Inelastic Demand Meets Optimal Supply of Risky Sovereign Bonds*

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Abstract

We formulate a sovereign debt model with a rich yet flexible investor demand structure. In our framework, bond prices depend not only on government policies and default risk but also on the composition of investors and their price elasticity. We estimate a demand elasticity by combining our model with a novel identification strategy that exploits variation in the composition of the largest emerging-market government bond index. Index changes influence the demand of passive investors who track it, shifting the available bond supply for active investors. Our estimates imply a structural inverse demand elasticity of -0.20 that rises with default risk. Compared to the perfectly elastic case, we show that governments optimally issue *more* debt when facing a downward-sloping demand curve, as it acts as a disciplining mechanism that reduces default risk and borrowing costs. A downward-sloping demand curve also dampens the procyclicality of debt issuance in the presence of default risk.

Keywords: sovereign debt, international lending, downward-sloping demand

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1 Introduction

Governments in emerging markets (EM) rely heavily on bonds issued in international capital markets for financing. The composition of investors in these markets and their responsiveness to changes in bond supply are thus critical factors influencing government borrowing costs, default risk, and optimal debt management strategies. Standard sovereign debt models typically abstract from these aspects, assuming perfectly elastic bond demand curves—implying that investors willingly absorb any borrowing at the risk-free rate plus a default-risk premium (Aguiar and Gopinath, 2006; Arellano, 2008; Chatterjee and Eyigungor, 2012). This assumption contrasts sharply with a growing demand-based asset pricing literature documenting downward-sloping demand curves across various asset markets (Koijen and Yogo, 2019; Gabaix and Koijen, 2021; Vayanos and Vila, 2021). It also conflicts with an increasing presence of global institutional investors—such as mutual funds and ETFs—in emerging market debt, whose demand is often perfectly inelastic, as they simply track benchmark indices.[1]

In this paper, we formulate a sovereign debt model with a more realistic investor base, comprising both passive and active investors with asset allocation mandates. In our framework, bond prices depend not only on government policies and default risk but also on the composition of investors and their price elasticity. We estimate a demand elasticity for sovereign bonds by combining our model with a novel identification strategy that exploits variation in the composition of the largest global index for EM sovereign bonds. Changes in the index composition influence the demand of passive investors who track it, shifting the bond supply available to active investors. By endogenizing the issuer's problem, our methodology further isolates any *future* endogenous response from the issuer, allowing us to identify a structural demand elasticity.

Far from the perfectly elastic benchmark, our estimates imply a structural inverse demand elasticity for active investors of -0.20, whose magnitude increases with a country's default risk. We show that a downward-sloping demand has non-trivial implications for bond prices, default risk, and optimal debt management. Contrary to intuition, we show that governments optimally issue *more* risky debt when facing a downward-sloping demand—relative to a perfectly elastic scenario. This occurs because a downward-sloping demand acts as a disciplining device, reducing future bond issuances, particularly in states where default risk

[1] For instance, Chari, Dilts Stedman, and Lundblad (2022) document that assets under management in global funds investing in emerging markets grew nearly twentyfold in the last two decades, with most of this growth driven by ETFs. Today, approximately 20% of assets under management in emerging markets fixed-income funds are passively managed.

is high—i.e., when demand is less elastic. Since bonds are long term, lower future issuances reduce current default risk and bond spreads, which incentivizes greater issuance today. A downward-sloping demand also alters the cyclicality of debt issuances: bond issuances become less responsive to changes in output, dampening the well-known procyclicality of debt issuances under default risk. As the share of passive investors rises, the market-wide elasticity becomes less elastic, which amplifies these effects.

We begin the analysis by formulating a model in which a government issues long-term bonds in international markets, has limited commitment, and can endogenously default on its debt obligations. We depart from standard models by introducing a rich yet flexible investor demand structure with multiple investor types, explicitly distinguishing between active and passive investors. As in Gabaix and Koijen (2021), we assume that active investors operate under a mandate that dictates how they allocate funds across a finite set of bonds. For example, the mandate might require investors to adjust their holdings based on bonds' expected returns but imposes limits on the extent of these adjustments. This flexible specification generates a downward-sloping demand for active investors. On the other hand, passive investors are perfectly inelastic as they just replicate the composition of a benchmark index.

A key parameter in our model is the demand elasticity of active investors. For risky long-term bonds, estimating this elasticity is particularly challenging because future borrowing decisions influence current default risk and, consequently, the pricing of outstanding bonds—i.e., these bonds are subject to debt dilution. Using our framework we show that, even if one could estimate bond price reactions to well-identified supply-shifting shocks, those shocks—though orthogonal to *current* fundamentals—can still affect the government's *future* borrowing decisions and, in turn, the current bond price. As a result, part of the estimated price reactions may not necessarily reflect a downward-sloping demand.

In this paper we overcome this issue by combining high-frequency bond price changes to well-identified shocks with our structural model. On the empirical front, we first estimate a reduced-form demand elasticity for active investors based on bond price reactions to exogenous shocks to the passive demand. Since passive demand is perfectly inelastic, an increase in it acts as a supply-shifting shock, reducing the quantity of bonds available to active investors, given a fixed bond supply. We construct these shocks by exploiting monthly changes in the composition of the largest benchmark index for dollar-denominated bonds from emerging economies, the J.P. Morgan Emerging Markets Bond Index Global Diversified (EMBIGD). These frequent rebalancings occur because qualifying new bond issuances are incorporated into the EMBIGD, while maturing bonds are removed. Changes in this index affect the demand of passive funds that seek to replicate its composition and imply a shift in the "effective supply" of bonds available to active investors.

We derive a measure of the flows implied by the rebalancings (FIR), combining the assets passively tracking the EMBIGD with the index's monthly changes. The FIR is an endogenous variable because index weights are a function of bond prices—which reflect country-specific fundamentals. We instrument the FIR by exploiting a particular diversification rule of the EMBIGD that caps country weights based on the *face value* of their outstanding bonds—rather than their market value. Using this rule, we construct *synthetic* index weights that do not depend on bond prices and are only a function of the face value of bonds included in the EMBIGD. To avoid these weights being affected by a country's own issuances or redemptions, we focus exclusively on countries that experience no changes in the face amount of their outstanding index bonds on each rebalancing event. Thus, variation in our instrument comes from *other* countries' bond issuances or retirements. When country i issues (or retires) bonds, the *synthetic* weight of country j adjusts depending on how much those issuances affect the diversification cap on j's weight. In our analysis, we combine this instrument with the specific timing of the rebalancings—which occur on the last business day of each month—to analyze how bond prices respond to FIR shocks within narrow time windows around these rebalancing dates.

We find that a higher FIR leads to higher bond prices. On average, a 1 percentage point (p.p.) increase in the FIR corresponds to a 0.30% increase in bond prices —which implies a reduced-form inverse demand elasticity for active investors of -0.30. We find that these price reactions vary across countries with different levels of default risk. For countries with higher default risk, a 1 p.p. change in FIR results in up to a 40 basis point increase in bond prices. In contrast, for safer countries, the estimates are small and statistically not significant. Overall, these findings suggest that active investors demand a premium as compensation for holding risky bonds—in excess of their default risk—, which we refer to as an "inconvenience" yield.

We discipline our model based on these reduced-form estimates and use it to identify a structural demand elasticity through indirect inference. To this end, we first extend the baseline model by incorporating secondary markets, which allows us to replicate the same high-frequency exercise of our empirical analysis. We then calibrate the parameter behind the structural elasticity to match the reduced-form elasticity. For our FIR instrument—which is inherently more temporary than other supply-shifting shocks in the literature, such as index additions or methodological recompositions—we find that over one-third of the reduced-form elasticity arises from endogenous changes in bonds' payoffs, resulting in a structural inverse elasticity of -0.20. Overall, our results highlight the importance of accounting for issuers' endogenous responses and changes in expected asset repayments when estimating demand elasticities—a dimension that has been widely overlooked in the literature.

Using the calibrated model, we then explore the implications of a downward-sloping demand on the optimal supply of risky sovereign bonds. We find that the government faces *lower* bond spreads and has a *higher* average debt-to-output ratio, compared to a scenario with perfectly elastic demand. This outcome is not mechanically driven by a convenience yield (i.e., a higher price that investors are willing to pay for the bond) but rather by the downward-sloping demand serving as a disciplining device for the government. The key mechanism is as follows: for a given default risk and expected repayment, a downward-sloping demand means that issuing an additional unit of debt reduces bond prices. Consequently, the government finds that issuing large amounts of debt is too costly, limiting the maximum amount of debt it is willing to issue. In our quantitative analysis, we find that this limit leads to a substantial reduction in default risk —of around 25%— and mitigates the debt dilution problem associated with long-term bonds, which ends up lowering bond spreads. As a result, the government optimally issues *more* debt, relative to the perfectly elastic benchmark.

A downward-sloping demand also has important implications for the cyclicality of debt issuances. Using our quantitative model, we show that when the government faces price-elastic investors, bond issuances become less responsive to shocks. This mechanism, thus, dampens the well-known procyclicality property of debt issuances under default risk.

Lastly, we use our model to analyze the macroeconomic implications of changes in the investor base. Motivated by the growing presence of passive investors, we examine a counterfactual scenario in which passive investors hold a larger fraction of bonds. With future bond payoffs held fixed, a higher passive share directly increases bond prices—the magnitude of this increase depends on the demand elasticity of active investors. In our simulations, we find that these improved bond prices incentivize the government to issue more debt, consequently raising default risk. These opposing effects largely offset each other, resulting in minimal net changes in bond prices overall.

Related Literature. Our findings contribute to various strands of literature. First, a growing literature on inelastic financial markets emphasizes the role of the demand side in explaining asset prices across various financial markets (Koijen and Yogo, 2019; Gabaix and Koijen, 2021; Vayanos and Vila, 2021). Most of these studies, focus on safe government bonds (U.S. Treasuries) and are silent on the implications of a downward-sloping demand on the provision of these assets (Krishnamurthy and Vissing-Jorgensen, 2012; Greenwood, Hanson, and Stein, 2015; Mian, Straub, and Sufi, 2022; Jiang, Lustig, Van Nieuwerburgh, and Xiaolan, 2024).[2] The closest study is Choi, Kirpalani, and Perez (2024) who provide a structural model to quantify the effects of a downward-sloping demand and a positive convenience yield on the underprovision of riskless U.S. Treasuries.[3] Instead, our focus is on the interplay between a downward-sloping demand curve, default risk, and the provision of risky bonds. We show that, in the presence of default risk, a downward-sloping demand leads to a *larger* bond supply.

Second, our paper is closely related to a large literature on quantitative sovereign debt models (Aguiar and Gopinath, 2006; Arellano, 2008; Chatterjee and Eyigungor, 2012). Our framework extends standard models by introducing a downward-sloping demand for bonds and different investor types (active and passive).[4] Using this setup, we show that a downward-sloping demand affects the cyclicality of bond issuances and acts as a disciplining device that lowers default risk. Our paper also contributes to a literature on debt dilution in long-term bonds subject to default risk (Hatchondo, Martinez, and Sosa-Padilla, 2016; Aguiar, Amador, Hopenhayn, and Werning, 2019). When governments cannot commit to a future issuance path, lenders anticipating additional borrowing in the future offer lower bond prices to account for the increased default risk. We show that a downward-sloping demand helps mitigate these issues by discouraging future borrowing. In this regard, our paper relates to a larger literature on the use of rules as commitment devices (Alfaro and Kanczuk, 2017; Dovis and Kirpalani, 2020; Hatchondo, Martinez, and Roch, 2022; Bianchi, Ottonello, and Presno, 2023). We show that if the demand for bonds is downward sloping, the market by itself creates incentives that discourage borrowing.

In our analysis, we are agnostic about the mechanisms behind the downward-sloping demand. Previous work by Borri and Verdelhan (2010), Lizarazo (2013), Pouzo and Presno (2016), and Arellano, Bai, and Lizarazo (2017) analyzes sovereign debt models with risk-averse investors. In these models, investors are price elastic because they must be compensated

[2] Koijen and Yogo (2020); Gourinchas, Ray, and Vayanos (2022); Greenwood, Hanson, Stein, and Sunderam (2023) are related studies focusing on international markets. Dathan and Davydenko (2020); Bretscher, Schmid, Sen, and Sharma (2022); Calomiris, Larrain, Schmukler, and Williams (2022); Kubitza (2023) analyze corporate bond markets.

