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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 101 countries across three decades. Private non-bank investors absorb disproportionately more debt supply than others. Moreover, non-bank investors' demand for emerging market debt is most responsive to its price. Counterfactual analysis of emerging market sovereigns shows a 10% increase in debt leads to a 5.8% yield increase, but an out-sized 8.4% increase without non-bank investors. We conclude that sovereigns are vulnerable to the loss of non-bank investors.

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A data appendix is available at http://www.nber.org/data-appendix/w30087

1 Introduction

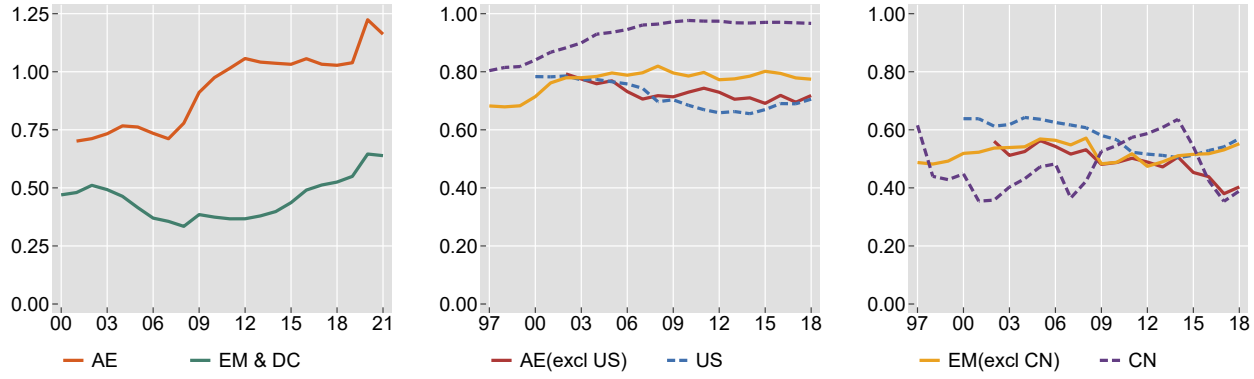
The ability to issue debt is an important instrument at the government's disposal. Sovereign borrowing can help buffer the economy from the impact of adverse macroeconomic shocks. Conversely, indebtedness can also make a country vulnerable to financial distress, as crisis episodes have illustrated. The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

We begin by documenting *who* holds sovereign debt around the world and establishing some new empirical regularities. For this purpose, we assemble a dataset that distinguishes the holders of each country's sovereign debt into investor groups that have been highlighted in the literature. Specifically, we disaggregate debt into that 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.Assembling these data series provides 1947 country-year observations for which we can decompose the holders of debt, spanning 101 countries over 1990-2018.

Figure 1 highlights both the growing importance of government debt as well as how the investor base varies in our data set. 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 advanced and emerging economies. Furthermore, our dataset shows that 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 a combined group of emerging markets (EMs) and developing countries (DCs). The share of aggregate debt holdings by domestic

investors has decreased for AEs while that same share has increased for EMs. The figure separates out the series for China (CN) and the United States (US), showing that while these countries follow the same patterns as EM and AE, respectively, they do not drive those results. 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 (AE) and for the emerging market and developing countries (EM & DC) 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 a balanced sample from our data set, of 17 AEs including the US and 22 EMs including China (CN).

In this paper, we systematically document how increases in sovereign debt are absorbed by these six different investor groups (foreign vs domestic and bank vs non-bank vs official) using a basic decomposition. Strikingly, we find that non-bank private investors absorb expansions in 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, 62% of the increase is allocated to non-bank investors, even though they make up only 44% of holdings on average. Moreover, for increases in foreign-held debt, 66% of the increase is held by non-bank investors, even though they comprise only 39% 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 take up 25% of new debt on the margin. This pattern holds

for increases in foreign and domestically held debt as well as in subsamples of AEs, EMs, and DCs. 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 absorbing 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. These data sets provide insights into the composition of, alternatively, the domestic and the foreign non-bank group.

For domestic non-bank investors, we begin by studying more disaggregated holdings data for two specific issuance countries: the US (Treasuries) and the UK (Gilts). Although these data series do not distinguish among foreign investors, they do provide important insights into domestic investors. In particular, they decompose domestic non-bank investors into finer categories such as insurance and pension funds, and other investment funds (e.g. hedge funds, mutual funds). Repeating the decomposition analysis from the aggregate series on these specific cases, we again find that non-banks are the most responsive investor group to sovereign debt changes. Moreover, within domestic non-banks, investment funds are the key players for both US Treasury and UK Gilts, while insurance and pension plays a more significant role for UK Gilts.

For analysis of the foreign non-bank sector, we turn to the Euro Area Securities Holdings Statistics (SHS). These data provide information on Euro area investor holdings of individual country's sovereign debt. Importantly, for our purposes, these holdings are disaggregated by investor institution type, including non-financial corporations, pensions and insurance companies, households, and a category of other financial institutions, largely representing investment funds. We focus on Euro Area holdings of debt issued by non-Euro area countries, where Euro Area based investors are foreign investors. Our analysis indicates that within this Euro Area subsample of foreign non-bank investors, financial institutions such as investment funds drive the large response of non-banks. Thus, overall, across

three different disaggregated data sets, we continue to find that non-bank investors are the most responsive to debt changes, and that investment funds drive the responses of these non-bank private investors.

Given these findings for *who* holds sovereign debt, we next consider *why* this composition matters to borrowers. The decomposition just described is a reduced form analysis, but understanding the importance of who holds debt requires more economic structure. Therefore, we estimate a system of demand equations representing investors' willingness to extend credit. We adapt the methodology of Koijen and Yogo (2019) and Koijen and Yogo (2024) to apply to the EM sovereign debt market. The adaptation based upon our data structure requires two additional assumptions. First, we assume that foreign investors of EM debt reside outside of the countries that issue this debt. A natural interpretation of this assumption is that foreign investors are global AE investors. Second, these foreign investors are assumed to be dollar based so that they care about returns in dollars. By contrast, local investors view returns in local currency. As a result, the demand of a country's debt depends on the expected excess return of holding this debt from the point of view of the investors, including country-level characteristics that capture issuer credit-worthiness.

Since this demand depends upon endogenous expected excess returns, we require an instrument. For this purpose, we exploit the fact that our data set fully allocates total sovereign debt into investor types for each country. Following Koijen and Yogo (2024), we utilize this market clearing condition to construct an instrument for the sovereign bond expected excess return that is uncorrelated with unobserved latent demand factors.

Our estimates provide striking results that again point to the importance of non-bank investors. Specifically, for EM sovereign debt, non-bank investors overall have a higher demand elasticity than banks. Moreover, among all the investor groups, the elasticity of foreign non-bank investors is the greatest. In addition, investors of EM sovereign debt generally dislike inflation and prefer higher income growth from the borrowing country.

To assess what these estimates imply for the sovereign borrower, we ask how much the cost of financing would increase for a hypothetical debt increase. Our estimates show that

a 10% increase in debt corresponds to a 5.8% increase in yield for the average EM borrower. However, if non-bank investors are not present and borrowers must substitute into borrowing from banks, the same 10% increase in debt corresponds to a substantially higher 8.4% 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 of a borrowing sovereign/country. For instance, if inflation increases by 1%, the required yield for the average EM would increase by 1.69% of the average yield. By contrast, if the real GDP growth decreases by 1%, the required yield for the average EM would increase by about 2.8% of the average yield. Furthermore, counterfactual analysis shows that the sensitivity of financing costs to inflation is vulnerable to the loss of non-bank investors, while the sensitivity to real GDP growth is more exposed to the loss of bank creditors.

The structure of the paper is as follows. Section 2 describes the data and some basic stylized facts, including a decomposition of how much government debt each investor group absorbs on the margin. It also reports the same decomposition using disaggregated non-bank investor holdings in US Treasury and UK Gilt markets, as well as holdings by Euro Area investors. Section 3 sets up a framework of sovereign debt pricing, establishes a demand system of sovereign debt for EMs and estimates these demand functions. Section 4 combines the investor demand estimates with average and marginal holding information to develop a counterfactual analysis. Section 5 provides robustness analysis for AE sovereigns. 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 (2024), Koijen, Richmond, and Yogo (2023), Jiang, Richmond, and Zhang (2024), 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 (2021), Jiang, Lustig, Van Nieuwerburgh, and Xiaolan (2024), 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 studying investor types jointly, we also further the defaultable sovereign debt literature that has instead highlighted specific investor types individually. For instance, an important part of the EM debt 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), Baskaya, Hardy, Şebnem Kalemli-Özcan, and Yue (2024), and Chari, Dovis, and Kehoe (2020). A further area focuses on explaining the reserve accumulation behavior of for-

eign 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 (2023), to name a few. We instead evaluate the entire set of creditors together and thereby contribute to these literatures by showing the relative contribution 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. This data decomposition is close to Arslanalp and Tsuda (2012, 2014), and the extension in Arslanalp and Sunder-Plassmann (2022).[1] In order to examine the impact of marginal investors and their demand, however, we construct a dataset that begins earlier than these papers, 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), Faia, Salomao, and Veghazy (2022), and Nenova (2024). Relative to these granular data sets, our analysis provides a complete accounting of the investors of a broad set of more than 100 countries' sovereign debt and spans both domestic and foreign investors.

2 Evolving Composition of Sovereign Debt Investor Groups

We begin by analyzing the holders of sovereign debt and examining how much debt they take up when the supply increases. We first describe the structure of the data and the investor group definitions, and highlight the broad trends in sovereign debt holdings. We then provide estimates for the marginal investment in sovereign debt for each group. This section finishes by examining non-bank investors in more depth with alternative datasets.

[1] 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.

2.1 Investor Group Definitions

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

The first group is private banks. These institutions are often considered the essential 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. For example, in the literature on emerging market borrowing, foreign global banks are often modeled as the primary creditor.[2] More broadly, liquidity and capital regulation incentivize domestic banks to hold domestic government debt, potentially creating a bank-sovereign doom loop.[3]

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.

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 focuses on the sovereign issuers of debt by detailing all holdings across the

[2]See for instance Eaton and Gersovitz (1981) and Arellano (2008) and Morelli, Ottonello, and Perez (2020) as discussed under Related Literature.

[3]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.

investor groups. As such, it allows us to analyze how the holdings of each investor group respond to changes in the sovereign's total debt. To see this decomposition, it will 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:

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

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 decomposition in Equation (1) to uncover the marginal ownership responses to supply changes over time below. Before doing so, we describe the data construction.

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 first derive each sovereign's total debt from the IMF Historical Public Debt Database (HPDD) and Global Debt Database (GDD).[4] The HPDD and GDD databases provide 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. 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

[4]These data sources cover general government debt, which includes debt from state and local governments, where applicable, and includes both loans and bonds.

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 constructed using the approach in AHKS. Foreign official holdings for advanced economies and China are taken directly from Arslanalp and Tsuda (2012, 2014), which capture the use of such debt as foreign reserves among other reasons. For all other countries, we measure foreign official holdings 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 series are 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 101 countries with a breakdown of debt by investor and time series spanning 1990 to 2018. For some of the analysis, we split the sovereigns into those coming from 3 country groups: advanced economies (AEs), emerging markets (EMs), and developing countries (DCs). Details of the country groups can be found in Appendix A.

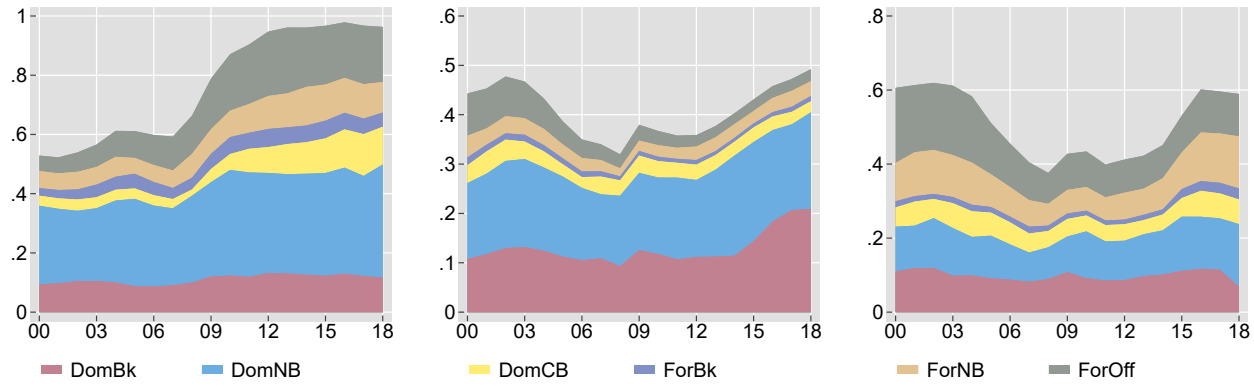
Advantages and limitations of the data. The main two advantages of our dataset are that it allocates all of a sovereign's debt to individual investor groups, and that it spans a large number of countries over a long time period. However, such coverage comes with drawbacks on detail. For instance, our dataset does not include detailed information on the currency or maturity of the debt or the specific location of the foreign investors. It does not have details on the non-sovereign debt portfolio holdings of these investors. Moreover, the data

frequency is annual, and therefore misses higher frequency dynamics. In the conclusion, we discuss avenues for future research to address these issues by building 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 as government debt changes. Panels (a), (b), and (c) of Figure 2 show the aggregate investor holdings-to-GDP shares for 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. However, Panel (a) of Figure 2 shows that the proportion of foreign official holdings has become larger for AEs, as central banks have increased their holdings of safe haven government debt presumably for reserve purposes. Moreover, Panel (b) illustrates how the proportion of foreign official creditor holdings have declined for emerging markets. By contrast, the AE holdings of domestic central banks has expanded over time, tied to the use of unconventional monetary policies and other programs.

Figure 2: Sovereign Debt Holdings by Investor Group



(a) Advanced Economies (b) Emerging Markets (c) Developing Countries

Note: The figures plot the aggregate debt by country group detailed in Appendix A divided by the aggregate GDP of the country group. The investor group holdings are broken down into Domestic Banks (DomBK), Domestic Nonbanks (DomNB), Domestic Central Bank (DomCB), Foreign Banks (ForBK), Foreign NonBanks (ForNB), and Foreign Official (ForOff). Each panel shows a balanced sample over the given time frame.

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 debt? To explore this question, we regress the change in debt held by each investor 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 $H_{i,t}(n)$ are the holdings of sovereign n's debt by investor group i and $D_t(n)$ is the total debt of sovereign n at time t. In the regression, both the change in debt held by each investor group and the change in total debt are scaled by the lagged total debt, while $a(n)$ and a_t represent country and time fixed effects, respectively. According to the accounting identity in Equation (1), the investor groups sum up to the total so that the coefficients estimated from this regression must sum to 1: $\sum_{i=1}^{I} a_i = 1$. Therefore, each coefficient a_i reflects the marginal holding response of investor group i to variations in the supply of debt. Clearly, this decomposition is a purely reduced-form analysis and does not imply any causal relationship, a point we will revisit in Section 3.

Table 1 shows the results of this regression. Panel A provides a baseline estimate labeled "All" using all countries in our dataset. The first two columns provide these results for an aggregate group of domestic and foreign investors, respectively. Columns (1) and (2) show that for every additional unit of debt supplied, 65% is absorbed by domestic investors while the other 35% is picked up by foreign investors. In AEs, this split is roughly equal, whereas for EM sovereign debt, domestic investors take over more than 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 23% 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, domestic and foreign non-banks are the most responsive investor groups for AEs, both with an estimated coefficient of 0.36. By contrast, domestic non-banks matter more for EMs, with a coefficient of 0.38 compared to 0.21 for foreign non-banks.

