# Inelastic Markets: The Demand and Supply of Risky Sovereign Bonds*

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**Abstract**

We present new evidence of downward-sloping demand curves for risky sovereign bonds and analyze their macroeconomic implications. Our methodology exploits index rebalancings to identify shocks that shift the bond supply. We find that bond prices significantly respond to these shocks, which are orthogonal to country fundamentals. Because the shocks might influence the government's *future* debt and default policies, part of the price responses could capture changes in default risk, not the demand elasticity. To account for this, we combine the estimated price reactions with a structural sovereign debt model that allows us to isolate default risk. We find that two-thirds of the price reactions can be attributed to the demand elasticity; the rest to default risk. We show that the downward-sloping demand acts as a commitment device that limits debt issuances and reduces default risk. Our findings have implications for a growing literature that estimates demand elasticities for risky assets.

**Keywords:** inelastic financial markets, international capital markets, small open economies, risky sovereign debt

**JEL Codes:** F34, F41, G11, G15

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# 1 Introduction

Governments in emerging economies heavily depend on bonds issued in liquid international capital markets for their overall financing. The behavior of investors in these markets is thus crucial to understanding those governments' borrowing costs, their default risk, and their optimal debt management. Standard sovereign debt models generally assume that investors' demand is perfectly elastic. This implies that investors are willing to lend any amount governments request at the risk-free rate plus a default risk premium. This assumption on investor behavior contrasts with a body of recent work that allows for a richer investor demand structure, typically involving an inelastic or downward-sloping demand in different asset markets (Koijen and Yogo, 2019; Gabaix and Koijen, 2021; Vayanos and Vila, 2021; Gourinchas et al., 2022; Greenwood et al., 2023).

In this paper, we present novel evidence of downward-sloping demand curves in risky sovereign bond markets and analyze their macroeconomic implications. In the context of risky bonds, estimating a price demand elasticity is challenging because the demand itself is intrinsically tied to a bond's default risk, which is endogenous and depends on a government's current and future debt policies. To properly identify the demand elasticity, we combine high-frequency bond price movements in response to exogenous shifts in the bond supply with a structural sovereign debt model.

First, we identify shocks that shift a country's supply of sovereign bonds by exploiting changes in the composition of the largest bond index for emerging economies bonds. We find that bond prices significantly react to these shocks, even though they are orthogonal to a country's fundamentals. The shocks, however, might still influence the government's *future* debt issuances and its likelihood to default. Thus, part of the price reaction could be capturing changes in default risk and not necessarily a downward-sloping demand.

Second, we develop a structural sovereign debt model that allows us to characterize the optimal bond supply and default policy as a function of observables. We use the model to decompose the mechanisms underpinning our empirical estimates and to back out a demand elasticity that isolates the effect of default risk. We find that two-thirds of the observed price reactions can be attributed to the inelastic demand and the rest to endogenous changes in default risk. We then use our model to analyze the aggregate implications of an inelastic bond demand. We show that downward-sloping demand curves act as a commitment device that limits a government's debt issuances and reduces its default risk.

On the empirical front, we start with a simple framework to guide our identification strategy. Our setup features heterogeneous investors (active and passive) that differ on how they allocate their funds across risky assets. Active investors adjust their portfolio holdings based on some given mandate that depends on the assets' expected excess returns (as in Gabaix and Koijen, 2021). Passive investors, on the other hand, simply track the composition of the index that they follow (they are perfectly inelastic). Following the literature (Pandolfi and Williams, 2019; Pavlova and Sikorskaya, 2022), one can interpret an exogenous shift in the demand of passive investors as a shift in the "effective" supply (i.e., assets available for active investors). The literature typically estimates if prices react around those shifts and map observed price changes into a demand elasticity. In this paper, we go one step further by decomposing the channels behind those price reactions. We show that, even in response to an exogenous shock, part of the price movements can be driven by changes in the asset's expected repayment (default risk in the case of bonds) and not necessarily reflect a downward-sloping demand (holding expected repayment constant).

We identify exogenous shifts in a country's effective supply of sovereign bonds by using monthly rebalancings in the J.P. Morgan Emerging Markets Bond Index Global Diversified (EMBI). The EMBI is the most widely tracked index by institutional investors that invest in dollar-denominated sovereign bonds issued by emerging countries. Changes in the composition of this index affects the effective supply because it leads to similar rebalancings in the portfolios of passive investors that tend not to deviate from the index, given the potential tracking error costs. Due to the EMBI's popularity, these rebalancings can have market-wide effects.

We derive a measure of flows implied by index rebalancings (FIR) by combining the assets passively tracking the EMBI with the monthly rebalancings. To avoid endogeneity issues, we develop an instrumental-variable strategy that exploits changes in the FIR that are generated by the behavior of *other* countries in the index, so that they are orthogonal to a country's own fundamentals. In addition, we focus on changes in the face value of the FIR (as opposed to market value) to exclude changes in index composition that may be triggered by (endogenous) changes in bond prices.

Our analysis reveals that a higher FIR leads to an increase in bond prices. On average, a 1 percentage point (p.p.) increase in the FIR corresponds to a 67 basis point increase in bond prices. Our estimates vary across countries with different levels of default risk. Specifically, for countries with higher default risk, a 1 p.p. FIR inflow results in a 100 basis point increase in bond prices, whereas for safer countries, the effect is close to zero and statistically non-significant.

On the quantitative front, we adopt a canonical sovereign debt model where the government has limited commitment and can endogenously default on its debt obligations. Traditional models of this nature typically assume a perfectly elastic demand for sovereign bonds, with changes in bond prices driven solely by variations in default risk (Arellano, 2008; Chatterjee and Eyigungor, 2012). We extend these models using a richer demand structure that incorporates active and passive investors, and a downward-sloping demand curve for active investors. In our model, an exogenous increase in the demand of passive investors influences the bond price through two interconnected mechanisms. First, since the demand of active investors is downward sloping, the implied reduction in the effective supply leads to a higher bond price. Second, the higher bond price lowers the cost of financing, reducing a government's incentives to default. This, in turn, increases the bond' expected repayment, and further raises the price that investors are willing to pay for the bond.

We discipline the model using our empirical estimates. In particular, we calibrate the model to match the bond price response to an exogenous change in the demand of passive funds (i.e., the FIR). We then use the calibrated model to derive the demand elasticity, isolating changes in default risk. To this end, we create a counterfactual scenario in which we maintain the default risk at a constant level and examine how an exogenous shift in the effective supply influences the price that active investors are willing to pay. Our findings reveal that endogenous changes in default risk can explain nearly a third of the overall price effect. Thus, failing to account for movements in default risk significantly biases upward the estimated demand elasticity.

Lastly, our model allows us to examine the impact of a downward-sloping demand on a government's optimal debt and default policies. In the presence of an inelastic demand, we observe *lower* default risk and *higher* bond prices compared to a scenario with a perfectly elastic demand (for similar debt levels). This result is not explained by a convenience yield but is instead rooted in the inelastic demand serving as a commitment device for the government. The mechanism is as follows. With a downward-sloping demand, an additional unit of debt decreases bond prices, even for a fixed level of default risk. As a result, the government does not find it optimal to issue large amounts of debt because it is too costly to do so. An inelastic demand, thus, introduces a limit to the maximum amount of debt that a government is willing to issue. Quantitatively, we find that this limit leads to a reduction in a government's default probability and an increase in its bond prices.

**Related Literature**. Our findings contribute to different strands of literature. First, our results relate to a long-standing literature that uses index rebalancings to estimate asset price reactions, demand elasticities, and changes in investors' portfolios across different asset classes

(Harris and Gurel, 1986; Shleifer, 1986; Greenwood, 2005; Hau et al., 2010; Chang et al., 2014; Raddatz et al., 2017; Pandolfi and Williams, 2019; Pavlova and Sikorskaya, 2022).[1] We contribute to this literature by showing that demand curves slope downward in one of the most important funding markets for governments in emerging economies, the international dollar-bond market. More broadly, we show that for risky bonds part of the price reaction to an index rebalancing is attributable to changes in default risk rather than the inelastic component of demand. Our analysis is not specific to sovereign bonds and, in fact, applies to any asset whose future cash flows or payoffs are affected by movements in the effective supply. As such, it can be extended to a wide literature in different asset markets (sovereign and corporate bonds and equities) that uses exogenous shifts in the effective supply as an instrument to estimate demand elasticities.

Second, there is a growing literature on inelastic financial markets that emphasizes the role of demand in explaining asset prices across various financial markets. Most of this literature focuses on safe assets (or equities) and they take as given the assets' expected payoffs. Koijen and Yogo (2019) formulate a demand-based asset-pricing model with flexible heterogeneity in asset demand across investors.[2] Gabaix and Koijen (2021) use their granular instrumental variable approach to estimate a macro-level demand elasticity for the US equity market. Vayanos and Vila (2021) explore the role of investor demand in explaining the term structure of interest rates. Krishnamurthy and Vissing-Jorgensen (2012), Greenwood et al. (2015), Mian et al. (2022), Jiang et al. (2021), and Choi, Kirpalani, and Perez (2022) analyze how an inelastic demand affect the pricing, term-structure, and issuances of riskless US Treasuries.[3] Koijen and Yogo (2020), Gourinchas et al. (2022), and Greenwood et al. (2023) investigate the impact of inelastic investors on the pricing of international financial assets. Among these studies, the one most closely related to ours is Choi, Kirpalani, and Perez (2022), which analyzes the implications of a downward-sloping demand on the optimal issuance of safe government bonds. In contrast, our focus is on the interplay between a downward-sloping demand curve, default risk, and the provision of risky bonds. We show that demand elasticity interacts with default risk and influences a government's supply of risky bonds. Failing to account for this endogenous link, can lead to biases when estimating elasticities.

[1] Beyond index rebalancings, Droste, Gorodnichenko, and Ray (2023) use high-frequency US Treasury auctions to estimate the effect of demand shocks on Treasury yields.

[2] In recent work, Bretscher, Schmid, Sen, and Sharma (2022) use this setup to estimate demand elasticities in the (risky) US corporate bond market. They find that these elasticities vary across institution types and bond characteristics (maturity, liquidity, credit rating).

[3] Dathan and Davydenko (2020), Kubitza (2022), and Calomiris et al. (2022) analyze empirically how institutional investors and their institutional constraints affect issuance decisions in corporate bond markets.

Third, our paper also connects to a recent body of work that examines how changes in the investor base of government debt impact bond yields.[4] A closely related paper is Fang, Hardy, and Lewis (2022), which develops a demand system to quantify how changes in the composition of investors (domestic versus foreign, banks versus non-banks) affect government bond yields. In this paper, we exploit exogenous changes in the composition of the investor base (passive versus active funds) to provide evidence of downward-sloping demand curves for risky sovereign bonds.

Lastly, our paper is related to a large literature on quantitative sovereign debt models. Our framework extends standard models (Aguiar and Gopinath, 2006; Arellano, 2008; Chatterjee and Eyigungor, 2012) in two ways: we incorporate different investor types (active and passive investors) and introduce a downward-sloping demand. This richer structure, allows us to discipline the model using our micro-level estimates.[5] We then use the model to isolate the role of default risk behind those estimates and to back out a demand elasticity. In our analysis, we are agnostic on the mechanisms behind a downward sloping demand. Previous work by Borri and Verdelhan (2010), Lizarazo (2013), Pouzo and Presno (2016), and Arellano, Bai, and Lizarazo (2017) analyze sovereign debt models with risk averse investors. In those models, investors' downward-sloping demand is a by-product of their own risk aversion. In other words, investors are inelastic only because they require to be compensated for each additional unit of risky debt that they hold. A downward-sloping demand may be driven by several other mechanisms. For instance, it may be explained by regulatory limitations, such as a Value-at-Risk constraint (as in Miranda-Agrippino and Rey, 2020), by investors' buy-and-hold strategies (which may be rationalized by a taste for simplicity or agency frictions), or by fixed-share mandates that specify how investors should allocate their funds across assets (as in Gabaix and Koijen, 2021). Our setup, relies on a flexible demand structure that can accommodate any of these potential drivers. Our focus is not to provide evidence on the roots of investors' inelastic behaviour, but rather to focus more broadly on its aggregate implications.

The paper is structured as follows. In Section 2, we introduce a simple framework to guide our analysis. Section 3 presents the empirical analysis, including details on the institutional setup of EMBI indexes, data sources, identification strategy, and results. Section 4 formulates

[4]See, for example, Arslanalp and Poghosyan (2016), Peiris (2013), and Dell'Erba et al. (2013). Warnock and Warnock (2009) and Ahmed and Rebucci (2022) present evidence for the US.

[5]In this regard, our paper connects with recent work by Costain et al. (2022), who introduce endogenous default risk into a Vayanos-Vila preferred habitat model to analyze the term structure of interest rates in the European Monetary Union.

a sovereign debt model with endogenous default and inelastic investors. Section 5 presents the quantitative analysis. Section 6 concludes.

# 2 The Demand Elasticity for Risky Bonds

We start by introducing a simple framework to guide our empirical analysis. Our setup features heterogeneous investors that differ on how they allocate their funds across risky assets. We use this highly stylized framework to illustrate how, under some assumptions, one can use exogenous shifts in the demand of certain investors to estimate a price demand elasticity. In doing that, we describe how such estimate might be affected by changes in the assets' expected repayment (default risk in the case of bonds).

## 2.1 The Model

Investors are heterogeneous and allocate their funds differently across a fixed set of risky assets. We assume that some of these investors are passive and they track an index $\mathcal{I}$. International markets are competitive and investors take prices as given. Let $j = \{1, ..., J\}$ denote the investor type. Let $i = \{1, ..., N\}$ denote the set of assets that are part of that index and let $\boldsymbol{w}_t = \left\{w_t^1, ..., w_t^N\right\}$ be the vector of index weights for each constituent asset. While our framework can be applied to any risky asset (equities for instance), we will focus on the case of risky bonds.

We define $x_{jt}^i = \frac{q_t^i B_{jt}^i}{W_{jt}}$ as the amount of wealth that investor $j$ invests in bond $i$ at time $t$. The term $q_t^i$ denotes the unit price of bond $i$, $B_{j,t}^i$ are the end-of-period holdings of investor $j$ and $W_{j,t}$ denotes its wealth. As in Gabaix and Koijen (2021), we assume that each investor $j$ has a mandate that specifies how it should allocate its funds across the $N$ bonds. In particular, we assume that $x_{jt}^i$ is given by

$$x_{jt}^i = \theta_j \left(\xi_j^i e^{\Lambda_j \hat{\pi}_{i,t}(.)}\right) + (1 - \theta_j)\, w_t^i, \tag{1}$$

where $\theta_j$ parameterizes the degree of activeness and passiveness. A (purely) passive fund can be characterized with $\theta_j = 0$ and, therefore, its portfolio simply replicates the weights of the index. An active investor (i.e., those with $\theta_j \in (0, 1]$), invest a given share $\xi_j^i$ of its wealth on bond $i$. The investor is allowed to modify the composition of such allocation, depending on the $\hat{\pi}_{i,t}(r_{t+1}^i)$ function, where $r_{t+1}^i$ denotes the next-period excess return of bond $i$. As we show next, this specification allows us to introduce (an aggregate) demand elasticity that can be parameterized by $\boldsymbol{\Lambda} \equiv \{\Lambda_1, .., \Lambda_J\}$. One can micro-found this specification along different lines (see Appendix A for some examples) but for all the purposes of this analysis we take it as given. Our goal is not to provide an explanation to why the demand for risky bonds may be inelastic, but rather to focus on its implications.[6]

After adding up all the individual demands, we can write the market clearing condition as follows:

$$q_t^i B_t^i = \tilde{\mathcal{A}}_t^i + \tilde{\mathcal{T}}_t^i(w_t^i), \tag{2}$$

where $B_t^i$ is the bond supply, $\tilde{\mathcal{A}}_t^i \equiv \sum_j W_{j,t}\theta_j \left(\xi_j^i e^{\Lambda_j \hat{\pi}_{i,t}}\right)$ denotes the purchases of active investors and $\tilde{\mathcal{T}}_t^i(w_t^i) \equiv \sum_j W_{j,t}\,(1-\theta_j)\,w_t^i$ are purchases of passive investors. We explicitly write $\tilde{\mathcal{T}}_t^i(w_t^i)$ as a function of $w_t^i$ to emphasize its dependence on the index weight.

