n)}} \tag{E.14}$$

We can then write the yield response as

$$\tilde{\varphi} = \frac{dy_t(n)}{d\varepsilon_{k,t}(n)} = -\frac{1}{T}\frac{\psi_k}{1 + \frac{1}{T}\sum_{i=1}^{I}\psi_i\eta_i} \tag{E.15}$$

Next, we calculate how much the book value of debt would have to change in order to keep the market value of debt unchanged. This calculation implies the differential relationship:

$$\frac{d\ln(P(D_t(n), X_t(n), \varepsilon_t(n)) + d\ln D_t(n))}{d\varepsilon_{k,t}(n)} = \frac{d\ln P_t(n)}{d\ln D_t(n)}\frac{d\ln D_t(n)}{d\varepsilon_{k,t}} + \frac{d\ln P_t(n)}{d\varepsilon_t^k} + \frac{d\ln D_t(n)}{d\varepsilon_t^k} = 0 \tag{E.16}$$

Solving for the implied percentage change of book value of debt to keep the market value of debt unchanged implies:

$$\frac{d\ln D_t(n)}{d\varepsilon_{k,t}(n)} = \frac{T\tilde{\varphi}}{1 - T\xi} \tag{E.17}$$

Then, defining the object of interest as φ, this relationship can be expressed as:

$$\varphi = \frac{\tilde{\varphi}}{1 - T\tilde{\xi}} \tag{E.18}$$

This derivation verifies Equation (19) in the text.

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