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	0.65***	0.35***	0.20***	0.39***	0.07***	0.05***	0.23***	0.06***
	(0.03)	(0.03)	(0.03)	(0.05)	(0.02)	(0.01)	(0.03)	(0.02)
AE	0.54***	0.46***	0.08*	0.36***	0.09	0.06***	0.36***	0.05*
	(0.11)	(0.11)	(0.04)	(0.08)	(0.07)	(0.02)	(0.10)	(0.03)
EM	0.70***	0.30***	0.26***	0.38***	0.06**	0.06***	0.21***	0.03
	(0.04)	(0.04)	(0.04)	(0.07)	(0.02)	(0.02)	(0.04)	(0.02)
DC	0.61***	0.39***	0.10***	0.42***	0.09*	0.03*	0.22***	0.13***
	(0.06)	(0.06)	(0.03)	(0.06)	(0.04)	(0.02)	(0.07)	(0.03)
Panel B: Average Share								
All	0.56	0.44	0.22	0.27	0.07	0.06	0.17	0.20
AE	0.56	0.44	0.21	0.30	0.05	0.10	0.21	0.13
EM	0.62	0.38	0.28	0.27	0.07	0.06	0.16	0.16
DC	0.48	0.52	0.14	0.24	0.09	0.04	0.14	0.34

Note: Panel A reports the regression coefficients for Equation (2) for each investor group based upon country groupings: All, Advanced Economies (AE), Emerging Markets (EM), Developing Countries (DC). 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. The number of observations for each regression row are: All = 1947; AE = 438; EM = 927; DC = 582. Panel B reports the average share of holding by each investor group.

Importantly, the pattern from non-bank investors holds within country groups and within the subset of foreign vs domestic investors. 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 21% of the total in contrast to only 6% 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 a key source of financing, accounting for 13% of the investment in debt supply increases.

These results consider the marginal decomposition of investor groups in response to an

expansion in a country's debt issuance 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 explanation is not the case. The large marginal contribution of non-bank investor holdings are greater than the average holdings for all country groups. For example, in the baseline "All" results, the average holdings of domestic non-banks and foreign non-banks sum to only 44% (that is, $0.27 + 0.17$). By contrast, the corresponding marginal share reported in Panel A are jointly 62% ($0.39 + 0.23$) of the change. This pattern is clearly robust across all the remaining decompositions including AE, EM, and DC. Appendix B.1 reports an extensive set of results of the same analysis under different scenarios of recessions vs. non-recessions, banking crisis vs. non-banking-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. Curcuru, Thomas, Warnock, and Wongswan (2011); Gourinchas and Rey (2007)).To consider this possibility, Appendix B.2 repeats the analysis taking into consideration the currency valuation effect. The basic patterns are largely unchanged: non-banks have a larger response to increased debt supply than other investor groups.

2.4 The Role of Non-Bank Investors

As we showed above, non-bank private investors play an important role in the sovereign debt market. This finding raises the obvious questions: who are these investors and how do different non-bank private investors respond to changes in sovereign debt? To shed light on this question, we turn to some other more disaggregated data sets: (i) US Treasuries TIC data; (ii) UK Gilt Holders data; and (iii) the Euro area securities holding statistics (SHS)

produced by the European Central Bank.[5] We utilise the US and UK data to examine the domestic non-bank segment and the Euro area data to shed light on the foreign non-bank segment.

2.4.1 Domestic Non-Bank Investors

We first turn to the US and UK data to examine the domestic non-bank group. As above, these data break out who is holding the sovereign debt issuance, although in this case we focus on US Treasuries and UK Gilts individually. Thus, these two country-specific data sets feature a decomposition of the debt into basic holder groups, as in our main dataset, but provide different breakdowns of investor types. As detailed below, these data sources offer more granularity on the identity of domestic non-bank holders, but less granularity for foreign holders. Moreover, these data are available quarterly, and therefore at a higher frequency than the broader annual data set, although over a different time window of 1995 Q1 to 2020 Q4.

To analyze the marginal investment response for these two countries, we apply our standard decomposition approach in Equation (2) but drop the time and country fixed effects as we are considering a single country at a time. This application implies the following regression equation:

$$\frac{H_{i,t}(n) - H_{i,t-1}(n)}{D_{t-1}(n)} = a_0(n) + a_i(n)\frac{D_t(n) - D_{t-1}(n)}{D_{t-1}(n)} + e_{i,t}(n), \quad n = US, UK \tag{3}$$

Clearly, the US and UK represent specific countries with unique features, but they nevertheless provide a useful window into domestic non-banks' holdings of government debt. Moreover, while the US TIC and UK Gilt data series both provide a more refined set of domestic investor groups, they differ in important ways from each other as detailed next in turn.

[5] 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.

The US TIC data set decomposes holders of US securities into the domestic central bank, domestic US banks, and domestic non-banks, and all foreigners regardless of investor sector. Within the group of domestic non-banks, it provides a further breakdown into money market funds (MMF), household and hedge funds (HH/HF)[6], insurance and pension funds (I & P), other financial institutions including investment funds (OthFin), and nonfinancial corporations (NonFin).

The results for estimating Equation (3) with the US Treasuries data are reported in Table 2, Panel A. The first four columns show the general aggregate breakdown as before, except that all foreign holders are aggregated into "Foreign" in the first column. Domestic non-banks are the primary marginal absorbers of US Treasuries ($0.56 of every dollar issued). Columns (5) to (9) break the domestic non-bank sector into subsectors. These estimates show that investment funds are the most important group. Specifically, Money Market Funds (MMFs) ($0.22 in Column (5)) together with hedge funds ($0.16 in Column (6)), account for about two-thirds of the non-bank marginal variation despite making up only 26% of non-bank holdings on average. The Insurance and Pension (I&P) sector accounts for $0.11 or about 19% ($0.11 /$0.56) of the non-bank marginal activity.

Table 2, Panel B shows the results for holdings of UK Gilts. Similar to the US Treasuries, domestic non-banks play an out-sized role relative to other investor groups, with the largest coefficient at 0.44. Columns (5) to (7) provide a disaggregated, but different breakdown of this group than the US TIC data. Specifically, the domestic non-bank group is broken into only three categories: investment funds and other similar institutions (Funds & Oth), insurance and pensions (I&P) and nonfinancial corporations (NonFin). As these estimates show, the I&P sector plays a much larger role for non-bank holdings than found in US Treasuries, accounting for about half of the marginal absorption of the domestic non-bank sector (0.22% of each pound issued). 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

[6]The "household" sector in the TIC data set includes hedge funds, private funds, and private trusts.

Table 2: **Marginal investors for US and UK Government Debt**

Panel A: US Treasuries

					Domestic Non-Banks				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Foreign	DomCB	DomBk	DomNB	MMFs	HF/HH	I&P	OthFin	NonFin
UST	0.247***	0.132***	0.0606***	0.560***	0.219***	0.162***	0.109***	0.0836***	-0.0135
	(0.0389)	(0.0395)	(0.0118)	(0.0494)	(0.0251)	(0.0421)	(0.0254)	(0.0233)	(0.0455)
Share of DomNB Marginal					0.391	0.289	0.195	0.149	-0.024
Obs	104	104	104	104	104	104	104	104	104

Panel B: UK Gilts

					Domestic Non-Banks		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Foreign	DomCB	DomBk	DomNB	Funds&Oth	I&P	NonFin
UKG	0.174***	0.256***	0.126***	0.443***	0.217***	0.220***	0.00596**
	(0.0293)	(0.0473)	(0.0251)	(0.0470)	(0.0434)	(0.0413)	(0.00284)
Share of DomNB Marginal					0.490	0.497	0.013
Obs	104	104	104	104	104	104	104

This table shows results from estimating Equation (3) for the holders of US Treasuries and UK Gilts over 1995Q1-2020Q4. For Panel A, Column (6) includes hedge funds, private equity, private trusts, and direct household holdings. Column (8) is all other financial institutions apart from funds and Insurance and Pension (I&P). Column (9) is all non-financial holders excluding households. For Panel B, Column (5) includes all financial firms besides banks, insurance companies, and pension funds. Column (7) is all non-financial holders. The rows labeled "Share of DomNB Marginal" provide the ratio of the coefficient estimates for each domestic nonbank investment group over the coefficient of total domestic nonbank holding in Column (4). Holdings in Panel A (B) are measured in US dollars (British pounds). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Gilt market regarding pension funds.[7]

2.4.2 Foreign Non-Bank Investors

The results above provide important additional insights into the behavior of domestic non-bank investor groups but not their foreign counterparts. To better understand the *foreign* non-bank investor group, we turn to the Euro Area SHS data set. The SHS provides data on the holdings of securities for all investors located in the Euro Area (EA), split by the investor group, the security asset class, and the sector and the residence country of the issuer.

[7]The higher marginal participation of this sector is driven by their large average holdings, rather than I&P being quite active traders. On average, this sector makes up 43% of domestic non-bank holdings of US Treasuries in the disaggregated data set, while for UK Gilts it accounts for 81% (not shown in the table). This finding fits with the perception that this sector is generally more stable in their holdings, as argued in Zhou (2024).

This granularity gives us a disaggregated look at EA Non-Bank investments into foreign countries. See Appendix A.3 for more detail on the data and coverage.

Using these data, we can observe Euro Area investor holdings of government debt, broken down by the issuer country. Importantly, for our purposes, these holdings are also disaggregated by investor type. Specifically, the non-bank sector in this data has the more granular breakdown into: (a) households and non-profits, (b) insurance and pensions, (c) non-financial corporations; and (d) "other financial institutions" which here 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, we do not have the Foreign Official holdings since the breakdown of the ECB holdings of foreign debt is not publicly available. As with the TIC and Gilt series, these data are provided quarterly. We therefore analyze these series over the available sample period to correspond with those results: 2013 Q4 (the earliest data) to 2020 Q3. Moreover, we focus on investment outside the Euro Area because the public SHS data do not allow us to separate out the domicile of investors within the Euro Area.

We begin by examining Euro Area investors in the context of our full dataset. For the investment destination countries, we split the foreign bank and foreign non-bank investor groups in our main dataset into Euro and non-Euro Area investors by subtracting the Euro Area holdings from the totals in the main dataset. This breakdown results in a much smaller sample of annual observations over 2013-2018 that spans fewer countries. The estimates therefore become less precise, but still highlight the contribution of Euro Area investors. Given the limited sample, we report results for holdings of all non-EA issuer countries combined.

Table 3 Panel A shows the results of re-estimating Equation (2) with annual data as before, but adding in the additional foreign sector splits. As in our aggregate data, Columns (1), (2), (3) and (8) show the estimates for the aggregate groups of domestic banks, domestic central banks, domestic non-banks and foreign official, respectively. However, Columns (4) to (5) now provide a decomposition of estimates based upon Foreign Banks from Non-EA

and EA while Columns (6) and (7) report for foreign non-banks domiciled in the Non-EA and EA. Again, the point estimates show that non-bank investors are the most responsive. In this sample, we find that foreign non-bank investors pick up roughly 17% of the marginal variation in total debt (12% from Non-EA plus 5% from EA). Thus, Euro Area non-bank investors are responsible for about one third of that total.

Table 3: **Euro Area Holders of Sovereign Debt**

Panel A: Marginal Investment from Euro Area (EA) Investors

	(1) DomBk	(2) DomCB	(3) DomNB	(4) ForBk Non-EA	(5) ForBk EA	(6) ForNB Non-EA	(7) ForNB EA	(8) ForOff
Non-EA	0.12*	0.06	0.62***	0.04	0.01	0.12*	0.05*	-0.01
	(0.06)	(0.05)	(0.12)	(0.03)	(0.01)	(0.06)	(0.02)	(0.02)
Obs	124	124	124	124	124	124	124	124
R^2	0.592	0.349	0.653	0.228	0.267	0.321	0.577	0.261

Panel B: Euro NonBank Decomposition: Quarterly

	(1) InsurPens	(2) OtherFin	(3) Households	(4) NFC
Non-EA	0.21*	0.78***	0.01	0.01
	(0.12)	(0.12)	(0.00)	(0.00)
Obs	691	691	691	691
R^2	0.323	0.826	0.084	0.058
Non-EA AE	0.09	0.89***	0.00	0.01
	(0.06)	(0.07)	(0.00)	(0.02)
Obs	241	241	241	241
R^2	0.428	0.927	0.214	0.123
Non-EA EM	0.25	0.74***	0.01	0.00*
	(0.14)	(0.14)	(0.00)	(0.00)
Obs	450	450	450	450
R^2	0.345	0.803	0.086	0.118

Note: This table reports results for marginal investment in Non-EA sovereign debt by EA investors. Panel A estimates Equation (2) for 8 categories of investors by separating Foreign banks and non-banks into EA (Columns (5) and (7)) and Non-EA (Columns (6) and (8)). Panel B reports estimates from Equation (4) on sovereign debt issued by non-European countries. Standard errors clustered at country level are reported in the parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Ultimately, our goal in this section is to better understand what types of foreign non-banks drive the investment behavior of this group. However, as Table 3 Panel A shows, the

Euro Area non-bank group takes up only 5% of the variation in sovereign debt of foreign Non EA countries. Thus, disaggregating Euro Area Foreign Non-banks further would lead to tiny marginal shares held by each Non-bank group which would be difficult to resolve with the limited annual observations from Panel A. Therefore to study the more granular behavior within Euro Area non-banks, we make two changes. First, we revise regression Equation (2) by replacing the right-hand side variable with the change of total Euro Area Non-bank holdings of country n's debt scaled by the lagged Euro area non-banks' holdings of debt of country n. For this purpose, we define $\overline{H}^{EA}_{NB,t}(n)$ as the holdings of sovereign n's debt by all Euro Area non-bank investors, and define $H^{EA}_{j,t}(n)$ as the holdings of country n's debt by Euro Area non-bank investor group j where $j \in \{1, ..., J\}$, the set of non-bank investor groups in the Euro Area. That is, $\sum_j H^{EA}_{j,t}(n) = \overline{H}^{EA}_{NB,t}(n)$. Second, by relying on the SHS data alone, we are able to run the regression at the quarterly level. These adjustments bring differences across these different non-bank investors into greater focus. Our resulting regression equation then looks as follows:

$$\frac{H^{EA}_{j,t}(n) - H^{EA}_{j,t-1}(n)}{\overline{H}^{EA}_{NB,t-1}(n)} = a_j \frac{\overline{H}^{EA}_{NB,t}(n) - \overline{H}^{EA}_{NB,t-1}(n)}{\overline{H}^{EA}_{NB,t-1}(n)} + a^{EA}(n) + a^{EA}_t + \varepsilon^{EA}_{j,t}(n), \quad \forall j \quad (4)$$

where by construction, $\sum_{j=1}^{J} a_j = 1$. Thus, this regression addresses the question of which investor types drive marginal investment of Euro Area investors in non-Euro Area sovereign debt.

The results are shown in Table 3 Panel B reported by all investment destination countries in the "Non-EA" line and then broken out into holdings of advanced economies("Non-EA AE") and emerging market ("Non-EA EM") debt in the following lines. As seen in Column (1) for all country investment destinations, insurance and pensions (I&P) account for 21% of the additional sovereign debt picked up by Euro Area non-banks. This effect is stronger for emerging markets, where they account for 25%. Nevertheless, Column (2) shows that most of the variation is explained by the "other financial institutions" (OthFin) sector, which consists primarily of investment funds such as hedge funds and mutual funds. This sector accounts for 78% of the marginal investment by all Euro Area non-bank investors, and an even

higher 89% for investment in (non-Euro Area) advanced economy sovereigns. By contrast, households in Column (3) and non-financial corporations in Column (4) are statistically and economically insignificant.

Overall, these disaggregated data suggest that the non-bank investor group is largely driven by the behavior of investment funds, although with more involvement domestically by the I&P sector in UK.

3 Investor Holdings and Sovereign Debt Pricing

We showed above who holds sovereign debt and how the composition of investor holdings varies when that debt expands on the margin. This reduced form decomposition is based on the basic accounting identity of Equation (1) and does not imply any causal relationship, as noted earlier. Moreover, it only helps answer *who* holds sovereign debt, but without more structural analysis, we cannot say much more. Therefore, in this section, we describe a framework of sovereign debt pricing, allowing us to consider why that composition matters.