Since passive investors are simply replicating the weights of an index, they exhibit a perfectly inelastic demand. For any bond $i$ that is in fixed supply, an increase in $w_t^i$ implies a reduction in the supply of bonds available to active investors (a leftward shift in the "effective" or "residual" supply). If the increase in $\tilde{\mathcal{T}}_t^i$ is exogenous (i.e., orthogonal to a country's fundamentals), one can use that variation to analyze whether demand curves for active investors slope downward.[7]

Figure 1 illustrates this point. If the demand of active investors is fully elastic, then the change in $\tilde{\mathcal{T}}_t^i$ should have no effect on prices (Panel a). If the active demand is downward sloping, bond prices should react (as shown in Panel b). Let $\eta^i \equiv \frac{\partial \log q_t^i}{\partial \log \tilde{\mathcal{A}}_t^i}$ denote the inverse demand elasticity of bond $i$. Given an exogenous $\Delta\tilde{\mathcal{T}}_t^i$, we can estimate this elasticity as follows:

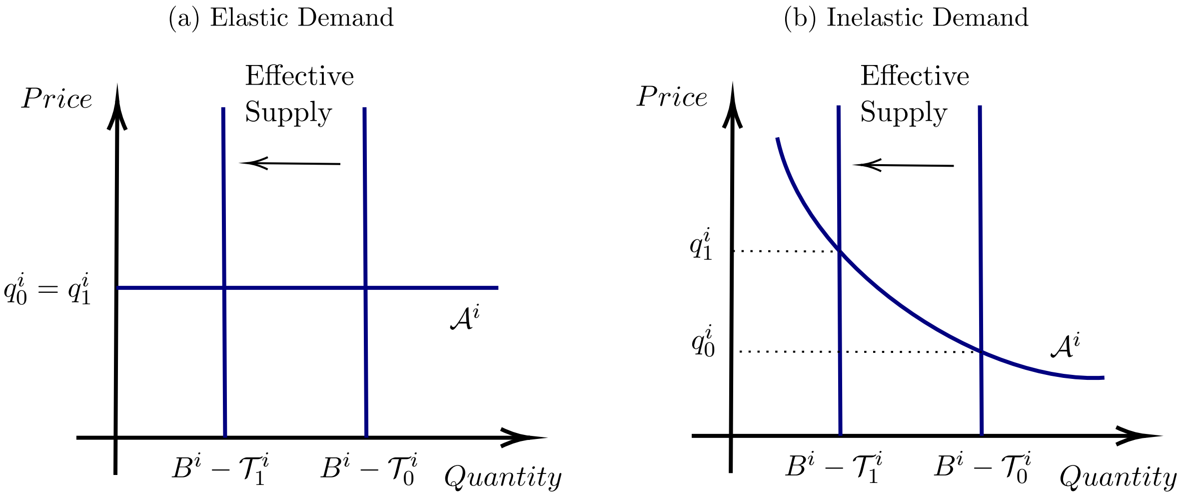
$$\eta^i \approx (-)\frac{\Delta q_t^i}{\Delta \tilde{\mathcal{T}}_t^i} \times \frac{q_{t-1}^i B^i - \tilde{\mathcal{T}}_{t-1}^i}{q_{t-1}^i}. \tag{3}$$

Underlying Equation (3) is the assumption that the intrinsic value of the bond is unaffected by changes in $\tilde{\mathcal{T}}_t^i$. This view has been the standard practice in the literature since Shleifer (1986), who uses index additions to the S&P 500 as an exogenous instrument for $\Delta\tilde{\mathcal{T}}_t^i$ to analyze whether demand curves for equities slope downward. In recent work, Pavlova and Sikorskaya (2022) use a similar strategy and a regression discontinuity design (RDD) on Russell indexes to estimate the price demand elasticity of active investors.

[6] As argued by Gabaix and Koijen (2021): "While identifying the exact reasons for low market elasticity is interesting, this question has a large number of plausible answers. Fortunately, it is possible to write a framework in a way that is relatively independent to the exact source of low elasticity [...]."

[7] We focus on active and passive investors to better link the model with our empirical analysis. We could also capture this mechanism using a preferred-habitat specification, in which some investors have a more inelastic demand for certain assets.

Figure 1
Index Rebalancing and the Demand Elasticity




Note: The figure depicts a reduction in the effective supply that is driven by an increase in $\mathcal{T}^i$. Panel (a) considers the case when the residual demand is fully elastic and panel (b) when it is price sensitive.

## 2.2 The Role of Default Risk

Even though the bond supply is fixed, exogenous shifts in the effective supply might still impact the intrinsic value of the bond (for instance, through changes in default risk). If the demand is downward sloping, an exogenous movement in the effective supply affects bond prices (as illustrated in Figure 1). Such price effect, can then impact the issuers' incentives to issue bonds in the future or its likelihood to default. Hence, the expected repayment or payoff from holding the bond may be affected, and investors should price such effect today.

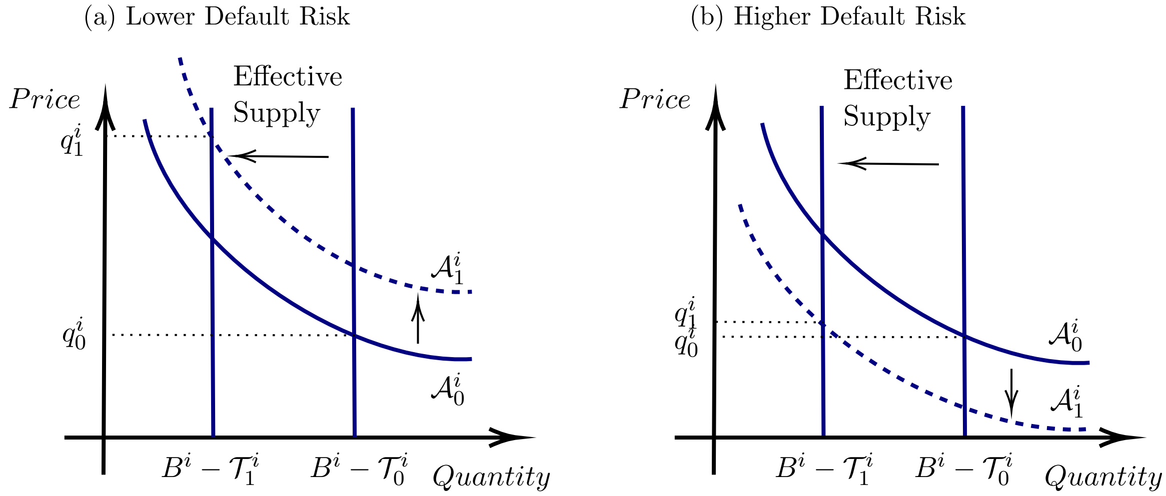
To see this more clearly, let us put more structure behind the investors' demand in order to derive a closed-form solution for the bond price. We assume that $\hat{\pi}_{i,t}(r^i_{t+1}) = \frac{\mathbb{E}_t(r^i_{t+1})}{\mathbb{V}_t(r^i_{t+1})}$, so that the (active) demand is a function of the bond's expected excess return and its variance (Sharpe ratio).[8] We define $\mathcal{R}^i_{t+1}$ as the next-period repayment per unit of the bond, which is a function of the next-period default.[9] Based on these definitions and the market clearing condition in Equation (2), we can can write the equilibrium bond price as

$$q_t^i = \frac{\mathbb{E}_t\left(\mathcal{R}^i_{t+1}\right)}{r^f} \times \Psi_t^i, \tag{4}$$

where $r_f$ denotes the risk-free rate. The term $\frac{\mathbb{E}_t(\mathcal{R}^i_{t+1})}{r^f}$ captures the bond price under perfectly elastic investors, which is only a function of the expected next-period repayment. The $\Psi_t^i$

[8]This is a similar specification to the one in Gabaix and Koijen (2021), which is a function of expected excess returns and a shock to tastes or perceptions of risk. As we show in our quantitative analysis, this specification allows us to capture a demand elasticity that differs across countries with different levels of default risk.
[9]For a short-term (one-period) bond, for instance, $\mathcal{R}^i_{t+1} = 1 - d^i_{t+1}$, where $d = 1$ denotes a default.

Figure 2
The Role of Default Risk




Note: The figure depicts a reduction in the effective supply that is driven by an increase in $\mathcal{T}^i$. Panel (a) considers a case in which the bonds' default risk decreases after the reduction in the effective supply (i.e., the expected repayment increases). Panel (b) shows the opposite case.

term, on the other hand, captures the downward-sloping nature of the demand and it is given by

$$\Psi_t^i \equiv 1 - \kappa_t^i(\mathbf{\Lambda}) \frac{\mathbb{V}_t\left(\mathcal{R}_{t+1}^i\right)}{\mathbb{E}_t\left(\mathcal{R}_{t+1}^i\right)} \left(B_t^i - \mathcal{T}_t^i - \bar{\mathcal{A}}_t^i\right), \tag{5}$$

where $\kappa_t^i(\mathbf{\Lambda})$ characterizes the degree of inelasticity in the market for bond $i$, $\mathcal{T}_t^i$ denotes the *face-value* holdings of passive funds and $\bar{\mathcal{A}}_t^i$ captures the average holdings of active investors (i.e., those implied by the fixed mandates $\xi_j^i$). See Appendix A for the details and derivations.

From Equation (5) it is then clear that the price response to an exogenous change in the passive demand contains two components: (i) the demand elasticity and (ii) any effect on the bonds' expected repayment. More formally,

$$(-)\frac{\Delta q_t^i}{\Delta \tilde{\mathcal{T}}_t^i} \times \frac{q_{t-1}^i B^i - \tilde{\mathcal{T}}_{t-1}^i}{q_{t-1}^i} = \underbrace{(-)\frac{\Delta \Psi_t^i}{\Delta \mathcal{T}_t^i} \frac{B_t^i - \mathcal{T}_t^i}{\Psi_t^i}}_{\equiv \eta^i < 0} + \underbrace{(-)\frac{\Delta \mathbb{E}_t\left(\mathcal{R}_{t+1}^i\right)}{\Delta \mathcal{T}_t^i} \frac{B_t^i - \mathcal{T}_t^i}{\mathbb{E}_t\left(\mathcal{R}_{t+1}^i\right)}}_{\equiv \alpha^i}. \tag{6}$$

Figure 2 provides a graphical illustration. If an increase in $\mathcal{T}_t^i$ raises the next-period expected repayment (i.e., $\alpha^i < 0$), then for any given $B_t^i$, investors are willing to pay a higher price for that bond. This results in an upward adjustment in the demand for active investors. Failing to account for such effect would lead us to overstate the demand elasticity, as illustrated in Panel (a). On the other hand, if $\alpha^i > 0$, an exogenous increase in $\mathcal{T}_t^i$ triggers a downward shift in the demand for active investors, which results in an underestimation of the demand elasticity (Panel b).

Since bond prices and expected payoffs are jointly determined, it is hard to disentangle the effect on bond prices that is driven by a downward-sloping demand versus the effect that is coming from changes in default risk. Moreover, the strength and direction of these biases are unclear. We may argue that changes in $\mathcal{T}_t^i$ that are more persistent will likely have a larger impact on the issuers' policies, potentially strengthening the effect of $\alpha^i$. A more transitory shock, on the other hand, may lead to a smaller $\alpha^i$. To formally quantify each mechanism separately, one would need a structural model in which bond prices, the supply of the bond, and its default risk are endogenous outcomes. Put it differently, to quantify $\alpha^i$, we first need to understand how the issuers' policies (debt issuances and default) are affected by movements in $\mathcal{T}_t^i$.

In the next section, we construct an instrument for $\Delta\tilde{\mathcal{T}}_t^i$ based on monthly index rebalancings for a major sovereign-bond index for emerging economies. We estimate bond price reactions to these rebalancings and informally discuss (using CDS data) how much of those estimates can be explained by the demand elasticity and expected-repayment channels. In Section 4, we formulate a structural model to formally separate these two channels.

# 3 Empirical Analysis

## 3.1 Index Rebalancings as Passive Demand Shocks

In this section, we exploit monthly rebalancings in the EMBI Global Diversified index to identify exogenous shifts in the available supply of bonds for active investors (effective supply).

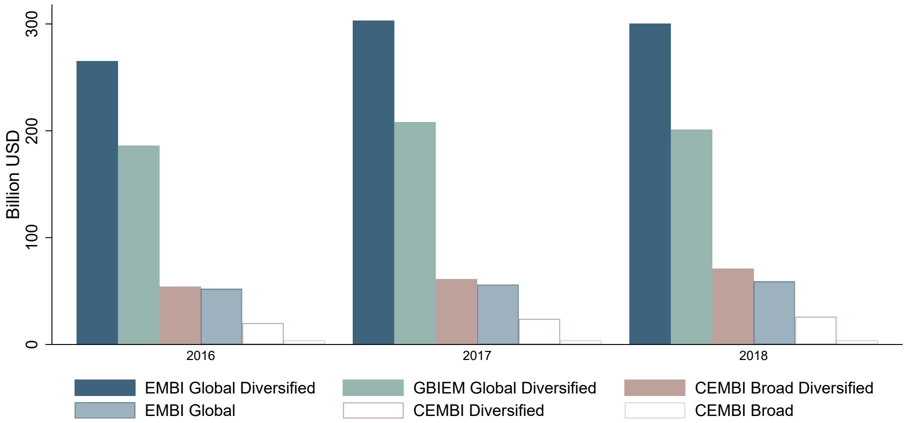
The J.P. Morgan EMBI Global Diversified is one of the most popular indexes for emerging sovereign-debt instruments. It includes sovereign and quasi-sovereign USD-denominated bonds issued by emerging countries with a maturity of at least 2.5 years and a face amount outstanding of at least US$500 million.[10] Among emerging-markets bond indexes, the EMBI Global Diversified is the the most widely tracked, with a combined assets under management (AUM) tracking the index of around US$300 billion in 2018 (Figure 3).[11] Unlike other indexes that adopt a traditional market capitalization-based weighting scheme, the EMBI Global Diversified limits the weights of countries with larger amounts of debt outstanding by only including a fraction of these countries' face amount of debt oustanding.[12]

[10] To be classified as an emerging market, a country's GNI per capita must be below an Index Income Ceiling (IIC) – defined by J.P. Morgan and adjusted every year by the growth rate of the World GNI per capita, Atlas method (current US$), provided by the World Bank – for three consecutive years. Bonds included in the index must settle internationally and have accessible and verifiable bid and ask prices. Once included, the bond may remain in the index until 12 months before maturity. Local law instruments are not eligible.

[11] Appendix Figures C1 and C2 show the total issuances of emerging government debt in international markets.

[12] Appendix Figure C3 plots the EMBI Global country weights of both the diversified and non-diversified versions for December 2018.

Figure 3
Assets under management (AUM) benchmarked to EM bond indexes




Note: Billion USD assets under management (AUM) benchmarked to EM bond indexes.
Sources: JPMorgan Markets, and authors' calculations.

Rebalancings in the EMBI Global Diversified index, such as inclusions and exclusions, take place on the last business day of each month, when J.P. Morgan releases a report with the updated index composition. These rebalancings lead to changes in the composition of the portfolios of passive investors tracking the index, who need to buy and sell bonds to replicate the index's weights.

Following Pandolfi and Williams (2019), one can measure the Flows Implied by the Rebalancings (FIR) for each country at each rebalancing date as follows:

$$FIR_{c,t} \equiv \frac{\Delta\tilde{\mathcal{T}}_{c,t}}{q_{c,t-1}B_{c,t-1} - w_{c,t-1}A_{t-1}}, \tag{7}$$

where $\Delta\tilde{\mathcal{T}}_{c,t} \equiv (w_{c,t} - w^{BH}_{c,t})A_t$. The first term in the numerator, $w_{c,t} \equiv \frac{q_{c,t}f_{c,t}B_{c,t}}{q_t I_t}$, is the benchmark weight for country $c$ at time $t$ in the index $\mathcal{I}$. It depends on the relative market capitalization of country $c$'s sovereign bonds included in $\mathcal{I}$. The term $q_{c,t}B_{c,t}$ denotes the market value of bonds from country $c$ at time $t$, and $f_{c,t}$ is the face-value share of country $c$ bonds tracked by the index, which only depends on a country's amount outstanding of debt and not on a country's bond prices.[13] The term $q_t I_t \equiv \sum_{c\in\mathcal{I}} q_{c,t}f_{c,t}B_{c,t}$ denotes the market value of the index $\mathcal{I}$ (the product of the unit price of the index, $q_t$, and the number of index units that are available, $I_t$). The second element of $\Delta\tilde{\mathcal{T}}_{c,t}$, $w^{BH}_{c,t}$ captures a "buy-and-hold weight", which is defined as the weight country $c$ would have had at time $t$ if the

[13]In a purely market capitalization-weighted index (such as the EMBI Global), $f_{c,t} = 1, \forall_{c,t}$. To preserve diversification, the weighting scheme of the EMBI Global Diversified entails a cap to the weight of countries with greater-than-average sovereign-bond markets, for whom the diversification coefficient is, therefore, smaller than one. That is, $f_{c,t} < 1$. Appendix B describes the rules of the EMBI Global Diversified to compute the weights of the instruments included in the index.

composition of the index had remained unchanged.[14] That is, $w^{BH}_{c,t} \equiv w_{c,t-1}\frac{q_{c,t}/q_{c,t-1}}{q_t/q_{t-1}}$. Lastly, $A_t$ represents the assets under the management of investors passively tracking the EMBI Global Diversified. To sum up, the numerator on Equation (7) is the amount of money that, on a given rebalancing date, enters or leaves a country because of the rebalancing in the portfolio of passive investors tracking the $\mathcal{I}$ index. For convenience, we normalize those flows by the market value of the bonds that are available for active investors, $q_{c,t-1}B_{c,t-1} - w_{c,t-1}A_{t-1}$.

Quantitatively, the FIR is a measure of the relative change in the purely passive demand for a country's sovereign bonds due to the rebalancing of the index: a 1% FIR can be therefore interpreted as a 1% reduction in the available supply of bonds in the market. These flows, however, may not be entirely exogenous to a country's fundamentals. First, the FIR is affected by countries' sovereign-bond issuances. If a country issues new bonds that are included in the index, that increases the country's weight in the index, which in turn leads to higher FIR. Second, even for countries whose face amount $B_{c,t}$ and share $f_{c,t}$ remain constant over time, the FIR may be mechanically correlated to present or past bond price changes.

Given that our goal is to isolate the impact of passive demand shocks on bond prices, these two issues can potentially bias our estimates. We tackle these challenges in two ways. First, for each rebalancing event, we only consider countries whose amount outstanding of bonds $B_{c,t}$ does not change relative to the previous period. In other words, we only consider countries with no new issuances, repurchases of bonds, or with bonds that drop out of the index because of their maturity. Additionally, we exploit the fact that the weighting scheme of the EMBI Global Diversified is based on the face amount outstanding of bonds. This is important because it allows us to net out the variation that is potentially correlated with current or past bond price changes.