[3] Kaldorf and Rottger (2023) also analyze the implications of convenience yields on the pricing and issuances of European sovereign bonds. In their setup, and similarly to Choi et al. (2024), investors are willing to pay a higher price for holding sovereign bonds due to their collateral services.

[4] Our paper is related to recent work by Costain, Nuño, and Thomas (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.

for each additional unit of risky debt they hold. There are several other mechanisms that can explain a downward-sloping demand. For example, regulatory limitations such as a Value-at-Risk (VaR) constraint (Gabaix and Maggiori, 2015; Miranda-Agrippino and Rey, 2020), liquidity considerations (He and Milbradt, 2014; Moretti, 2020; Passadore and Xu, 2022; Bigio, Nuño, and Passadore, 2023; Chaumont, 2024), or investors' buy-and-hold strategies. Our setup relies on a flexible demand structure that can accommodate any of these potential drivers. Our aim is not to uncover the causes of investors' inelastic behavior but to examine its aggregate implications.

Third, our study connects to recent empirical studies examining how changes in investor base impact the pricing and elasticities of government and corporate bonds (Faia, Lewis, and Zhou, 2024; Faia, Salomao, and Veghazy, 2024; Jansen, Li, and Schmid, 2024; Zhou, 2024; Fang, Hardy, and Lewis, 2025). From these papers, Fang et al. (2025) is the closest to our study. The authors employ a standard demand-based asset pricing approach to estimate demand elasticities for sovereign bonds across different investor types—domestic versus foreign, banks versus non-banks— Our methodology differs from a demand system approach as it combines high-frequency bond price reactions to well-identified shocks with a structural model that endogenizes issuers' policies and bond payoffs. This enables us to move beyond reduced-form pricing effects by examining how changes in investor composition—active versus passive—affect not only bond yields but also the optimal issuance of sovereign bonds.

Lastly, our empirical analysis contributes to a long-standing literature using index rebalancings as supply-shifting shocks to estimate asset price reactions and demand elasticities (Harris and Gurel, 1986; Shleifer, 1986; Greenwood, 2005; Hau, Massa, and Peress, 2010; Chang, Hong, and Liskovich, 2014; Raddatz, Schmukler, and Williams, 2017; Pandolfi and Williams, 2019; Pavlova and Sikorskaya, 2022; Beltran and Chang, 2024).[5] An important contribution of our work is showing that part of the price reaction can be attributed to endogenous changes in assets' expected payoffs rather than solely reflecting an inelastic demand component. This decomposition is absent in the literature, and we show that it quantitatively matters when estimating demand elasticities —particularly for long-term assets. Our methodology can be applied to any asset, beyond sovereign bonds, whose future cash flows or payoffs are affected by movements in the (effective) supply.

The rest of the paper is structured as follows. Section 2 formulates a sovereign debt model with endogenous default and price-sensitive investors. Section 3 presents the empirical

[5]Beyond index rebalancings, Ray, Droste, and Gorodnichenko (2024) use high-frequency U.S. Treasury auctions to estimate the effect of demand shocks on Treasury yields. Monteiro (2024) uses auction data for Portuguese sovereign bonds.

analysis, including details on the institutional setup of the EMBIGD index, data sources, identification strategy, and results. Section 4 presents the quantitative analysis. Section 5 concludes.

2 A Sovereign Debt Model with Price-elastic Investors

We formulate a quantitative sovereign debt model with price-elastic investors. On the issuer side, the model closely follows a standard framework, featuring an endowment economy in which a risk-averse, infinite-lived government issues long-term debt in international markets. The government lacks commitment and can default on its debt, in which case it is temporarily excluded from financial markets and faces an output cost. On the investors' side, we introduce a rich demand structure that incorporates a downward sloping demand and different investors types.

2.1 Model Setup

We consider a small open economy with incomplete markets in which an infinite-lived government issues long-term bonds in international markets. Output in this economy y is exogenous and follows a continuous Markov process with transition function $f_y\left(y_{t+1} \mid y_t\right)$. The government chooses debt to maximize the utility of a risk-averse representative household, which are given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t\right), \tag{1}$$

where β is the discount factor, c denotes consumption, and $u\left(.\right)$ is strictly increasing and concave.

Let B_{t-1} denote the beginning-of-period stock of government bonds. The government lacks commitment and can default on its debt. Each bond unit matures in the next period with probability λ. If a bond does not mature (and the government does not default), it pays a coupon ν. Let $d_t = \{0, 1\}$ denote the default policy, where $d = 1$ indicates a default. Default leads to a temporary exclusion from international debt markets and an exogenous output loss, $\phi(y_t)$. The government is benevolent and chooses $\{d_t, B_t\}$ to maximize Equation (1), subject to the economy's resource constraint.

If the government is currently not in default and given a choice of debt, the resource constraint of the economy can be written as

$$c_t = y_t + q_t \times \left(B_t - (1-\lambda)B_{t-1}\right) - \left(\lambda + (1-\lambda)\nu\right) B_{t-1}, \tag{2}$$

where q_t denotes the price of a unit of debt—as defined in Equation (7). The q_t price is an endogenous function that depends on the government's default policy, and on the underlying assumptions for investors —i.e., the demand side. The term $B' - (1-\lambda)B$ captures new bond issuances, and $(\lambda + (1-\lambda)\nu)\,B$ are current debt services. Lastly, if the government is in default, the resource constraint is simply given by $c_t = y_t - \phi(y_t)$.

Bonds are priced by global investors operating in international markets. We assume that the bonds issued by the government are part of a benchmark bond index $\mathcal{I}$—composed of other bonds issued by other sovereigns. We consider two types of investors, active and passive, who differ on how they allocate funds towards the bonds issued by the government of our small open economy. Active investors are price elastic and, for a given expected payoff, their demand depends on the quantity of bonds issued by the government. On the other hand, passive investors are perfectly inelastic as they simply replicate the composition of the index $\mathcal{I}$ that they follow. Next, we describe in detail the investors' block.

2.2 Investor Block

Let $j = \{1, ..., J\}$ denote the investor. We define $x^i_{j,t} = \frac{q^i_t B^i_{j,t}}{W_{j,t}}$ as the share of wealth that investor j invests in bond (or country) i at time t. The term q^i_t denotes the unit price of bond i, $B^i_{j,t}$ denotes the holdings of investor j in bond i, and $W_{j,t}$ denotes their wealth. We assume that bond i is part of the benchmark bond index $\mathcal{I}$, and we let $\boldsymbol{w}_t = \left\{w^1_t, ..., w^N_t\right\}$ to denote the vector of time-varying index weights for each constituent bond.

Following Gabaix and Koijen (2021), we assume that the share $x^i_{j,t}$ is given by the following mandate:

$$x^i_{j,t} = \theta_{j,t}\left(\xi^i_{j,t} e^{\Lambda_j \pi^i_t}\right) + (1-\theta_{j,t})\, w^i_t, \tag{3}$$

where $\theta_{j,t}$ parameterizes the degree of activeness of investor j. Purely passive investors can be characterized by $\theta_{j,t} = 0$, indicating that their portfolio simply replicates the benchmark index $\mathcal{I}$. Conversely, active and semi-active investors are those with $\theta_{j,t} \in (0, 1]$. Within their active allocation, investors apportion a fraction $\xi^i_{j,t}$ of their wealth to bond i and a price-elastic component determined by $\Lambda_j \pi^i_t$, where π^i_t is an arbitrary function of the next-period (expected) excess return of bond i—denoted with r^i_{t+1}. For instance, if $\pi^i_t\left(r^i_{t+1}\right) = \mathbb{E}_t\left(r^i_{t+1}\right)$, investors allocate a higher share of their wealth to bonds with higher expected excess returns. The sensitivity to which active investors respond to changes in π^i_t is given by $\Lambda_j > 0$, which, as we will see next, parameterizes investor j's demand elasticity. For our analysis, we assume that $\xi^i_{j,t} = \xi^i_j q^i_t$, so that ξ^i_j captures a fix component of investors' mandates. This specification implies that purely active investors do not change their holdings of bond i, unless their wealth or π_t^i change.

The simple mandate in Equation (3) allows us to introduce an aggregate demand elasticity for bond i that can be parameterized by $\mathbf{\Lambda} \equiv \{\Lambda_1, .., \Lambda_J\}$. While this mandate can have different microfoundations (as shown in Appendix A), we take it as given for our analysis.

After aggregating all the individual demands, the market clearing condition for bond i is given by $B_t^i = \frac{1}{q_t^i} \sum_j W_{j,t} x_{j,t}^i$. It is useful to decompose the right-hand-side of the previous expression into an active and passive component. To this end, we define the active and passive demand as $\mathcal{A}_t^i \equiv \sum_j W_{j,t}\theta_{j,t}\xi_j^i e^{\Lambda_j \pi_t^i}$ and $\mathcal{T}_t^i \equiv \frac{1}{q_t^i} \sum_j W_{j,t}\left(1-\theta_{j,t}\right) w_t^i$, respectively. We let $\overline{\mathcal{A}^i}_{j,t} \equiv W_{j,t}\theta_{j,t}\xi_j^i$ to capture active investor j's wealth targeted towards country i, as implied by their total wealth, degree of activeness, and fixed mandates. Adding up all the individual demands, we get $\overline{\mathcal{A}^i}_t \equiv \sum_j \overline{\mathcal{A}^i}_{j,t}$.

To get a closed-form solution for the bond price, q_t^i, we start by approximating each investor j's active demand around $\overline{\mathcal{A}^i}_{j,t} = \overline{\mathcal{A}^i}_j$, and around a no-excess return case, $\pi_t^i = 0$. We can then write the active demand as:

$$\mathcal{A}_t^i \approx \overline{\mathcal{A}^i}_t + \mathbf{\Lambda}^i\, \pi_t^i. \tag{4}$$

The term $\mathbf{\Lambda}^i$ denotes the aggregate active demand elasticity for bond i, and it is given by a weighted average of investors' elasticities, $\mathbf{\Lambda}^i \equiv \overline{\mathcal{A}^i} \sum_j s_j^i \Lambda_j$, with $s_j^i \equiv \overline{\mathcal{A}^i}_j / \overline{\mathcal{A}^i}$ and $\overline{\mathcal{A}^i} \equiv \sum_j \overline{\mathcal{A}^i}_j$.

As for the demand of passive investors, we first define $\mathcal{W}_{j,t} = \sum_j W_{j,t}\left(1-\theta_{j,t}\right)$ as the assets under management tracking the $\mathcal{I}$ index. We let $M_t^{\mathcal{I}} = q_t^{\mathcal{I}} \times Q_t^{\mathcal{I}}$ to denote the market value of the index $\mathcal{I}$, where $q_t^{\mathcal{I}}$ is the unit price of one unit of the index and $Q_t^{\mathcal{I}}$ are the number of index units. We assume that S_t^i units of bond i are included in the index. Then, $w_t^i = \frac{S_t^i q_t^i}{M_t^{\mathcal{I}}}$ and we can rewrite the passive demand as $\mathcal{T}_t^i = \alpha_t^i \times \mathcal{W}_t^{\mathcal{I}}$, where $\alpha_t^i \equiv \frac{S_t^i}{Q_t^{\mathcal{I}}}$ captures the face-value share of bond i in the index and $\mathcal{W}_t^{\mathcal{I}} \equiv \frac{1}{q_t^{\mathcal{I}}}\mathcal{W}_t$ are the assets under managements tracking the benchmark index, in units of the index.