3.1 General Framework

We begin by describing a framework to relate the debt financing of a sovereign to its investor holdings and to study how those investors respond to the change of debt price. 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 as dependent on the price of country n's debt, $P_t(n)$, 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 since most sovereigns issue debt long term. Thus, we can write the debt supply function as: $D_t(n) = D\left(P_t(n), \mathbf{x}_t(n), D_{t-1}(n)\right)$.

A government then raises debt according to factors that both drive preferred spending through $\mathbf{x}_t(n)$ and the price $P_t(n)$ implied by the willingness to fund by a set of creditors. To see the connection between these effects, it will be useful to rewrite the identity in Equation (1) in terms of the contribution of price. For this purpose, we define the market value of investor group i as: $H^m_{i,t}(n) \equiv P_t(n)H_{i,t}(n)$. As we will describe in Section 3.2 below, investor group i's desired holdings of country n's debt also depend on the price of debt $P_t(n)$ and other country characteristics $\mathbf{x}_t(n)$.[8] The market clearing condition can then be rewritten as:

$$P_t(n)D_t(n) = \sum_{i=1}^{I} H^m_{i,t}(n). \tag{5}$$

This condition then implies an equilibrium price level of country n's debt, $P_t(n)$, as a function of various supply and demand factors, including the composition of creditor willingness to hold.

Understanding whether investor composition matters for the sovereign debt market therefore requires estimating demand for sovereign debt. Intuitively, if demand functions are the same across investors, then who holds the debt does not matter for the sovereign. By contrast, if these demand functions differ, then the composition of investors with different demand elasticities may have different implications for the stability of sovereign funding.

Therefore, the remainder of this section will describe an approach to identify investor demand using the structure of our data for sovereign debt issued by EMs. Section 4 will combine this information together with our reduced form decomposition above to consider the implications for sovereign funding risks. Section 5 provides analysis of investor holdings of AE issuers.

[8] In the equilibrium of the demand system below, the demand of a country's debt will also depend endogenously on the price and characteristics of other countries' debt as investors substitute across these securities.

3.2 Investor Demand Estimation for Emerging Market Debt

Given the potential importance of investor differences, we require an approach that can identify their demand elasticities. For this purpose, we exploit a novel feature of our data set. That is, all debt holdings for any given country are observable so that the identity in Equation (5) holds in our data sample. Therefore, we can identify investor demand using the insight based upon this market clearing condition developed by Koijen and Yogo (2019).

In this subsection, we then estimate different investor groups' demand for sovereign debt using this feature of the sovereign debt holdings. Our specific application of this approach is closest to the global asset demand setting of Koijen and Yogo (2024), hereafter KY. However, we cannot apply their methodology directly due to differences in the structure of our data. In particular, KY use data for country-specific portfolio holdings of securities with information for both the investment destination country as well as other securities held. By contrast, our data set provides richer information about the sector of the investor within a country; i.e., whether it is a bank, non-bank, or official investor. But it does not provide information about where foreign investors are located and what base currencies they are using. Moreover, we only observe the sovereign debt holdings of these different investor groups, but not their holdings of other asset classes. This omission is important because, in reality, investors substitute between sovereign debt and other asset classes. In principle, these issues could be addressed with a more granular data set that includes the identity of these investors and their portfolios. We leave this important question for future research.

Despite these differences in data structure, two key assumptions enable us to adapt the demand estimation methodology in KY for our purpose. First, we assume that foreign sovereign debt investors are not domestic sovereign debt investors for any debt issuer within the estimation sample set. Put differently, a foreign bank that invests in a country's debt does not become a domestic bank for debt issued by another country within the pooled country sample. This assumption appears more reasonable for EM sovereign borrowers since most of their foreign investors reside in advanced economies that are outside

of the estimation for EM debt. By contrast, domestic investors do not require such an assumption since their residence country identity is given by our data sample. As such, there are as many domestic investor groups as there are countries.[9]

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. Domestic investors are assumed to be local-currency-based.

Under these assumptions, we then treat the six creditor groups as distinct investor types with different demand functions. As in KY, we treat investor i's relative portfolio share of country n's debt as a log-linear function of expected excess returns and the set of country characteristics $\mathbf{x}_t(n)$.[10] That is, we denote the investor group i portfolio holdings of sovereign debt issued by country n as: $H^m_{i,t}(n) = \omega_{i,t}(n)A_{i,t}$ where $A_{i,t}$ is the wealth of investor group i in US dollars and $\omega_{i,t}(n)$ is the share of country n's sovereign debt in investor group i's portfolio. Similarly, $H^m_{i,t}(0) = A_{i,t}\omega_{i,t}(0)$ is the amount of investor group i's outside asset holdings in US dollars and $\omega_{i,t}(0)$ is the portfolio share of that outside asset. The investor net worth $A_{i,t}$ and characteristics $\mathbf{x}_t(n)$ of demand are assumed exogenous to the investors in the sovereign debt market. For later reference, it will be useful to define $\mathbf{x}_t(n) \equiv \{x_{1,t}(n), x_{2,t}(n), ..., x_{K,t}(n)\}$ as a 1 x K dimensional vector of country characteristics at each time t. The regression model is then specified as:

$$\delta_{i,t}(n) \equiv \ln\left(\frac{\omega_{i,t}(n)}{\omega_{i,t}(0)}\right) = \tilde{\lambda}_{0,i}\mu_{i,t}(n) + \tilde{\lambda}_{1,i}\mathbf{x}_t(n)' + \tilde{\lambda}_{i,t} + \tilde{\lambda}_i(n) + \tilde{\varepsilon}_{i,t}(n) \tag{6}$$

where $\tilde{\lambda}_{i,t}$ and $\tilde{\lambda}_i(n)$ 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 group i. Moreover, $\tilde{\lambda}_{1,i} \equiv \{\tilde{\lambda}_{1,i,1}, \tilde{\lambda}_{1,i,2}, , ..., \tilde{\lambda}_{1,i,K}\}$

[9] That is, for N countries of debt issuance, there are in total $3N + 3$ investor groups, among which 3 are representative foreign investors and 3N are domestic investors. However, for a particular country n, its sovereign borrower only faces 6 investor groups: 3 representative foreign investors and 3 domestic investors. The other $3N - 3$ domestic investors do not invest in country n's debt.

[10] Unlike KY, we do not have a breakdown of total debt holdings and holdings of other asset classes by investor group and therefore we collapse the two-step decision process within and across asset classes in that paper into one single step.

is a 1 x K vector of coefficients on the characteristics. 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 (6) poses several challenges. First, we do not directly observe investor group i's portfolio shares $\omega_{i,t}(n)$ and $\omega_{i,t}(0)$. Second, the expected excess return faced by domestic and foreign investors differ according to their base currencies. Third, the expected excess return depends upon the price of debt, which is in general correlated with the latent demand of investors. Therefore, we next discuss how we approach these challenges.

Outside Assets We next describe our approach to the outside asset for the foreign 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. Though we do not observe the wealth or outside asset holdings of these investors, they are common within a given group and therefore are absorbed by the time fixed effect in Equation (6).

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. Domestic investors substitute between the domestic sovereign debt and an outside asset. Given our annual frequency and short time period, we do not have a sufficient number of observations to estimate the domestic investors' demand function by country. Therefore, we pool all country-year observations together to estimate the average response of the domestic investors using a proxy for the outside asset. We assume that this proxy is proportional to GDP.[11] Without loss of generality, we assume that log GDP is the first element in the characteristics vector, $x_{1,t}(n)$.

Using the fact that $H^m_{i,t}(n) = A_{i,t}\omega_{i,t}(n)$, we then add $\ln H^m_{i,t}(0) = \ln\left(A_{i,t}\omega_{i,t}(0)\right)$ to both

[11] Other outside asset proxies such as bank credit for banks and the equity market cap for non-banks generate qualitatively similar results.

sides of Equation (6) to obtain:

$$\ln H_{i,t}^{m}(n) = \lambda_{0,i}\mu_{i,t}(n) + \lambda_{1,i}\mathbf{x}_t(n)' + \lambda_{i,t} + \lambda_i(n) + \varepsilon_{i,t}(n) \tag{7}$$

where $\lambda_{1,i}$ is the 1 x K coefficient vector corresponding to the characteristics. This expression allows us to see the connection between the coefficients for both domestic and foreign investors. That is, comparing Equations (7) to (6), it is straightforward to see that $\lambda_{0,i} = \tilde{\lambda}_{0,i}$, $\lambda_i(n) = \tilde{\lambda}_i(n)$ and $\varepsilon_{i,t}(n) = \tilde{\varepsilon}_{i,t}(n)$ for both domestic and foreign investors. Moreover, for foreign investors, the elements in the parameter vector are the same; that is, $\lambda_{1,i,k} = \tilde{\lambda}_{1,i,k}$ for all k, and $\lambda_{i,t} = \tilde{\lambda}_{i,t} + \ln(A_{i,t}\omega_{i,t}(0))$. By contrast, for domestic investors, the outside asset is proxied by $x_{1,t}(n)$ alone and therefore, $\lambda_{i,t} = \tilde{\lambda}_{i,t}$ and $\lambda_{1,i,k} = \tilde{\lambda}_{1,i,k}$, for all $k \neq 1$ but $\lambda_{1,i,1} = \tilde{\lambda}_{1,i,1} + 1$.

Expected Excess Returns We next discuss our treatment of expected excess returns for foreign and domestic investor groups. All foreign investors are assumed to be US dollar-based, while sovereign debt is assumed to be denominated in local currency (Onen, Shin, & von Peter, 2023). Thus, for foreign investors, we follow KY in measuring the expected excess return $\mu_f(n)$ 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:

$$r_{t+1}(n) + s_{t+1}(n) - s_t(n) - y_t(US) = \phi_f p_t(n) + \phi_r(s_t(n) - z_t(n)) + \chi_f(n) + \nu_{f,t+1}(n) \tag{8}$$

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 local-currency 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.

By contrast, domestic investors are local-currency based and thus we measure local-currency expected excess returns $\mu_d(n)$ using the fitted value of the following predictive

regressions for each currency n:

$$r_{t+1}(n) - y_t(n) = \phi_d p_t(n) + \chi_d(n) + \nu_{d,t+1}(n) \tag{9}$$

where $y_t(n)$ is the short-term interest rate in local currency of country n. Appendix C.1 presents the estimation results of the return system.

Instrument The estimation of Equation (7) is subject to standard identification issues. The price of debt is determined in equilibrium by equating demand to supply and thus is clearly endogenous to the latent demand of different investors. The same is true for the expected excess return, as it too depends on the price of debt. To address this problem, we construct an instrument for the expected excess return of debt based on the insight of KY. We first drop the expected excess return in Equation (7) and run the following regression with characteristics only:

$$\ln H^m_{i,t}(n) = \beta'_{1,i}\mathbf{x}_t(n) + \beta_{i,t} + \beta_i(n) + u_{i,t}(n) \tag{10}$$

The fitted value of this equation, $\widehat{H}^m_{i,t}$, is the predicted demand of country n's debt by investor group i based on exogenous country characteristics $\mathbf{x}_t(n)$ alone.

On the supply side, according to the debt supply function described in Section 3.1, we predict the supply of debt-to-GDP using the similar set of characteristics $\mathbf{x}_t(n)$ and the lag of total debt supply to GDP (but not the price of debt). For this purpose, it is useful to define the debt-to-GDP for country n as $d_t(n) \equiv (D_t(n)/Y_t(n))$. Then this relationship can be estimated through the following regression:

$$\ln d_t(n) = \gamma_0 + \gamma_1 \ln d_{t-1}(n) + \gamma_2 \mathbf{x}_t(n) + \gamma(n) + \gamma_t + v_{i,t}(n) \tag{11}$$

In this regression, γ_1 measures the fraction of legacy debt inherited from the previous period, so that $(1-\gamma_1)^{-1}$ is approximately the maturity of debt. The fitted value $\widehat{d}_t(n)$ is the predicted supply of debt-to-GDP using characteristics and lagged supply only.

Then we obtain our instrument by substituting in both the predicted debt supply from Equation (11) and predicted demand by different investors from Equation (10) into the mar-

ket clearing condition:

$$\widehat{P}_t(n) \times \widehat{d}_t(n) Y_t(n) = \sum_{i=1}^{I} \widehat{H}_{i,t}^m \tag{12}$$

This market clearing condition implies a hypothetical debt price $\widehat{P}_t(n)$ in which demand and supply are only determined by characteristics $\mathbf{x}_t(n)$. We use $\widehat{P}_t(n)$ as an instrument for the expected excess return of debt for both foreign and domestic investors. By construction, the instrument is orthogonal to the latent demand of all investor groups.

Estimation Results Estimating investor demand requires specifying a set of country-specific characteristics, $\mathbf{x}_t(n)$. For this purpose, we draw from 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 expected excess return, 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.[12] In light of the literature on sovereign debt and following KY, we include the logarithm of the nominal GDP ("GDP"), real GDP growth ("GDP growth"), inflation, the logarithm of the export-to-GDP ratio ("Exp-to-GDP") and sovereign credit ratings ("Ratings").[13] We assume that the price of debt is $P_t(n) = \exp(-Ty_t(n))$, where $y_t(n)$ is the 5-year bond yield for each country n.[14]

Table 4 provides the results of this baseline estimation while Appendix C presents first-stage results for the construction of the instrument. The first two rows of Panel A show how different investor groups respond to changes in expected excess returns. Among the foreign investors, foreign non-banks are the most sensitive as a 1% change in expected excess returns corresponds to a 12.8% change in the relative debt holdings of a particular country.

[12] 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.

[13] Using a data base of bilateral holdings across countries with a larger number of observations, Koijen and Yogo (2024) also include some other variables such as imports-to-GDP, real GDP per capita, and equity volatility. Using our unilateral data base of holdings by country (naturally with fewer observations), we found that these variables were generally insignificant.

[14] 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 have been increasingly borrowing from abroad in local currency, thereby making the liquidity in these markets greater. See for example Du and Schreger (2016) and Onen et al. (2023), as well as Table C4 in the BIS Debt Securities Statistics.

Among the domestic private investors, domestic non-banks are more responsive to expected excess returns than domestic banks at 9.9% and 4.9%, respectively.[15] Domestic central banks are responsive, although the coefficient is imprecisely estimated. This response is likely motivated by policy decisions and not by the desire for a higher return in the future. Across investor groups, higher inflation leads to a decline in holdings while higher real GDP growth generally increase these holdings by different investors.

The estimates of investor's demand responses to expected excess return changes can further be used to calculate these investors' demand elasticities with respect to debt price and yield. Investors who increase their holdings of a particular country's sovereign debt in response to an increased expected excess return 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. As shown in Appendix C.4, investor group i's demand elasticity with respect to debt price is given by:

$$\eta_i \equiv \frac{\partial \ln H^m_{i,t}(n)}{\partial \ln P_t(n)} = \lambda_{0,i}(1-\omega_i(n))\phi_i \tag{13}$$

where, as above, $\lambda_{0,i}$ is the regression coefficient in Equation (7), $\omega_i(n)$ is the portfolio share allocated by investor group i to sovereign debt issued by country n, and ϕ_i is the debt price coefficient in the predictive regression Equations (8) and (9) where $\phi_i = \phi_d$ for domestic investors and $\phi_i = \phi_f$ for foreign investors. Similarly, we define investor group i's demand elasticity with respect to characteristic $x_k(n)$ as:

$$\psi_{i,k} \equiv \frac{\partial \ln H^m_{i,t}(n)}{\partial x_k(n)} = \lambda_{1,i,k}(1-\omega_i(n)) \tag{14}$$

where $\lambda_{1,i,k}$ is the regression coefficient for characteristics x_k in Equation (7).