In particular, we construct an instrument for the FIR based on a theoretical index in which country weights are only a function of the diversified amount outstanding of bonds included in the index: $w^{FA}_{c,t} \equiv \frac{f_{c,t}B_{c,t}}{\sum_c f_{c,t}B_{c,t}}$. Then, we compute the fractional change in theoretical weights:

$$\frac{\Delta w^{FA}_{c,t}}{w^{FA}_{c,t-1}} = \left(\frac{f_{c,t}B_{c,t}}{\sum_c f_{c,t}B_{c,t}} - \frac{f_{c,t-1}B_{c,t-1}}{\sum_c f_{c,t-1}B_{c,t-1}}\right) / \left[\frac{f_{c,t-1}B_{c,t-1}}{\sum_c f_{c,t-1}B_{c,t-1}}\right], \tag{8}$$

which, given our focus on countries whose debt outstanding in the index remains unchanged,

[14] Notice that $w^{BH}_{c,t} = \frac{q_{c,t}f_{c,t-1}B_{c,t-1}}{q_t I_{t-1}}$. Absent any change in the index composition (i.e., inclusions or exclusions of new bonds or countries), if the price of a country's sovereign bonds increases more than that of the other countries in the index, the weight of that country in the index increases but investors do not need to make any rebalancing to their portfolios as the "buy-and-hold weight" coincides with the new weight in the index, $w_{c,t}$.

reduces to

$$Z_{c,t} \equiv \left( \frac{f_{c,t}}{\sum_c f_{c,t} B_{c,t}} - \frac{f_{c,t-1}}{\sum_c f_{c,t-1} B_{c,t-1}} \right) \; / \left[ \frac{f_{c,t-1}}{\sum_c f_{c,t-1} B_{c,t-1}} \right]. \tag{9}$$

Given that $f_{c,t}$ is not a function of bond prices and because we only consider countries where $B_{c,t}$ is fixed, then $\frac{\partial Z_{c,t}}{\partial q_{c,t}} = \frac{\partial Z_{c,t}}{\partial q_{c,t-1}} = 0$. By instrumenting the FIR with $Z_{c,t}$ we can thus isolate the variation in FIR that is coming exclusively from changes in the amount outstanding of bonds of other countries, either because of changes in the relative size of the country's sovereign-bond market or because of changes in the diversification coefficient, $f_{c,t}$.

In what follows, we use the $Z_{c,t}$ instrument to estimate how exogenous demand changes induced by passive flows affect sovereign-bond prices. For this, we take advantage of the specific timing of the rebalancings: index changes always occur on the last business day of each month, which is when passive funds will rebalance their portfolios. For each rebalancing date, we can therefore identify pre- and post-rebalancing periods, and estimate the effect of the $FIR_{c,t}$ (instrumented by $Z_{c,t}$) on bond prices.

We adopt an instrumented difference-in-differences design (DDIV) and estimate, in our main specification:

$$\log(q_{i,t,h}) = \theta_{c(i),t} + \theta_{b(i),t} + \gamma \mathbb{1}_{h \in Post} + \beta(\hat{FIR}_{c(i),t} \times \mathbb{1}_{h \in Post}) + \mathbf{X}_{i,t} + \varepsilon_{i,t,h}, \tag{10}$$

where $q_{i,t,h}$ is the price of bond $i$ at rebalancing date $t$, $h$ trading days before or after the rebalancing. For each rebalancing date, $t$, we consider a 10-day window around it, so that $h \in [-5, 5]$. $\theta_{c(i),t}$ are country-by-month fixed effects, and $\theta_{b(i),t}$ are bond characteristics-by-month fixed effects, where we include characteristics such as maturity, rating, and bond type (sovereign or quasi-sovereign). $\hat{FIR}_{c(i),t}$ is our $FIR$ measure instrumented with the percentage change in the theoretical index weights, $Z_{c,t}$, obtained by regressing $FIR_{c,t}$ on $Z_{c,t}$ (first stage). The term $\mathbb{1}_{h \in Post}$ is an indicator function that is equal to one in the 5 days after the rebalancing and 0 in the 5 days before it. $\mathbf{X}_{i,t}$ is a vector of monthly bond controls including the bond's face amount and the (beginning-of-month) spread. Our coefficient of interest is $\beta$, which captures the effect of the FIR on bond prices.

Additionally, we also estimate a specification with leads and lags, in which the instrumented FIR is interacted with trading-day dummies. This analysis allows us to explore the dynamic effect of the FIR. It also allows us to test for parallel trends in the period prior to rebalancing.

### 3.2 Data and Summary Statistics

To compute both the FIR and our instrument, we collect data from different sources. Most of the variables used in the analysis are retreived directly from J.P. Morgan. There is one variable that is not straightforward to measure: the assets under management of funds that passively track the EMBI Global Diversified, $A_t$. While J.P. Morgan provides data on the amount of assets benchmarked against their indexes, it does not distinguish between passive and active funds. Additionally, even if such information were available, many active funds may passively manage a significant share of their portfolios, as highlighted by Pavlova and Sikorskaya (2022).

To compute $A_t$, we start with J.P. Morgan data on assets tracking the EMBI Global Diversified and re-scale it by an estimate of the share of passive funds. To estimate the share of passive funds, we perform the following steps. We retrieve from Morningstar data on the returns of funds benchmarked against the EMBI Global Diversified and EMBI Global Core.[15] For each fund, we estimate a regression of its returns on the returns of the index and compute the corresponding $R^2$, that is, the share of the variance in the fund's return that is explained by variation in index returns (see Appendix Figure C4). We categorize as passive all funds whose $R^2$ is higher than 0.96. We choose 0.96 as a threshold because it is the average $R^2$ of ETFs in our sample.[16] Nonetheless results are robust to considering different thresholds.[17] Using this classification rule, the share in terms of market capital of 'passive' funds tracking the EMBI Global Diversified in the Morningstar database is 30%.[18] We calculate $A_t$ by adjusting the assets under management tracking the EMBI Global Diversified index, using a rescaling factor of 30%.

We gather data on individual bond prices from Datastream. We also retrieve several bond characteristics (maturity, duration, among others) directly from J.P. Morgan data. We clean our dataset by dropping extreme values in terms of daily returns, stripped spreads, and $Z_{c,t}$. We drop daily returns that are in absolute value larger than 50%, and stripped spreads that are below 0 or above 5000 basis points. We also drop the three largest and smallest $Z_{c,t}$. In general, extreme values of $Z_{c,t}$ could be potentially driven by large changes in the EMBI Global Diversified that are pre-announced during the month and thus are not appropiate for our identification strategy, which relies on the assumption that most information is known in

[15] The criteria for inclusion of bonds in the EMBI Global Core is the same as the EMBI Global and EMBI Global Diversified, except that the minimum face amount of the bonds must be US$1 billion, and the maturity required to be maintained in the index is of at least one year. As the EMBI Global Diversified, it utilizes the diversification methodology described in Appendix B to calculate the bond weights.

[16] For this calculation we only include ETFs that are passive and whose base currency is the USD.

[17] Appendix Table C1 provides results using alternative shares of passive funds used to construct the FIR measure. While our quantitative estimates do change slightly, the qualitative implications remain the same.

[18] The share of market capital of these funds is first computed for every month of the period under analysis in the paper (2016-2018), and then is averaged across all months in the period. This produces the value of 30%.

Table 1
Summary statistics

| Variable | Mean | Std. Dev. | 25th Ptile | 75th Ptile | Min | Max |
|---|---|---|---|---|---|---|
| log(Price) | 4.604 | .229 | 4.579 | 4.683 | 2.708 | 5.192 |
| Instrumented FIR (in bps) | -.095 | .144 | -.204 | .022 | -.462 | .212 |
| Stripped Spread | 371.172 | 555.982 | 134.00 | 396.00 | 0.00 | 4993.00 |
| EIR duration | 6.436 | 3.961 | 3.525 | 7.833 | -.037 | 19.081 |
| Average Life | 10.082 | 8.949 | 4.224 | 11.208 | 1.075 | 94.519 |
| Face Amount (USD billion) | 1.320 | .812 | .75 | 1.619 | .5 | 7.00 |
| CDS | 495.650 | 1247.065 | 105.599 | 311.790 | 42.450 | 13956.959 |

Note: The table displays summary statistics for the main variables utilized in the empirical analysis. Instrumented FIR values are in basis points, and face amount values are in billion USD. The Effective Interest Rate (EIR) duration is a measure of sensitivity of dirty price with respect to the US interest rates parallel shift. It approximately shows the percentage change of dirty price if all US interest rates change by 100bp (JPMorgan). Sources: Morningstar Direct, JPMorgan Markets, DataStream, and authors' calculations.

the last business day of the month.[19]

Our final dataset consists of 247,826 bond-time observations for 702 bonds in 67 countries. Table 1 displays summary statistics for our main measure of the instrumented flows implied by the rebalancing, $F\hat{I}R_{ct}$, as well as for the other key variables in our database. Bonds in our sample have an average stripped spread of 371 basis points, an average maturity of 10 years, and an average face amount of US$1.3 billion.

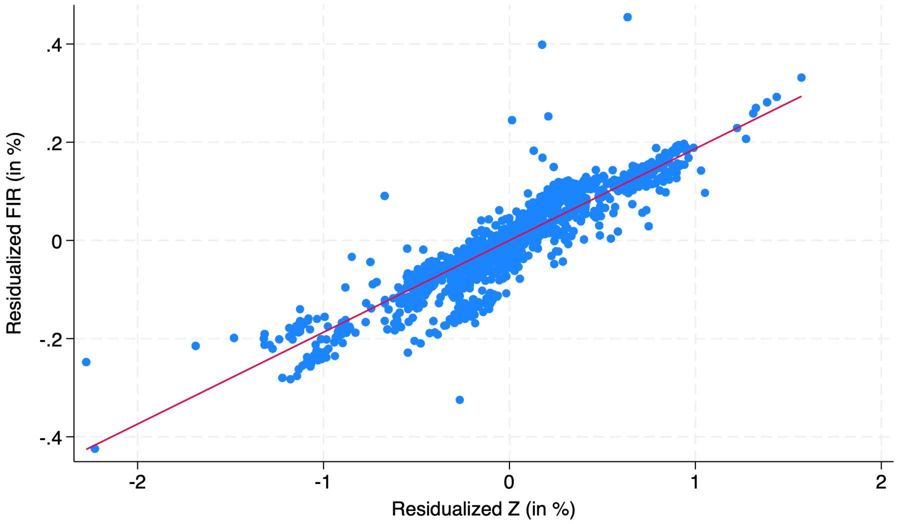
Figure 4 displays results regarding our first stage. It shows a scatter plot of the FIR and our $Z_{c,t}$ instrument after both variables have been residualized with rebalancing-month and country fixed effects. There is a clear positive relation between the two variables and the R-squared is 71%. Figure 5 presents the distribution of our instrumented FIR measure. The values range from -0.5% to around 0.2%, with more negative than positive observations. This is consistent with the fact that over time the number of bonds included in the EMBI Global Diversified increased. Since we restrict our analysis to countries whose face amount remains constant, the inclusion of bonds from other countries typically leads to a reduction in the weight of sample countries (i.e., a negative FIR).

### 3.3 Results

We present results for our baseline estimation from Equation (10) in Table 2. Our coefficient of interest, $\beta$, is always positive and statistically significant in the different specifications. The estimate in our preferred specification —the one with bond controls, country-by-time and bond-type-by-time fixed effects— is 0.67. This implies that a 1-percentage-point increase in FIR increases bond returns by 0.67 percentage points.

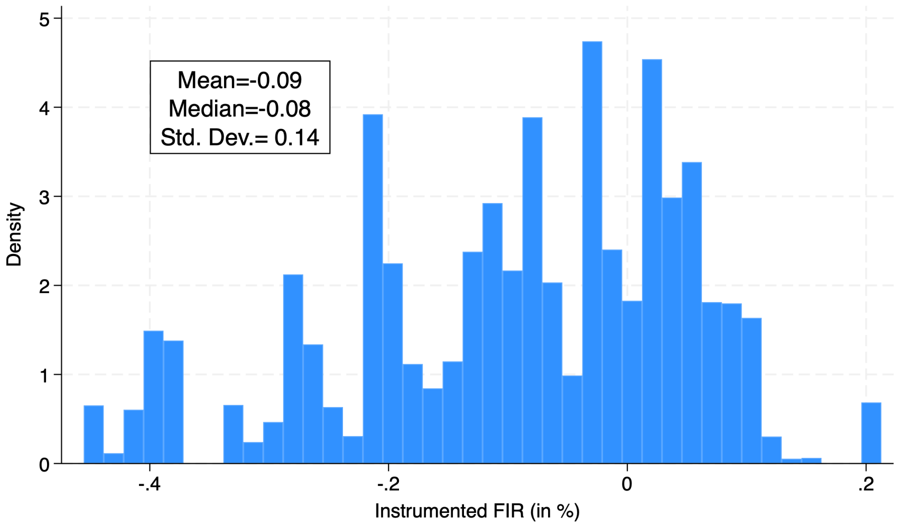
[19]For our baseline analysis, we also exclude country-year observations with large sovereign spreads (Argentina and Turkey in 2018). In Appendix Tables C2, C3, and C4 we present robustness tests with respect to this winsorizing and show that our results are similar.

Figure 4
Relationship between FIR and $Z$




Note: This figure presents a scatter plot of the FIR and the $Z$ instrument. Both variables are residualized based on a regression with rebalancing-month and country fixed effects. FIR is computed as in Equation (7) and $Z$ as in Equation (9). Sample period is 2016-2018.

Figure 5
Distribution of instrumented FIR values




Note: This figure shows a histogram of the instrumented FIR. Sample period is 2016-2018.

One potential concern with these results is that bonds receiving larger or smaller FIR on the rebalancings are on different price trends even before the rebalancing date. To show that this is not the case, we estimate a leads-and-lags specification, where we interact the instrumented FIR with a dummy for each of the trading days around the rebalancing event. The estimated coefficients are reported in Figure 6. On the days prior to the rebalancing date,

Table 2
Log Price and FIR

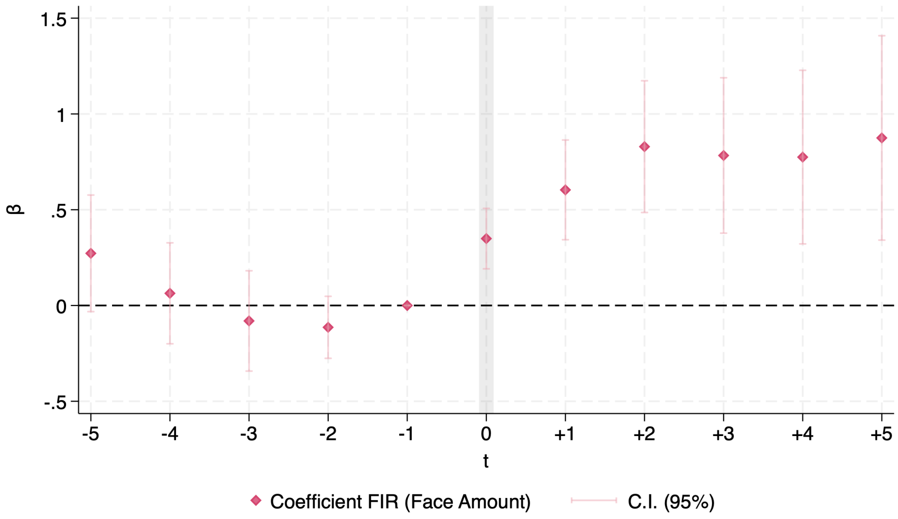
| Dependent Variable: Log Price | | | | | |
|---|---|---|---|---|---|
| FIR Instrumented | -8.766*** | -1.803 | 1.336 | | |
| | (1.390) | (2.467) | (1.237) | | |
| FIR Instrumented*Post | 0.676*** | 0.675*** | 0.674*** | 0.674*** | 0.674*** |
| | (0.193) | (0.193) | (0.195) | (0.195) | (0.195) |
| Post | 0.002*** | 0.002*** | 0.002*** | 0.002*** | 0.002*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Bond FE | Yes | Yes | Yes | Yes | Yes |
| Time FE | No | Yes | Yes | No | No |
| Maturity-Rating-Bond Type-Time FE | No | No | Yes | Yes | Yes |
| Country-Time FE | No | No | No | Yes | Yes |
| Bond Controls | No | No | No | No | Yes |
| Observations | 134,891 | 134,891 | 134,891 | 134,891 | 134,847 |
| N. of Bonds | 758 | 758 | 758 | 758 | 758 |
| N. of Countries | 69 | 69 | 69 | 69 | 69 |
| N. of Clusters | 1,813 | 1,813 | 1,813 | 1,813 | 1,812 |
| $R^2$ | 0.010 | -0.001 | 0.001 | 0.002 | 0.002 |

Note: This table presents results from 2SLS estimations of log price on different explanatory variables around rebalancing dates. The first stage and second stage equations are described in Equation (10). The sample period is 2016-2018 and contains a window of 10 trading days around each end-of-the-month rebalancing date. The dependent variable is the log price of a bond. FIR Instrumented is the FIR from Equation (7) instrumented with $Z$ in (9). Post is an indicator variable that is 1 for the day of the rebalancing and 5 trading days after it, and 0 otherwise. Time fixed effects are dummy variables for each month of rebalancing. Maturity fixed effects are constructed by dividing the time to maturity of a bond into four different categories: short (less than 5 years), medium (between 5 and years), long (10 to 20 years) and very long (more than 20 years). Ratings from each bond are from Moody's. Bond Type indicates whether a bond is sovereign or quasi-sovereign. Bond controls indicates whether the estimation includes the log face amount and log stripped spread of the bond. Standard errors are clustered at the country by month of rebalancing level. *** p<0.01, **p<0.05, * p<0.1.

from $-5$ to $-1$, changes in FIR are not associated with systematic differences in bond prices. On the rebalancing day, instead, the estimated coefficient becomes positive and significant, and remains so until the end of our estimation window. This is consistent with the patterns of rebalancings from different institutional investors highlighted in Escobar et al. (2021), where most investors rebalance their portfolio on the effective date of the rebalancing but not before that. Additionally, this finding is not consistent with prior leakage of information regarding the rebalancing changes.