Replacing with all these expressions, the market clearing condition boils down to:

$$B_t^i = \left(\overline{\mathcal{A}^i}_t + \mathbf{\Lambda}^i\, \pi_t^i\right) + \mathcal{T}_t^i. \tag{5}$$

We introduce additional structure to derive a closed-form solution for the bond price. We assume that $\pi_t^i(r_{t+1}^i) = \frac{\mathbb{E}_t\left(r_{t+1}^i\right)}{\mathbb{V}_t\left(r_{t+1}^i\right)}$ so that active investors allocate a larger share of their wealth to bonds with a higher Sharpe ratio.[6] This assumption is for tractability, and by any means implies that investors do not care about the entire variance-covariance structure of returns across the N bonds included in the index. We view that dependence as already captured through the mandates, ξ^i_j. For instance, investors may allocate a larger share of their wealth to bonds that serve as a hedge, reflected in a larger ξ^i_j. We define $\mathcal{R}^i_{t+1}$ as the next-period repayment per unit of the bond so that $r^i_{t+1} \equiv \frac{\mathcal{R}^i_{t+1}}{q^i_t} - r^f$, where r^f denotes the gross risk-free rate. For now, we take $\mathcal{R}^i_{t+1}$ as given —we will endogenize it in the next section. Using this notation, we can rewrite the π^i_t function as

$$\pi^i_t\left(r^i_{t+1}\right) = q^i_t \frac{\mathbb{E}_t\left(\mathcal{R}^i_{t+1}\right) - q^i_t r^f}{\mathbb{V}_t\left(\mathcal{R}^i_{t+1}\right)}. \tag{6}$$

By combining Equations (5) and (6)—see Appendix A for the derivations—, we get the following pricing equations:

$$q^i_t = \frac{\mathbb{E}_t\left(\mathcal{R}^i_{t+1}\right)}{r^f} \Psi^i_t. \tag{7}$$

The term $\frac{\mathbb{E}_t\left(\mathcal{R}^i_{t+1}\right)}{r^f}$ captures the price under perfectly elastic investors, which is only a function of the expected next-period repayment. On the other hand, Ψ^i_t captures the downward-sloping component of demand, which is given by

$$\Psi^i_t \equiv 1 - \kappa^i\left(\mathbf{\Lambda}\right) \frac{\mathbb{V}_t\left(\mathcal{R}^i_{t+1}\right)}{\mathbb{E}_t\left(\mathcal{R}^i_{t+1}\right)} \left(B^i_t - \mathcal{T}^i_t - \overline{\mathcal{A}^i}_t\right). \tag{8}$$

The $B^i_t - \mathcal{T}^i_t$ term is the bond supply that is available to active investors and $\overline{\mathcal{A}^i}_t$ is the part of the active demand that depends on the fixed component of the mandates, ξ^i_j. Thus, $B^i_t - \mathcal{T}^i_t - \overline{\mathcal{A}^i}_t$ is the part of the active demand that is price elastic. The term $\kappa^i\left(\mathbf{\Lambda}\right) \equiv 1/\mathbf{\Lambda}^i$ characterizes the slope of the active demand—given by $\mathcal{S}^i_t \equiv (-)\frac{1}{r^f}\kappa^i\left(\mathbf{\Lambda}\right)\mathbb{V}_t\left(\mathcal{R}^i_{t+1}\right)$. For $\kappa^i\left(\mathbf{\Lambda}\right) = 0$, the active demand is perfectly elastic and the bond's price only depends on its expected repayment. When $\kappa^i\left(\mathbf{\Lambda}\right) > 0$, the demand curve is downward-sloping and its slope increases with the bond repayment variance—in Section 3, we provide evidence consistent with this specification. Equation (8) shows that composition of investors—active versus passive— only matters to the extent that the active demand is not perfectly elastic. If it were, then a raise in passive investors have no effect on the bond price since prices are only a function of the bond's expected repayment.

[6] This specification is similar to the one in Gabaix and Koijen (2021), in which $\hat{\pi}\left(\cdot\right)$ is a function of expected excess returns and shocks to taste or perception of risk.

2.3 Recursive Formulation

We focus on a Recursive Markov Equilibrium (RME) and represent the infinite horizon decision problem of the government as a recursive dynamic programming problem (see Appendix A.3 for the equilibrium definition). In order to have a recursive formulation of the problem, we assume that the passive demand is given by $\mathcal{T}' = \mathcal{T}(\tau, B')$ where B' denotes the end-of-period stock of government bonds and τ is the share of government bonds that are part of the benchmark index. We assume that τ is time varying and follows a continuous Markov process with a transition function $f_\tau(\tau' \mid \tau)$. Variation in τ could come from changes in the weights of index $\mathcal{I}$ or from changes in the wealth of passive investors that track the index. By market clearing, the end-of-period active demand is $\mathcal{A}' = \mathcal{A}(\tau, B') = B' - \mathcal{T}(\tau, B')$. We further assume that investors' total wealth and the fixed component of investors' mandates are fixed, which imply that $\overline{\mathcal{A}}_t = \overline{\mathcal{A}}$.

Under these simplifying assumptions, the state space can be summarized by the n-tuple (h, B, s), where h captures the government's current default status, B is the beginning-of-period stock of debt, and $s = (y, \tau)$ are the exogenous states. For a given default status h and choice of B', the resource constraint of the economy can be written as

$$\begin{aligned} c(h=0, B, y, \tau; B') &= y + q\left(y, \tau, B'\right)\left(B' - (1-\lambda)B\right) - \left(\lambda + (1-\lambda)\nu\right)B, \\ c(h=1, y) &= y - \phi_j(y), \end{aligned} \tag{9}$$

where $q(y, \tau, B')$ denotes the price of a unit of debt, $B' - (1-\lambda)B$ are new bond issuances, and $(\lambda + (1-\lambda)\nu)B$ are current debt services.

If the government is not in default, its value function is given by

$$V(y, \tau, B) = \mathrm{Max}_{d=\{0,1\}} \left\{ V^r(y, \tau, B), V^d(y) \right\}, \tag{10}$$

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

$$\begin{aligned} V^r(y, \tau, B) &= \mathrm{Max}_{B'} \;\; u(c) + \beta\, \mathbb{E}_{s'|s} V\left(y', \tau', B'\right), \\ \text{subject to} \quad c &= y + q(y, \tau, B')\left(B' - (1-\lambda)B\right) - \left(\lambda + (1-\lambda)\nu\right)B. \end{aligned} \tag{11}$$

While in default, the country is excluded from debt markets and cannot issue new debt. The government exits a default with probability θ, with no recovery value. Additionally, we assume that demand from passive investors is zero during the default period. Under these assumptions, the value function in case of default is given by

$$V^d(y) = u(y - \phi(y)) + \beta\, \mathbb{E}_{s'|s}\left[\theta V\left(y', \tau', 0\right) + (1-\theta)\, V^d\left(y'\right)\right]. \tag{12}$$

Given these assumptions and the demand structure in Section 2.2, we can rewrite the bond price in Equation (7) recursively as a function of B' and the exogenous states $\{y, \tau\}$:

$$q\left(y, \tau, B'\right) = \frac{1}{r^f}\, \mathbb{E}_{s'|s}\left(\mathcal{R}\left(y', \tau', B'\right)\right)\, \Psi\left(y, \tau, B'\right), \tag{13}$$

where $1/r^f$ is the lenders' discount factor, $\mathcal{R}'(.) \equiv \mathcal{R}\left(y', \tau', B'\right)$ denotes the next-period repayment function, and $\Psi(y, \tau, B')$ captures the downward-sloping component of the active demand. The next-period repayment function is given by

$$\mathcal{R}\left(y', \tau', B'\right) = \left[1 - d\left(y', \tau', B'\right)\right]\left[\lambda + (1-\lambda)\left(\nu + q(y', \tau', B'')\right)\right], \tag{14}$$

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 next-period exogenous states, $\{y', \tau'\}$, and the next-period debt, $B'' \equiv B'\left(y', \tau', B'\right)$. Lastly,

$$\Psi\left(y, \tau, B'\right) = 1 - \kappa \frac{\mathbb{V}_{s'|s}\left(\mathcal{R}'(.)\right)}{\mathbb{E}_{s'|s}\left(\mathcal{R}'(.)\right)}\left(B' - \mathcal{T}\left(\tau, B'\right) - \overline{\mathcal{A}}\right). \tag{15}$$

From Equations (13) and (14), it is clear that the bond price decreases with the expected default probability. Specifically, a larger B' (weakly) increases the default risk (conditional on a level of output), and thus $q(y, \tau, B')$ (weakly) decreases in B'. The $\Psi\left(y, \tau, B'\right)$ term introduces another mechanism for the bond price to be decreasing in B': the downward-sloping demand of active investors. Based on our recursive formulation, we can write the inverse elasticity for active investors as

$$\eta\left(y, \tau, B'; \kappa\right) = \mathcal{S}\left(y, \tau, B'; \kappa\right) \frac{\mathcal{A}\left(\tau, B'\right)}{q\left(y, \tau, B'\right)}, \tag{16}$$

where the slope of the demand is $\mathcal{S}\left(y, \tau, B'; \kappa\right) \equiv (-)\frac{1}{r_f}\, \kappa\, \mathbb{V}_{s'|s}\mathcal{R}\left(y', \tau', B'\right)$, and increases with the volatility of payments. Importantly, if the bond is risk-free, then the demand is perfectly elastic.

2.4 Implications of a Downward-sloping Demand

When choosing its optimal debt policy, the government internalizes the effects of changes in B' on the bond price $q(y, \tau, B')$, accounting for both the impact on expected repayment and the downward-sloping demand component. Let $\epsilon\left(y, \tau, B'; \kappa\right) \equiv \frac{\partial \log q(y, \tau, B')}{\partial \log B'}$ denote the (inverse) supply elasticity. To simplify the analysis in this section, we will make two simplifying assumptions. First, an additional unit of debt does not affect the passive demand, $\frac{\partial \mathcal{T}(\tau,B')}{\partial B'} = 0$. Second, we consider a case for which $B' - \mathcal{T}(\tau, B') - \overline{\mathcal{A}} \approx 0$, which implies that changes in κ do not directly affect the bond price. Under these assumptions, we can decompose the supply elasticity as:

$$\epsilon\left(y,\tau,B';\kappa\right) = \left[\frac{1}{r^f}\frac{\partial \mathbb{E}_{s'|s}\mathcal{R}\left(y',\tau',B'\right)}{\partial B'} + \mathcal{S}\left(y,\tau,B';\kappa\right)\right]\frac{B'}{q\left(y,\tau,B'\right)} < 0, \tag{17}$$

The first term on the right-hand side captures the elasticity of the expected repayment function with respect to the bond supply. This elasticity is (weakly) negative because a larger B' increases default risk and reduces the expected bond payoff. The second term (also weakly negative) captures the additional decline in the bond price resulting from the downward-sloping demand curve.

Under some further simplifying assumptions (see Appendix A.4 for the full derivation), the first-order condition for B' can be expressed as:

$$u_c\left(c\right) q\left(y,\tau,B'\right) = \beta \mathbb{E}_{s'|s}\left[u_c(c')\,\mathcal{R}'\left(\cdot\right)\right] - u_c\left(c\right)\left[\frac{1}{r^f}\frac{\partial \mathbb{E}_{s'|s}\mathcal{R}'\left(\cdot\right)}{\partial B'} + \mathcal{S}\left(\cdot\,;\kappa\right)\right]\Delta B', \tag{18}$$

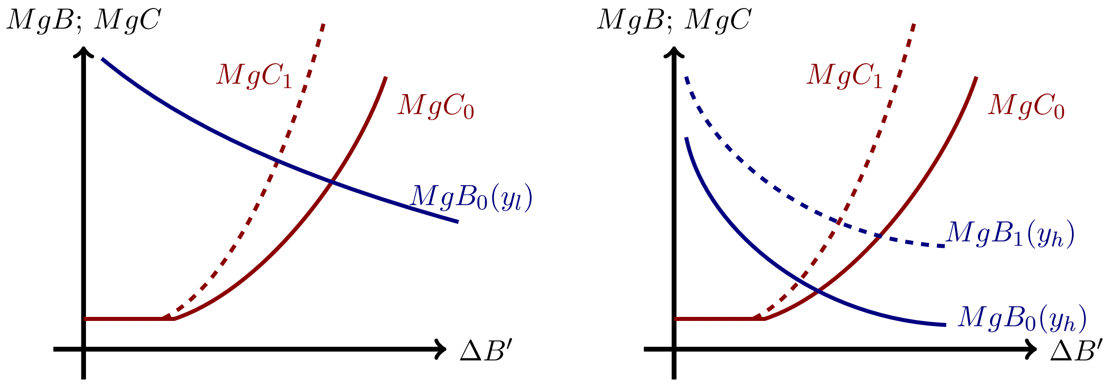
where $u_c\left(\cdot\right) \equiv \frac{\partial u(\cdot)}{\partial c}$, $\mathcal{S}\left(\cdot;\kappa\right) \equiv \mathcal{S}\left(y,\tau,B';\kappa\right)$ is the slope of the active demand and $\Delta B' \equiv (B' - (1-\lambda)B)$ are new issuances. The left-hand side captures the marginal benefit of an additional unit of debt. This term depends on the price that the government gets from selling an additional unit of debt, $q\left(\cdot\right)$, and by how much the representative household values the extra consumption. The right-hand side captures the marginal cost, which consists of two components. The first component captures the value of the additional debt repayment that the government has to incur if it does not default. The second term follows from the decomposition in Equation (18) and captures the impact on bond prices of issuing an additional unit of debt. In our framework, this term depends not only on changes in expected repayment but also on the slope of the demand curve.