Note that calculating the elasticities requires information about investor group i's portfolio share of a country n debt, $\omega_{i,t}(n)$. Although we do not have measures of portfolio shares of each investor group, we can get estimates of domestic and foreign shares from other sources. 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

[15] For some of the investors, the coefficients with respect to expected excess return are significant only at 10% level. This lack of precision is likely driven by the smaller group of EM countries along with the short sample of annual data.

Table 4: Investor Demand: Emerging Markets

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForOff
Panel A: IV Estimates						
Return - Domestic	4.913*	9.898**	13.205			
	(2.921)	(4.024)	(8.620)			
Return - Foreign				6.764*	12.846**	7.565*
				(3.661)	(5.902)	(4.430)
GDP	0.795***	1.111***	0.333	1.673***	2.586	0.523
	(0.159)	(0.277)	(0.494)	(0.622)	(1.593)	(0.752)
GDP_growth	3.849	6.721*	12.174	3.230	18.992**	8.362
	(2.451)	(3.558)	(7.658)	(4.253)	(7.453)	(5.113)
inflation	-3.820***	-4.075**	-5.766*	-6.730***	-7.433*	-5.758**
	(1.118)	(1.629)	(3.160)	(2.400)	(3.825)	(2.885)
Exp-to-GDP	-0.248	-0.400	-0.785	-0.448	0.721	-0.332
	(0.187)	(0.300)	(0.611)	(0.340)	(0.837)	(0.376)
Ratings	0.016	-0.002	0.051	-0.021	0.013	0.033
	(0.013)	(0.021)	(0.038)	(0.026)	(0.044)	(0.029)
Panel B: Shares and Elasticities						
Mean $\omega_i(n)$	0.140	0.340	NA	0.01	0.015	NA
Predictive coefficient ϕ_i	-0.57	-0.57	NA	-0.77	-0.77	NA
Price Elasticity η_i	-2.41	-3.72	NA	-5.16	-9.74	NA
Yield elasticity $-T\eta_i$	12.04	18.62	NA	25.78	48.71	NA
Growth Elasticity $\psi_{i,k}$	3.31	4.44	NA	3.20	18.71	NA
Inflation Elasticity $\psi_{i,k}$	-3.29	-2.69	NA	-6.66	-7.32	NA

Note: Panel A reports the EM sovereign debt IV estimates of the demand function in Equation (7), including country and year fixed effects. The sample spans 1990-2018 at annual frequency. The dependent variable is log holding of the group indicated in the column title. The standard errors clustered at country and year level are reported in the parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Panel B gives the average portfolio share of sovereign debt, predictive coefficients and the implied price and yield demand elasticities, as well as demand elasticities with respect to real GDP growth and inflation.

(from our main data set) to assets (taken from the IMF Financial Soundness Indicators). On average across EMs, these ratios are 0.14 for banks (average of 25 EMs over 2005-2021) and

0.34 for non-banks (average of 11 EMs over 2006-2021, limited by data availability on assets). For foreign investors, we compute proxies from the data from the Euro Area SHS for foreign non-banks and the BIS banking statistics for foreign banks. In particular, holdings of EM sovereign debt by Euro Area non-bank investors are about 1.5% of their debt securities portfolio as of end-2015. From the BIS banking statistics, roughly 1% of banks' cross-border claims are on EM sovereigns on average over 2018-2022 (Hardy and Zhu (2023)). These portfolio shares are reported in the first row of Table 4, Panel B. The second row of the panel reports the predictive coefficient estimates for domestic and foreign returns on the bond price, ϕ_d and ϕ_f, respectively.

The third and fourth rows of Panel B of Table 4 then report the implied elasticities with respect to both debt price and yield as "Price Elasticity" and "Yield Elasticity," respectively. Since the price of debt is $P_t(n) = \exp(-Ty_t(n))$, the yield elasticity is simply $-T\eta_i$. The price elasticities show that non-banks relative to banks have the highest elasticities within their domicile groups, with -3.7 relative to -2.4 for domestic investors and -9.7 relative to -5.2 for foreigners. Similarly, the yield elasticities show the importance of non-banks. They vary from 12 for domestic banks to around 49 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, Richmond, and Zhang (2024) 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 different fixed income securities may have similar demand elasticities across the globe. The last two rows report the demand elasticities with respect to characteristics of real GDP growth and inflation. In Panel B of Table 4, we leave out the Domestic and Foreign Official investors as their responses reflect policy motivations rather than demand elasticities.

4 Financing Costs and Counterfactual Analysis

So far, we have established important results about who holds sovereign debt. Section 2 began by showing that investor holdings respond differently to sovereign debt variation depending on the investor group. Section 3 then reported estimates of the demand response of different investors to changes in the expected excess return of debt and to other characteristics of EM countries. This section connects these two sets of findings and illustrates *why* the investor composition of sovereign debt holdings matters. For this purpose, we develop a financing cost measure that depends on a number of investor demand factors. We use this metric to consider various counterfactuals including increases in debt, changes in country characteristics, and latent demand. These measures are detailed below.

4.1 Financing Cost Sensitivity to Debt Increases

To consider the potential impact of investors, we begin by asking the basic question: how much would the cost of financing increase if the government were to increase debt? This question is clearly an important one given the rising levels of debt-to-GDP in recent years. To answer this question, we will consider the impact on borrowing costs due to potential increases in the market value of debt that we define as $D_t^m(n) \equiv D_t(n)P_t(n)$. In our analysis below, we treat the yield on sovereign debt as a measure of this borrowing cost and consider two related measures described next.

Financing Cost Sensitivity based on Debt Holding Shares Given each investor group's debt holding shares defined as $\theta_i(n) \equiv \frac{H_i^m(n)}{D^m(n)}$, the following expression measures how much the government yield would increase in response to an increase in debt.

$$\frac{\partial y(n)}{\partial \ln D^m(n)} = -\frac{1}{T}\left(\sum_{i=1}^{I}\theta_i(n)\eta_i\right)^{-1} \tag{15}$$

where $\eta_i \equiv \frac{\partial \ln H_i^m(n)}{\partial \ln P(n)}$ and T is the maturity of the debt. The proof is in Appendix D.1.

The borrowing cost sensitivity in Equation (15) is the inverse of a weighted average of demand elasticities of different investors in which the weight is the share held by each investor,

$\theta_i(n)$. Clearly, if an investor group with a larger share is also more elastic, this investor group will be willing to absorb the debt increase with a lower rate of increase in yield. In such a case, the increase in borrowing costs will be mitigated.

Note that 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. Addressing this substitution would require information on other assets such as non-EM sovereign debt assets, as for example in the portfolio analysis of KY described earlier. We leave this interesting question for future research.

Table 5 reports this and other financing cost sensitivities to debt based on inputs from our analysis above to consider the exposure of an average EM country. Note that calculating the debt cost sensitivity in Equation (15) requires the investor elasticities of demand, η_i, and their holdings of country n debt, $\theta_i(n)$. Price elasticities measures η_i throughout the different measures are taken directly from Table 4. For the holding shares, we use the average holding shares in Table 1. The domestic and foreign official sectors are omitted because the behavior of these institutions are more likely driven by policy objectives, instead of market returns. We therefore rescale $\theta_i(n)$ by allocating the official sectors' holding shares to the four private investor groups proportionately. For convenience, Panel D reports the parameter inputs that are used in this and all the counterfactual calculations in Table 5.

Table 5 Panel A reports this calculation based on Equation (15) under the column heading "Using Average Shares" in the first row of labeled "Actual." As that row shows, an increase in debt by 10 percent would lead to an increase of 43 basis points in yield. Based on the average yield of EM debt o 8.8% in our sample, this change corresponds to a 4.9% increase in borrowing costs.

This debt cost sensitivity takes as given the investor base in the sample. However, this composition raises the question: how vulnerable are sovereigns to funding from particular investors? To address this question, we consider how a change in the investor base would impact the financing cost 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 remain-

Table 5: Cost of Financing Sensitivity and Counterfactuals

Panel A: Cost of Financing Sensitivity to Debt Increase				
	Using Average Shares		Using Marginal Shares	
	Sensitivity	% Yield change	Sensitivity	% Yield change
Actual	0.43	4.9%	0.51	5.8%
No Bank	0.34	3.8%	0.41	4.6%
No Non-bank	0.69	7.9%	0.74	8.4%
Panel B: Cost of Financing Sensitivity to Characteristics				
	Real GDP growth decrease		Inflation increase	
	Sensitivity	% Yield change	Sensitivity	% Yield change
Actual	0.25	2.80%	0.15	1.69%
No Bank	0.28	3.18%	0.13	1.44%
No Non-bank	0.17	1.92%	0.20	2.27%
Panel C: Cost of Financing Sensitivity to Latent Demand				
	DomBK	DomNB	ForBK	ForNB
Sensitivity	-1.28	-1.23	-0.32	-0.73
Panel D: Components from Prior Table Estimates				
	DomBK	DomNB	ForBK	ForNB
Price Elasticity η_i	-2.41	-3.72	-5.16	-9.74
Average Shares θ_i	0.36	0.35	0.08	0.21
Marginal Shares a_i	0.29	0.42	0.07	0.23
GDP growth $\psi_{i,k}$	3.31	4.44	3.20	18.71
Inflation $\psi_{i,k}$	-3.29	-2.69	-6.66	-7.32

Notes: Panel A reports the cost of financing sensitivity to debt increase in Equation (15) and (16) based upon, alternatively, average portfolio shares and marginal responses. Rows are based upon the "Actual" for all investors, for "No Bank" and "No Non-bank" in turn assuming shares are redistributed to other investors. Panel B gives borrowing cost sensitivity due to the characteristics as in Equation (18). Panel C provides the effects of latent demand by investor group given in Equation (19). Panel D provides the inputs used in the counterfactual calculations. The marginal shares a_i and average shares θ_i are from Table 1 and rescaled. The price elasticities η_i, and characteristics elasticities ψ_i for GDP growth and inflation are from Table 4. All percentage change calculations are based upon average EM five-year yield in our sample of 8.8%.

ing shares are distributed proportionately across the remaining investors according to their average levels. As Table 5 Panel A shows in the row labeled "No Bank", excluding the bank investor groups as a whole would move this cost of financing sensitivity from 43 basis points to 34 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 69 basis points, representing a 7.9% increase for an average emerging market sovereign borrower. 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, these creditors are willing to absorb the increased debt at a lower required financing cost increase.

The financing cost sensitivity in Equation (15) depends upon investor holdings shares of debt from a given country sovereign. For the counterfactual analysis based on the average EM borrower, we have measured these shares with the sample mean of these holdings across countries and time. In the data, however, the holding shares may change over time. Therefore, we next provide an alternative calculation of this cost of financing sensitivity using the shares of marginal investor responses to debt variation.

Financing Cost Sensitivity based on Marginal Shares Defining each investor group's debt marginal response shares as $a_i(n) \equiv \frac{\partial H_i(n)}{\partial D(n)}$, the increase in the borrowing cost in response to an increase in the market value of debt can alternatively be expressed as:

$$\frac{\partial y(n)}{\partial \ln D^m(n)} = -\frac{1}{T}\frac{\sum_{i=1}^{I}\frac{a_i(n)}{\eta_i - 1}}{1+\sum_{i=1}^{I}\frac{a_i(n)}{\eta_i - 1}} \tag{16}$$

where as above, $\eta_i \equiv \frac{\partial \ln H_i^m(n)}{\partial \ln P(n)} < 0$ and T is the maturity of the debt. Appendix D.2 provides the proof. The intuition of Equation (16) is similar to the one in Equation (15). When a country's sovereign debt is held by an elastic investor that also absorbs that debt more actively than others on the margin, the increased cost of borrowing due to debt expansion is lowered.

Table 5 Panel A shows the results of this financing cost sensitivity based upon the measures of marginal shares from the reduced form regressions in Table 1 Panel A for an average EM borrower. This measure is reported under the column headings "Using Marginal Shares." These sensitivity measures follow the same pattern as for Average Shares in the first two columns. For all investors, reported as "Actual," a 10% increase in debt leads to a 51 basis point increase or a 5.8% yield increase. However, if "No Non-banks" are present, that response substantially increases to a 74 basis increase or an 8.4% yield increase. Thus, when investors absorb debt with different marginal propensities, the Non-bank investors continue to be important.

Marginal Shares, Average Shares and Demand Elasticity Equations (15) and (16) provide two expressions of the financing cost elasticity to a given country borrower using investor holding shares and marginal shares, respectively. However, these two relations are connected to each other because the marginal share of an investor group i, $a_i(n)$, is related to its holding share of the country debt, $\theta_i(n)$ and its demand elasticity η_i. To see this relationship, recall that $a_i(n) \equiv \frac{\partial H_i(n)}{\partial D(n)}$ and note that:

$$\frac{\partial H_i(n)}{\partial D(n)} = \frac{H_i(n)}{D(n)} \frac{\partial \ln H_i(n)}{\partial \ln P(n)} \frac{\partial \ln P(n)}{\partial \ln D(n)} = \theta_i(n)(\eta_i - 1) \frac{\partial \ln P(n)}{\partial \ln D(n)} \tag{17}$$

This equation shows that the marginal response of a given investor to variations in the supply of debt, $a_i(n)$, depends on the aggregate market price response, $\frac{\partial \ln P(n)}{\partial \ln D(n)}$, adjusted by the investor's own holdings share, $\theta_i(n)$, and demand elasticity, η_i. Intuitively, when the sovereign issues more debt, the price drops and all investors pick up more debt. The most elastic investor group picks up the most debt depending on their average holdings. This response is therefore consistent with our findings that non-bank investors are both more elastic and have the greatest marginal responses to debt supply increases relative to their average shares. Therefore, according to Equation (17), the general reduced-form finding that more elastic investors have stronger marginal responses provides independent validation for our analysis of the vulnerability of sovereigns to losing non-bank investors.

4.2 Financing Cost Sensitivity to Characteristics Changes

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 counterfactuals, we ask the question: how much would the yield have to change in response to changes in characteristics x_k in order to keep the market value of debt constant?

To answer this question, the following equation shows that, for a given market value of country n debt, $D^m(n)$, the change in borrowing costs in response to a change in one of the characteristics $x_k(n)$ is:

$$\frac{\partial y(n)}{\partial x_k(n)} = -\frac{1}{T}\frac{\sum_{i=1}^{I}\psi_{i,k}(n)\theta_i(n)}{1-\sum_{i=1}^{I}\theta_i(n)\eta_i} \tag{18}$$

where $\psi_{i,k}(n) = \frac{\partial \ln H_i^m(n)}{\partial x(n)}$. Appendix D.3 provides the proof.

This expression therefore provides information about the investor substitutability between the borrowing costs and characteristics. The intuition can be seen as follows. Subsuming the dependence on country n and assuming that $\psi_{i,k} > 0$ for all i, then when x_k increases by one unit, the total demand increases on the margin by $\sum_{i=1}^{I}\psi_{i,k}\theta_i$ ceteris paribus. This increase in demand pushes the price up and the yield down. The effect on the market value of debt as distributed across existing investors is reflected in the denominator $1-\sum_{i=1}^{I}\theta_i(n)\eta_i$.

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 in the first two columns and one percent increase in inflation in the last two columns. As shown in Table 4 (repeated in Table 5 Panel D), a decrease of real GDP growth or an increase in inflation induces investors to reduce their demand of debt, so that the yield increases. As shown under the columns labeled "Real GDP decrease," a one percentage point decrease of real GDP growth would require an increase in yield of 25 basis points, which is equal to a 2.80% rise in the average yield to EM debt. Similarly, under the columns labeled "Inflation increase," an increase of inflation by one percent would require an increase of 15 basis points, or equivalently 1.69% of the average EM yield. Simply put, all investors dislike investing in the debt of countries with low GDP growth and high inflation so they require compensation

with higher yield.