The previous effects are heterogeneous across countries' with varying levels of default

Figure 6
Leads and Lags Coefficients




Note: This figure presents leads and lags coefficients from a 2SLS estimation of the log price of bonds on a set of trading-day dummies around the rebalancing date. The 2SLS procedure is identical to the one described in Table 2. The estimation includes both bond and month-of-rebalancing-maturity-rating-bond-type fixed effects. $t = 0$ indicates the day of the rebalancing. The vertical red lines show a 95% confidence interval for each horizon. Standard errors are clustered at the country by month of rebalancing level.

risk. To see this, we divide our sample into high- and low-spread bonds—those above and below the median spread in our sample, respectively. We estimate Equation (10) for each of these subsamples and report the results in Table 3. We find that the price of high-spread bonds react more to rebalancing-driven demand shocks. For bonds issued by riskier countries, a 1-percentage-point increase in FIR is associated with a 1.09-percentage-point increase in bond returns. Instead, the effect is quantitatively close to zero for low-spread countries and not statistically significant.[20]

### 3.4 Interpretation of the Estimates as Demand Elasticities

As we explained in Section 2, the standard assumption in the literature is that exogenous shifts in the effective supply (i.e., our FIR measure) do not affect the fundamental value of the assets (default risk in the case of risky bonds). In that case, we can directly map the previous estimates to a demand elasticity for risky sovereign bonds. To see this, notice that we can rewrite the elasticity in Equation (3) in terms of our FIR measure as $\eta \approx (-)\frac{\Delta \log(q_t^i)}{FIR_{c,t}}$. This is exactly what our $\beta$ coefficient in Equation (10) captures. Based on the results in

[20]In Appendix Table C5 we re-estimate this dividing bonds into 3 groups and find that bond prices are positively associated with FIR for both high (above 328 bps) and medium spread bonds (between 166 and 328 bps), while they are not for bonds with low spreads (below 166 bps). The estimated coefficient is increasing in the risk profile of bonds.

Table 3
Log Price and FIR - Spread Heterogeneity

| Dependent Variable: Log Price | | | | |
|---|---|---|---|---|
| | High Spread | | Low Spread | |
| FIR Instrumented | -12.130*** | | -4.044*** | |
| | (2.310) | | (0.869) | |
| FIR Instrumented*Post | 1.096*** | 1.093*** | 0.160 | 0.160 |
| | (0.312) | (0.316) | (0.135) | (0.137) |
| Post | 0.003*** | 0.003*** | 0.000 | 0.000 |
| | (0.001) | (0.001) | (0.000) | (0.000) |
| Bond FE | Yes | Yes | Yes | Yes |
| Maturity-Rating-Bond Type-Time FE | No | Yes | No | Yes |
| Country-Time FE | No | Yes | No | Yes |
| Bond Controls | No | Yes | No | Yes |
| Observations | 67,209 | 67,209 | 67,682 | 67,638 |
| N. of Bonds | 504 | 504 | 521 | 521 |
| N. of Countries | 63 | 63 | 52 | 52 |
| N. of Clusters | 1,365 | 1,365 | 996 | 995 |
| $R^2$ | 0.012 | 0.036 | 0.001 | 0.003 |

Note: This table presents results from 2SLS estimations of log bond prices on different explanatory variables around rebalancing dates. The 2SLS procedure is identical to the one described in Table 2. We divide the sample into bonds with high spreads (Columns 1 and 2) and low spreads (Columns 3 and 4). High (low) spread bonds are those above (below) the median stripped spread in our sample. Standard errors are clustered at the country by month of rebalancing level. *** p<0.01, **p<0.05, * p<0.1.

Table 2, one can infer that the inverse demand elasticity for this market is around -0.67 (the demand elasticity is -1.49). These estimates are in the ballpark of other estimates in the literature for other financial markets and assets (see Appendix Figure C5).

If default risk does change with exogenous movements in $\tilde{\mathcal{T}}$, we can no longer interpret our $\beta$ estimate as a demand elasticity. This is because, in that case, $\beta$ also captures the effects that $\Delta\tilde{\mathcal{T}}$ has on the expected next-period repayment, as shown in Equation (6) (the $\alpha^i$ term). The question, thus, is how sensitive is default risk to exogenous changes in the composition of indexes?

One way to assess the magnitude of $\alpha^i$ is to quantify how a country's default risk is affected with changes in the FIR. To this end, we use credit default swaps (CDS) as a proxy for default risk. In Appendix Table C6 we find that the FIR tends to decrease the spreads of CDS. The estimates imply that for the median CDS spread in the sample (of about 190 basis points) a 1-percentage-point increase in FIR decreases CDS spreads by 3 basis points. Given a median duration for bonds of 5.5, a simple back-of-the-envelope calculation suggests that the lower CDS spread increases bond prices by almost 16.5 basis points. This effect accounts for about 25% of our baseline estimate in Table 2. One may argue that a larger and more permanent shock should exert a more substantial impact on the fundamental value of the asset (hence, on default risk). Our FIR measure, thus, holds an advantage over the common index additions and deletions that are frequently used in other studies, since it exhibits a more temporary nature.

Although informative, the previous estimates should be taken with caution because bond prices and the price of CDS are determined jointly. If demand shocks are correlated across markets, it might be the case that the fall in CDS spreads (i.e., a higher price) is not really capturing a lower default risk. In the next section we build a quantitative model that allows us to quantify the role of (endogenous) movements in default risk behind the documented price responses.

# 4 The Supply of Risky Sovereign Bonds

We formulate a quantitative sovereign debt model to disentangle the mechanisms behind our empirical estimates and to back out a demand elasticity that isolates the effects of default risk. The model features a risk-averse government that issues long-term debt in international debt market. It has limited commitment and can endogenously default on its debt obligations. We introduce a rich demand structure that allows us to capture different investor types (active and passive) and a downward-sloping demand for active investors.

## 4.1 The Issuer Problem

We consider a small open economy with incomplete markets and limited commitment. Output is exogenous and follows a continuous Markov process with a transition function $f_y(y' \mid y)$. We assume that the preferences of the representative consumer are given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t), \tag{11}$$

where $\beta$ is the discount factor, $c_t$ denotes consumption, and the function $u(.)$ is strictly increasing and concave. An infinite-lived risk-averse government issues debt in international markets to smooth consumption. Let $B$ denote the beginning-of-period stock of government debt.

Government bonds are long term. Debt contracts mature probabilistically. Each unit of $B$ matures in the next period with probability $\lambda$. If the bond does not mature (and the government does not default), it pays a coupon $\nu$. Let $d = \{0, 1\}$ denote the default policy, where $d = 1$ denotes a default. Default leads to a temporary exclusion from international debt markets and an exogenous output loss, $\phi(y)$. We assume that it regains access to debt markets with probability $\theta$ and there is no recovery value.

We assume that international markets are competitive and populated by two types of investors: active and passive. Active investors have a downward-sloping demand curve. Motivated by the analysis of Section 2, we assume that this demand is a function of the expected returns and the volatility of such returns. Passive investors, on the other hand, have a perfectly inelastic demand: They buy the government's bonds to not deviate from their benchmark portfolio index $\mathcal{I}$. Let $\mathcal{A}'(.)$ and $\mathcal{T}'(.)$ denote the demand functions (at face value) for active and passive investors, respectively. For the demand of passive investors, we assume that $\mathcal{T}' = \mathcal{T}(\tau, B')$. That is, passive funds adjust their purchases based on the end-of-period supply of bonds, $B'$, and based on some time-varying index weight, $\tau$. For tractability, we assume that $\tau$ is exogenous and follows a continuous Markov process with transition function $f_\tau(\tau' \mid \tau)$. Given an end-of-period supply of bonds $B'$, by market clearing, the residual demand of active investors is $\mathcal{A}'(\tau, B') = B' - \mathcal{T}'$.

The state-space can be summarized by the $n$-tupple $(h, B, s)$, where $s = (y, \tau)$ captures the exogenous states and $h$ the current default status of the government. Under these assumptions, depending on the default status of the government and for a given choice of $B'$, the resource constraint of the economy can be written as

$$\begin{aligned} c(h=0, B, y, \tau; B') &= y + q\left(y, \tau, B'\right)\left(B' - (1-\lambda)B\right) - \left(\lambda + (1-\lambda)\nu\right)B \\ c(h=1) &= y - \phi_j(y), \end{aligned} \tag{12}$$

where $q(y, \tau, B')$ denotes the price of a unit of debt. This pricing function is an endogenous object that depends on the default risk of the bond. Since the demand of active investors is downward sloping, it also depends on the investors' composition (i.e., share of bonds that are purchased by passive funds).

### 4.2 Government's Recursive Problem

The government is benevolent and chooses $\{d, B'\}$ to maximize Equation (11) subject to the resource constraint in (12). If the government is not currently in default, its value function is given by

$$V(y,\tau,B) = Max_{d=\{0,1\}} \left\{ V^r(y,\tau,B), V^d(y) \right\}, \tag{13}$$

where $V^r(.)$ denotes the value of repayment and $V^d(.)$ denotes the value function in case of a default. If the government chooses to repay, then its value function is given by the following Bellman equation:

$$V^r(y,\tau,B) = Max_{B'} u(c) + \tilde{\beta}\mathbb{E}_{s'|s} V\left(y',\tau',B'\right), \tag{14}$$

subject to

$$c = y + q(y,\tau,B')\left(B' - (1-\lambda)B\right) - (\lambda + (1-\lambda)\nu)\, B.$$

If the government defaults, it is excluded from debt markets and it cannot issue new debt. The government exits the default with probability $\theta$ and there is no recovery value. We also assume that the demand of passive funds is zero while the government is in default (i.e., the share in the index $\mathcal{I}$ is zero). Under these assumptions, the government's value function is given by

$$V^d(y) = u(y - \phi(y)) + \tilde{\beta}\mathbb{E}_{s'|s}\left[\theta V\left(y',\tau',0\right) + (1-\theta)\, V^d\left(y'\right)\right]. \tag{15}$$

### 4.3 Bond-pricing Kernel

Foreign lenders are competitive and discount payoffs at the risk-free rate. Given the government's current choice of $B'$ and given the passive investors' demand, the bond-price function faced by the government is given by

$$q\left(y,\tau,B'\right) = \beta^\star\, \mathbb{E}_{s'|s}\left[\mathcal{R}\left(y',\tau',B'\right)\right]\, \Psi\left(y,\tau,B'\right), \tag{16}$$

where $\beta^\star \equiv 1/(1+r_f)$, $\mathcal{R}'(.) \equiv \mathcal{R}\left(y',\tau',B'\right)$ denotes the next-period repayment function, and the $\Psi(y,\tau,B')$ term captures the downward-sloping component of the residual demand (i.e., the inelastic behavior of active investors).[21] The next-period repayment function, in turn, is given by

$$\mathcal{R}\left(y',\tau',B'\right) = \left[1 - d\left(y',\tau',B'\right)\right](1-\lambda)\left(\nu + q(y',\tau',B'')\right), \tag{17}$$

[21]The case in which $\Psi(y,\tau,B') = 1$ for all $\{y,\tau,B'\}$ captures the perfectly elastic case, in which the price of the bond is only a function on the expected next-period repayment function.

where $d(y', \tau', B')$ is the next-period default choice and $q(y', \tau', B'')$ denotes the next-period bond price, which is a function of the next-period debt policy and passive investors' demand.

From Equations (16) and (17), it is easy to see that the bond price decreases with the expected default probability. Since a larger $B'$ increases the risk of default (conditional on a level of output), $q(y, \tau, B')$ is thus typically decreasing in $B'$. As for $\Psi(y, \tau, B')$, we assume that $\frac{\partial \Psi(y,\tau,B')}{\partial \mathcal{A}'(\tau,B')} \leq 0$. Thus, this term introduces another mechanism for the bond price to be decreasing in $B'$: the downward-sloping demand of active investors.

### 4.4 Demand and Supply Elasticities

Similarly to our empirical exercise, we can exploit exogenous movements in $\tau$ and analyze its effects on bond prices. This is straightforward to do in the model because we can directly construct counterfactuals in which we change $\tau$ and at the same time, we keep the country's fundamentals fixed. Let $\Delta\mathcal{T}' \equiv \mathcal{T}(\tau_1, B') - \mathcal{T}(\tau_0, B')$ denote an exogenous change in the demand of passive investors, in which we keep the (end-of-period) bond supply fixed. We can derive an analogous expression to the one in Equation (6):

$$(-)\frac{\Delta q(.)}{\Delta\mathcal{T}'} \times \frac{B' - \mathcal{T}'}{q(.)} = \underbrace{(-)\frac{\Delta\Psi(.)}{\Delta\mathcal{T}'}\frac{B' - \mathcal{T}'}{\Psi(.)}}_{\equiv\eta<0} + \underbrace{(-)\frac{\Delta\mathbb{E}_{s'|s}\mathcal{R}'(.)}{\Delta\mathcal{T}'}\frac{B' - \mathcal{T}'}{\mathbb{E}_{s'|s}\mathcal{R}'(.)}}_{\equiv\alpha}. \tag{18}$$

Using the model, we can easily isolate the price effect that is coming from a downward-sloping demand. By keeping $\Delta\mathbb{E}_{s'|s}\mathcal{R}'(.)$ fixed, we can disentangle the effects of an exogenous change in the composition of an index into an elasticity channel ($\eta$) and a return or risk channel ($\alpha$).

Apart from being able to recover the price elasticity, the model has important implications regarding the optimal supply of risky bonds when the demand for those bonds is downward sloping. When the government chooses its debt policy it internalizes not only the effects of a larger $B'$ on $q(y, \tau, B')$ through changes in its default probability, but also its effects through the downward-sloping demand component. Let $\varepsilon \equiv \frac{\Delta q(.)}{\Delta B'}\frac{B'}{q(.)}$ denote the elasticity of the bond-pricing kernel with respect to the supply of the bond. It is easy to show the following:

$$\varepsilon = \underbrace{\frac{\Delta\mathbb{E}_{s'|s}\mathcal{R}'(.)}{\Delta B'}\frac{B'}{\mathbb{E}_{s'|s}\mathcal{R}'(.)}}_{\text{Default Risk}(\leq 0)} + \underbrace{\frac{\Delta\Psi(.)}{\Delta B'}\frac{B'}{\Psi(.)}}_{\text{Inelastic Demand}(<0)} - \underbrace{[\eta + \alpha]\frac{\Delta\mathcal{T}'}{\Delta B'}\frac{B'}{B' - \mathcal{T}'}}_{\text{Index Composition}}. \tag{19}$$

The first term on the right-hand side captures the elasticity of the expected repayment function. This elasticity is typically negative, since a larger $B'$ increases default risk and reduces the expected repayment. The second term captures the decline in the bond price due to the downward-sloping demand. The third term accounts for the effect of a larger $B'$ on the relative weight in the index $\mathcal{I}$ (and thus in the purchases of passive investors), influencing the bond-pricing kernel through the elasticity ($\eta$) and risk ($\alpha$) channels.

From Equation (19), it is thus clear that an increased $B'$ not only lowers the bond price due to heightened default risk but also due to the downward-sloping demand of active investors. Given that the government internalizes both effects, a more inelastic demand affects its optimal bond supply. In the next section, we use a calibrated version of the model to quantify the implications of an inelastic demand on a government's supply of bond and on its default policy.

# 5 Quantitative Analysis

## 5.1 Calibration

The model is calibrated at quarterly frequency based on Argentine data. The calibration follows a two-step procedure. We first fix a subset of parameters to standard values in the literature or based on historical Argentine data, following Morelli and Moretti (2023). We internally calibrate the remaining parameters to match relevant moments for Argentine spreads and other business-cycle statistics. Table 4 describes the model calibration.

In terms of functional forms and stochastic processes, we assume that the government has CRRA preferences: $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$, where $\gamma$ denotes the risk aversion. Output follows an AR(1) process given by $\log(y') = \rho_y \log(y) + \epsilon'_y$, with $\epsilon'_y \sim N(0, \sigma_y)$. If the government defaults, output costs are governed by a quadratic loss function $\phi(y) = \max\left\{d_0 y + d_1 y^2, 0\right\}$. For $d_0 < 0$ and $d_1 > 0$, the output cost is zero whenever $0 \leq y \leq -\frac{d_0}{d_1}$ and rises more than proportionally with $y$ when $y > -\frac{d_0}{d_1}$. This type of loss function is identical to the one used in Chatterjee and Eyigungor (2012) and allows us to match reasonably well the sovereign spreads observed in the data. As for the demand of passive investors, we assume that it is proportional to the (end-of-period) amount of bonds outstanding. That is, $\mathcal{T}' = \mathcal{T}(\tau, B') = \tau \times B'$. We let $\tau$ follow an AR(1) process given by $\log(\tau') = (1-\rho_\tau)\log(\tau^\star) + \rho_\tau \log(\tau) + \epsilon'_\tau$, where $\epsilon'_\tau \sim N(0, \sigma_\tau)$. We calibrate $\tau^\star$ to match the share of Argentina's external debt that is on average tracked by passive investors. We then calibrate $\rho_\tau$ and $\sigma_\tau$ to match the persistence and volatility of our FIR measure.