Figure 1 illustrates the effects of a rise in the slope parameter κ. Panel (a) considers a high default risk (low endowment) case and Panel (b) shows a low default risk (high endowment) scenario.[7] In both cases, a higher κ leads to a less elastic demand, which implies higher marginal costs. For a given marginal benefit curve, this results in lower debt issuances. These effects are stronger when default risk is high (Panel a), since the demand elasticity increases with the variance of repayments. We refer to this as a "disciplining device" because it incentivizes the government to reduce the bond supply precisely when default risk is high.

[7] The $MgB_0\left(y_l\right)$ curve in Panel (a) lies above the $MgB_0\left(y_h\right)$ curve in Panel (b) because the representative household places greater value on additional q units of consumption when the endowment is smaller—i.e., when consumption is low.

Figure 1: Effects of a lower demand elasticity

(a) High default risk (low y) (b) Low default risk (high y)



Note: The figure illustrates the effects of a higher slope parameter κ on the government's marginal benefits and costs of issuing an additional unit of debt. Panel (a) shows a case in which default risk is high and thus the demand is less elastic. Panel (b) depicts a scenario with low default risk.

Given that the government optimally reduces its issuance, especially when default risk is high, a larger κ indirectly increases bond prices by lowering default risk. This is illustrated in Panel (b) with an upward shift in the marginal benefit curve.[8] If the shift is large enough, it may even lead to the government issuing *more* debt when the demand is less elastic. Whether this holds is a quantitative question, which we will revisit in Section 4.

3 Empirical Analysis

3.1 Identifying a Structural Demand Elasticity

To solve the previous model and to quantify the implications of a downward-sloping demand, we first need an estimate for κ—the structural parameter behind the active demand elasticity.

Based on the model pricing equations—Equations (13)-(15)— and for a fixed $\{y, B'\}$ and repayment, bond price reactions to shocks to the passive demand $\Delta\mathcal{T}' \equiv \mathcal{T}(\tau', B') - \mathcal{T}(\tau, B')$ are informative about the slope of active investors. Panel (a) of Figure 2 illustrates this point. For a fixed supply, an increase in the passive demand implies a decrease in the quantity of bonds available to active investors—a leftward shift in the "effective" bond supply. Passive demand shifts, thus, provide a basis for analyzing the slope of active demand.

This strategy—while common in the literature— is not enough to identify κ and the structural elasticity $\eta(y, \tau, B'; \kappa)$ in Equation (16) because it overlooks any potential impact

[8]Obviously, a similar shift occurs in the high default risk case (in Panel a), but we omit that for simplicity.

that the $\Delta\mathcal{T}'$ shock may have on bonds' payoffs, $\mathcal{R}(y', \tau', B')$.[9] If a positive $\Delta\mathcal{T}'$ raises the next-period expected repayment or decreases its volatility, investors are willing to pay a higher price for any given quantity of the bond, resulting in an upward shift in the active demand. Failing to account for this endogenous shift leads to overestimate the true magnitude of κ —i.e., the slope of the demand curve. Panel (b) of Figure 2 shows this case.

More formally, suppose that we compute the following reduced-form inverse elasticity based on bond price changes to exogenous shifts in the passive demand:

$$\hat{\eta}\left(y, \tau, B'; \kappa\right) \equiv (-)\frac{\Delta \log q\left(y, \tau, B'\right)}{\Delta\mathcal{T}' / \left(B' - \mathcal{T}\left(\tau, B\right)\right)}, \tag{19}$$

where we normalize the change in the passive demand by the size of the active demand. After some algebra, one can decompose the previous expression in two components, the structural elasticity and changes in bond prices driven by changes in expected future payoffs. That is,

$$\hat{\eta}\left(y, \tau, B'; \kappa\right) = \eta\left(y, \tau, B'; \kappa\right) + \alpha\left(y, \tau, B'; \kappa\right), \tag{20}$$

where the function $\alpha(\cdot)$ is given by

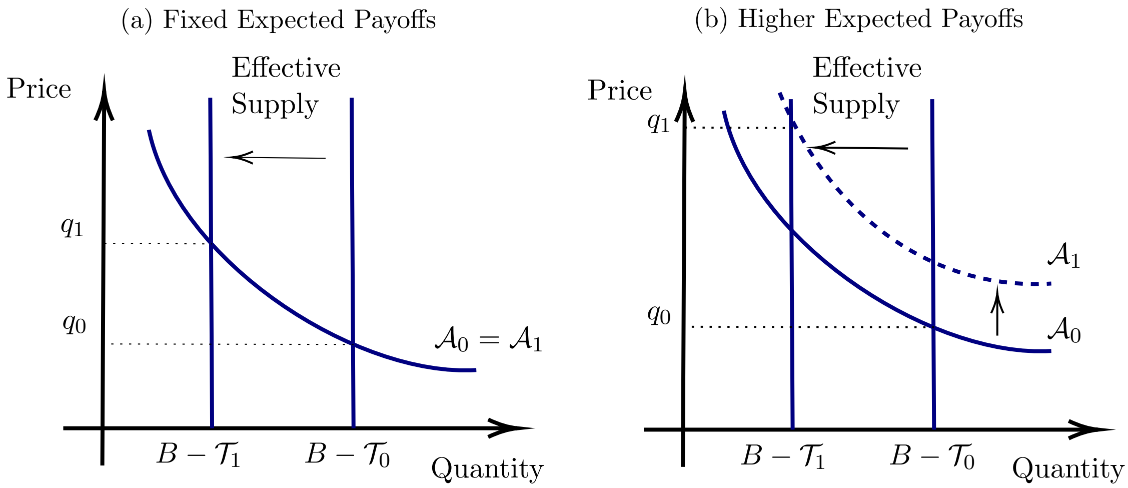
$$\alpha\left(y, \tau, B'; \kappa\right) = (-)\frac{\Delta\mathbb{E}_{s'|s}\mathcal{R}'(\cdot) - \kappa\Delta\mathbb{V}_{s'|s}\mathcal{R}'(\cdot) \times \left(B' - \mathcal{T}\left(\tau, B'\right) - \bar{\mathcal{A}}\right)}{\Delta\mathcal{T}' / \left(B' - \mathcal{T}\left(\tau, B'\right)\right)} \frac{1}{r^f q(\cdot)},$$

$\Delta\mathbb{E}_{s'|s}\mathcal{R}'(\cdot) \equiv \mathbb{E}_{s'|s}\mathcal{R}\left(y, \tau', B'\right) - \mathbb{E}_{s'|s}\mathcal{R}\left(y, \tau, B'\right)$, and $\Delta\mathbb{V}_{s'|s}\mathcal{R}'(\cdot) \equiv \mathbb{V}_{s'|s}\mathcal{R}\left(y, \tau', B'\right) - \mathbb{V}_{s'|s}\mathcal{R}\left(y, \tau, B'\right)$. From this decomposition, it is clear that the information contained in bond price changes alone is not enough to identify the slope parameter κ (and thus the structural elasticity) as they are confounded by changes in expected future payoffs.

The rest of our analysis proceeds as follows. In this section, we start by constructing an instrument for $\Delta\mathcal{T}'$ using index rebalancings. We then use this instrument to estimate a reduced-form demand elasticity, $\hat{\eta}$, based on high-frequency bond price reactions to $\Delta\mathcal{T}'$. In Section 4, we extend our baseline model to replicate the same exercise within the model framework. Since the model endogenizes the repayment function, we can identify the structural elasticity from our reduced-form estimates and recover κ. Our approach is based on indirect inference. That is, when calibrating the model, we set a value for κ so that our model matches the estimated reduced-form elasticity.

[9] There is a large literature that uses index rebalancings as supply-shifting shocks to estimate asset price reactions and demand elasticities. For instance, 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); Beltran and Chang (2024).

Figure 2: Index rebalancing and the demand elasticity



Note: The figure depicts a decrease in the effective supply available to active investors driven by an increase in the passive demand $\mathcal{T}$. Panel (a) considers a case in which expected payoffs do not change as a consequence of the lower effective supply. Panel (b) shows a case in which the expected payoffs increase.

3.2 Flows Implied by Index Rebalancings

We construct a measure of shocks to the passive demand based on changes in the composition of a benchmark bond index. To this end, we exploit end-of-month rebalancings in the J.P. Morgan EMBIGD to identify exogenous shifts in the supply of bonds available to active investors. The EMBIGD tracks the performance of emerging market sovereign and quasi-sovereign U.S. dollar-denominated bonds issued in international markets. Among bond indexes for emerging economies, the EMBIGD is the most widely used as benchmark and is tracked by funds with combined assets under management (AUM) of around US$300 billion in 2018 (Appendix Figure B4). Unlike most indices that use a traditional market capitalization-based weighting scheme, the EMBIGD limits the weights of countries with above-average debt outstanding (relative to other countries in the index) by including only a fraction of their face amount in the index (referred to as *diversified face amount*). Its goal is to achieve greater diversification by lowering the index weight of large countries, and we refer to it as a cap rule.[10]

Rebalancings in the EMBIGD index occur on the last business day of each month in the United States and are triggered by bond inclusions and exclusions. J.P. Morgan announces these updates through a report detailing the updated index composition. Upon the announcement, passive investors mimicking the index composition need to adjust their

[10] In comparison, the J.P. Morgan Emerging Markets Bond Index Global (EMBIG) has the same bond inclusion criteria as the EMBIGD. The only difference between the EMBIG and the EMBIGD is that while the former uses a market capitalization weighting scheme, the latter adopts the cap rule to limit the weights of countries with above-average debt outstanding.

portfolios by buying or selling bonds to match the new index weights.

We construct a measure of flows implied by rebalancings (FIR) for each country c on each rebalancing date. The FIR measures the amount of funds that, on a given rebalancing date, enter or leave a country's bonds due to the rebalancing in the portfolio of passive investors tracking the EMBIGD index. It is defined as:

$$\mathrm{FIR}_{c,t} \equiv \frac{\Delta\tilde{\mathcal{T}}_{c,t}}{q_{c,t-1}B_{c,t-1} - w_{c,t-1}\mathcal{W}_{t-1}}. \tag{21}$$

The $\Delta\tilde{\mathcal{T}}_{c,t}$ term captures the change in passive demand implied by the index rebalancing, $\Delta\tilde{\mathcal{T}}_{c,t} \equiv (w_{c,t} - w^{BH}_{c,t})\mathcal{W}_t$, where $w_{c,t}$ is the benchmark weight for country c at time t —just after the rebalancing—and $\mathcal{W}_t$ denotes the AUM passively tracking the EMBIGD. The term $w^{BH}_{c,t}$ denotes a "buy-and-hold weight," which can be thought of as the weight of country c in the portfolio of an investor mimicking the EMBIGD absent any bond inclusions or exclusions between $t-1$ and t. We normalize $\Delta\tilde{\mathcal{T}}_{c,t}$ by the market value of bonds available to active investors, $q_{c,t-1}B_{c,t-1} - w_{c,t-1}\mathcal{W}_{t-1}$. More specifically, the index weights are given by $w_{c,t} \equiv \frac{q_{c,t}B_{c,t}f_{c,t}}{q_t I_t}$, where $q_{c,t}B_{c,t}$ denotes the market value of bonds from country c at time t, $q_{c,t}$ denotes the price, and $B_{c,t}$ denotes the face amount (FA). The diversified face amount (DFA) is defined as $f_{c,t}B_{c,t}$, where $f_{c,t} \in (0,1]$ is a diversification coefficient determined by the EMBIGD cap rule, with $f_{c,t} < 1$ for countries with above-average outstanding debt. The $q_t I_t$ term denotes the market value of the EMBIGD index, where q_t is the unit price of the index and I_t is the number of available index units. Lastly, the "buy-and-hold weight" is given by the previous period's index weight, adjusted for changes in relative bond prices: $w^{BH}_{c,t} \equiv w_{c,t-1}\frac{q_{c,t}/q_{c,t-1}}{q_t/q_{t-1}} = \frac{q_{c,t}f_{c,t-1}B_{c,t-1}}{q_t I_{t-1}}$.[11]

As defined, a 1 p.p. FIR implies a 1% reduction in the supply of a country's bonds available to active investors at the time of the rebalancing. Since it is an outcome of changes in the composition of an index, the FIR is endogenous and may be correlated with country fundamentals. First, the FIR is influenced by countries' sovereign bond issuances: when a country issues new bonds that enter the index (or redeems existing ones), its weight changes, which, in turn, affects the FIR. Second, because index weights depend on bond prices, the FIR is inherently linked to price movements.