To evaluate how investors differ according to their view of these attributes and their impact on the cost of financing, we next consider how this measure changes with different investor bases as before. Table 5 Panel B shows the results of this analysis under the rows labeled "No Bank" and "No Non-bank." Excluding the bank investor groups as a whole, the yield would increase by 28 basis points in response to a one-percent real GDP growth decrease and 13 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 17 basis points to a one percent decrease in real GDP growth but a higher 20 basis points to an increase in inflation. As Panel D shows, the reason for the differences is that foreign non-banks have the largest elasticity with respect to GDP growth at 18.7, while banks' holdings of debt have the largest elasticity with respect to inflation on average. Thus, excluding investor groups with the strongest responses reduces the yield pressure from these changes. Overall, these results highlight the importance of non-banks not only for their cost of financing sensitivity to debt increases, but to characteristics changes as well.

4.3 Financing Cost Sensitivity to Investor Latent Demand

Finally, we analyze the impact of changes in investor latent demand on the borrowing costs. That is, we ask: how much would yield change in response to a one percent increase in a given investor group's latent demand, keeping the market value of debt unchanged? Intuitively, if investors in a particular group, j, increase their latent demand, the yield will decrease. Thus, the government can issue less book value of debt to maintain the same market value. The reduced debt issuance will further lower the debt yield. The following equation shows that for a given market value of debt $D^m(n)$, the change of borrowing cost in response to a change in investor group j's latent demand is

$$\frac{\partial y(n)}{\partial \varepsilon_j(n)} = -\frac{1}{T}\frac{\theta_j(n)}{1-\sum_{i=1}^{I}\theta_i(n)\eta_i} \tag{19}$$

Appendix D.4 provides the proof. As the equation shows, the effect of latent demand by a particular investor group j increases according to its holdings share, θ_j.

Table 5 Panel C reports the results of this analysis using the average EM holdings for $\theta_i(n)$ as before. As the table shows, the effect from an increased latent demand by the domestic investors is larger. This finding results from the fact that domestic investors generally hold higher shares than foreign investors.[16]

4.4 Financing Cost Sensitivity and the Role of Exchange Rates

The counterfactual analysis in Table 5 is based upon the excess return specification in Section 3.2 but otherwise treats inputs as independent of the exchange rate. We followed this approach because, unlike KY, we only have data on the investor holdings and supply of sovereign debt without further information on its maturity or currency. Therefore, we cannot compute the implied exchange rates in equilibrium. Nevertheless, to consider whether our general findings are sensitive to this treatment of exchange rates, we allow for correlation between the price of debt and the real exchange rate and then conduct an alternative set of counterfactual exercises. Appendix E derives demand elasticities under this alternative assumption and recomputes the implied counterfactuals.These results show that the results are similar to the main results in Table 5. The results are similar because exchange rates and the prices of EM debt are only weakly correlated in the data. In addition, this appendix reports the sensitivity of expected excess returns faced by domestic and foreign investors, respectively, to debt increase, characteristics changes and latent demand increase. Again, the results share the same pattern as above. Overall, these results suggest that our counterfactuals are relatively insensitive to the baseline exchange rate assumptions.

5 Advanced Economy Sovereign Debt Holdings

Lastly, we turn to Advanced Economy sovereign debt. A natural approach would be to estimate these holdings as a demand system based upon the investors in the AE country government debt as we do for EM sovereigns. Recall that for EM issuers, we use the plausible assumption that foreign investors are primarily Advanced Economy investors who are

[16] Jansen (2024) finds that a decline in the latent demand of the Dutch I&P sector (driven by a regulatory change) increased the yield on long-term Dutch government bonds.

outside of our estimation panel. However, to estimate demand for AE sovereign debt, we face more significant limitations from our data. As noted earlier, in our data set foreigners are only known to reside outside the country issuing debt and thus we cannot identify the domicile of these foreigners. Thus, the requirement that all foreign investors reside outside the given country sample for demand estimation would clearly be false for Advanced Economies. For example, in the AE country sample, German banks are in the "Domestic bank" group for German debt (n = Germany) but in the "Foreign bank" group for French debt (n = France). Moreover, these positions may be important since holdings of sovereign debt securities across AE countries is common and can be a large part of investor portfolios. Therefore, assuming that all foreign investors are outside of the estimation panel is unrealistic for these country issuers.[17]

For these reasons, we cannot estimate a demand system for AE government debt as in Section 3.2 using our data. Nevertheless, we can still study investor debt holdings in response to the same factors similar to EM investors as a robustness exercise. Given that we do not know the currency-base of foreign holders of AE debt, we abstract from exchange rate effects and use the log yield of debt, $y_t(n)$, as the relevant price variable. As such, we rewrite Equation (7) as:

$$\ln H_{i,t}^m(n) = \alpha_{i,0} \ln y_t(n) + \alpha_{i,1}' \mathbf{x}_t(n) + \alpha_i(n) + \alpha_{i,t} + u_{i,t}(n). \tag{20}$$

The instrument for log yield is constructed using a similar methodology as for the emerging market debt. That is, we first estimate the holdings in Equation (20) without the yield and the debt supply Equation (11). Then, we use the fitted values in the market clearing condition as Equation (12) to obtain an instrument for the yield of the debt. For this estimation, we drop all observations with zero or negative yields, as well as Greece over 2011-2013 when the yield to debt rose to an extremely high level during its debt crisis.[18]

Table 6 reports the estimation results. As the first row shows, the responses of each

[17] 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.

[18] Appendix (F.1) below show the results for the first-stage regressions and the projected debt.

Table 6: Advanced Economy Sovereign Debt Holdings

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
Bond Yield	1.196***	0.953***	2.742***	0.885***	2.819***	0.689***
	(0.333)	(0.304)	(0.774)	(0.290)	(1.061)	(0.186)
GDP growth	7.785**	-0.184	19.948**	2.683	14.968*	4.899**
	(3.460)	(3.098)	(8.777)	(3.039)	(8.747)	(2.324)
GDP	-0.052	0.294	0.397	2.050***	-0.323	1.972***
	(0.488)	(0.433)	(1.301)	(0.427)	(1.322)	(0.366)
Exp-to-GDP	1.274*	0.718	8.167***	2.096***	6.066**	1.352**
	(0.696)	(0.595)	(1.831)	(0.610)	(2.471)	(0.584)
Ratings	-0.139***	-0.091**	-0.308***	-0.118***	-1.455**	0.7
	(0.042)	(0.037)	(0.104)	(0.037)	(0.604)	(0.026)
Inflation	5.142	3.846	30.277**	14.965***	6.764	10.857***
	(4.574)	(3.858)	(12.074)	(4.017)	(9.946)	(3.990)
Observations	316	298	290	317	305	291

Note: This table reports the estimates of the Equation (20). The sample spans 2000-2018 at annual frequency. The dependent variable is holding of the group indicated in the column title. The standard errors clustered at country and year level are reported in the parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

investor group's holdings to yield changes are all positive. Moreover, as with the holdings of EM debt, the foreign non-banks are the most responsive to changes in yields. In particular, a one percent change in yield leads to a 2.82% change in holding by foreign non-banks compared to only a 0.89% change in that of foreign banks. By contrast, domestic banks and non-banks are similar at around 1%. These results should be viewed with caution given the issues described above. Nevertheless, the pattern echoes the findings among emerging market investors, suggesting that foreign non-banks are more responsive to yield than other investors.

6 Concluding Remarks

The rising levels of government debt worldwide in the wake of the Covid-crisis have made urgent the answers to questions about their repayment. At the front of those questions is:

who holds this debt and does it matter to borrowers in this market? In this paper, we address these questions by analyzing a unique data set that decomposes sovereign debt into investor holding groups for a large number of countries over almost three decades.

Based upon our analysis, the answers to these questions are striking. First, private financial institutions that are not banks absorb substantially more of the variation in outstanding government debt than other investor groups. 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. We then identify the propensity to provide funding for EM sovereigns 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 the average and marginal shares of holdings together with EM investor demand estimates to calculate the cost of financing sensitivities. An average EM country faces significant financing cost sensitivity since a 10% increase would lead to a nearly 5% 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 5% to 8%. 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.

References

Aguiar, M., Chatterjee, S., Cole, H., & Stangebye, Z. (2020). Self-fulfilling debt crises, revisited. *Federal Reserve Bank of Philadelphia Working Paper*, *No 20-03*.

Aguiar, M., & Gopinath, G. (2007). Emerging market business cycles: The cycle is the trend. *Journal of Political Economy*, *115*(1), 69-102.

Arellano, C. (2008). Default risk and income fluctuations in emerging economies. *American Economic Review*.

Arellano, C., Bai, Y., & Mihalache, G. P. (2020). *Monetary policy and sovereign risk in emerging economies (nk-default)* (Tech. Rep.). National Bureau of Economic Research.

Arellano, C., & Ramanarayanan, A. (2012). Default and the maturity structure in sovereign bonds. *Journal of Political Economy*, *120*(2), 187-232.

Arnone, M., & Ugolini, P. (2005). Primary dealers in government securities. *International Monetary Fund*, *Washington, D.C.*.

Arslanalp, S., & Sunder-Plassmann, L. (2022). Sovereign debt repatriation during crises. *IMF Working Paper*, *No. 2022/077*.

Arslanalp, S., & Tsuda, T. (2012). Tracking global demand for advanced economy sovereign debt. *IMF Working Paper*, *No. 12/284*.

Arslanalp, S., & Tsuda, T. (2014). Tracking global demand for emerging market sovereign debt. *IMF Working Paper*, *No. 14/39*.

Avdjiev, S., Hardy, B., Şebnem Kalemli-Özcan, & Servén, L. (2022). Gross capital flows by banks, corporates, and sovereigns. *Journal of the European Economic Association*, *20*(5).

Baskaya, Y. S., Hardy, B., Şebnem Kalemli-Özcan, & Yue, V. (2024). Sovereign risk and bank lending: evidence from the 1999 Turkish earthquake. *Journal of International Economics*, *150*(103918).

Bianchi, J., Hatchondo, J. C., & Martinez, L. (2018). International reserves and rollover risk. *American Economic Review*, *108*(9), 2629–2670.

Bianchi, J., & Sosa-Padilla, C. (2023). *Reserve accumulation, macroeconomic stabilization, and sovereign risk* (Tech. Rep.).

Bocola, L. (2016). The pass-through of sovereign risk. *Journal of Political Economy*, *124*(4), 879–926.

Bretscher, L., Schmid, L., Sen, I., & Sharma, V. (2020). Institutional corporate bond pricing. *Swiss Finance Institute Research Paper*(21-07).

Brunnermeier, M., Garicano, L., Lane, P., Pagano, M., Reis, R., Santos, T., ... Vayanos, D. (2016). The sovereign-bank diabolic loop and esbies. *American Economic Review*, *106*(5), 508-512.

Bruno, V., & Shin, H. S. (2015). Cross-border banking and global liquidity. *Review of Economic Studies*, *82*(2), 535-564.

Chari, V. V., Dovis, A., & Kehoe, P. J. (2020). On the optimality of financial repression. *Journal of Political Economy*, *128*(2), 710–739.

Cruces, J., & Trebesch, C. (2013). Sovereign defaults: the price of haircuts. *American Economic Journal: Macroeconomics*, *5*(3), 85-117.

Curcuru, S. E., Thomas, C. P., Warnock, F. E., & Wongswan, J. (2011). Us international equity investment and past and prospective returns. *American Economic Review*, *101*(3440-55).

Dominguez, K., Hashimoto, Y., & Ito, T. (2012). International reserves and the global financial crisis. *Journal of International Economics*, *88*(2), 388-406.

Du, W., & Schreger, J. (2016). Local currency sovereign risk. *Journal of Finance*, *71*(3), 1027-1069.

Eaton, J., & Gersovitz, M. (1981). Debt with potential repudiation: Theoretical and empirical analysis. *Review of Economic Studies*, *48*(2), 289–309.

Fahri, E., & Tirole, J. (2018). Deadly embrace: Sovereign and financial balance sheets doom loops. *Review of Economic Studies*, *85*(3), 1781–1823.

Faia, E., Salomao, J., & Veghazy, A. V. (2022). Granular investors and international bond prices: Scarcity-induced safety. *Available at SSRN*.

Fang, X., & Liu, Y. (2020). Volatility, intermediaries, and exchange rates. *Journal of Financial Economics*.

Gabaix, X., & Maggiori, M. (2015). International liquidity and exchange rate dynamics. *Quarterly Journal of Economics*, 1369-1420.

Garcia Luna, P., & Hardy, B. (2019). Non-bank counterparties in international banking. *BIS Quarterly Review*, *September*, 15-31.

Gennaioli, N., Martin, A., & Rossi, S. (2014). Sovereign default, domestic banks, and financial institutions. *Journal of Finance*, *69*(2), 819-866.

Ghosh, A., Ostry, J., & Tsangarides, C. (2017). Shifting motives: Explaining the buildup in official reserves in emerging markets since the 1980s. *IMF Economic Review*, *65*, 308–364.

Gourinchas, P.-O., & Rey, H. (2007). International financial adjustment. *Journal of Political Economy*, *115*(4), 665-703.

Hardy, B., & Zhu, S. (2023). Covid, central banks and the bank-sovereign nexus. *BIS Quarterly Review*, *March*, 15-31.

Jansen, K. (2024). Long-term investors, demand shifts, and yields. *Review of Financial Studies*, *Forthcoming*.

Jiang, Z., Krishnamurthy, A., & Lustig, H. (2021). Foreign safe asset demand and the dollar exchange rate. *The Journal of Finance*, *76*(3), 1049–1089.

Jiang, Z., Lustig, H., Van Nieuwerburgh, S., & Xiaolan, M. Z. (2024). The us public debt valuation puzzle. *Econometrica*, *92*(4), 1309–1347.

Jiang, Z., Richmond, R. J., & Zhang, T. (2024). A portfolio approach to global imbalances. *The Journal of Finance*, *79*(3), 2025–2076.

Koijen, R. S., Koulischer, F., Nguyen, B., & Yogo, M. (2021). Inspecting the mechanism of quantitative easing in the euro area. *Journal of Financial Economics*, *140*(1), 1-20.

Koijen, R. S., Richmond, R. J., & Yogo, M. (2023). Which investors matter for equity valuations and expected returns? *Review of Economic Studies*, rdad083.

Koijen, R. S., & Yogo, M. (2019). A demand system approach to asset pricing. *Journal of Political Economy*, *127*(4), 1475–1515.

Koijen, R. S., & Yogo, M. (2024). *Exchange rates and asset prices in a global demand system* (Tech. Rep.). National Bureau of Economic Research.

Krishnamurthy, A., & Vissing-Jorgensen, A. (2012). The aggregate demand for treasury debt. *Journal of Political Economy*, *120*(2).

Laeven, L., & Valencia, F. (2020). Systemic banking crises database ii. *IMF Economic Review*, *68*(2), 307–361.

Liu, Y. (2022). Government debt and risk premia. *Journal of Monetary Economics, Forthcoming*.

Liu, Y., Schmid, L., & Yaron, A. (2020). The risks of safe assets. *Available at SSRN 3699618*.

Maggiori, M., Neiman, B., & Schreger, J. (2020). International currencies and capital allocation. *Journal of Political Economy*, *128*(6), 2019-2066.

Mendoza, E., & Yue, V. (2012). A general equilibrium model of sovereign default and business cycles.

Quarterly Journal of Economics, *127*(2), 889-946.

Miranda-Agrippino, S., & Rey, H. (2021). Us monetary policy and the global financial cycle. *Review of Economic Studies*.

Morelli, J., Ottonello, P., & Perez, D. J. (2020). Global banks and systemic debt crises. *Working Paper*.

Nenova, T. (2024). Global or regional safe assets: evidence from bond substitution patterns. *Available at SSRN 4736704*.

Onen, M., Shin, H., & von Peter, G. (2023). Overcoming original sin: insights from a new dataset. *BIS Working Papers*, *No 1075*.

Perez, D. J. (2014). Sovereign debt, domestic banks and the provision of public liquidity.

Reinhart, C. M., & Rogoff, K. S. (2011). This time is different: Eight centuries of financial folly. In *This time is different: Eight centuries of financial folly.*

Wooldridge, P. (2006). The changing composition of official reserves. *BIS Quarterly Review*, *September 2006*, 25-38.