Panel (A) of Table 4 lists the parameters we fix in the calibration. We set the risk aversion $\gamma = 2$, which is a standard value in the literature. We set $r_f = 1\%$, in line with the observed average real risk-free rate in the United States. We set the re-entry parameter to $\theta = 0.0385$, which implies an average exclusion from international markets of 6.5 years.

Table 4
Calibration of the Model

| Panel A: Fixed Parameters | | | Panel B: Calibrated Parameters | | |
|---|---|---|---|---|---|
| Param. | Description | Value | Param. | Description | Value |
| $\gamma$ | Risk aversion | 2.00 | $\beta$ | Discount rate | 0.947 |
| $r$ | Risk-free interest rate | 0.01 | $\bar{d}_0$ | Default cost—level | −0.24 |
| $\lambda$ | Debt maturity | 0.05 | $\bar{d}_1$ | Default cost—curvature | 0.29 |
| $z$ | Debt services | 0.03 | $\kappa_0$ | Downward sloping demand | 50.0 |
| $\theta$ | Reentry probability | 0.0385 | $\kappa_1$ | Downward sloping demand | 0.54 |
| $\rho_{\mathrm{y}}$ | Output, autocorrelation | 0.93 | | | |
| $\sigma_{\mathrm{y}}$ | Output, shock volatility | 0.02 | | | |

We set $\lambda = 0.05$ to target a maturity of 5 years and $\nu = 0.03$ to match Argentina's average debt services. Parameters for the endowment process, $\rho_y$ and $\sigma_y$, are estimated based on log-linearly detrended quarterly real GDP data for Argentina.

The remaining parameters (Panel B of Table 4) are internally calibrated to match key moments of the Argentine economy (described in Table 5). We jointly calibrate $\{d_0, d_1\}$ together with the government's discount factor $\beta$ to target Argentina's average ratio of (external) debt to GDP, average spread, and volatility of spreads.[22]

Based on the analysis in Section 2, we consider the following functional form for the $\Psi(.)$ function:

$$\Psi\left(y, \tau, B'\right) = \exp\left\{-\kappa_0 \frac{\mathbb{V}_{s'|s}\left(\mathcal{R}'(.)\right)}{\mathbb{E}_{s'|s}\left(\mathcal{R}'(.)\right)} \times \left(B' - \mathcal{T}' - \kappa_1\right)\right\}, \tag{20}$$

where $\kappa_0$ captures the downward-slopping component of the demand and $\kappa_1 \equiv \bar{\mathcal{A}}$ denotes the average holdings of active investors (as determined by their fixed mandates). For tractability, we assume time-invariant values for both $\kappa_0$ and $\kappa_1$.[23] This specification introduces a wedge only for risky bonds (i.e., those with $\mathbb{V}_{s'|s}\left(\mathcal{R}'(.)\right) > 0$) and, as we show next, it allows us to capture the two key features of our empirical analysis: (i) a downward-sloping demand for active investors; (ii) an elasticity that is larger (in magnitude) for riskier countries (i.e., countries with a larger return variance). Since $\Psi(.) \leq 1$, we view this term as an inconvenience yield, that leads investors to pay a lower price for any given level of default risk.

We calibrate $\kappa_0$ to match our empirical estimates. In particular, we target the on-impact effect of an exogenous index rebalancing on the price of sovereign bonds (as reported in Figure 6). We then set $\kappa_1$ to match the average holdings of active investors. That is, $\kappa_1 = \bar{B} - \bar{\mathcal{T}}$,

[22] Annualized spreads are computed as $SP = \left(\frac{1+i\left(y,\tau,B'\right)}{1+r_f}\right)^4 - 1$, where $i\left(y,\tau,B'\right)$ is the internal quarterly rate of return, which is the value of $i(.)$ that solves $q\left(y,\tau,B'\right) = \frac{[\lambda+(1-\lambda)\nu]}{\lambda+i(y,\tau,B')}$.

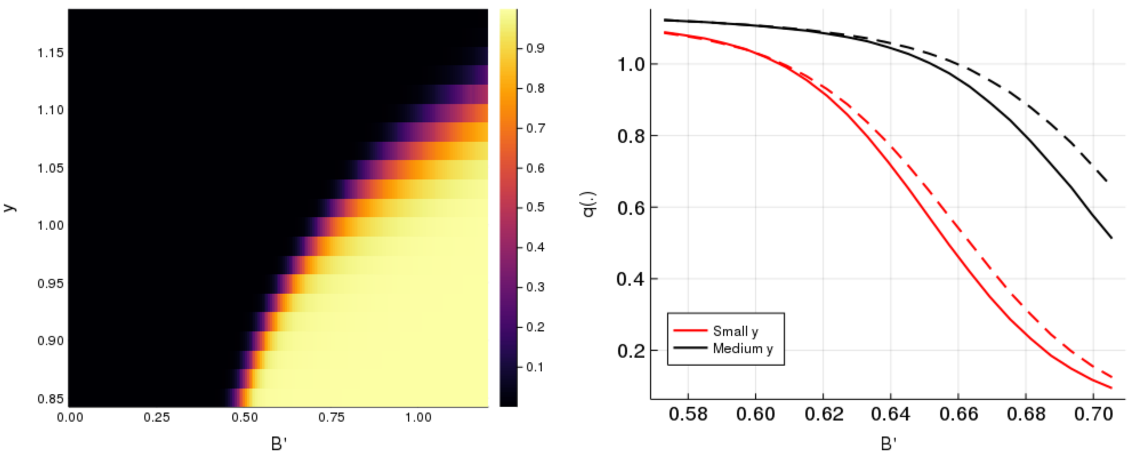
[23] As we showed in Section 2, these terms could be in principle time-varying functions. We also use an exponential specification purely for computational reasons: to avoid having a negative price.

Table 5
Targeted Moments

| Target | Description | Data | Model |
|---|---|---|---|
| $\mathbb{E}[SP]$ | Average bond spreads | 630bp | 514bp |
| $\sigma(SP)$ | Volatility spreads | 253bp | 166bp |
| $\mathbb{E}[D/Y]$ | Average debt | 72% | 62% |
| $\eta$ | Demand Elasticity | $-0.35$ | $-0.32$ |
| $\Psi$ | Average Premium | 1.0 | 1.005 |

Figure 7
Default Set and Bond Prices

(a) Default Set (b) Bond Price




Note: Panel A: The figure shows the default policy for different combinations of $B'$ and $y$. Panel B: The solid lines show the bond-pricing kernel $q(y, \tau, B')$ for different values of $B'$ and for two values of output. The dashed lines show the bond price under a perfectly elastic demand, taking as given the same bond and repayment policies as in our baseline model (i.e., $q(.)/\Psi(.)$).

where $\bar{B}$ denotes the average debt stock and $\bar{\mathcal{T}}$ denotes passive investors' average holdings. This is equivalent to target an average $\Psi(.)$ that is equal to one ($\mathbb{E}\left(\Psi\left(y, \tau, B'\right)\right) = 1$). The only effect of introducing $\Psi(.)$ is thus to affect the sensitivity of changes in $B'$ in the pricing of the sovereign bonds around the average $\{\bar{B}, \bar{\mathcal{T}}, \bar{\mathcal{A}}\}$ point.

Figure 7 shows the default set and the bond-price function $q(.)$ for different values of $B'$ and $y$. Panel (a) shows that the government defults in states with high debt and low output. The bond price is thus decreasing in $B'$ and increasing in $y$ (Panel (b), solid lines). The dashed lines in Panel (b) show the bond price in a counterfactual in which we take the baseline $B'(.)$ policy but we assume that the demand is perfectly elastic (i.e., it shows the $q(.)/\Psi(.)$ function). For low levels of $B'$, when the default risk is small, bond prices are almost unaffected by the downward-sloping demand. As $B'$ increases, the larger volatility of returns decreases $\Psi$ and thus the bond price $q$.

## 5.2 Decomposing the Demand Elasticity

We formally disentangle the different channels through which changes in $\mathcal{T}$ affect bond prices. As explained in Section 2 and as shown in Equation (18), index rebalancing affects bond prices through two channels: (i) the demand elasticity of active investors, $\eta$, (ii) changes in default risk and in the expected repayment function, $\alpha$. Using the calibrated model, we can easily shut down the effect of changes in default risk on bond prices, which allows us to properly identify the demand elasticity.

Figure 8 decomposes the different elements behind Equation (18). The black line shows the relative change in bond prices driven by an exogenous index rebalancing (the "total" effect). The blue line shows the demand elasticity, $\eta$. The vertical differences between the two curves (dotted red lines) capture the repayment channel, $\alpha$. Consistent with our empirical analysis based on CDS spreads, we find that the index rebalancings lead to changes in the expected repayment that amplify the response of bond prices. The absolute bias can be substantial, particularly for larger values of $B'$ and for higher bond spreads. In Table 6, report the unconditional average for $\eta$, $\alpha$, and for the total effect. On average, the repayment channel, $\alpha$, explains about a third of the total effect.

To sum up, even if the fundamentals of the economy $(y, B')$ are fixed, changes in the demand of passive investors (our FIR measure) affect a country's default risk, which ends up affecting bond prices. Failing to account for these effects, thus, introduces a bias in the empirical estimates of the price demand elasticity.

Table 6
The Demand Elasticity

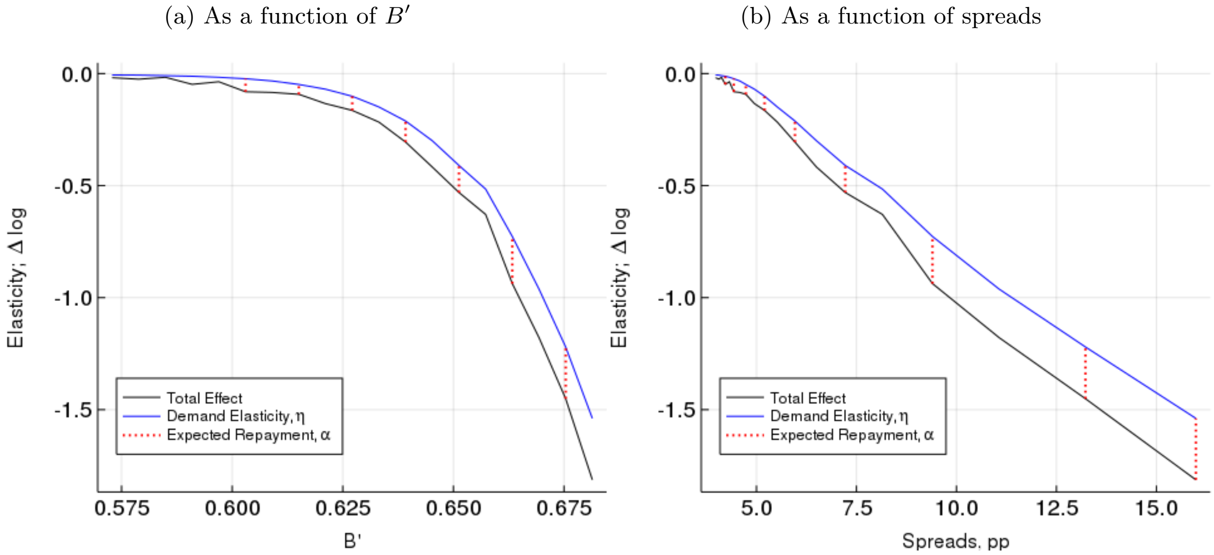
| Moment | Demand Elasticity, $\eta$ | | | Repayment Effect, $\alpha$ | Total Effect |
|---|---|---|---|---|---|
| | Slope | Rel. Var | Total | | |
| Average | -0.235 | 0.029 | -0.206 | -0.108 | -0.315 |
| Standard Deviation | 0.499 | 0.158 | 0.402 | 0.214 | 0.591 |

Given our specification for $\Psi(.)$, we can further decompose the demand elasticity as follows:

$$\eta = -\kappa_0 \frac{\mathbb{V}(\mathcal{R}'(.))}{\mathbb{E}(\mathcal{R}'(.))}(B' - \mathcal{T}') + \kappa_0 \frac{\Delta\left(\frac{\mathbb{V}(\mathcal{R}'(.))}{\mathbb{E}(\mathcal{R}'(.))}\right)}{\Delta \mathcal{T}'}(B' - \mathcal{T}') \times (B' - \mathcal{T}' - \kappa_1). \tag{21}$$

The first term on the right hand side captures the "slope" of the demand of active investors when keeping the (relative) variance of the repayment function fixed. By design, the slope is higher (in magnitude) the larger the variance of the repayment function, which captures our

Figure 8
Disentangling the Demand Elasticity




Note: The figure decomposes the different channels through which index rebalancings affect bond prices. The black lines show the total effect: $(-)\frac{\Delta q(.)}{\Delta \mathcal{T}'} \times \frac{B'-\mathcal{T}'}{q(.)}$. The blue lines show the demand elasticity $\eta$. The vertical difference between the two lines captures the $\alpha$ channel (dotted red lines). Panel (a) shows the results as a function of $B'$. Panel (b) shows the results as a function of annualized bond spreads.

empirical finding that the demand elasticity is higher for riskier countries. The second term captures changes in the relative variance of the repayment function with respect to $\mathcal{T}'$. Table 6 shows that the latter mechanism is small (given our calibration strategy) and most of the demand elasticity is explained by the "slope" term.

### 5.3 Implications of a Downward-sloping Demand

We analyze next how a downward-sloping demand affects a government's optimal policy functions, and its implications on bond prices. Table 7 reports the set of targeted moments as well as other untargeted moments for our baseline model and for a counterfactual with a perfectly elastic demand ($\kappa_0 = \kappa_1 = 0$). When facing an inelastic demand, we find that the default frequency and average spreads are *lower* relative to the perfectly elastic case, despite similar values of debt.

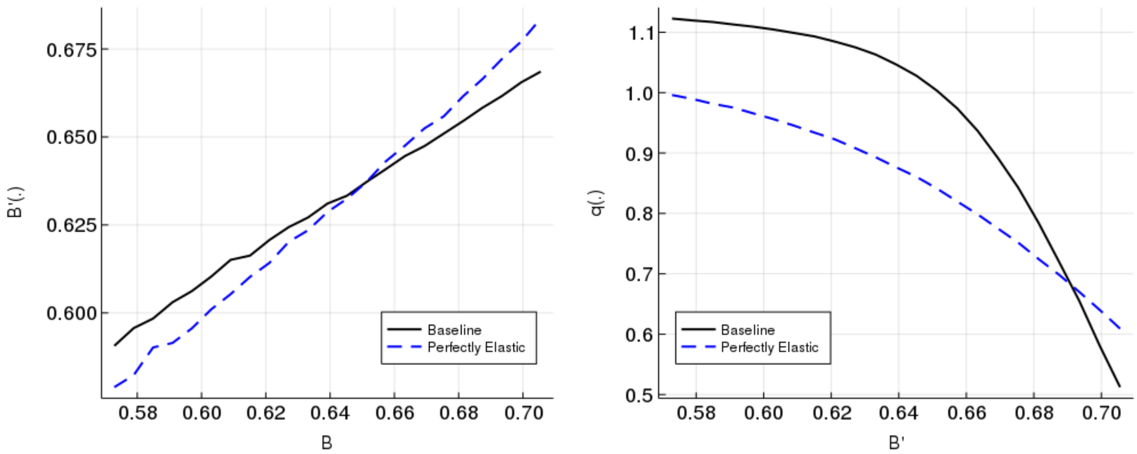
Table 7
Comparison with Perfectly Elastic Case

| Moment | Description | Baseline | Perfectly Elastic |
|---|---|---|---|
| $\mathbb{E}(SP)$ | Average bond spreads | 514bp | 880bp |
| $\sigma(SP)$ | Volatility spreads | 166bp | 509bp |
| $\mathbb{E}(B/y)$ | Average debt | 62% | 59% |
| $\mathbb{E}(d)$ | Default Frequency | 3.88% | 4.82% |
| $\sigma(B)/\sigma(y)$ | Standard deviation of debt, relative to output | 1.925 | 2.404 |
| $\rho(SP, y)$ | Correlation between spreads and output | -0.723 | -0.469 |

Why is this the case? First, the government's bond policy is significantly affected by a downward-sloping demand. Panel A of Figure 9 shows the optimal debt policy in our baseline model and in the perfectly elastic case. For large values of $B$ (in states where $\mathbb{V}(\mathcal{R}'(.))$ is high), an additional unit of $B'$ reduces the bond price $q(.)$ not only due to a higher default risk, but also due to investors' inelastic behavior. As a result, the government does not find it optimal to issue large amounts of debt because it is too costly to do so. An inelastic demand, thus, introduces a limit to the maximum amount of debt that a government is willing to issue.