Our empirical strategy tackles these endogeneity issues in two ways. First, for each rebalancing event, we limit our analysis to countries whose outstanding bond amounts, $B_{c,t}$,

[11] In the absence of inclusions or exclusions, the weight of a country in the index is equal to its "buy-and-hold weight," $w_{c,t} = w^{BH}_{c,t}$. If the price of a country's sovereign bonds rises more than those of other countries in the index between rebalancing events, that country's weight in the index increases. However, investors do not need to actively rebalance their portfolios, as the buy-and-hold weight already adjusts to match the updated index weight.

remain unchanged relative to the previous month. Specifically, we focus on countries that neither issue new bonds, repurchase existing ones, nor have bonds removed from the index due to maturity. Second, we exploit the specific features of the cap rule in the EMBIGD's weighting scheme. This rule introduces a weighting coefficient, $f_{c,t}$, which limits a country's weight in the index based on its face amount, regardless of its bond price and market value. By focusing on variations in $f_{c,t}$, we can isolate changes in the FIR that are not driven by fluctuations in bond prices.

We construct an instrument for the FIR based on a synthetic index in which country weights are only a function of the diversified face amount, $\tilde{w}_{c,t} \equiv \frac{f_{c,t}B_{c,t}}{\sum_c f_{c,t}B_{c,t}}$. Our instrument is given by the relative change in these synthetic weights, $Z_{c,t} \equiv \frac{\Delta\tilde{w}_{c,t}}{\tilde{w}_{c,t-1}}$. Given our focus on countries whose debt outstanding in the index remains unchanged ($B_{c,t} = B_{c,t-1}$), this instrument simplifies to:

$$Z_{c,t} \equiv \left(\frac{f_{c,t}}{\sum_c f_{c,t}B_{c,t}} - \frac{f_{c,t-1}}{\sum_c f_{c,t-1}B_{c,t-1}}\right) \;/\; \left[\frac{f_{c,t-1}}{\sum_c f_{c,t-1}B_{c,t-1}}\right]. \tag{22}$$

For each country c, the $Z_{c,t}$ instrument captures two sources of variation. First, it accounts for fluctuations *across* rebalancing events arising from changes in the diversified face amount $f_{c,t}B_{c,t}$ of other countries included in the index. For instance, when a newly issued bond from Brazil is added to the index, the $Z_{c,t}$ values for all other countries decrease proportionally. Second, the EMBIGD cap rule allows us to exploit variation across countries *within* each rebalancing event. This variation arises because $f_{c,t}$ adjusts differently across countries, depending on whether the face value of their bonds included in the index is above or below the average face value in the index. In the next subsection, we provide a simple example to illustrate this point.

3.3 The EMBIGD Cap Rule in Practice

To illustrate how rebalancings and the cap rule operate, we consider an example involving five countries, $c = \{A, B, C, D, E\}$, with bonds included in the index in month $t-1$. For simplicity, we assume that each of these countries has only one qualifying bond and does not issue or redeem bonds during month t. Additionally, we assume that another country, F, issues an eligible bond during month t, which will be included in the index on the rebalancing date at the end of that month.

Table 1 presents the assumed face amount FA_c for each country in the index, before and after the rebalancing date t. The columns labeled DFA_c display the diversified face amounts (i.e., f_cB_c) calculated based on the EMBIGD methodology. Each month, J.P.

Table 1: The cap rule

Country	Before Rebalancing			After Rebalancing			Instrument
	$FA_{c,t-1}$	$DFA_{c,t-1}$	$\tilde{w}_{c,t-1}$	$FA_{c,t}$	$DFA_{c,t}$	$\tilde{w}_{c,t}$	$Z_{c,t} \equiv \frac{\Delta \tilde{w}_{c,t}}{\tilde{w}_{c,t-1}}$
A	1,000	1,000	4.46%	1,000	1,000	3.19%	-28.54%
B	2,000	2,000	8.92%	2,000	2,000	6.37%	-28.54%
C	3,000	3,000	13.38%	3,000	3,000	9.56%	-28.54%
D	7,000	6,429	28.66%	7,000	6,769	21.57%	-24.75%
E	12,000	10,000	44.59%	12,000	11,000	35.05%	-21.39%
F	-	-	-	8,000	7,615	24.26%	-
ICA	5,000			5,500			
FA_{max}	12,000			12,000			

Note: The table presents as simple example to illustrate the cap rule. The columns FA display the assumed face amounts for each country before and after the rebalancing. The DFA columns show the diversified face amount, computed based on Equation (23). The other columns show the synthetic index weights, $om\tilde{e}ga$ and our instrument, Z.

Morgan computes the "Index Country Average" (ICA_t), which is the average country-level face amount of bonds included in the index. Using this average, the diversified face amount for each country is then computed as follows:

$$DFA_{c,t} = \begin{cases} ICA_t \times 2 & \text{if } FA_{c,t} = FA_{max,t} \\ ICA_t + \frac{ICA_t}{FA_{max,t} - ICA_t} \left(FA_{c,t} - ICA_t \right) & \text{if } FA_{c,t} > ICA_t \\ FA_{c,t} & \text{if } FA_{c,t} \leq ICA_t, \end{cases} \tag{23}$$

where FA_{max} refers to the country with the largest face amount (see Appendix B.1 for additional details). In our example, countries D and E are capped in periods $t-1$ and t (since their face values exceed the ICA), while country F becomes capped in t. The table also reports the synthetic weights before and after the rebalancing—$\tilde{w}_{c,t-1}$ and $\tilde{w}_{c,t}$— and our $Z_{c,t}$ instrument, as defined in Equation (22). In this example, changes in $\tilde{w_{c,t}}$, and therefore $Z_{c,t}$, are exclusively driven by country F's issuance and, by construction, do not depend on bond price changes.

From this simple example, one can easily identify the sources of variation that we exploit. First, the issuance of a new bond by country F and its inclusion in the index reduce the weights of all other countries. In the absence of the cap rule, a purely market capitalization-based index would rely solely on this mechanism, leading to a relative decrease in index weights that is homogeneous across all other countries. Second, the cap rule introduces heterogeneity in the relative changes in the synthetic weights. This variation arises because the diversified face amount (which is used to calculate $\tilde{w}$) is capped for countries with above-average amounts of outstanding bonds, and this cap changes after the inclusion of country F.[12] By relaxing the cap for countries with above-average face amounts (D and E), the addition of country F to the index results in a smaller decrease in the weights of countries with greater outstanding face amounts. An analogous mechanism would ocurr if the new addition in month t leads to a decrease in the ICA.

3.4 Data and Summary Statistics

We collect data from three main sources: Datastream, J.P. Morgan, and Morningstar. Datastream provides daily bond price data for bonds included in the EMBIGD. From J.P. Morgan Markets, we obtain index weights, the face amounts of bonds included in the index, and various bond characteristics, such as maturity and duration. Lastly, Morningstar provides asset holdings of funds benchmarked against the EMBIGD, which we use to compute our measure of AUM that passively track the EMBIGD. Our final dataset comprises 131,820 bond-time observations, covering 751 bonds from 68 countries over the 2016-2018 period.

While J.P. Morgan provides data on the amount of assets benchmarked against their indexes, it does not distinguish between passive and active funds.[13] To compute the AUM that passively track the EMBIGD, $\mathcal{W}_t$, we then proceed as follows. First, we retrieve data from Morningstar on the asset holdings of funds benchmarked against the EMBIGD and EMBI Global Core.[14] Second, we compute for each fund its $Passive\ Share = 100 - Active\ Share$, where *Active Share* is a measure developed by Cremers and Petajisto (2009) that quantifies how much the country-level holdings of a fund differ from the benchmark index it tracks. This allows us to separate, even for active funds, the fraction of a fund's portfolio that behaves passively. We estimate the variable at the country-level holdings because this is the level at which we compute the FIR.[15] Third, we calculate an aggregate *Passive Share* weighting

[12] The inclusion of the bond from country F increases the average country face amount outstanding (ICA) from $\$5,000$ to $\$5,500$. The diversified face amounts of countries A, B, and C are unaffected because their face amounts are below the ICA. However, the increase in the ICA relaxes the cap for initially capped countries D and E, altering their diversified face amounts outstanding even though their face values remain constant.

[13] Even if such data were available, many active funds may semi-passively manage a significant share of their portfolios, as highlighted by Pavlova and Sikorskaya (2022).

[14] We include the EMBI Global Core given its similarities with the EMBIGD. This index uses the same diversification methodology as the EMBIGD —as described in Appendix B.1— and a similar criteria for including bonds in the index. The main difference is that, to be included in the index, 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.

[15] We calculate the *Active Share* at the country level by using the country weights in the index and in the funds' portfolios. For the portfolios, we assign bonds to a given country only if they are included in the EMBIGD. That is, a country's weight in a portfolio is determined by adding together the weights of all bonds from that country that are included in the EMBIGD. For comparison, we also construct the *Active Share* at the bond level, and obtain a value-weighted average of 72%. Cremers and Petajisto (2009) show an average value-weighted *Active Share* that fluctuates between 55% and 80%.