Zhou, H. (2024). *The fickle and the stable: Global financial cycle, transmission via heterogeneous investors* (Tech. Rep.). SSRN 4616192.

Online Appendix

A Data construction

This appendix provides detailed information about the data used in the paper. Sections A.1 covers the aggregate holdings data, while Section A.2 lists the countries included. Section A.3 describes the disaggregated data. Section A.4 discusses the financial data and various measures used as characteristics for demand estimation.

A.1 Debt and Investor Holdings

This subsection describes the sources and construction of our dataset decomposing sovereign debt into 6 main holder groups. 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, and includes both bonds and loans.

Total Total debt holdings are measured by combining the data from the IMF Global Debt Database (GDD) and Historical Public Debt Database (HPDD) – both of which are expressed as a percent of GDP - with annual GDP from The World Bank (to convert into US dollars). We default to GDD data first, and then use HPDD if series are missing. For some countries HPDD is not available after 2015.[2] In this case, we use growth rates[3] from the Quarterly Public Sector Debt (QPSD) database to compute debt levels in 2016-2018. For countries not in the QPSD dataset but still with missing values after 2015, we use growth rates from total debt reported in Arslanalp and Tsuda (2012) and Arslanalp and Tsuda (2014) (converted into US dollars) to estimate missing observations of the data without introducing artificial

[1] Series that are originally reported in local currency are converted to US dollars using the end of period exchange rate from the World Bank. We take special care when converting data from countries that join the euro late, as their data when reported in local currency is sometimes expressed in euros even for years before they were pegged to and adopted the euro (including pre-1999). To account for this, we construct a hypothetical euro exchange rate for each country by using their original local currency exchange rate with the euro, and adjusting it by the fixed conversion rate at the time they joined the euro. Robustness to currency valuation effects are described in Section B.2

[2] This is the case for 28 countries in our sample: Angola, Argentina, Bahamas, Bahrain, Bolivia, Cote d'Ivoire, Ecuador, Ghana, Jamaica, Jordan, Kenya, Kuwait, Liberia, Morocco, Namibia, New Zealand, Oman, Pakistan, Papua New Guinea, Qatar, Samoa, Singapore, South Africa, Sri Lanka, Sudan, Tunisia, Uruguay, and Venezuela.

[3] We use this approach throughout, sometimes referred to as backcasting or forwardcasting. By this, we mean that we use the earliest/latest available data point as the level to work from, and then use growth rates computed from other data series spanning the missing values to estimate, from the initial level, what the previous/following levels of debt holdings should be.

jumps. Finally, when there is a gap in the data without any filling series, we linearly interpolate across the gap.[4]

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 methodology 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, we fill missing observations with data from 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). To capture bonds (i.e. portfolio debt), we use the BIS International Debt Securities (IDS) data. The IDS consists of all debt securities issued in international markets, which target foreign investors.[5] These data are available for a wide range of countries and time periods, and include granular splits by issuer country and sector. Internationally issued bonds serve as a good proxy for bonds held by foreign investors, especially in the case of emerging markets.[6]

To capture data for outstanding amounts of non-bond external sovereign liabilities (i.e. other investment debt), we use the BIS International Banking Statistics, to capture lending from foreign banks (described below), and foreign official holdings (described below). These are then summed together with the bond series above to get an estimated foreign total for observations when IIP data are missing.

To avoid jumps when switching data series, we compute growth rates from the filling series and use those to backcast/forward cast values from the non-missing data (i.e. after filling internally and with QEDS data).[7] When there are no data from these previous sources, the filling series are used directly.

[4] This is done for Guatemala, Liberia and Samoa.

[5] 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 flag classifies in essence any bond whose issuance targets investors outside of its local market.

[6] 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.

[7] To prevent jumps from breaks in series for cases where the foreign official data are missing until partway through the filling series, the growth rate without foreign official is used up until the year of the first foreign official observation, then the growth rate using foreign official is used.

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.[8] 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), with the following description largely taken from their data appendix. This methodology 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).[9]

The second set of banking data is the Consolidated Banking Statistics (CBS). This data set differs from the LBS in that the positions of banks reporting to the BIS are aggregated by the nationality (rather than by the residence) of the reporting bank.[10] We use the CBS on an immediate counterparty basis (CBS/IC).[11] 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 claims for each sector from the CBS to estimate

[8] The public facing COFER data do not allow us to identify well the amount of each sovereign's debt held abroad as official reserves.

[9] 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).

[10] 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.

[11] 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.

the split of the Non-Bank LBS data into Public and Private components.[12] International bank claims (INTC) consist of cross-border claims (XBC) and claims extended locally (i.e. by a bank's foreign office) in foreign currency (LCFC). 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 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 assumption is reasonable since for most countries, LCFC tends to be small relative to XBC.[13] 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 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. For them, we assume constant shares from 2000 backwards.[14]

Recently, the BIS has released its enhanced banking data, starting in 2013. These data contain more granular borrowing sector splits. This means that for some countries where coverage is good, we can split the XBC from the LBS to non-banks into NBFIs, government, and private non-financial (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.[15] Based on these data, we make one correction for Switzerland where holdings by

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

[13] 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.

[14] This assumption is reasonable, as these shares do not change quickly and we only extend back 4 years.

[15] 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.

external banks are significantly overestimated with our methodology.[16]

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 Domestic central bank holdings are derived from the IMF's International Financial Statistics (IFS) data set. We rely first on the more recent standardized reporting forms (SRF) version of the data which has data back to 2001. This series comes from central bank surveys capturing net claims of central banks on the central government plus (when available) claims on state and local government. To extend the data further back in time, we rely on the non-standardized presentation of the data (non-SRF) for Monetary Authorities claims on central government and state and local government, which was reported in earlier years, sometimes up until 2008.[17] These data are all converted into US dollars. In order to avoid breaks in series when switching between reporting forms, we use growth rates from the non-SRF data to backcast data from the SRF data.

If only non-SRF data are available, then we use these data directly. If there is no overlap between SRF and non-SRF data, we use data from the national central bank in order to get growth rates to bridge the gap.[18] If no data are available, we do a linear interpolation for gaps up to 2 years.[19]

Domestic Bank These holdings were compiled using the same procedure as for the Domestic Central Bank. For the SRF data, we use the Other Depository Corporations Survey and examine net claims on central government and (when available) claims on state and local government. For non-SRF data, we use the Banking Institutions data with claims on the same sectors.[20]

[16] 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.

[17] These data are continually revised and updated, so the exact data series and amounts used may not match newer downloads of the data.

[18] This procedure is done only for countries in the euro area (Belgium, France, Germany, Italy, Netherlands, Portugal, Spain, Sweden). The gap is typically 2-3 years. The growth rates are adjusted with a multiplicative constant such that the estimated data series exactly connect both end points of the two data series (in these cases, the levels for the SRF and non-SRF data are comparable). We utilize data for the United Kingdom from Arslanalp and Tsuda (2012), as it does not have data in the IMF collection.

[19] This approach is done for Austria, Finland, Ireland, and Vietnam. The gaps are 1-2 years.

[20] The list of countries for which additional data from the official Central Bank websites was used is: Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Portugal, Spain. We utilize data for the United Kingdom from Arslanalp and Tsuda (2012), as it does not have data in the IMF collection, and also for Canada, as the IMF data stops in 2009. We do a linear interpolation over 1-2 year gaps for Barbados, Croatia, Ireland, New Zealand, and Vietnam.

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 data construction produces negative observations for residually computed groups (e.g. domestic non-banks). In general, we used the following procedure to maintain internal consistency in the dataset (i.e. the sum of the parts add up to the whole) for these special cases.

1. 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).

2. 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)

3. Given these updated variables, we then recompute the residual categories: Foreign Non-bank, Domestic Total, and 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 either drop the data or replace the observation with linear interpolation (before computing residual sectors). These cases are described here:

- Albania: there is a large spike in foreign total holdings in 2005. This observation is deleted and replaced with a linear interpolation

- Bolivia: The initial value of foreign total holdings has a large spike in 1995-6. We drop these observations and start the series in 1997.

- Cote d'Ivoire: The initial value of foreign total has a large spike in 2004 which makes the domestic total negative. We drop this observation and start the series in 2005.

A.2 Country Groups

The final sample consists of the following 101 countries:

Advanced economies (24): Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Malta, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom, and the United States.

Emerging markets (48): Argentina, Bahrain, Bangladesh, Belarus, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Cyprus, Czech Republic, Egypt, Estonia, Hungary, India, Indonesia, Israel, Jordan, Korea, Kuwait, Latvia, Lithuania, Malaysia, Mauritius, Mexico, Montenegro, Morocco, Nigeria, Oman, Pakistan, Peru, Philippines, Poland, Qatar, Romania, Russia, Slovak Republic, Slovenia, South Africa, Thailand, Turkey, Ukraine, United Arab Emirates, Uruguay, Venezuela, and Vietnam.

Developing economies (29): Albania, Angola, Bahamas, Barbados, Bolivia, Costa Rica, Cote d'Ivoire, Dominican Republic, Ecuador, El Salvador, Gabon, Ghana, Guatemala, Jamaica, Kazakhstan, Kenya, Lebanon, Liberia, Mongolia, Namibia, North Macedonia, Papua New Guinea, Paraguay, Samoa, Serbia, Sri Lanka, St. Lucia, Sudan, and Tunisia.

A.3 Disaggregated Holdings Data

In Section 2.4, we use investor holdings data for different countries in order to understand the nonbank sector components better. Below we describe the data sources for this analysis.

Disaggregated Holdings of U.S. Treasuries The holdings of US Treasuries are from the Treasury International Captial (TIC) system data base. This quarterly series provides a breakdown of domestic nonbank holders of US treasuries into Money Market Funds (MMF), a "Households" sector which also includes hedge funds (HF/HH), Insurance and Pensions (I&P), Other Financial sector which includes funds and investment funds (OthFin), and a NonFinancial corporation sector (NonFin). While these data provide a breakdown of domestic private US investors into their own sovereign debt, the foreign investors are combined into a single category "Foreign" investor. The results of our decomposition regression are given in Table 2 Panel A.

Disaggregated Holdings of UK Gilts The holdings of UK Gilt are from the United Kingdom Debt Management Office (DMO) database. Similar to the US TIC data, they provide a detailed quarterly breakdown of private nonbank investors, but all foreigners are combined into one series. In contrast

to the TIC data, however, the breakdown into domestic investor components is different and generally coarser. That is, while domestic UK investors are disaggregated into Insurance and Pensions (I&P) and Nonfinancials (NonFin) as in the TIC, the other investor groups are combined together into a broad category Funds and Others (Funds & Oth). The results of our decomposition regression for Gilts are given in Table 2 Panel B.

Disaggregated Holdings by Euro Area of Foreign Sovereign Debt The Euro Area Securities Holdings Statistics (SHS), obtained from the European Central Bank, capture all securities held by investors domiciled in the Euro area. In the public data, these series can be split along a number of dimensions, including country of the issuer, sector of the issuer, type of asset (debt vs equity), and sector of the holder (investor). These data are available from 2013q1-2020q4 on a quarterly basis.[21] We keep only debt securities and select the government sector as the issuer. For each specific sovereign issuer, we can distinguish between a number of different euro area domiciled holders: banks, insurance and pensions, other financials (mostly investment funds), households, government, and non-financial corporations.[22] We focus on counterparty countries outside the euro-area (and thus where euro area investors are foreign), and drop counterparty countries with few observations. This process leaves us with 25 counterparty countries: Argentina, Australia, Brazil, Bulgaria, Canada, China, Croatia, Czech Republic, Denmark, Hungary, India, Indonesia, Japan, Korea, Mexico, Norway, Poland, Romania, Russia, South Africa, Sweden, Switzerland, Turkey, United Kingdom, and the United States. The Euro Area investors in our combined data set come from 18 different countries: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Malta, Netherlands, Portugal, Slovak Republic, Slovenia, and Spain. Given the limited sample, we report results for holdings of all non-EA issuer countries combined.

For the first set of analysis, we combine these data with our primary dataset. We use the SHS data to split foreign bank and foreign non-bank investors into Euro Area and non-Euro area. We get the non-Euro Area foreign split for foreign banks and foreign non-banks by subtracting the amounts in the SHS data (converted to dollars) from the relevant totals in the main dataset. The main dataset is provided at an annual frequency, so we use quarter 4 values from the SHS. Due to the shorter sample period beginning in 2013 and the limited country coverage in the SHS data, along with the annual frequency

[21] This dataset was replaced by an alternative presentation of the data (SHSS), which differs in the available dimensions and detail.

[22] There is also a residual "other" category as well as entries not categorized by sector. Both of these series tend to be small. Central bank holdings are not provided in the dataset.

of the main dataset, we are left with a smaller sample of 124 country-year observations.

A.4 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 provided by the Global Financial Data. Countries with available yields are: Angola, Armenia, Australia, Austria, Bangladesh, Belarus, Belgium, Brazil, Bulgaria, Canada, China, Colombia, Croatia, Denmark, Egypt, Fiji, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Malaysia, Malta, Mauritius, Mexico, Morocco, Netherlands, New Zealand, Norway, Pakistan, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russia, Singapore, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Thailand, Tunisia, Turkey, Uganda, United Kingdom, United States, Venezuela, Vietnam, Zambia.

For relevant short term rates by currency, we 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 rates 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.

For the characteristics data, 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 S&P 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 (2024).

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.[23] The results shown in Tables B1, B2, and B3 report these results and also 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, Table B1 shows that domestic non-banks absorb more emerging market debt during recessions, whereas domestic banks decrease their absorption. In advanced economies, the domestic central bank becomes a key investor during a crisis as seen in Table B2. After the Global Financial Crisis (GFC) in Panel C of Table B3, domestic non-banks increase the share of debt they absorb. A similar pattern holds for foreign official lenders in the case of advanced economies, though the estimate is not statistically significant.[24]

For developing countries, the role of domestic investors expands considerably during recessions. The pattern over time is also interesting. After 2000, domestic investors play a larger role in picking up debt issued by DC sovereigns. The foreign official sector also plays a larger role during 2000-2009 for DC sovereigns.

Comparing the decomposition for periods of banking crisis in Panel A of Table B2 compared to typical periods without banking crisis in Panel B highlights the relative importance of nonbanks during

[23] 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. Splitting the sample reduces the number of observations for each subperiod and therefore necessarily provides less efficient estimates. Nevertheless, it shows, that the importance of Nonbank responses is not isolated to a particular period.

[24] 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 and Hardy and Zhu (2023)).

the crisis. For example, for "All" countries during a banking crisis, the marginal response of Domestic Nonbanks rises from 0.38 during no crisis in Panel B to 0.49 during a crisis in Panel A. At the same time, Foreign Nonbanks become generally less important during Banking crises with the exception of Developing countries for which Foreign Official are also important.

The basic finding that non-bank investors are the most important marginal investors continues to hold across these different periods. This suggests their role as marginal investors is robust, but also that the relative importance of each investor group can vary by circumstance.