Figure 9
Implications on Policies and Prices

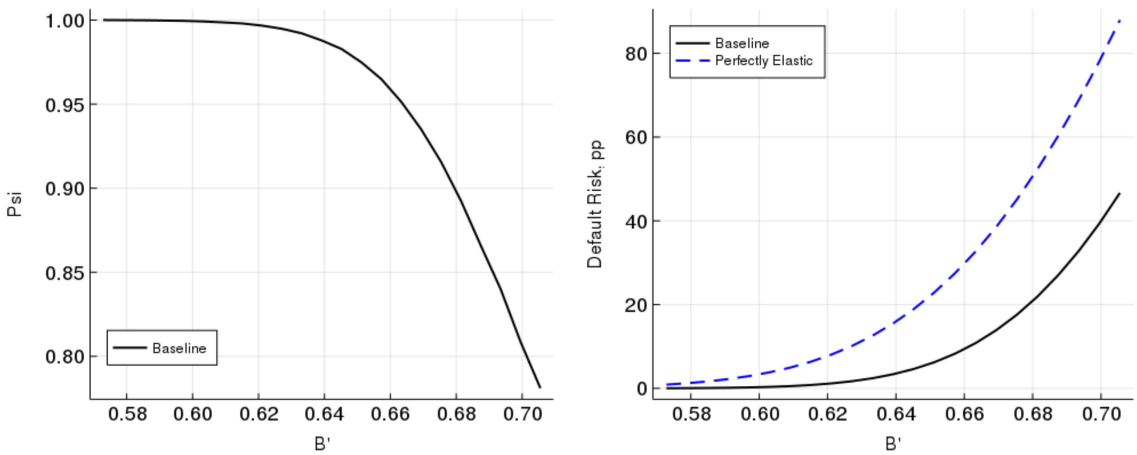
(a) Bond Policy (b) Bond Price




Note: The figure shows bond policies and prices for our baseline model with inelastic investors (black solid lines) and in an alternative model in which investors are perfectly elastic (blue dotted lines).

Figure 10
Inconvenience Yield and Default Risk

(a) $\Psi(y, \tau, B')$ (b) Default Risk, Annualized




Note: Panel A shows the $\Psi(y, \tau, B')$ function for different values of $B'$. Panel B shows the default risk in our baseline model (black solid lines) and in a counterfactual in which investors are perfectly elastic (blue dotted lines).

Second, these changes in the optimal bond policy have important effects on the pricing of bonds (Panel B of Figure 9). For small values of $B'$ (low default risk), $q(.)$ is actually *higher* than under the perfectly elastic case. As shown in Figure 10 (Panel A), this larger bond price is not driven by a convenience yield since, by construction, $\Psi(.)$ is always smaller than one. Instead, the higher bond price is explained by a lower default risk (Panel B), which is a direct consequence of the government's lower incentives to issue large values of $B'$.

To sum up, an inelastic demand diminishes a government's incentives to issue additional units of debt. Consequently, it acts as a commitment device, reducing a government's default risk and increasing bond prices.

# 6 Conclusion

We present novel evidence of downward-sloping demand curves in international sovereign-debt markets and analyze its implications on the optimal supply of risky sovereign bonds. Estimating a demand elasticity for risky bonds poses additional challenges (relative to a safe bond) because the demand itself depends on a bond's default risk. To address this, we combine a structural model with high-frequency bond-level price reactions to exogenous shifts in the effective supply of bonds. This combination allows us to isolate the role of default risk and back out a demand elasticity.

Overall, we find that global investors in sovereign-debt markets are inelastic. An exogenous 1% reduction in the effective supply of sovereign bonds leads to a 67 basis point increase in bond prices. Our structural model reveals that two thirds of this effect can be attributed to a demand elasticity component (the rest is captured by changes in default risk). We use the model to analyze the implications of downward-sloping demand curves for governments' optimal debt and default policies. We show that by diminishing a government's incentives to issue additional units of debt, a downward-sloping demand acts as a commitment device that reduces default risk.

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# A Appendix: A Model of Heterogeneous Inelastic Investors

In this appendix, we first provide additional material and derivations for the analysis in Section 2. We then describe micro-foundations for the assumed demand structure. We analyze two related cases. In the first one, the inelasticity comes from investors' risk aversion. In the second one, it is rooted in a Value-at-Risk constraint to which investors are subject to.

## A.1 Additional Derivations

From Equation (1) in the main text, and based on a first-order approximation for the elastic component of the demand, $e^{\kappa_j \hat{\pi}_{i,t}}$, around $\bar{\pi}_i$, we can write the purchases of active investors as follows:

$$\tilde{\mathcal{A}}_t^i = \sum_j (1 - \Lambda_j \bar{\pi}_i) W_{j,t} \theta_j \xi_j^i e^{\Lambda_j \bar{\pi}_i} + \frac{\mathbb{E}_t \left(r_{t+1}^i\right)}{\mathbb{V}_t \left(r_{t+1}^i\right)} \sum_j \Lambda_j W_{j,t} \theta_j \xi_j^i e^{\Lambda_j \bar{\pi}_i} \tag{A1}$$

The first term captures investor $j$'s average purchases of bond $i$, which are given by the exogenous mandate $\xi_j^i$. The second term captures deviations from those purchases (i.e., the elastic component of the demand), which is a function of the bond's expected next-period excess return and its variance (Sharpe ratio).

Define $\mathcal{R}_{t+1}^i$ as the next-period repayment per unit of the bond, so that $r_{t+1}^i \equiv \frac{\mathcal{R}_{t+1}^i - r_f}{q_t^i}$, where $r_f$ denotes the risk-free rate. We can then write $\frac{\mathbb{E}_t\left(r_{t+1}^i\right)}{\mathbb{V}_t\left(r_{t+1}^i\right)} = q_t^i \times \left(\frac{\mathbb{E}_t \mathcal{R}_{t+1}^i - q_t^i r_f}{\mathbb{V}_t \mathcal{R}_{t+1}^i}\right)$. Without loss of generality, consider a case in which $\bar{\pi}_i$ is close to zero. After replacing with $\mathcal{R}_{t+1}^i$ we can rewrite Equation (A1) as follows:

$$\tilde{\mathcal{A}}_t^i = q_t^i \bar{\mathcal{A}}_t^i + q_t^i \left(\frac{\mathbb{E}_t \mathcal{R}_{t+1}^i - q_t^i r_f}{\mathbb{V}_t \mathcal{R}_{t+1}^i}\right) \sum_j \Lambda_j W_{j,t} \theta_j \xi_j^i, \tag{A2}$$

where $\bar{\mathcal{A}}_t^i \equiv \sum_j \theta_j \bar{B}_{j,t}^i$.

As for the demand of passive investors, let $M_t$ denote the market value of the index $\mathcal{I}$ and define $S_t^i$ as bond $i$'s face value included in such index. For simplicity, assume that bond $i$ is only included in index $\mathcal{I}$. Then, $w_t^i = \frac{S_t^i q_t^i}{M_t}$ and we can write the purchases made by passive investors as:

$$\tilde{\mathcal{T}}_t = q_t^i S_t^i \sum_j \frac{W_{j,t} (1 - \theta_j)}{M_t} = q_t^i \mathcal{T}_t^i \tag{A3}$$

where $\mathcal{T}_t^i \equiv S_t^i \sum_j \frac{W_{j,t}(1-\theta_j)}{M_t}$ denotes the face value of passive investors' holdings of bond $i$.

After replacing Equations (A2) and (A3) in the market clearing condition (Equation 2 in the main text), we obtain a closed-form solution for the bond price:

$$q_t^i = \frac{\mathbb{E}_t \left(\mathcal{R}_{t+1}^i\right)}{r_f} \left[1 - \kappa_t^i \frac{\mathbb{V}_t \left(\mathcal{R}_{t+1}^i\right)}{\mathbb{E}_t \left(\mathcal{R}_{t+1}^i\right)} \left(B_{t+1}^i - \mathcal{T}_{t+1}^i - \bar{\mathcal{A}}_t^i\right)\right], \tag{A4}$$

where $\kappa_t^i (\boldsymbol{\Lambda}) = \frac{1}{\sum_j \Lambda_j W_{j,t} \theta_j \xi_j^i}$ parameterizes the downward slopping behavior of the demand. It is a weighted average of investors' $\{\Lambda_j\}$ parameters, where the weights are given by the amount that each investor allocates (by mandate) on bond $i$.

Next, we show that we can obtain an analogous pricing kernel under risk-averse investors or in a case in which investors are risk neutral but subject to a standard Variance-at-Risk constraint.

## A.2 Microfoundation Based on Risk-averse Investors

Consider a case in which investors are risk averse and have mean-var preferences. They care about the total return of their portfolio and also about their return relative to a benchmark index $\mathcal{I}$ they track. Investors are heterogeneous and they differ on their degree of risk aversion and on how their compensation depends on their total and relative return. Following the same notation as in the main text, let $j = \{1, ..., J\}$ denote the investor type. Let $i = \{1, ..., N\}$ denote the set of bonds that are part of the $\mathcal{I}$ index and let $\boldsymbol{w}_t = \left\{w_t^1, ..., w_t^N\right\}$ be the vector of index weights for each constituent bond. The vector $\boldsymbol{r}_{t+1} = \left\{{r_{t+1}^i}^1, ..., {r_{t+1}^i}^N\right\}$ denotes the next-period (gross) returns (i.e., the bond gross return in excess of the risk-free rate, $r^f$). Lastly, let $\boldsymbol{B}_t = \left\{B_t^1, ..., B_t^N\right\}$ denote the supply of bonds.

For an investor of type $j$, its total compensation is a convex combination between the return of its portfolio and the relative return versus the index $\mathcal{I}$. Let $\boldsymbol{x}_{j,t} = \left\{x_{j,t}^1, ..., x_{j,t}^N\right\}$ be the vector of portfolio weights for investor $j$. Its compensation is

$$
\begin{aligned}
TC_{j,t} &= \theta_j \left(\boldsymbol{x}_{j,t}\right)' \cdot \boldsymbol{r}_{t+1} + \left(1-\theta_j\right)\left(\boldsymbol{x}_{j,t} - \boldsymbol{w}_t\right)' \cdot \boldsymbol{r}_{t+1} \\
&= \left[\boldsymbol{x}_{j,t} - \left(1-\theta_j\right)\boldsymbol{w}_t\right]' \cdot \boldsymbol{r}_{t+1},
\end{aligned}
$$

where $\theta_j$ captures the weight that relative returns have on the compensation of the investor.

Each investor chooses a combination of portfolio weights $\boldsymbol{x}_{j,t}$ to maximize $\mathbb{E}_t\left(TC_{j,t}\right) - \frac{\sigma_j}{2}\mathbb{V}_t\left(TC_{j,t}\right)$, where $\sigma_j$ captures the investor's risk aversion. In matrix form, we can write this problem as follows:

$$
\mathrm{Max}_{\boldsymbol{x}_j} \left[\boldsymbol{x}_{j,t} - \left(1-\theta_j\right)\boldsymbol{w}_t\right]' \boldsymbol{\mu}_t - \frac{\sigma_j}{2}\left[\boldsymbol{x}_{j,t} - \left(1-\theta_j\right)\boldsymbol{w}_t\right]' \boldsymbol{\Sigma}_t \left[\boldsymbol{x}_{j,t} - \left(1-\theta_j\right)\boldsymbol{w}_t\right],
$$

where $\boldsymbol{\mu}_t \equiv \mathbb{E}_t\left(\boldsymbol{r}_{t+1}\right)$ denotes the expected excess return of the portfolio and $\boldsymbol{\Sigma}_t \equiv \mathbb{V}_t\left(\boldsymbol{r}_{t+1}\right)$ denotes the variance-covariance matrix of excess returns. It is straightforward to show that the optimal portfolio allocation for investor $j$ is given by

$$
\boldsymbol{x}_{j,t} = \frac{1}{\sigma_j}\boldsymbol{\Sigma}_t^{-1}\boldsymbol{\mu}_t + \left(1-\theta_j\right)\boldsymbol{w}_t. \tag{A5}
$$

The first term in the right-hand side of Equation (A5) captures the usual mean-variance portfolio. We can obtain an analogous expression under CARA preferences (see, for instance Pavlova and Sikorskaya, 2022). The second term accounts for the fact that some investors do not want to deviate from the benchmark portfolio, $\boldsymbol{w}$. Such demand is inherently inelastic. It is not a function of the expected return or riskiness of the bonds and depends only on how much investors penalize deviations from the benchmark. Purely passive investors (i.e., those with $\theta_j = 0$ and $\sigma_j \to \infty$) never deviate from the benchmark portfolio and exhibit a perfectly inelastic demand.

Let $W_{j,t}$ denote the wealth of each type of investor $j$. Then $B_{j,t}^i = \frac{W_{j,t}x_{j,t}^i}{q_t^i}$ are the purchases of bond $i$ made by investor $j$, where $q_t^i$ denotes the bond price. For each bond $i$, its market clearing condition is $q_t^i B_t^i = \sum_j W_{j,t}x_{j,t}^i$. After we replace with investors' optimal portfolio weights, the market clearing conditions are given by

$$\begin{bmatrix} q_t^1 B_t^1 \\ \vdots \\ q_t^N B_t^N \end{bmatrix} = \sum_j W_{j,t} \left[ \frac{1}{\sigma_j} \boldsymbol{\Sigma}_t^{-1} \boldsymbol{\mu}_t + (1-\theta_j)\, \boldsymbol{w}_t \right] \tag{A6}$$

$$= \tilde{\boldsymbol{\mathcal{A}}}_t + \tilde{\boldsymbol{\mathcal{T}}}_t,$$

where $\tilde{\boldsymbol{\mathcal{A}}}_t \equiv \sum_j W_{j,t} \frac{1}{\sigma_j} \boldsymbol{\Sigma}_t^{-1} \boldsymbol{\mu}_t$ denotes the active component of investors' demand (at market value). Since investors are risk averse, $\tilde{\mathcal{A}}_t^i$ is downward sloping and it is a function of the expected return of bond $i$ and of its variance-covariance matrix. The term $\tilde{\boldsymbol{\mathcal{T}}}_t \equiv \boldsymbol{w}_t \sum_j W_{j,t} (1-\theta_j)$ denotes the passive demand (at market value).

Take the market clearing condition of Equation (A6) and assume for simplicity only two assets. For easiness of exposure consider that bond $i$ is risky and that bond $-i$ is not. It is straightforward to show that the price for bond $i$ is given by

$$q_t^i = \frac{\mathbb{E}_t \left( \mathcal{R}_{t+1}^i \right)}{r^f} \times \Psi_t^i, \tag{A7}$$

where $\mathcal{R}_{t+1}^i$ denotes the next-period repayment per unit of the bond and $\Psi_t^i$ captures the downward-sloping nature of the demand and is given by

$$\Psi_t^i \equiv 1 - \kappa_t^{\mathrm{RA}} \frac{\mathbb{V}_t \left( \mathcal{R}_{t+1}^i \right)}{\mathbb{E}_t \left( \mathcal{R}_{t+1}^i \right)} \left( B_t^i - \mathcal{T}_t^i \right), \tag{A8}$$

where $1/\kappa_t^{\mathrm{RA}} \equiv \sum_j \frac{W_{j,t}}{\sigma_j}$ denotes the weighted-average risk aversion coefficient and $\mathcal{T}_t^i \equiv \tilde{\mathcal{T}}_t^i / q_t^i$ denotes the (face value) holdings of passive investors.

Notice that the bond price in Equation (A8) is analogous to the one in Equation (A4). The key difference is that, with risk-averse lenders the price elasticity is captured only by investors' risk aversion. In our main analysis, we do not take a stand on what is the mechanism behind that elasticity.

### A.3 Microfoundation Based on a Value-at-Risk Constraint

An identical expression can be also derived for investors that are risk neutral and subject to a Value-at-Risk (VaR) constraint. These constraints are common both in the literature and in the regulatory sphere (see, for instance, Miranda-Agrippino and Rey, 2020).[24]

Consider an analogous setup to the one in the previous subsection. Investors are heterogeneous and they care about their absolute and relative return with respect to an index $\mathcal{I}$. They are risk neutral and are subject to a Value-at-Risk constraint that imposes an upper limit on the amount of risk that it can take. In particular, the problem for investor $j$ can be written as:

$$\begin{aligned} &\mathrm{Max}_{\{x_{j,t+1}^1, \dots x_{j,t+1}^N\}}\ \mathbb{E}_t \Big( \left[ \boldsymbol{x}_{j,t+1} - (1-\alpha_j)\, \boldsymbol{s}_{t+1} \right]' \cdot \boldsymbol{r}_{t+1} \Big) \\ &\qquad \text{subject to} \ \ \varPhi^2 \mathbb{V}_t \Big( \left[ \boldsymbol{x}_{j,t+1} - (1-\alpha_j)\, \boldsymbol{s}_{t+1} \right]' \cdot \boldsymbol{r}_{t+1} \Big) - 1 \leq 0, \end{aligned}$$

[24] Adrian and Shin (2014) provide a microfoundation for VaR constraints. Gabaix and Maggiori (2015) use a similar constraint, in which the outside option of a financier is increasing in the size and variance of its balance sheet.

where the parameter $\varPhi^2$ captures the intensity of the risk constraint. We view $\varPhi^2$ as a regulatory parameter that limits the amounts of risk that an investor can take. Let $\varrho_j$ denote the Lagrange multiplier associated with the Var-at-Risk constraint. It is straightforward to show that the optimal portfolio is given by:

$$\boldsymbol{x}_{j,t} = \frac{1}{\varrho_j \varPhi^2} \boldsymbol{\Sigma}_t^{-1} \boldsymbol{\mu}_t + (1 - \theta_j)\, \boldsymbol{w}_t. \tag{A9}$$

The previous optimal portfolio is identical to that of Equation (A5). The only difference is that the risk-aversion parameter $\sigma$ has been replaced by the product of the Lagrange multiplier $\varrho_j$ and the regulatory parameter $\varPhi^2$. Following the same steps as before, we can then derive an analogous pricing kernel to that of Equations (A7) and (A8). That is,

$$q_t^i = \frac{\mathbb{E}_t\left(\mathcal{R}_{t+1}^i\right)}{r^f} \left[1 - \kappa_t^{\mathrm{VaR}} \frac{\mathbb{V}_t\left(\mathcal{R}_{t+1}^i\right)}{\mathbb{E}_t\left(\mathcal{R}_{t+1}^i\right)} \left(B_t^i - \mathcal{T}_t^i\right)\right]. \tag{A10}$$

where $1/\kappa_t^{\mathrm{VaR}} \equiv \sum_j \frac{W_{j,t}}{\lambda_j \varPhi^2}$ denotes the (weighted-average) intensity for which the Variance-at-Risk constraint binds in the aggregate.