Table 2: Summary statistics

Variable	Mean	Std. Dev.	25th Pctl	75th Pctl	Min	Max
log(Price)	4.64	0.13	4.59	4.68	3.07	5.19
Stripped spread (bps)	278	288	128	356	0	4904
EIR duration (%)	6.36	3.92	3.48	7.71	-0.03	19.08
Average life (years)	9.6	8.9	4.0	9.9	1.0	99.8
Face amount (billion U.S. dollars)	1.3	0.8	0.7	1.6	0.5	7.0
Instrumented FIR (%)	-0.15	0.20	-0.32	0.00	-0.66	0.23

Note: This table displays summary statistics for the main variables in the analysis. *Stripped Spread* is the difference between a bond yield-to-maturity and the corresponding point on the U.S. Treasury spot curve, where the value of collateralized flows are "stripped" from the bond. *EIR Duration* measures the sensitivity of dirty prices to parallel shifts of the U.S. interest rates, expressed as the percentage change of dirty price if all U.S. interest rates change by 100 basis points. *Average Life* is the weighted average period until principal repayment. Sources: Bloomberg, Datastream, J.P. Morgan Markets, Morningstar Direct, and authors' calculations.

each fund by its AUM. Our calculations lead to an aggregate passive share of 50%. Fourth, we multiply this aggregate share against the AUM benchmarked against the EMBIGD —as reported by J.P. Morgan— to compute our $\mathcal{W}_t$ measure.[16]

Table 2 displays summary statistics for our main variables. The bonds in our sample have an average stripped spread of 278 basis points, and an average face amount of US$1.3 billion. In terms of maturity, most of these bonds are medium and long-term bonds —the average maturity is around 10 years. Panel (a) of Figure 3 shows a scatter plot of the FIR and our Z instrument, after both variables have been residualized with rebalancing-month and country fixed effects. There is a clear positive relationship between the variables, with an R-squared value of 86%. Panel (b) shows the distribution of our instrumented FIR measure. The values range from -0.7% to 0.25%, and feature a larger share of negative observations.[17]

3.5 Estimation Strategy and Results

We exploit the rebalancing-driven shifts in the passive demand, along with the timing of the EMBIGD and the cap rule, to estimate a demand elasticity for active investors. We focus on 5-day symmetric windows around each rebalancing date, where we estimate the average price reactions to exogenous changes in the FIR using our $Z_{c,t}$ instrument.[18]

We adopt an instrumented difference-in-differences design and estimate the following

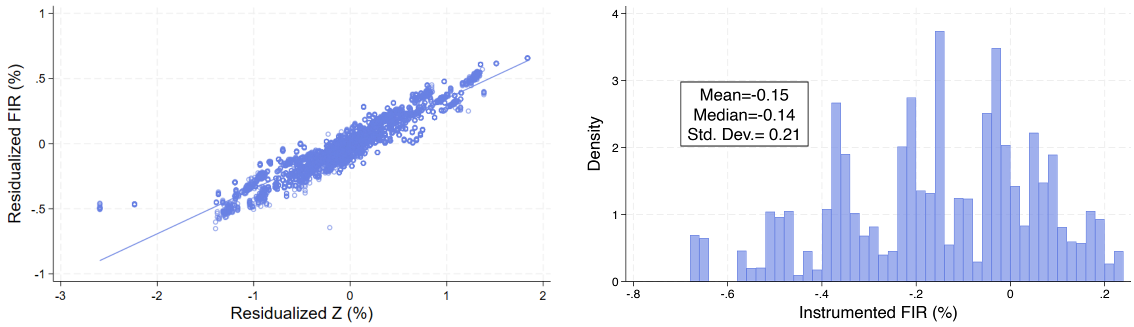
[16] Notice that this 50% passive share we only apply it to the index-tracking funds reported by J.P. Morgan. Since there are other investors that hold EMBIGD bonds, this number is not the same as the total passive holdings as a share of outstanding EMBIGD bonds, which is on average 29% in our sample. The underlying assumption is that J.P. Morgan reports all index-tracking investors, and thus there are no index-tracking investors in the rest of bondholders of EMBIGD bonds.

[17] Since our analysis focuses on countries with a constant face amount, the larger proportion of bond inclusions than exclusions from other countries generally results in a reduction of the weight assigned to the sample countries.

[18] Appendix Figure B2 presents a visual representation of a rebalancing event and the specific days included in the estimation window.

Figure 3: Flows implied by rebalancing (FIR)

(a) Relation between FIR and Z (b) Distribution of instrumented FIR values



Notes: Panel (a) 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. The FIR is computed as described in Equation (21) and Z is computed according to Equation (22). Panel (b) shows a histogram of the instrumented FIR. The sample period is 2016–2018.

specification using two-stage least squares (2SLS):

$$\log(q_{i,t,h}) = \theta_{c(i),t} + \theta_{b(i),t} + \gamma \mathbb{1}_{h \in Post} + \beta(FIR_{c(i),t} \times \mathbb{1}_{h \in Post}) + \mathbf{X}_{i,t} + \varepsilon_{i,t,h}, \tag{24}$$

where $FIR_{c(i),t}$ are the flows implied by the rebalancing to country c in rebalancing day t, instrumented by $Z_{c,t}$ in a first stage regression. The term $q_{i,t,h}$ is the price of bond i at rebalancing event t, h trading days before or after the rebalancing information is released. For example, $h = 1$ indicates the first trading day after J.P. Morgan releases the EMBIGD's new composition. This release occurs during trading hours on the last business day of each month, so $h = 1$ corresponds to that same day. The indicator $\mathbb{1}_{h \in Post}$ equals 1 in the h days after the rebalancing and 0 in the h days before, $\theta_{c(i),t}$ are country-month fixed effects, and $\theta_{b(i),t}$ are bond characteristics-month fixed effects, including maturity, rating, and bond type (sovereign or quasi-sovereign). Lastly, $\mathbf{X}_{i,t}$ is a vector of monthly bond controls, which includes the bond's face amount and (beginning-of-month) spread. Our coefficient of interest is β, which captures the effect of shifts in the available supply of a country's index bonds on their prices. Specifically, it measures how a 1 p.p. increase in the FIR influences the average change in the log price of bonds around the rebalancing date.

Our preferred specification replaces the country-month fixed effects, bond characteristics-month fixed effects, and bond controls with bond-month fixed effects, $\theta_{i,t}$. This specification allows us to exploit variation both within and across rebalancing events. Additionally, leveraging the cap rule, we present results that focus exclusively on cross-country variation within rebalancing events. To this end, we include in our specification month-$\mathbb{1}_{h \in Post}$ fixed effects.

Table 3: Log price and FIR

Dependent Variable: Log Price						
	Symmetric window: [-5:+5]				Excl. h=-1	
FIR	0.006					
	(0.808)					
FIR X Post	0.231**	0.232**	0.231**	0.300**	0.263***	0.319**
	(0.099)	(0.100)	(0.099)	(0.134)	(0.098)	(0.135)
Post	0.001*	0.001*	0.001*		0.001**	
	(0.000)	(0.000)	(0.000)		(0.000)	
Bond FE	Yes	Yes	No	No	No	No
Month FE	Yes	No	No	No	No	No
Bond Characteristics-Month FE	No	Yes	No	No	No	No
Country-Month FE	No	Yes	No	No	No	No
Bond-Month FE	No	No	Yes	Yes	Yes	Yes
Month-Post FE	No	No	No	Yes	No	Yes
Bond Controls	No	Yes	No	No	No	No
Observations	105,548	105,508	105,548	105,548	84,433	84,433
N. of Bonds	738	738	738	738	738	738
N. of Countries	68	68	68	68	68	68
N. of Clusters	1,576	1,575	1,576	1,576	1,576	1,576
F (FS)	654	1,616	1,666	476	1,670	476

Note: The table presents 2SLS estimates of log bond prices on the instrumented FIR measure, around rebalancing events. *Post* is an indicator variable equal to 1 for the five trading days after each rebalancing, and 0 otherwise. *Bond Characteristics* refer to fixed effects that interact maturity bins, credit rating grades, and bond type fixed effects. Maturity bins are constructed by dividing a bond's time to maturity into four different categories: short (less than 5 years), medium (5–10 years), long (10–20 years), and very long (20+ years). Rating bins are based on Moody's (categorical) grades. Bond type fixed effects captures the sovereign or quasi-sovereign classification. Bond controls indicate whether the estimation includes the log face amount and log stripped spread of the bond. The analysis focuses on a symmetric five-trading-day window around each event. The last two columns drop the trading day before each rebalancing and the trading day at $h = +5$. Standard errors are clustered at the country-month level, and the sample period is 2016–2018. *, **, and *** denote statistically significant at the 10%, 5%, and 1% level, respectively.

Table 3 reports the results of our baseline estimation using a five-day window around each rebalancing event (i.e., $h \in [-5, 5]$).[19] Our coefficient of interest, β, is always positive and statistically significant in the different specifications. The estimate in the last column, with month-post and bond-month fixed effects (column 4), implies that a 1 p.p. increase in the FIR increases bond returns by around 0.30 p.p.[20]

One potential concern with these results is that bonds receiving a larger or smaller FIR during the rebalancings are on different price trends even before the rebalancing date. To this end, we estimate a leads-and-lags regression in which the instrumented FIR is interacted with trading-day dummies around each rebalancing event. This analysis allows us to explore the dynamic effect of the FIR around each rebalancing. In particular, we estimate the following regression via 2SLS:

$$\log(q_{i,t,h}) = \theta_{c(i),t} + \theta_{b(i),t} + \sum_{h \notin -2} \gamma_h \mathbb{1}_h + \sum_{h \notin -2} \beta_h (FIR_{c(i),t} \times \mathbb{1}_h) + \mathbf{X}_{i,t} + \varepsilon_{i,t,h}, \tag{25}$$

where $\mathbb{1}_h$ are dummy variables equal to 1 for the h trading day in our $[-5, 5]$ estimation window and 0 otherwise. The estimated β_h coefficients are reported in Figure 4.

On the initial four of the five trading days before the index rebalancing, changes in the FIR are not associated with systematic differences in bond prices. Instead, in the trading days after the event, the coefficient increases, becomes positive and significant, and eventually stabilizes below 0.35 by the end of our estimation window. We do observe a slight anticipation in the day before the index rebalancing, which is not uncommon in these setups.[21] In the last two columns of Table 3, we show the estimates based on our preferred specification of Equation (24) but after excluding the trading day before the index rebalancing. This leads to estimates between 0.26 and 0.32, which we take as our baseline since it does not contain any anticipation effect in the pre-period.

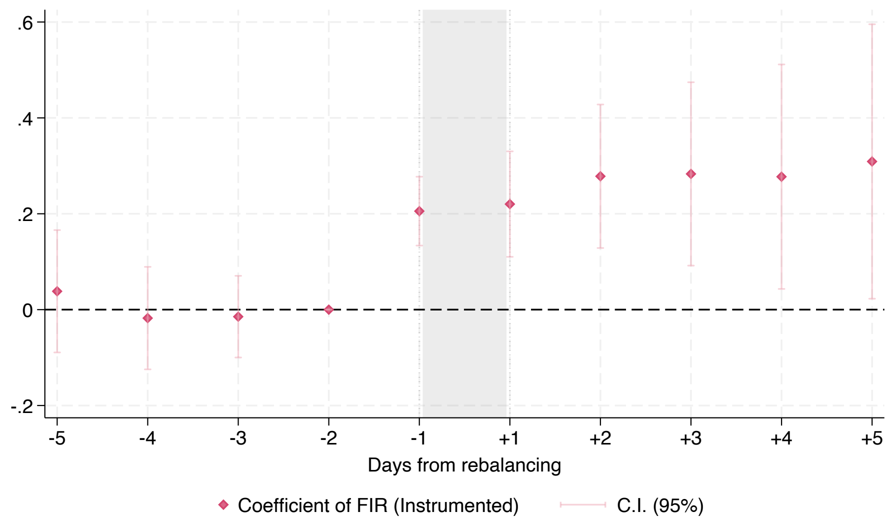
A related concern is the potential for additional anticipation throughout the month. Between the middle and end of every month, J.P. Morgan releases preliminary estimates about end-of-month face amounts, market values, and bond weights. While it is conceivable that active investors trade on this information before the actual index rebalancing date,

[19] In Appendix Table B1 we present also the estimates obtained with simple OLS regressions of log bond prices on the FIR. In this case, the coefficients are slightly lower than in the 2SLS, consistent with a potential downward bias due to the endogeneity of the FIR measure to price changes around the rebalancing date.

[20] In Appendix Table B2 we estimate an OLS regression with an alternative FIR that holds prices constant, using previous rebalancing period prices. Results are similar to our main estimates. Additionally, our results are robust to alternative windows around the rebalancing events (Appendix Table B3) and to excluding quasi-sovereign bonds from the analysis (Appendix Table B4).

[21] For example, this is consistent with the patterns of portfolio rebalancings by different institutional investors highlighted in Escobar, Pandolfi, Pedraza, and Williams (2021), who show that institutional investors could move in the day before the actual index rebalancing event.