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) ForOff
Panel A: Recessions								
All	0.69***	0.31**	0.23**	0.45***	0.01	-0.03	0.32**	0.02
	(0.13)	(0.13)	(0.10)	(0.11)	(0.01)	(0.03)	(0.14)	(0.03)
AE	0.68**	0.32	0.02	0.58**	0.08*	-0.10	0.70***	-0.28
	(0.26)	(0.26)	(0.09)	(0.25)	(0.04)	(0.11)	(0.21)	(0.20)
EM	0.62***	0.38**	0.21*	0.43**	-0.02	-0.00	0.35**	0.03
	(0.14)	(0.14)	(0.10)	(0.16)	(0.02)	(0.03)	(0.16)	(0.05)
DC	0.74***	0.26**	0.08	0.59***	0.08	-0.06	0.17**	0.15***
	(0.12)	(0.12)	(0.15)	(0.16)	(0.08)	(0.08)	(0.07)	(0.05)
Panel B: Non Recessions								
All	0.67***	0.33***	0.20***	0.39***	0.08***	0.06***	0.21***	0.06***
	(0.03)	(0.03)	(0.04)	(0.05)	(0.02)	(0.01)	(0.04)	(0.02)
AE	0.60***	0.40***	0.08	0.39***	0.13	0.05**	0.26***	0.08*
	(0.10)	(0.10)	(0.05)	(0.08)	(0.08)	(0.02)	(0.09)	(0.04)
EM	0.72***	0.28***	0.27***	0.37***	0.08***	0.08***	0.18***	0.01
	(0.04)	(0.04)	(0.05)	(0.08)	(0.03)	(0.02)	(0.04)	(0.01)
DC	0.60***	0.40***	0.09***	0.43***	0.09*	0.03*	0.23***	0.14***
	(0.06)	(0.06)	(0.02)	(0.06)	(0.05)	(0.01)	(0.07)	(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.

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) ForOff
				Panel A: Banking Crisis				
All	0.78***	0.22***	0.21	0.49***	0.08	0.02	0.09	0.10
	(0.07)	(0.07)	(0.15)	(0.16)	(0.07)	(0.02)	(0.07)	(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)	(0.12)	(0.04)	(0.25)	(0.05)
EM	0.78***	0.22**	0.34**	0.44*	0.00	0.00	0.12***	0.10
	(0.08)	(0.08)	(0.14)	(0.22)	(0.01)	(0.01)	(0.02)	(0.07)
DC	0.41**	0.59***	0.06	0.21**	0.14	0.02	0.47**	0.10**
	(0.16)	(0.16)	(0.05)	(0.09)	(0.11)	(0.01)	(0.18)	(0.04)
				Panel B: No Banking Crisis				
All	0.65***	0.35***	0.20***	0.38***	0.07***	0.06***	0.24***	0.05***
	(0.04)	(0.04)	(0.03)	(0.05)	(0.02)	(0.01)	(0.04)	(0.01)
AE	0.48***	0.52***	0.13***	0.34***	0.01	0.07**	0.42***	0.02
	(0.10)	(0.10)	(0.04)	(0.10)	(0.01)	(0.03)	(0.09)	(0.04)
EM	0.69***	0.31***	0.25***	0.37***	0.07**	0.07***	0.23***	0.01
	(0.05)	(0.05)	(0.04)	(0.07)	(0.03)	(0.02)	(0.05)	(0.01)
DC	0.66***	0.34***	0.11***	0.48***	0.06**	0.03	0.17***	0.15***
	(0.06)	(0.06)	(0.04)	(0.07)	(0.02)	(0.02)	(0.04)	(0.03)

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.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

Table B3: Marginal Holders of Sovereign Debt: Different Subperiods

	(1) Dom	(2) For	(3) DomBK	(4) DomNB	(5) DomCB	(6) ForBK	(7) ForNB	(8) ForOff
				Panel A: Before 2000				
All	0.45***	0.55***	0.11**	0.24**	0.10**	0.01	0.48***	0.05
	(0.14)	(0.14)	(0.05)	(0.11)	(0.05)	(0.02)	(0.15)	(0.03)
EM	0.50**	0.50**	0.15	0.26	0.09*	0.04*	0.47**	-0.01
	(0.21)	(0.21)	(0.09)	(0.15)	(0.05)	(0.02)	(0.22)	(0.01)
DC	0.41*	0.59**	0.08	0.22	0.11	-0.01	0.51**	0.09
	(0.21)	(0.21)	(0.05)	(0.17)	(0.08)	(0.03)	(0.21)	(0.06)
				Panel B: 2000-2009				
All	0.69***	0.31***	0.23***	0.36***	0.10***	0.05**	0.20***	0.06**
	(0.05)	(0.05)	(0.06)	(0.08)	(0.04)	(0.02)	(0.04)	(0.03)
AE	0.53***	0.47***	0.05	0.36***	0.12	0.05*	0.39**	0.03*
	(0.14)	(0.14)	(0.06)	(0.10)	(0.09)	(0.03)	(0.14)	(0.02)
EM	0.72***	0.28***	0.30***	0.35***	0.07*	0.05	0.19***	0.04
	(0.07)	(0.07)	(0.07)	(0.11)	(0.04)	(0.03)	(0.06)	(0.03)
DC	0.69***	0.31***	0.16	0.39**	0.14*	0.02*	0.12**	0.17***
	(0.08)	(0.08)	(0.11)	(0.16)	(0.08)	(0.01)	(0.05)	(0.05)
				Panel C: After 2009				
All	0.71***	0.29***	0.17***	0.51***	0.04	0.06***	0.18***	0.05**
	(0.05)	(0.05)	(0.04)	(0.07)	(0.02)	(0.01)	(0.04)	(0.02)
AE	0.57***	0.43***	0.14**	0.39***	0.04	0.06	0.23**	0.14
	(0.11)	(0.11)	(0.06)	(0.10)	(0.03)	(0.04)	(0.10)	(0.09)
EM	0.73***	0.27***	0.23***	0.46***	0.05	0.07***	0.19***	0.01
	(0.05)	(0.05)	(0.04)	(0.09)	(0.03)	(0.01)	(0.05)	(0.01)
DC	0.69***	0.31***	0.04	0.63***	0.02	0.05	0.14***	0.12**
	(0.10)	(0.10)	(0.03)	(0.11)	(0.01)	(0.03)	(0.05)	(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.

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

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

We 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.

Table B4: Marginal Holders of Sovereign Debt Adjusting for Currency Valuation Effects

	(1) Dom	(2) For	(3) DomBK	(4) DomNB	(5) DomCB	(6) ForBK	(7) ForNB	(8) ForOff
All	0.76***	0.24***	0.17***	0.51***	0.08***	0.04***	0.16***	0.05***
	(0.04)	(0.04)	(0.03)	(0.06)	(0.02)	(0.01)	(0.03)	(0.01)
AE	0.64***	0.36***	0.09***	0.46***	0.09	0.06***	0.28**	0.03
	(0.12)	(0.12)	(0.02)	(0.08)	(0.07)	(0.02)	(0.11)	(0.02)
EM	0.78***	0.22***	0.23***	0.47***	0.09***	0.04***	0.15***	0.03
	(0.05)	(0.05)	(0.04)	(0.07)	(0.02)	(0.01)	(0.04)	(0.02)
DC	0.73***	0.27***	0.07***	0.60***	0.06*	0.02*	0.16**	0.08***
	(0.08)	(0.08)	(0.02)	(0.11)	(0.03)	(0.01)	(0.07)	(0.03)

Note: 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.

C Supplemental Results for Demand System Estimation

In this appendix, we provide more detailed results about the demand system approach of estimation in Section 3.2 of the paper.

C.1 Predictive Regression Results

Table C5 reports the return predictive regression results for Equations (8) and (9) in the main text.

Table C5: Bond Return Predictive Regression

	(1) Domestic Excess Return	(2) Foreign Excess Return
$p_t(n)$	-0.57***	-0.77***
	(0.04)	(0.07)
$q_t(n)$		0.26***
		(0.07)
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.

C.2 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 C6 gives the results for Equation (10) for Emerging Market countries.

C.3 Projected Debt-to-GDP Estimates: EMs

Table C7 reports the projections of debt-to-GDP, $d_t(n)$, for EM countries using Equation (11). As described in the text, this variable is projected on exogenous characteristics and its lag modified by the gross GDP growth. A coefficient of 0.68 indicates about a 32% 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 3.125 years, which is close to the 5-year bond yield we choose in the main analysis.

Table C6: Reduced-form Holding Regression: EM

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
GDP	0.83***	1.20***	0.43	0.69***	-0.72**	-0.68***
	(0.10)	(0.17)	(0.34)	(0.18)	(0.31)	(0.17)
GDP Growth	-0.39	-0.68	2.06	-3.75***	3.91**	0.58
	(0.63)	(1.21)	(2.50)	(1.22)	(1.73)	(1.15)
Inflation	-2.15***	-0.47	-1.09	-2.28***	0.39	-1.04**
	(0.24)	(0.42)	(0.80)	(0.47)	(0.63)	(0.44)
Exp-to-GDP	0.02	-0.13	-0.38	-0.21	0.19	0.04
	(0.10)	(0.18)	(0.34)	(0.19)	(0.38)	(0.18)
Rating	0.01	-0.01	0.02	-0.04***	-0.02	0.00
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
Observations	381	351	314	381	334	370
r2	0.98	0.95	0.88	0.90	0.87	0.91

Note: This table reports the reduced-form estimates of Equation (10) for EMs. The sample spans 1990-2018 at annual frequency. The standard errors are reported in the parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C7: Projected Debt-to-GDP Supply: EMs

	Debt-to-GDP
Lag Debt-to-GDP	0.68***
	(0.03)
GDP	-0.03*
	(0.02)
GDP growth	-0.02
	(0.11)
Inflation	0.10**
	(0.04)
Exp-to-GDP	-0.04**
	(0.02)
Rating	0.00**
	(0.00)
Observations	356
r2	0.96

Note: This table reports the estimates of Equation (11) for emerging market economies. The sample spans 1990-2018 at annual frequency. The standard errors are reported in the parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

C.4 Price Elasticity

We next describe the derivation of the investor demand elasticity following the literature of Koijen and Yogo (2019) and Jiang, Richmond, and Zhang (2024).

C.4.1 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 the ratio of shares for a given country n with respect to expected returns given in Equation (7) in the text. This differentiation implies:

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

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

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

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

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

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

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

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

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

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

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

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

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

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:

$$\frac{d \ln H^m_{i,t}(n)}{d\mu_{i,t}(n)} = \frac{d \ln \omega_{i,t}(n)}{d\mu_{i,t}(n)} = \lambda_{0,i}(1 - \omega_{i,t}(n)) \tag{C.8}$$

C.4.2 Domestic Investors

We derive the elasticity of demand with respect to expected excess returns for domestic investors by differentiating Equation (7) in the text. In particular, we differentiate this share as in:

$$\frac{d \ln(H^m_{i,t}(n))}{d\mu_{i,t}(n)} = \frac{d \ln \omega_{i,t}(n)}{d\mu_{i,t}(n)} \tag{C.9}$$

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 (7) with respect to expected excess 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,

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

Comparing this equation with Equation (C.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 those in Koijen and Yogo (2019) and Jiang, Richmond, and Zhang (2024).

Price elasticity. Bond price and expected excess return are linked through the predictive regression of excess returns described in Equation (8) and (9) for domestic and foreign investors, respectively.

Defining the demand elasticity of investor group i with respect to the debt price as η_i, we obtain

$$\eta_i \equiv \frac{d \ln H_{i,t}^m(n)}{d \ln P_t(n)} = \frac{d \ln H_{i,t}^m(n)}{d \mu_{i,t}(n)} \frac{d \mu_{i,t}^n}{d \ln P_t(n)} = \lambda_{0,i}(1 - \omega_{i,t}(n)) \phi_0^i \tag{C.11}$$

The last equality holds based on the assumption that foreign investors in the sovereign debt market consider exchange rates to be exogenous.

Yield elasticity. Since the price of debt is $P_t(n) = \exp(-T y_t(n))$ and $T = 5$ year, we can derive the yield elasticity for investor group i as

$$\frac{d \ln H_{i,t}^m(n)}{d y_t(n)} = -T \eta_i \tag{C.12}$$

D Proofs of Results in Section 4

This Appendix section provides proofs for the Equations (15), to (19) in Section 4.

D.1 Proof of Equation (15)

The increase in the borrowing cost in response to an increase in debt is given by:

$$\frac{\partial y(n)}{\partial \ln D^m(n)} = -\frac{1}{T}\left(\sum_{i=1}^{I}\theta_i(n)\eta_i\right)^{-1}$$

where $\theta_i(n) \equiv \frac{H_i^m(n)}{D^m(n)}$, each investor group's holding share, and as above, $\eta_i \equiv \frac{\partial \ln H_i^m(n)}{\partial \ln P(n)}$ and T is the maturity of the debt.

Proof: The market clearing condition of country n's debt can be written as

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

where $H_i^m(n)$ is the market value of country n's debt held by investor group i.

Taking logs on both sides of Equation (D.1) and differentiating this equation with respect to the log price of debt implies:

$$\frac{\partial \ln P(n)}{\partial \ln D^m(n)} = \left(\sum_{i=1}^{I}\theta_i(n)\frac{\partial \ln H_i^m(n)}{\partial \ln P(n)}\right)^{-1} \tag{D.2}$$

Since $y_t(n) = -\frac{1}{T}\ln P_t(n)$, substituting $d\ln P_t(n) = -Tdy_t(n)$ into Equation (D.2) implies Equation (15).

D.2 Proof of Equation (16)

The increase in borrowing costs in response to an increase in debt is given by:

$$\frac{\partial y(n)}{\partial \ln D^m(n)} = -\frac{1}{T}\frac{\sum_{i=1}^{I}\frac{a_i(n)}{\eta_i - 1}}{1+\sum_{i=1}^{I}\frac{a_i(n)}{\eta_i - 1}}$$

where $a_i(n) \equiv \frac{\partial H_i(n)}{\partial D(n)}$, the marginal holding share of investor i, and as before, $\eta_i \equiv \frac{\partial \ln H_i^m(n)}{\partial \ln P(n)}$ and T is the maturity of the debt.

Proof: The proof is in two steps. In the first step, we derive $\frac{\partial \ln P(n)}{\partial \ln D(n)}$. In the second step, we derive $\frac{\partial \ln P(n)}{\partial \ln D^m(n)}$ and thus $\frac{\partial y(n)}{\partial \ln D^m(n)}$.

Step 1: The market clearing condition for country n's debt is

$$P(n)D(n) = \sum_{i=1}^{I} P(n)H_i(n) \tag{D.3}$$

Denote investor group i's demand function in book value of debt as

$$H_i(n) = f_i(P(n)) \tag{D.4}$$

The market clearing condition (D.3) is then written as

$$P(n)D(n) = \sum_{i=1}^{I} f_i^{-1}(H_i(n))H_i(n) \tag{D.5}$$

Totally differentiating this equation with respect to $D(n)$ implies:

$$\frac{\partial P(n)}{\partial D(n)}D(n) + P(n) = \sum_{i=1}^{n} \frac{\partial (f_i^{-1}(H_i(n))H_i(n))}{\partial D(n)} = \sum_{i=1}^{n} \left[\frac{\partial f_i^{-1}(H_i(n))}{\partial D(n)} H_i(n) + \frac{dH_i(n)}{dD(n)} P(n) \right]$$

$$= \sum_{i=1}^{I} \left[\frac{1}{f_i'(P(n))} \frac{dH_i(n)}{dD(n)} H_i(n) + \frac{dH_i(n)}{dD(n)} P(n) \right] \tag{D.6}$$

Note that $f_i'(P(n)) = \frac{\partial \ln H_i(n)}{\partial \ln P(n)} \frac{H_i(n)}{P(n)}$ and $\frac{\partial \ln H_i(n)}{\partial \ln P(n)} = \frac{\partial \ln H_i^m(n)}{\partial \ln P(n)} - 1$. Rearranging terms and using the definition of $a_i(n)$, we obtain:

$$\frac{\partial \ln P(n)}{\partial \ln D(n)} = \sum_{i=1}^{I} \frac{a_i(n)}{\eta_i - 1} \tag{D.7}$$

Step 2: Now totally differentiating the logarithm of debt and price and using Equation (D.7) implies:

$$\frac{\partial \ln P(n)}{\partial \ln D^m(n)} = \frac{\partial \ln P(n)}{\partial \ln D(n) + \partial \ln P(n)} = \frac{\sum_{i=1}^{I} \frac{a_i(n)}{\eta_i - 1}}{\sum_{i=1}^{I} \frac{a_i(n)}{\eta_i - 1} + 1} \tag{D.8}$$

Therefore,

$$\frac{\partial y(n)}{\partial \ln D^m(n)} = -\frac{1}{T} \frac{\sum_{i=1}^{I} \frac{a_i(n)}{\eta_i - 1}}{\sum_{i=1}^{I} \frac{a_i(n)}{\eta_i - 1} + 1} \tag{D.9}$$

which verifies the result in Equation (16).