# B Appendix: Diversification Methodology

The diversification methodology anchors on the average size (debt stock) of countries in the index and the debt stock of the largest country in the index.

$$Index\ Country\ Average\ (ICA)\ =\ \frac{\sum(Ctry\ Face\ Amount)}{No.\ of\ Countries\ in\ the\ Index}$$

Based on the ICA, the diversified face amount for any country in the index is derived according to the following rules:

1. The largest country based on face amount will be capped at double the average country debt stock in the index (ICA*2). This is the maximum threshold and sets the scale to determine the diversified face amounts of other countries in the index.

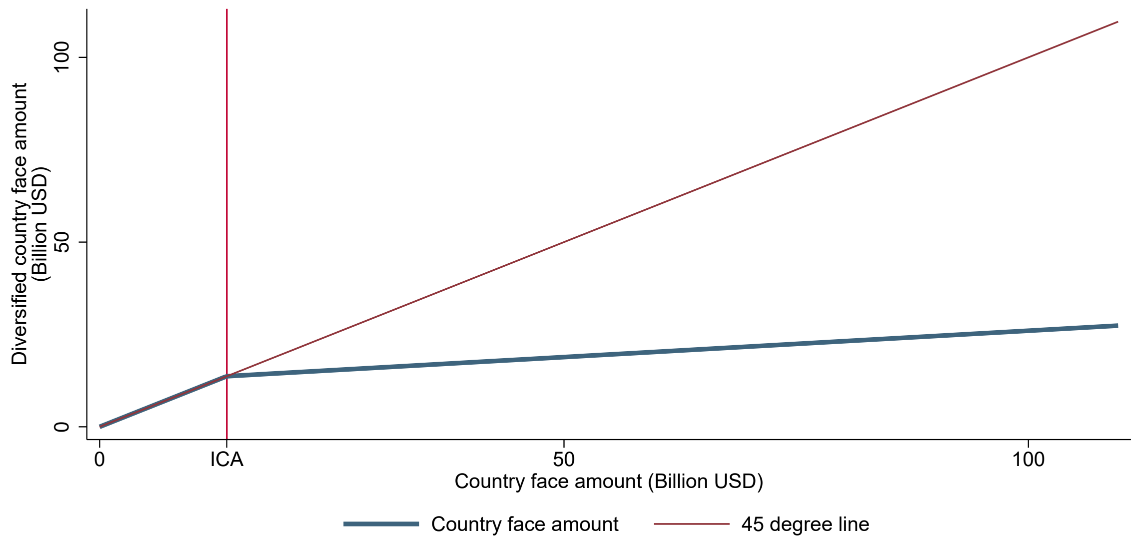
2. If a county's debt stock is below the index country average (ICA), the entire amount will be eligible for inclusion.

3. Countries whose debt stock falls between the index country average (ICA) and double the average (ICA * 2) will be linearly interpolated.

The below formula summarizes the calculation of diversified country face amount:

$$Div.\ Ctry\ FA = \begin{cases} ICA*2 & if\ \ FA_{max} \\ ICA + \frac{ICA}{FA_{max}-ICA} * (Ctry\ FA\ -\ ICA) & if\ \ Ctry\ FA\ >\ ICA \\ Ctry\ FA & if\ \ Ctry\ FA\ \leq\ ICA \end{cases}$$

Figure B1
Effect of the diversification methodology on the amount of the bonds' face values used to compute the weights

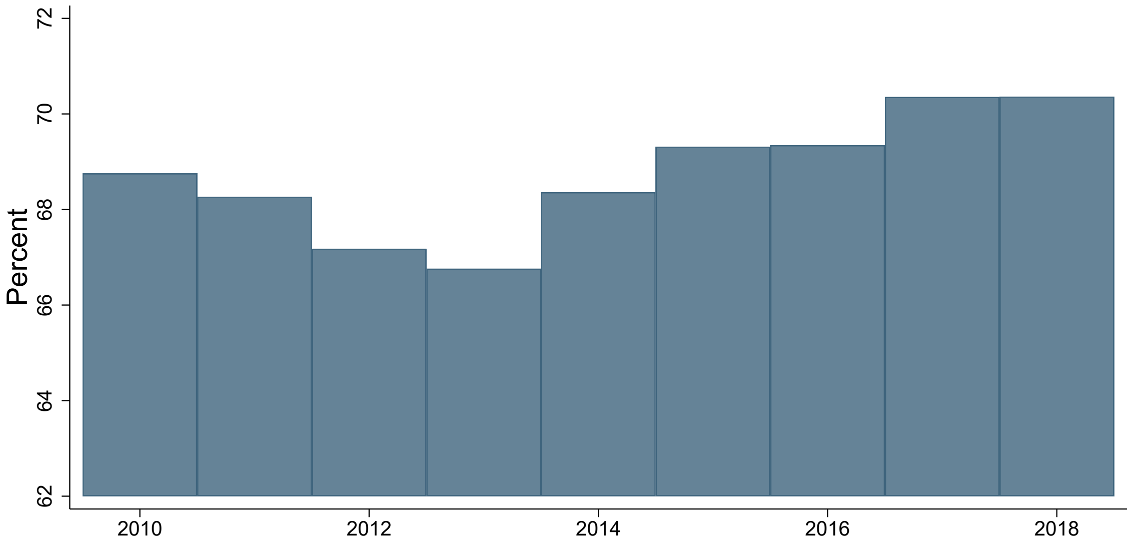



Note: The figure illustrates the differences between the country-level face values and their diversified versions, which the index uses to generate bond weights. The data used is from December 2018.
Sources: JPMorgan Markets, and authors' calculations.

Subsequently, the same proportional reduction or increase that the country-level face amount suffered is applied to each bond from that country. The diversified market value is then computed by multiplying the diversified face amount by the price of the bond. The diversified weight of each bond is its share of the index diversified market capital. In addition, country weights will be capped at 10%. Any excess weight above the cap will be redistributed to smaller countries that are below the cap in a pro rata form across all bonds of countries not capped at 10%. Figure B1 compares the country-level diversified vs non-diversified face amounts.

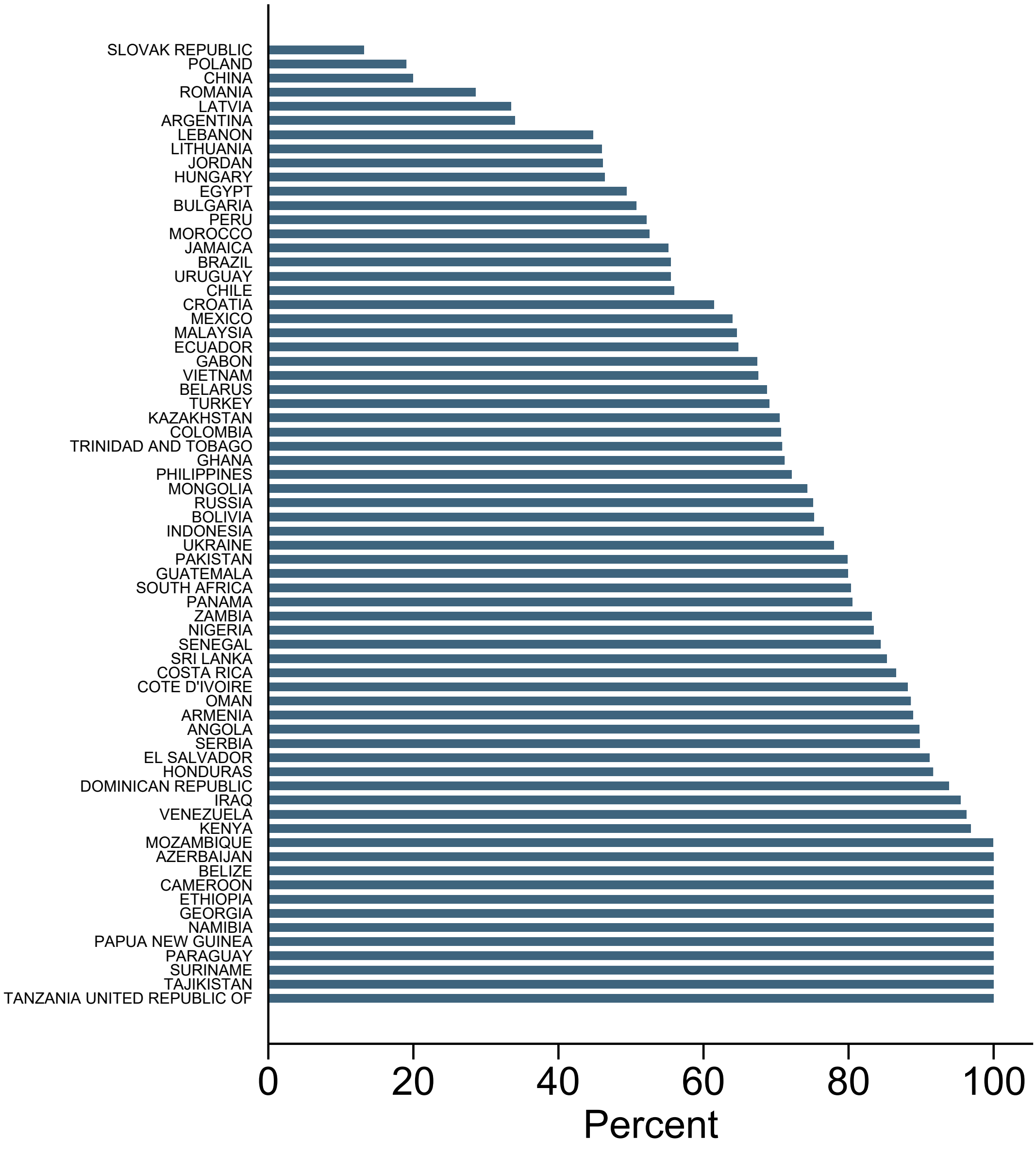
## C Appendix: Additional Tables and Figures

Figure C1
USD-denominated emerging-market sovereign debt as a share of emerging-market general government international debt securities



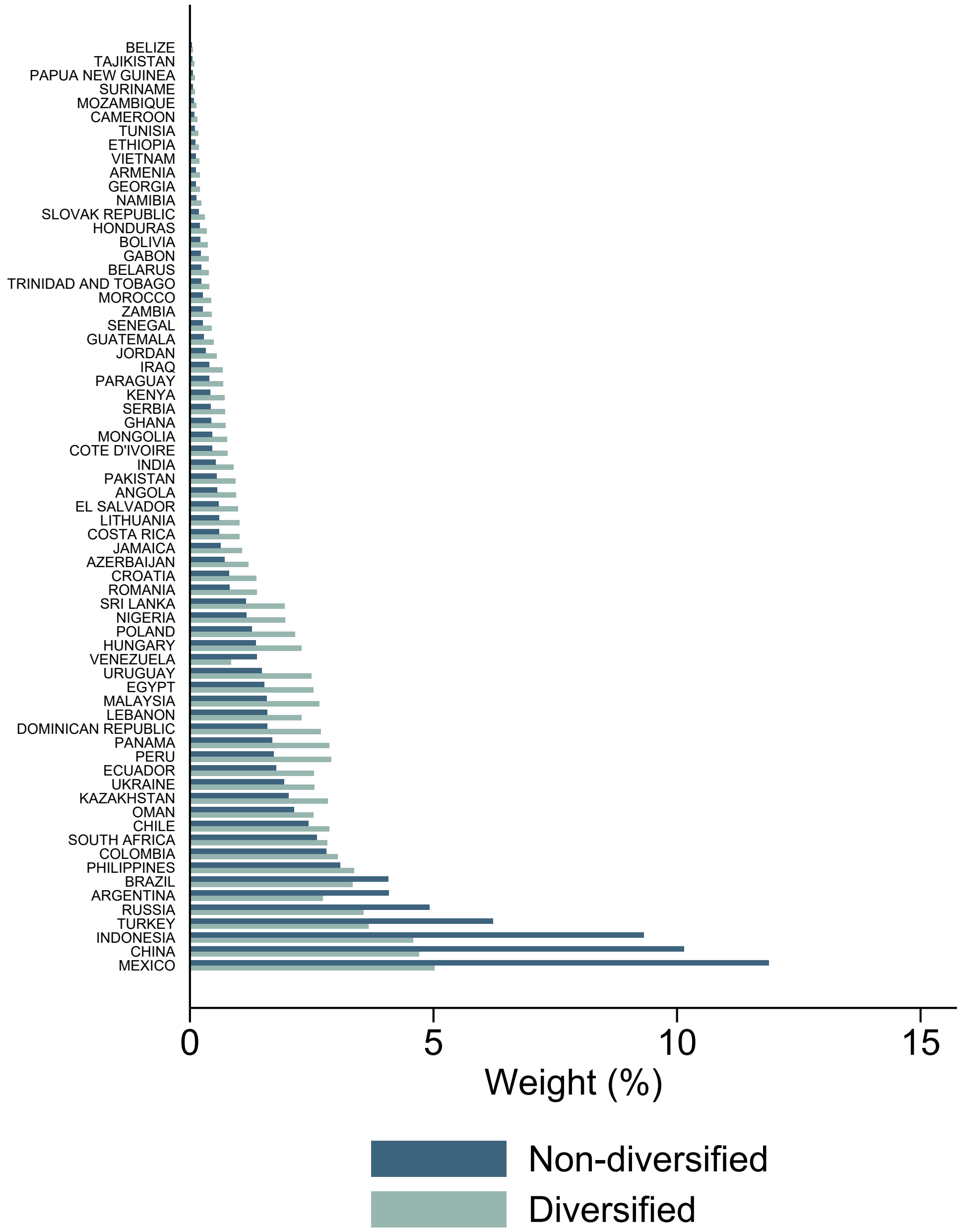

Note: The bars represent the value of USD-denominated sovereign debt included in the EMBI Global index as a percentage of general government international debt securities of the corresponding countries. The averages are created by computing the percentage for each country and year and then averaging across countries in each year. Each country's percentage is weighted by its debt amount outstanding included in the EMBI indexes.
Sources: BIS, JPMorgan Markets, and authors' calculations.

Figure C2
USD-denominated emerging-market sovereign debt as a share of emerging-market general government international debt securities



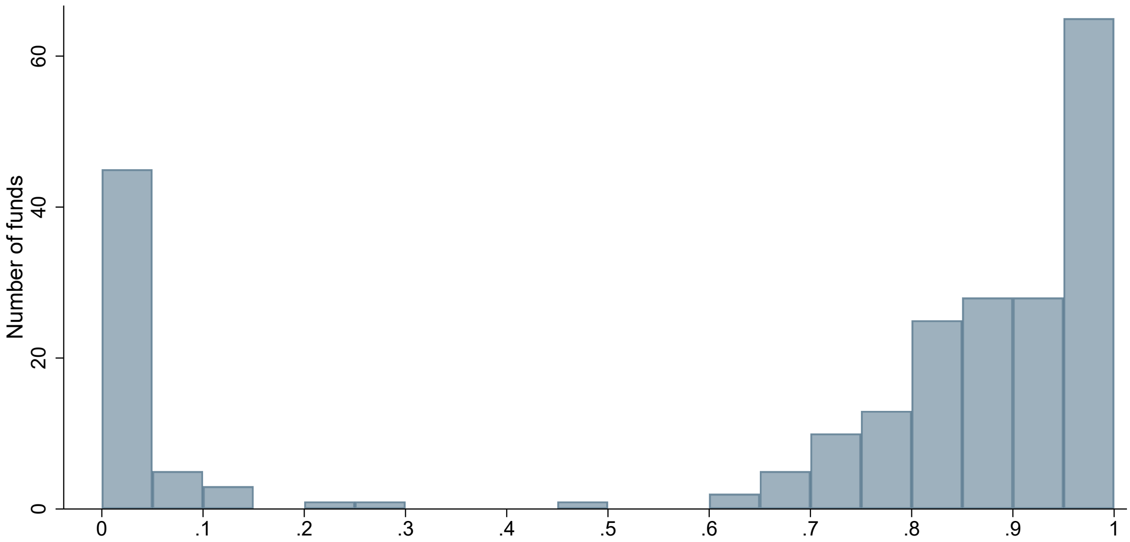

Note: The bars represent the value of USD-denominated sovereign debt included in the EMBI Global index as a percentage of general government international debt securities of the corresponding countries. The averages are created by computing the percentage for each country and year and then averaging across years 2010-2018 for each country.
Sources: BIS, JPMorgan Markets, and authors' calculations.

Figure C3
Country-level weights in December 2018




Note: The figure illustrates the country-level diversified and non-diversified weights for December 2018. Country-level weights are computed as the sum of the weights of all bonds from the country included in the index.
Sources: JPMorgan Markets, and authors' calculations.