Figure 4: Leads and lags coefficients



Note: This figure presents leads and lags coefficients from a 2SLS estimation of bond log prices on a set of trading-day dummies around each rebalancing event, using the same 2SLS procedure as in Table 3. The estimation includes bond characteristics-month fixed effects (maturity, rating, and bond type). The shaded gray area indicates the rebalancing day and $h = +1$ captures the price change in that day. Vertical red lines show 95% confidence intervals. Standard errors are clustered at the country-month level.

our data do not suggest this behavior Normally, if a significant number of investors were anticipating the index rebalancing, we would expect to observe pre-trends in bond prices before the actual event. However, our analysis reveals no correlation between the FIR and bond returns in the week leading up to the rebalancing (with the only exception being the day before the event). Our empirical strategy do not allow us to analyze the middle of the month since those time periods conflate two different rebalancing events. However, if part of the rebalancing-driven inflows were to occur before the event, our FIR measure would overestimate them at the index rebalancing date. This, in turn, implies that our estimates can be understood as a lower bound.[22]

The documented effects are heterogeneous across bonds with varying levels of default risk and across maturities. We divide our sample into terciles based on the bonds' spreads and estimate Equation (24) for each of these subsamples. Panel (a) of Table 4 shows that the price of high-spread bonds is more sensitive to rebalancing shocks, with a 1 p.p. FIR increase associated with almost 0.40 p.p. increase in bond returns. In contrast, for low-spread bonds, the effect is smaller (around 0.10 p.p.) and not statistically significant. Overall, these findings suggest that investors demand a premium as compensation for holding risky bonds, that

[22] Appendix Table B5 shows how our estimates change as we proportionally decrease the FIR measure (due to a lower share of passive funds). These results could serve as guidance for what might happen if the FIR measure were lower due to some investors' portfolio rebalancings being anticipated.

Table 4: Heterogeneous effects

(a) Across default risk

Dependent Variable: Log Price	High Spread		Median Spread		Low Spread	
FIR X Post	0.380**	0.381**	0.325**	0.322**	0.087	0.087
	(0.166)	(0.165)	(0.152)	(0.151)	(0.098)	(0.098)
Bond FE	Yes	No	Yes	No	Yes	No
Month FE	Yes	No	Yes	No	Yes	No
Bond-Month FE	No	Yes	No	Yes	No	Yes
Observations	28,105	28,104	28,055	28,053	28,276	28,276
N. of Bonds	381	381	453	453	375	375
N. of Countries	58	58	51	51	43	43
N. of Clusters	975	975	837	837	634	634
F (FS)	501	2,342	436	720	0	882

(b) Across maturity

Dependent Variable: Log Price	Long Maturity		Medium Maturity		Short Maturity	
FIR X Post	0.411**	0.412**	0.303***	0.303***	0.095	0.093
	(0.198)	(0.196)	(0.094)	(0.093)	(0.061)	(0.061)
Bond FE	Yes	No	Yes	No	Yes	No
Month FE	Yes	No	Yes	No	Yes	No
Bond-Month FE	No	Yes	No	Yes	No	Yes
Observations	28,199	28,198	28,145	28,144	28,092	28,091
N. of Bonds	333	333	295	295	324	324
N. of Countries	55	55	65	65	57	57
N. of Clusters	937	937	1,364	1,364	1,135	1,135
F (FS)	502	989	678	2,569	729	1,274

Note: The table presents 2SLS estimates of log bond prices on the instrumented FIR measure around rebalancing events. In Panel a, the sample is divided into high-spread bonds (those above the 66th percentile of stripped spreads), medium-spread bonds, and low-spread bonds (those below the 33rd percentile). In Panel b, we split the sample into three maturity buckets (based on the 33rd and 66th percentiles): "short" (< 4.8 years), "medium", and "long" (> 8.8 years). The sample period and the 2SLS procedure are identical to those described in Table 3. The estimation excludes the trading day before each rebalancing day. The coefficients for *Post* and FIR are included in the estimation but not reported for brevity. Standard errors are clustered at the country-month level. *, **, and *** denote statistically significant at the 10%, 5%, and 1% level, respectively.

is, an inconvenience yield. Price responses also vary across bonds with different maturities. Panel (b) splits our bond sample into three maturity buckets (based on the 33rd and 66th percentiles): "short" (<4.8 years), "medium", and "long" (>8.8 years). For a given 1 p.p increase in the FIR, we observe price reactions for longer-maturity bonds that are four times larger.[23]

3.6 Discussion of Results

We can directly map the estimated bond price reactions to a reduced-form demand elasticity for active investors. Based on our definition of the FIR, the inverse elasticity in Equation (19) can be written as $\hat{\eta}^i \equiv (-)\frac{\Delta \log(q_t^i)}{FIR_{c,t}}$, which is precisely what the β coefficient in Equation (24) captures. Based on the results in Table 3 (last column), our estimate for β implies a demand elasticity for active investors close to -3.0.

We derive the market-wide elasticity through a simple back-of-the-envelope calculation, where we weight the elasticity of active investors by their market share. Since passive demand is perfectly inelastic, the market-wide elasticity is $\frac{1}{\beta} \times \frac{B_t - \mathcal{T}_t}{B_t} + 0 \times \frac{\mathcal{T}_t}{B_t}$, where $\frac{B_t - \mathcal{T}_t}{B_t}$ captures the share of active holdings relative to bonds outstanding. In our sample, the median country has a share of active holdings of 71%, which implies a market-wide elasticity of around -2.0.

As emphasized at the beginning of the section, the previous estimates do not necessarily capture a structural elasticity because bonds' expected payoffs may be affected by our supply-shifting shock, which should be reflected in the price. This aligns with our finding that price reactions are more pronounced for longer-term bonds, whose expected payoffs may be more responsive due to the longer horizon —Table 4b. Additionally, we find that credit default swaps (CDS) spreads decrease with the instrumented FIR —see Appendix Table B6— which further supports the notion that expected payoffs may be affected by the supply-shifting instrument. While these findings are suggestive, they underscore the need for our structural model to disentangle these forces —a task we address in the next section.

Comparison with other studies. Our estimated reduced-form demand elasticity is smaller compared to that of sovereign bonds issued in advanced economies (Jiang, Lustig, Van Nieuwerburgh, and Xiaolan, 2021; Krishnamurthy and Vissing-Jorgensen, 2012; Greenwood et al., 2015; Mian et al., 2022), highlighting a relatively inelastic nature of the market for EM bonds. Our estimates are in line with those for corporate bonds in advanced economies (Bretscher et al., 2022), which are typically riskier than government bonds. Overall, these

[23] This is in line with Broner, Lorenzoni, and Schmukler (2013), who show that short-term bonds are more closely tied to policy rates.

results are consistent with our finding that price reactions to the instrumented FIR are higher for countries with higher default risk. In comparison to another study focusing on EM government debt, our estimates imply a more elastic demand than Fang et al. (2025). This is expected, as we focus on the most liquid bonds within the emerging market asset class, whereas their estimates are for bonds and loans issued by a larger panel of countries. Moreover, their analysis includes bonds denominated in local currency, which are typically less elastic —likely due to their predominant ownership by domestic investors (see Pandolfi and Williams, 2019). Appendix Figure B6 provides a detailed comparison of our estimates with other studies.

4 Quantitative Analysis

4.1 Calibration

We calibrate the model at a quarterly frequency using data on Argentina. 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. We then internally calibrate the remaining parameters to match relevant moments for Argentine spreads and other business cycle statistics. Key to our analysis, we calibrate the structural parameter behind the active demand elasticity, κ, to match our reduced-form estimates of Section 3.

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 γ denotes the risk aversion. Log 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 loss function is identical to the one used in Chatterjee and Eyigungor (2012) and allows us to closely match 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, we let $\mathcal{T}(\tau, B') = \tau B'$, where τ is stochastic and follows and AR(1) process, $\tau' = (1-\rho_\tau)\tau^\star + \rho_\tau \tau + \epsilon'_\tau$, where $\epsilon'_\tau \sim N(0, \sigma_\tau)$.

Table 5 lists the calibrated parameters. For the subset of fixed parameters (Panel a), we set $\gamma = 2$, which is a standard value for risk aversion in the literature. We also set a quarterly risk-free rate of $r_f = 0.01$, in line with the average real risk-free rate observed in the United States. The probability of re-entering international markets is set to $\theta = 0.0385$, implying an average exclusion duration of 6.5 years. We set $\lambda = 0.05$ to target a debt maturity of

Table 5: Calibration of the model

Panel a: Fixed Parameters			Panel b: Calibrated Parameters		
Param.	Description	Value	Param.	Description	Value
γ	Risk aversion	2.00	β	Discount rate	0.952
r	Risk-free interest rate	0.01	$\bar{d}_0$	Default cost—level	-0.262
λ	Debt maturity	0.05	$\bar{d}_1$	Default cost—curvature	0.31
z	Debt services	0.03	κ	Slope parameter	70.0
θ	Reentry probability	0.0385	$\bar{\mathcal{A}}$	Active investors demand	0.443
ρ_{y}	Output, autocorrelation	0.93			
σ_{y}	Output, shock volatility	0.02			
$\tau^{\star}$	Share of passive demand	0.123			
$\rho_{\mathcal{T}}$	FIR, autocorrelation	0.66			
$\sigma_{\mathcal{T}}$	FIR, shock volatility	0.02			

5 years and $\nu = 0.03$ to match Argentina's average debt services. The parameters for the endowment process, ρ_y and σ_y, are based on log-linearly detrended quarterly real GDP data for Argentina. All these parameters are taken from Morelli and Moretti (2023). Last, we set $\tau^{\star}$ to match the average share of bonds tracked by passive investors and calibrate $\rho_{\mathcal{T}}$ and $\sigma_{\mathcal{T}}$ to match the persistence and volatility of the passive demand.[24]

We internally calibrate the remaining parameters (Table 5, Panel b). First, we jointly calibrate the default cost parameters $\{d_0, d_1\}$, together with the government's discount factor β, to target Argentina's average ratio of (external) debt to GDP, average spread, and volatility of spreads.[25] Regarding the parameters on the demand side, we calibrate κ to match the estimated (inverse) reduced-form demand elasticity, $\hat{\eta}(\cdot)$, which is derived from high-frequency price responses within a short window around the rebalancing of the $\mathcal{I}$ index. To this end, we introduce secondary markets into our model to better capture the high-frequency nature of our empirical analysis. In particular, we consider two instances of trading in secondary markets within a period. The timing assumption is as follows:

1. *The endowment y is realized. The initial states are: $\{y, \tau, B\}$*
2. *The government chooses $d(y, \tau, B)$ and $B'(y, \tau, B)$.*
3. *The primary and secondary market open. Let $q^{SM,0}(y, \tau, B')$ denote the opening price.*
4. *The next-period index weights τ' are realized. Bond prices are updated.*
5. *The secondary market closes. Let $q^{SM,1}(y, \tau', B')$ denote the closing price.*

[24] We assume that the entire stock of debt is part of the $\mathcal{I}$ index. This is for tractability as it allows us to reduce the dimensionality of the state space. For Argentina, around 80% of its external government debt is part of a bond index.

[25] Annualized spreads are computed as $SP(y, \tau, B') \equiv \left(\frac{1+i(y,\tau,B')}{1+r_f}\right)^4 - 1$, where $i(y, \tau, B')$ is the internal quarterly return rate, which is the value of $i(.)$ that solves $q(\cdot) = \frac{\lambda+(1-\lambda)(\nu+q(\cdot))}{\lambda+i(\cdot)}$. Our target for debt-to-output is based on Argentina's "external debt stocks, public and publicly guaranteed", as reported by the World Bank. Since our model does not consider a recovery rate in case of default, we target only the unsecured portion of debt —70% based on Chatterjee and Eyigungor (2012).

Table 6: Targeted moments

Target	Description	Data	Model
$\mathbb{E}[SP]$	Bond spreads (%)	4.72	4.69
$\sigma(SP)$	Volatility of spreads (%)	2.00	1.58
$\mathbb{E}[B/Y]$	Debt to output (%)	53.0	52.8
$\hat{\eta}$	Reduced-form elasticity	-0.30	-0.27
$\mathbb{E}\left(\vartheta\right)$	Inconvenience yield (%)	0.00	0.09

Note: The table reports the moments targeted in the calibration and their model counterpart.

With this simple extension, we can compute bond price reactions to exogenous changes in index weights for a fixed debt supply and fundamentals, similar to what we did in our empirical setup. The only difference between bond prices $q^{SM,1}$ and $q^{SM,0}$ arises from the update of the passive demand share τ, since both the endowment and the stock of debt remain fixed while secondary markets are open. In Appendix C, we describe in detail the pricing functions under this extension. What it is important to note is that, absent secondary markets, the timing assumption is exactly the same as in the baseline model. This implies that the proposed extension nests our baseline model of Section 2.