D.3 Proof of Equation (18)

For a given market value of country n debt $D^m(n)$, the change in borrowing costs in response to a change in one of the characteristics $x_k(n)$ is:

$$\frac{\partial y(n)}{\partial x_k(n)} = -\frac{1}{T}\frac{\sum_{i=1}^{I}\psi_{i,k}(n)\theta_i(n)}{1-\sum_{i=1}^{I}\theta_i(n)\eta_i}$$

Proof: The market clearing condition is

$$\sum_{i=1}^{I} H_i^m(n) = P(n)\times D(n)$$

Therefore, differentiating this equation implies:

$$\sum_{i=1}^{I}\frac{\partial H_i^m(n)}{\partial P(n)}\frac{\partial P(n)}{\partial x_k(n)} + \frac{\partial H_i^m(n)}{\partial x_k(n)} = D(n)\times\frac{\partial P(n)}{\partial x_k(n)}$$

Rewriting this relationship using the definition of elasticities and dropping the country n reference for simplicity yields:

$$\sum_{i=1}^{I}\frac{\partial \ln H_i^m}{\partial \ln P}\frac{H_i^m}{P}\frac{\partial \ln P}{\partial x_k}P + \frac{\partial \ln H_i^m}{\partial x_k}H_i^m = D\times\frac{\partial \ln P}{\partial x_k}P$$

Rearranging terms implies:

$$\frac{\partial \ln P}{\partial x_k} = -\frac{\sum_{i=1}^{I}\partial \ln H_i^m/\partial x_k \times H_i^m}{-D\times P + \sum_{i=1}^{I}\partial \ln H_i^m/\partial \ln P \times H_i^m} = \frac{\sum_{i=1}^{I}\psi_{i,k}\theta_i}{1-\sum_{i=1}^{I}\theta_i\eta_i}, \tag{D.10}$$

and therefore,

$$\frac{\partial y}{\partial x_k} = -\frac{1}{T}\frac{\sum_{i=1}^{I}\psi_{i,k}\theta_i}{1-\sum_{i=1}^{I}\theta_i\eta_i} \tag{D.11}$$

verifing Equation (18).

D.4 Proof of Equation (19)

For a given market value of debt $D^m(n)$, the change of borrowing cost in response to a change in investor group j's latent demand is

$$\frac{\partial y(n)}{\partial \varepsilon_j(n)} = -\frac{1}{T}\frac{\theta_j(n)}{1-\sum_{i=1}^{I}\theta_i(n)\eta_i}$$

Proof: We start from the market clearing condition

$$\sum_{i=1}^{I} H_i^m(n) = P(n) \times D(n)$$

Totally differentiating this equation with respect to latent demand yields,

$$\sum_{i=1}^{I} \frac{\partial H_i^m(n)}{\partial P(n)} \frac{\partial P(n)}{\partial \varepsilon_j(n)} + \frac{\partial H_j^m(n)}{\partial \varepsilon_j(n)} = D \frac{\partial P(n)}{\partial \varepsilon_j(n)} \tag{D.12}$$

Rearranging terms obtains:

$$\frac{\partial \ln P(n)}{\partial \varepsilon_j(n)} = \frac{\theta_j(n)}{1 - \sum_{i=1}^{I} \theta_i(n) \eta_i}$$

Therefore,

$$\frac{\partial y(n)}{\partial \varepsilon_j(n)} = -\frac{1}{T} \frac{\theta_j(n)}{1 - \sum_{i=1}^{I} \theta_i(n) \eta_i}$$

which verifies in Equation (19).

E Alternative Exchange Rate Assumptions and Expected Excess Return Sensitivities

E.1 Cost of Financing Sensitivities under Alternative Exchange Rate Assumptions

Given the limitation of our data, we cannot separately identify the equilibrium price of debt jointly with the exchange rate as in Koijen and Yogo (2024). Therefore, in the baseline analysis, we assume that the real exchange rates are uncorrelated with the prices of debt. This appendix derives the implied counterfactual analysis based on alternative exchange rate assumptions that allow for interdependent real exchange rates and debt prices. In particular, we assume that the real exchange rate is related to the price of debt through

$$s_t(n) - z_t(n) = \zeta_0 + \zeta_1 p_t(n) + \zeta(n) + v_t(n)$$

Using our sample estimate, we find that $\hat{\zeta}_1 = -0.11$. This weak relationship from our data is also common to a large body of research that finds exchange rates are only weakly correlated with many asset prices and macro fundamentals. We use this parameter to reconsider our counterfactuals below.

If the real exchange rate is related to the price of debt, we need to revise the algebra in Section C.4 for foreign investors as follows:

$$\eta_i \equiv \frac{d \ln H^m_{i,t}(n)}{d \ln P_t(n)} = \frac{d \ln H^m_{i,t}(n)}{d\mu_{i,t}(n)} \frac{d\mu^n_{i,t}}{d \ln P_t(n)} = \lambda_{0,i}(1 - \omega_{i,t}(n))(\phi_f + \zeta_1 \phi_r) \tag{E.1}$$

The price sensitivity for domestic investors does not change.

Table E8 repeats the analysis in Table 5 by using the demand elasticities η as illustrated in in Equation (E.1). The differences between the debt sensitivities in Panel A compared to those in the text Table 5 are very small. That is, when there are No Non-banks, the percentage increase in yield increases to 7.8% and 8.3% depending upon whether the Average Shares or Marginal Shares are used, respectively. Similarly, Panels B and C show that the counterfactuals for characteristics changes and latent demand are relatively unchanged using this assumption.Thus the general relationships described in the text remain. Intuitively, since the price of debt and exchange rates have a very low correlation, the implications are similar to assuming the correlation is zero.

Table E8: Borrowing Cost Sensitivity and Counterfactuals under Alternative FX

Panel A: Borrowing Cost Sensitivity to Debt Increase				
	Using Average Shares		Using Marginal Shares	
	Sensitivity	% Yield change	Sensitivity	% Yield change
Actual	0.43	4.8%	0.51	5.8%
No Bank	0.33	3.7%	0.41	4.6%
No Non-bank	0.68	7.8%	0.73	8.3%
Panel B: Borrowing Cost Sensitivity to Characteristics				
	Real GDP growth Decline		Inflation Increase	
	Sensitivity	% Yield change	Sensitivity	% Yield change
Actual	0.24	2.75%	0.15	1.67%
No Bank	0.27	3.12%	0.12	1.41%
No Non-bank	0.17	1.90%	0.20	2.22%
Panel C: Borrowing Cost Sensitivity to Latent Demand				
	DomBK	DomNB	ForBK	ForNB
Sensitivity	-1.28	-1.23	-0.27	-0.73
Panel D: Price Elasticities under Alternative Exchange Rate Assumptions				
	DomBK	DomNB	ForBK	ForNB
Price Elasticity η_i	-2.41	-3.72	-5.35	-10.10

Note: This table allows for interdependence between the real exchange rate and the price of EM debt to compute demand elasticity η. Panel A reports the cost of financing sensitivity to debt increase in Equation (15) and (16) based upon, alternatively, average portfolio shares and marginal responses. Rows are based upon the "Actual" for all investors, for "No Bank" and "No Non-bank" in turn assuming shares are redistributed to other investors. Panel B gives borrowing cost sensitivity due to the characteristics as in Equation (18). Panel C provides the effects of latent demand by investor group given in Equation (19). Panel D provides price elasticities under the alternative exchange rate assumption. All percentage change calculations are based upon average EM five-year yield in our sample of 8.8%.

E.2 Expected Excess Return Sensitivity

In this appendix subsection, we study the sensitivity of expected excess returns $\mu_d(n)$ and $\mu_f(n)$ to debt increase, characteristics change and latent demand. This analysis does not directly relate to the financing costs of the sovereign as it relates to the perceived returns by investors. Nevertheless, we ask how

much the expected excess returns faced by domestic and foreign investors will change in response to one percent of increase in market value of debt, characteristics and latent demand of different investors.

The expected excess returns $\mu_d(n)$ and $\mu_f(n)$ are linked to the price of debt through the predictive regressions (8) and (9). Assuming exchange rates are exogenous, the expected excess return sensitivity for domestic and foreign investors are

$$\frac{d\mu_d}{dz} = \frac{d\mu_d}{d\ln P}\frac{d\ln P}{dz} = \phi_d \frac{d\ln P}{dz} = -T\phi_d \frac{dy}{dz} \tag{E.2}$$

$$\frac{d\mu_f}{dz} = \frac{d\mu_f}{d\ln P}\frac{d\ln P}{d\ln z} = \phi_f \frac{d\ln P}{dz} = -T\phi_f \frac{dy}{dz} \tag{E.3}$$

where z can be $\ln D^m$, x or ε_j. For expositional brevity, we drop the country indicator n in the equation.

The expected excess return changes with the implied change of the price of debt. If the price of debt increases by 1 percent, the expected excess return for foreign and domestic investors changes by ϕ_f and ϕ_d percent, respectively, where ϕ_f and ϕ_d are the predictive regression coefficients in Equation (8) and (9)

Table E9 presents the results for expected excess return sensitivities under the assumption that exchange rates are exogenous. The first two columns of Panel A use debt average holding shares and the last two columns use the marginal shares. Domestic and foreign expected excess return sensitivities are reported separately because ϕ_d and ϕ_f are different. These results show that the expected excess return for both domestic and foreign investors will increase more without non-bank investors, regardless of whether average shares or marginal shares are used.

In Panel B, the first two columns report the sensitivities of domestic and foreign expected excess returns to 1 percent decrease in real GDP growth, while the last two columns report these sensitivities to a 1 percent increase in inflation. Similar to the result in Table 5 in the main analysis, expected excess return will increase more with a real GDP growth decrease if banks are absent. When inflation rises, both domestic and foreign expected excess returns will increase more without non-banks.

Panel C of the table reports the sensitivities of domestic and foreign investors' expected excess returns with respect to the latent demand shocks of each investor group as in Table 5 and find similar results. A demand increase for domestic investors leads to a larger reduction in expected excess returns than the same demand shock to foreign investors.

Alternatively, Table E10 presents the results for expected excess return sensitivities allowing for interdependence of exchange rate and the price of debt. In this case, the expected excess return sensitivity

for domestic investors is still calculated as Equation (E.2) implies. The expected excess return sensitivity for foreign investor, however, is calculated as

$$\frac{d\mu_f}{d\ln D^m} = \frac{d\mu_f}{d\ln P}\frac{d\ln P}{d\ln z} = (\phi_f + \phi_r\zeta_1)\frac{d\ln P}{dz} = -T(\phi_f + \phi_r\zeta_1)\frac{dy}{dz} \tag{E.4}$$

Again, we find the results are very close to Table E9 due to the weak correlation between real exchange rate and the price of debt.

Table E9: Expected Excess Return Sensitivity and Counterfactuals

Panel A: Expected Excess Return Sensitivity to Debt Increase				
	Using Average Shares		Using Marginal Shares	
	Domestic	Foreign	Domestic	Foreign
Actual	1.24	1.67	1.46	1.98
No Bank	0.96	1.29	1.16	1.57
No Non-bank	1.97	2.66	2.10	2.83
Panel B: Expected Excess Return Sensitivity to Characteristics				
	Real GDP growth		Inflation	
	Domestic	Foreign	Domestic	Foreign
Actual	0.70	0.95	0.42	0.57
No Bank	0.80	1.08	0.36	0.49
No Non-bank	0.48	0.65	0.57	0.77
Panel C: Expected Excess Return Sensitivity to Latent Demand				
	DomBK	DomNB	ForBK	ForNB
Domestic	-3.70	-4.22	-0.79	-2.23
Foreign	-4.99	-5.71	-1.07	-3.07
Panel D: Price Elasticities				
	DomBK	DomNB	ForBK	ForNB
Price Elasticity η_i	-2.41	-3.72	-5.16	-9.74

Notes: This table reports the expected excess return sensitivity and counterfactuals under the assumption that exchange rates are exogenous. These numbers are computed according to equations (E.2) and (E.4). Panel A through C reports counterfactual results for increase in debt, change in characteristics and change in latent demand. Panel D reports the price elasticities used in the calculation.

Table E10: Expected Excess Return Sensitivity and Counterfactuals under Alternative FX

Panel A: Expected Excess Return Sensitivity to Debt Increase				
	Using Average Shares		Using Marginal Shares	
	Domestic	Foreign	Domestic	Foreign
Actual	1.21	1.64	1.46	2.04
No Bank	0.93	1.26	1.15	1.62
No Non-bank	1.95	2.73	2.09	2.92
Panel B: Expected Excess Return Sensitivity to Characteristics				
	Real GDP growth		Inflation	
	Domestic	Foreign	Domestic	Foreign
Actual	0.69	0.97	0.42	0.59
No Bank	0.78	1.10%	0.35	0.50
No Non-bank	0.48	0.67	0.56	0.79
Panel C: Expected Excess Return Sensitivity to Latent Demand				
	DomBK	DomNB	ForBK	ForNB
Domestic	-3.64	-3.51	-0.78	-2.08
Foreign	-5.10	-5.71	-1.09	-2.91
Panel D: Price Elasticities under Alternative FX				
	DomBK	DomNB	ForBK	ForNB
Price Elasticity η_i	-2.41	-3.72	-5.35	-10.10

Notes: This table reports the expected excess return sensitivity and counterfactuals allowing for interdependence between the real exchange rate and the price of EM debt. These numbers are computed according to equations (E.2) and (E.4) under the assumption that exchange rates are exogenous. Panel A through C reports counterfactual results for increase in debt, change in characteristics and change in latent demand. Panel D reports the price elasticities used in the calculation.

F Additional Results for Advanced Economy Debt Estimation

F.1 IV Construction: AE

This section reports the estimates used to construct the Advanced Economy instruments for Table 6. The following Table F11 gives the first stage estimates for Advanced Economies.

Table F11: Reduced-form holding regressions: AEs

	(1) DomBK	(2) DomNB	(3) DomCB	(4) ForBK	(5) ForNB	(6) ForCB
GDP	0.22	0.66***	0.66	2.21***	1.51***	1.70***
	(0.21)	(0.25)	(0.68)	(0.24)	(0.37)	(0.26)
GDP growth	-0.38	-6.30***	0.34	-3.02**	-2.42	-0.09
	(1.15)	(1.33)	(3.55)	(1.28)	(1.89)	(1.35)
Inflation	-1.75	-0.04	11.76**	11.00***	-2.17	4.15
	(1.85)	(2.14)	(5.83)	(2.07)	(3.07)	(2.70)
Exp-to-GDP	0.18	0.08	5.60***	1.35***	1.02**	0.15
	(0.27)	(0.32)	(0.86)	(0.30)	(0.49)	(0.37)
Rating	-0.03**	-0.01	-0.06	-0.04***	-0.12	0.07***
	(0.01)	(0.02)	(0.04)	(0.02)	(0.10)	(0.01)
Observations	335	316	307	336	322	307
R2	0.97	0.96	0.87	0.97	0.93	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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

F.2 Projected Debt-to-GDP Estimates: AEs

Table F12 reports the projections of debt-to-GDP, $d_t(n)$ for AE countries. As described in the text, this variable is projected on exogenous characteristics and its lag modified by the gross GDP growth.

Table F12: Projected Debt-to-GDP Supply: AEs

Lag Debt-to-GDP	0.78***
	(0.03)
GDP Growth	-0.44**
	(0.18)
Inflation	0.23
	(0.28)
Exp-to-GDP	0.00
	(0.04)
Rating	-0.01**
	(0.00)
Observations	319
R2	0.98

Note: This table reports the estimates of Equation (11) for Advanced Economies. The sample spans 1996-2018 at the annual frequency. The standard errors are reported in the parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.