Figure C4
Distribution of $R^2$ from linear regressions of returns of funds benchmarked to the EMBI Global Diversified versus EMBI Global Diversified returns




Note: Distribution of the $R^2$ values from fund-by-fund regressions of fund returns against EMBI Global Diversified returns. Only funds benchmarked to the CEMBI Global Diversified and Core indexes are included. Returns expressed in USD are utilized.
Sources: Morningstar Direct, JPMorgan Markets, and authors' calculations.

Table C1
Log Price and FIR

| Dependent Variable: Log Price | | | | |
|---|---|---|---|---|
| | 20% | 25% | 30% | 35% |
| FIR Instrumented*Post | 1.076*** | 0.835*** | 0.674*** | 0.621*** |
| | (0.311) | (0.242) | (0.195) | (0.180) |
| Post | 0.002*** | 0.002*** | 0.002*** | 0.002*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Bond FE | Yes | Yes | Yes | Yes |
| Maturity-Rating-Bond Type-Time FE | Yes | Yes | Yes | Yes |
| Country-Time FE | Yes | Yes | Yes | Yes |
| Bond Controls | Yes | Yes | Yes | Yes |
| Observations | 134,847 | 134,847 | 134,847 | 134,847 |
| N. of Bonds | 758 | 758 | 758 | 758 |
| N. of Countries | 69 | 69 | 69 | 69 |
| N. of Clusters | 1,812 | 1,812 | 1,812 | 1,812 |
| $R^2$ | 0.002 | 0.002 | 0.002 | 0.002 |

Note: This table presents results from 2SLS estimations of log price on different explanatory variables around rebalancing dates. The first stage and second stage equations are described in 10. The sample period is 2016-2018 and contains a window of 10 trading days around each end of the month rebalancing date. The dependent variable is the log price of a bond. FIR Instrumented is the FIR from 7 instrumented with $Z$ in 9. Post is an indicator variable that is 1 for the day of the rebalancing and 5 trading days after it, and 0 otherwise. Each different column indicates the share of passive funds used to construct the FIR face amount measure. Time fixed effects are dummy variables for each month of rebalancing. Maturity fixed effects are constructed by dividing the time to maturity of a bond into four different categories: short (less than 5 years), medium (between 5 and years), long (10 to 20 years) and very long (more than 20 years). Ratings from each bond are from Moody's. Bond Type indicates whether a bond is sovereign or quasi-sovereign. Bond controls indicates whether the estimation includes the log face amount and log stripped spread of the bond. Standard errors are clustered at the country by month of rebalancing level. *** p<0.01, **p<0.05, * p<0.1.

Table C2
Log Price and FIR - Dropping Different Extreme Values for $Z$

| Dependent Variable: Log Price | | | | |
|---|---|---|---|---|
| | 4 Extreme Values | | 2 Extreme Values | |
| FIR Instrumented | -8.826*** | | -7.521*** | |
| | (1.490) | | (1.304) | |
| FIR Instrumented*Post | 0.523*** | 0.521** | 0.576*** | 0.575*** |
| | (0.203) | (0.204) | (0.179) | (0.181) |
| Post | 0.001*** | 0.001*** | 0.001*** | 0.001*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Bond FE | Yes | Yes | Yes | Yes |
| Maturity-Rating-Bond Type-Time FE | No | Yes | No | Yes |
| Country-Time FE | No | Yes | No | Yes |
| Bond Controls | No | Yes | No | Yes |
| Observations | 133,384 | 133,340 | 136,321 | 136,277 |
| N. of Bonds | 758 | 758 | 758 | 758 |
| N. of Countries | 69 | 69 | 69 | 69 |
| N. of Clusters | 1,772 | 1,771 | 1,854 | 1,853 |
| $R^2$ | 0.008 | 0.002 | 0.007 | 0.002 |

Note: This table presents results from 2SLS estimations of log price on different explanatory variables around rebalancing dates. The first stage and second stage equations are described in 10. The sample period is 2016-2018 and contains a window of 10 trading days around each end of the month rebalancing date. The dependent variable is the log price of a bond. FIR Instrumented is the FIR from 7 instrumented with $Z$ in 9. Post is an indicator variable that is 1 for the day of the rebalancing and 5 trading days after it, and 0 otherwise. Each different column indicates the share of passive funds used to construct the FIR face amount measure. Time fixed effects are dummy variables for each month of rebalancing. Maturity fixed effects are constructed by dividing the time to maturity of a bond into four different categories: short (less than 5 years), medium (between 5 and years), long (10 to 20 years) and very long (more than 20 years). Ratings from each bond are from Moody's. Bond Type indicates whether a bond is sovereign or quasi-sovereign. Bond controls indicates whether the estimation includes the log face amount and log stripped spread of the bond. Standard errors are clustered at the country by month of rebalancing level. *** p<0.01, **p<0.05, * p<0.1.

Table C3
Log Price and FIR - Keeping Country-Year Crises (Argentina and Turkey in 2018)

| Dependent Variable: Log Price | | | | | |
|---|---|---|---|---|---|
| FIR Instrumented | -9.764*** | -1.757 | 1.657 | | |
| | (1.414) | (2.446) | (1.219) | | |
| FIR Instrumented*Post | 0.564*** | 0.564*** | 0.563*** | 0.563*** | 0.563*** |
| | (0.197) | (0.197) | (0.199) | (0.199) | (0.199) |
| Post | 0.001** | 0.001** | 0.001** | 0.001** | 0.001** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Bond FE | Yes | Yes | Yes | Yes | Yes |
| Time FE | No | Yes | Yes | No | No |
| Maturity-Rating-Bond Type-Time FE | No | No | Yes | Yes | Yes |
| Country-Time FE | No | No | No | Yes | Yes |
| Bond Controls | No | No | No | No | Yes |
| Observations | 138,246 | 138,246 | 138,246 | 138,246 | 138,202 |
| N. of Bonds | 766 | 766 | 766 | 766 | 766 |
| N. of Countries | 69 | 69 | 69 | 69 | 69 |
| N. of Clusters | 1,829 | 1,829 | 1,829 | 1,829 | 1,828 |
| $R^2$ | 0.006 | -0.002 | 0.002 | 0.001 | 0.001 |

Note: This table presents results from 2SLS estimations of log price on different explanatory variables around rebalancing dates. The first stage and second stage equations are described in 10. The sample period is 2016-2018 and contains a window of 10 trading days around each end of the month rebalancing date. The dependent variable is the log price of a bond. FIR Instrumented is the FIR from 7 instrumented with $Z$ in 9. Post is an indicator variable that is 1 for the day of the rebalancing and 5 trading days after it, and 0 otherwise. Each different column indicates the share of passive funds used to construct the FIR face amount measure. Time fixed effects are dummy variables for each month of rebalancing. Maturity fixed effects are constructed by dividing the time to maturity of a bond into four different categories: short (less than 5 years), medium (between 5 and years), long (10 to 20 years) and very long (more than 20 years). Ratings from each bond are from Moody's. Bond Type indicates whether a bond is sovereign or quasi-sovereign. Bond controls indicates whether the estimation includes the log face amount and log stripped spread of the bond. Standard errors are clustered at the country by month of rebalancing level. *** p<0.01, **p<0.05, * p<0.1.

Table C4
Log Price and FIR - Dropping Quasi-Sovereign Bonds

| Dependent Variable: Log Price | | | | | |
|---|---|---|---|---|---|
| FIR Instrumented | -8.770*** | -0.833 | 0.879 | | |
| | (1.228) | (2.705) | (1.118) | | |
| FIR Instrumented*Post | 0.796*** | 0.796*** | 0.794*** | 0.794*** | 0.794*** |
| | (0.195) | (0.195) | (0.196) | (0.196) | (0.196) |
| Post | 0.002*** | 0.002*** | 0.002*** | 0.002*** | 0.002*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Bond FE | Yes | Yes | Yes | Yes | Yes |
| Time FE | No | Yes | Yes | No | No |
| Maturity-Rating-Bond Type-Time FE | No | No | Yes | Yes | Yes |
| Country-Time FE | No | No | No | Yes | Yes |
| Bond Controls | No | No | No | No | Yes |
| Observations | 93,708 | 93,708 | 93,708 | 93,708 | 93,664 |
| N. of Bonds | 439 | 439 | 439 | 439 | 439 |
| N. of Countries | 66 | 66 | 66 | 66 | 66 |
| N. of Clusters | 1,745 | 1,745 | 1,745 | 1,745 | 1,744 |
| $R^2$ | 0.010 | -0.000 | 0.000 | 0.002 | 0.005 |

Note: This table presents results from 2SLS estimations of log price on different explanatory variables around rebalancing dates. The first stage and second stage equations are described in 10. The sample period is 2016-2018 and contains a window of 10 trading days around each end of the month rebalancing date. The dependent variable is the log price of a bond. FIR Instrumented is the FIR from 7 instrumented with $Z$ in 9. Post is an indicator variable that is 1 for the day of the rebalancing and 5 trading days after it, and 0 otherwise. Each different column indicates the share of passive funds used to construct the FIR face amount measure. Time fixed effects are dummy variables for each month of rebalancing. Maturity fixed effects are constructed by dividing the time to maturity of a bond into four different categories: short (less than 5 years), medium (between 5 and years), long (10 to 20 years) and very long (more than 20 years). Ratings from each bond are from Moody's. Bond Type indicates whether a bond is sovereign or quasi-sovereign. Bond controls indicates whether the estimation includes the log face amount and log stripped spread of the bond. Standard errors are clustered at the country by month of rebalancing level. *** p<0.01, **p<0.05, * p<0.1.

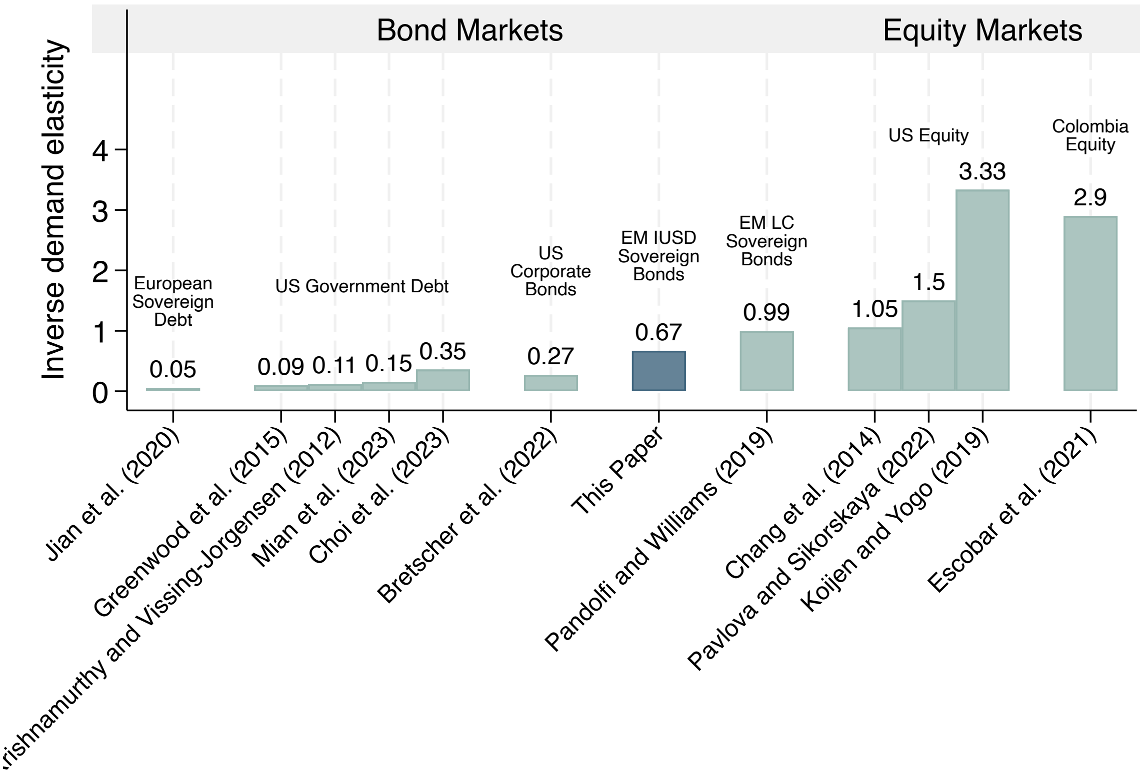
Table C5
Log Price and FIR - Spread Heterogeneity (3 Groups)

Dependent Variable: Log Price

| | High Spread | | Median Spread | | Low Spread | |
|---|---|---|---|---|---|---|
| FIR Instrumented | -14.102*** | | -5.285*** | | -4.099*** | |
| | (3.186) | | (0.825) | | (1.047) | |
| FIR Instrumented*Post | 1.230*** | 1.227*** | 0.526*** | 0.526*** | 0.116 | 0.115 |
| | (0.417) | (0.423) | (0.199) | (0.201) | (0.137) | (0.139) |
| Post | 0.003*** | 0.003*** | 0.001*** | 0.001*** | -0.000 | -0.000 |
| | (0.001) | (0.001) | (0.000) | (0.000) | (0.000) | (0.000) |
| Bond FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Maturity-Rating-Bond Type-Time FE | No | Yes | No | Yes | No | Yes |
| Country-Time FE | No | Yes | No | Yes | No | Yes |
| Bond Controls | No | Yes | No | Yes | No | Yes |
| Observations | 44,901 | 44,901 | 45,000 | 45,000 | 44,990 | 44,946 |
| N. of Bonds | 373 | 373 | 484 | 484 | 400 | 400 |
| N. of Countries | 58 | 58 | 53 | 53 | 45 | 45 |
| N. of Clusters | 1,082 | 1,082 | 958 | 958 | 739 | 738 |
| $R^2$ | 0.010 | 0.042 | 0.015 | 0.065 | 0.001 | 0.005 |

Note: This table presents results from 2SLS estimations of log price on different explanatory variables around rebalancing dates. The first stage and second stage equations are described in 10. The sample period is 2016-2018 and contains a window of 10 trading days around each end of the month rebalancing date. We divide the sample into bonds with high spreads (Columns 1 and 2), median spreads (Columns 3 and 4), and low spread (Columns 5 and 6). Spreads are divided according to their 33.3 and 66.6 percentile into the three different buckets. The dependent variable is the log price of a bond. FIR Instrumented is the FIR from 7 instrumented with $Z$ in 9. Post is an indicator variable that is 1 for the day of the rebalancing and 5 trading days after it, and 0 otherwise. Time fixed effects are dummy variables for each month of rebalancing. Maturity fixed effects are constructed by dividing the time to maturity of a bond into four different categories: short (less than 5 years), medium (between 5 and years), long (10 to 20 years) and very long (more than 20 years). Ratings from each bond are from Moody's. Bond Type indicates whether a bond is sovereign or quasi-sovereign. Bond controls indicates whether the estimation includes the log face amount and log stripped spread of the bond. Standard errors are clustered at the country by month of rebalancing level. *** p<0.01, **p<0.05, * p<0.1.

Figure C5
Estimated inverse demand elasticities for financial markets




Sources: EM IUSD Sovereign Bonds stands for emerging-market sovereign bonds issued internationally in US dollars. EM LC Sovereign Bonds stands for emerging-market sovereign bonds issued in local currency. The elasticities in Jiang et al. (2021), Krishnamurthy and Vissing-Jorgensen (2012), and Greenwood et al. (2015) are taken from the review Table 2 in Mian et al. (2022) and are converted into an inverse demand price elasticity assuming a duration of 7 for the average bond. For Choi et al. (2022), we take the midpoint elasticity from the IV estimates. For this paper, we compute the midpoint in elasticity from Table 2. For the EM local currency sovereign bonds we take the estimated number in Table 15 in Pandolfi and Williams (2019) for GBI bonds (Panel D). We adjust that number by the share of AUM (23.6%) that behave de facto in a passive way. For that, we compute the share of assets in EPFR tracking the GBI-EM Global Diversified that have an $R^2$ higher than that of ETFs tracking the GBI-EM Global Diversified. We compute the average $R^2$ of ETFs using a weighted average (weighted by assets) of the $R^2$ of the different ETFs.

Table C6
Log CDS and FIR

| Dependent Variable: Log CDS | | | |
|---|---|---|---|
| FIR Instrumented | 16.151*** | -15.814* | |
| | (5.519) | (8.171) | |
| FIR Instrumented*Post | -1.575*** | -1.575*** | -1.575*** |
| | (0.602) | (0.603) | (0.601) |
| Post | -0.008*** | -0.008*** | -0.008*** |
| | (0.002) | (0.002) | (0.002) |
| Country FE | Yes | Yes | No |
| Time FE | No | Yes | No |
| Country-Time FE | No | No | Yes |
| Observations | 12,166 | 12,166 | 12,166 |
| N. of Countries | 44 | 44 | 44 |
| N. of Clusters | 1,106 | 1,106 | 1,106 |
| $R^2$ | -0.014 | -0.003 | 0.007 |

Note: This table presents results from 2SLS estimations of log price on different explanatory variables around rebalancing dates. The first stage and second stage equations are described in 10. The sample period is 2016-2018 and contains a window of 10 trading days around each end-of-the-month rebalancing date. The dependent variable is the log CDS (5-year) of country. FIR Instrumented is the FIR from 7 instrumented with $Z$ in 9. Post is an indicator variable that is 1 for the day of the rebalancing and 5 trading days after it, and 0 otherwise. Time fixed effects are dummy variables for each month of rebalancing. Standard errors are clustered at the country by month of rebalancing level. *** p<0.01, **p<0.05, * p<0.1.