Let $\Delta\mathcal{T}' \equiv \mathcal{T}(\tau', B') - \mathcal{T}(\tau, B')$ denote an exogenous shift in the passive demand implied by a change in index weights. Given $\Delta\mathcal{T}'$, and by means of simulations, we can compute the same reduced-form inverse elasticity of our empirical analysis:

$$\hat{\eta}\left(y, \tau, B'; \kappa\right) = (-)\frac{\Delta \log q}{\Delta\mathcal{T}' / \left(B' - \mathcal{T}\left(\tau, B'\right)\right)}, \tag{26}$$

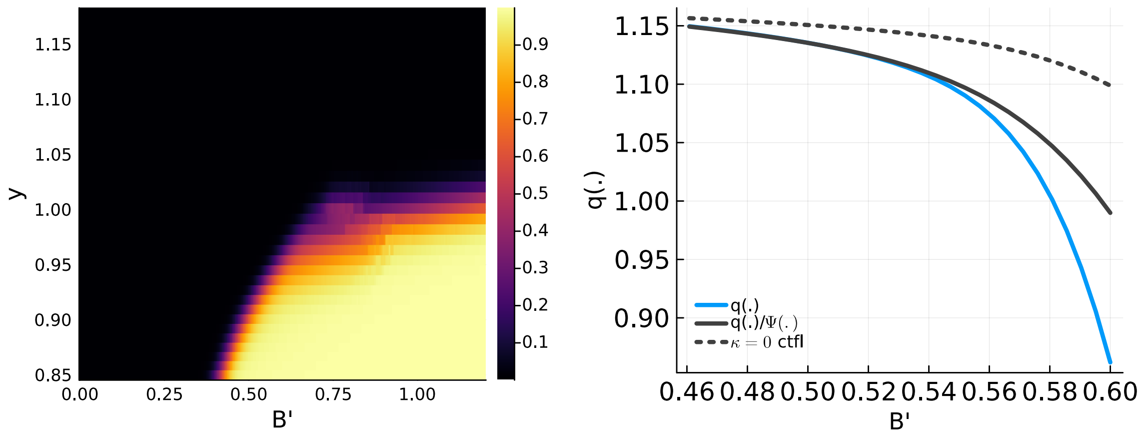
where $\Delta \log q \equiv \log q^{SM,1}\left(y, \tau', B'\right) - \log q^{SM,0}\left(y, \tau, B'\right)$ is the relative change in the bond price before and after the change in the passive demand—for a fixed endowment y and debt B'. Lastly, we set $\bar{\mathcal{A}}$ so that the model-implied inconvenience yield is zero.[26] The introduction of the $\Psi(.)$ term thus only affects the sensitivity of the pricing kernel to changes in B' around the $\{\bar{B}, \bar{\mathcal{T}}, \bar{\mathcal{A}}\}$ point.

Table 6 reports the set of targeted moments and the model's fit— in the next subsection, we will analyze untargeted moments. Overall, the model performs well in matching all of our targeted moments. Figure 5 depicts the default set and the bond price function $q(.)$ for different values of B' and y. Panel (a) shows that the government defaults in states with high debt and low output. As a consequence, the bond price is decreasing in B' and increasing in y (Panel (b), blue line).

[26] We first compute bond prices for a counterfactual scenario in which demand is perfectly elastic ($\kappa = 0$), holding the policies from our baseline model fixed. We then define the inconvenience yield, $\vartheta\left(\cdot\right)$, as the difference between the bond spread implied by the baseline model and that of the counterfactual. Specifically, $\vartheta\left(y, \tau, B'\right) \equiv \mathrm{SP}\left(y, \tau, B'\right) - \mathrm{SP}\left(y, \tau, B'; \kappa = 0\right)$. A positive value indicates that investors are willing to lend, for a given level of default risk, at a higher spread.

Figure 5: Default set and bond prices

(a) Default set (b) Bond price



Note: Panel (a) shows the default policy for different combinations of B' and y. The black area depicts combinations of B' and y such that default probability is zero. Lighter colors indicate a higher default probability. In Panel (b), the blue solid line shows the bond pricing kernel $q(y, \tau, B')$ for different values of B'—evaluated at the mean y and τ. The solid black line shows $\frac{1}{r^f}\mathbb{E}_{s'|s}\left(\mathcal{R}'\left(\cdot\right)\right)$—i.e., $q\left(\cdot\right)/\Psi\left(\cdot\right)$. The dashed black line shows the bond price in a counterfactual in which we maintain the baseline government policies but assume that the demand is perfectly elastic.

Figure 5 also highlights the role of a downward-sloping demand on bond prices. The solid black line in Panel (b) shows the expected repayment per unit of the bond $\frac{1}{r^f}\mathbb{E}_{s'|s}\left(\mathcal{R}'\left(\cdot\right)\right)$. At lower B' levels, where default risk and the variance of payments is minimal, bond prices remain largely unaffected by the downward-sloping demand. However, as B' increases, the larger repayment volatility lowers the $\Psi\left(\cdot\right)$ term, which decreases the bond price $q(.)$. The dotted line depicts bond prices under a counterfactual scenario in which we maintain the baseline $\{B'(\cdot), d(\cdot)\}$ policies but solve a new pricing equation with $\kappa = 0$. This adjustment affects not only the current $\Psi(\cdot)$ but also its future values. In this case, bond prices exhibit a much lower curvature relative to our baseline. This simple analysis highlights the dynamics effects of a downward-sloping demand on bond prices: not only does the current $\Psi\left(\cdot\right)$ matters for prices, but the entire future path of $\Psi\left(\cdot\right)$ plays a crucial role.

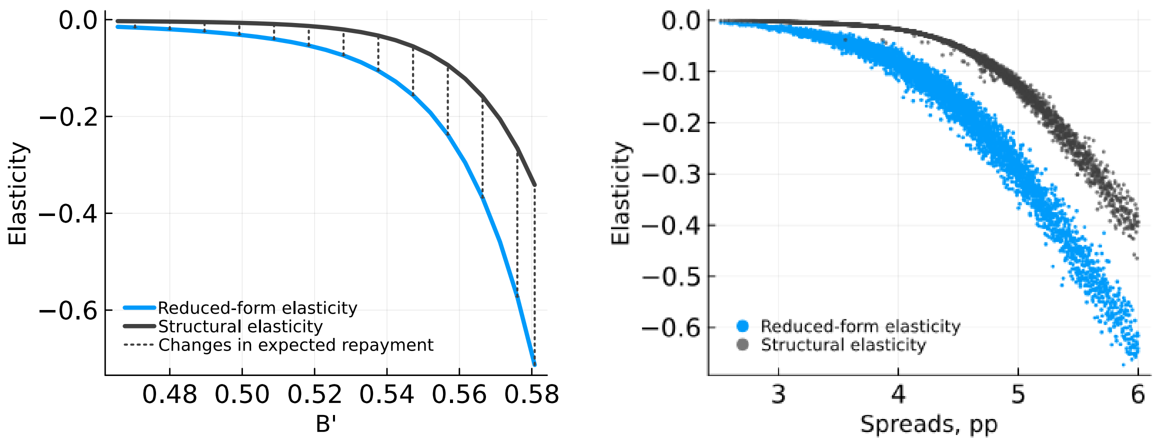
4.2 Recovering the Demand Structural Elasticity

Given our calibrated κ and the endogenous repayment function $\mathcal{R}\left(y', \tau', B'\right)$, we can decompose the components behind the reduced-form (inverse) elasticity $\hat{\eta}\left(y, \tau, B'; \kappa\right)$ and back out the structural demand elasticity $\eta\left(y, \tau, B'; \kappa\right)$—following Equation (16).

Figure 6 presents the results of the decomposition. Panel (a) shows the reduced-form inverse elasticity, $\hat{\eta}\left(y, \tau, B'; \kappa\right)$, and the structural one, $\eta\left(y, \tau, B'; \kappa\right)$, for different values of B'. The vertical differences between these two curves indicate the portion of the reduced-form elasticity attributable to endogenous changes in the repayment function, $\alpha\left(y, \tau, B'; \kappa\right)$. We

Figure 6: Disentangling the demand elasticity

(a) As a function of spreads (b) Model simulations



Note: Panel a shows the reduced-form inverse demand elasticity $\hat{\eta}$ and the structural one η for different values of B', and for the mean y and τ. The vertical differences between the two lines (represented by the dotted lines) capture the endogenous changes in bonds' expected repayment, α. Panel (b) shows the elasticities obtained from simulating the model, as a function of annualized bond spreads.

Table 7: Persistence of shocks and demand elasticity

Moment	Baseline	Lower persistence	Low persistence	Higher persistence
Reduced-form $\hat{\eta}$	-0.27	-0.23	-0.25	-0.37
Structural η	-0.17	-0.17	-0.17	-0.17
Bias, $1 - \eta/\hat{\eta}$	37%	24%	30%	53%

Note: The table compares the reduced-form inverse demand elasticity $\hat{\eta}$ with the structural one η. The "Baseline" column shows the elasticities under our baseline calibration. In the "Lower persistence" case, we decrease the persistence of the $\{\tau\}$ process by setting $\rho_\tau = 0.30$. The "Low persistence" column is based on $\rho_\tau = 0.50$. The "Higher persistence" column shows the results for $\rho_\tau = 0.90$.

find that the magnitude of $\hat{\eta}(\cdot)$ is always higher than that of $\eta(\cdot)$. The difference can be substantial, particularly for larger values of B'. Panel (b) shows a binscatter plot with the reduced-form and structural inverse elasticities obtained from simulating the model, as a function of spreads. On average, we find that the structural elasticity accounts for less than two-thirds of the reduced-form elasticity—first column of Table 7.

The difference between the structural and reduced-form elasticity depends on the persistence of the τ process. The last two columns of Table 7 compare the reduced-form and structural elasticities for different persistence values of the $\{\tau\}$ process. When the process is more (less) persistent, the structural elasticity accounts for a smaller (larger) share of the reduced-form elasticity. In other words, the more persistent the shock, the smaller the total price response attributed to the downward-sloping component of investors' demand. In Appendix C.3, we analyze these differences in more detail.

Overall, our analysis highlights the importance of accounting for issuers' endogenous responses to an exogenous (supply-shifting) shock and the resulting changes in assets' expected

Table 8: Comparison with perfectly elastic case and other counterfactuals

Moment	Description	Baseline model (i)	Perfectly elastic (ii)	Δ Def. cost (iii)	No dilution (iv)	Partial dilution (v)
$\mathbb{E}(SP)$	Bond spreads (%)	4.69	8.48	4.77	0.85	4.75
$\sigma(SP)$	Std of spreads (%)	1.58	5.03	2.00	0.53	1.76
$\mathbb{E}(B/y)$	Debt to output (%)	52.8	51.3	82.1	50.7	53.5
$\mathbb{E}(d)$	Default frequency (%)	3.08	4.57	3.17	0.69	3.26
$\sigma(\Delta B'/y)$	Std of issuances (%)	0.80	0.84	1.08	1.62	1.43
$\rho(\Delta B'/y, y)$	Corr issuances & output	0.48	0.64	0.57	0.49	0.56
$\rho(SP, y)$	Corr spreads & output	-0.69	-0.63	-0.61	-0.28	-0.62
$\rho(\Delta tb/y, y)$	Corr trade bal. & output	-0.41	-0.41	-0.41	-0.30	-0.34
$\rho(\mathcal{B}/y, y)$	Corr debt service & output	0.37	0.56	0.46	0.78	0.72

Note: The table compares a set of moments between our baseline model (column i) and alternative counterfactual scenarios. Column (ii) shows the results for a case in which investors perfectly elastic ($\kappa = 0$). Column (iii) shows a perfectly elastic case, but in which we change the default cost parameter d_0 to match the average bond spreads of our baseline. Columns (iv) and (v) show counterfactuals in which we shut down or dampen the debt-dilution mechanism—see text for further details. The term $\Delta B'$ captures bond issuances and it defined as $\Delta B' \equiv B' - (1-\lambda)B$. The term $\mathcal{B}$ are debt services, defined as $\mathcal{B} = B \times ((1-\lambda)z + \lambda)$.

repayment. Neglecting these factors can introduce significant biases into the estimated demand elasticity, particularly if the shock is persistent.

4.3 Implications of a Downward-sloping Demand

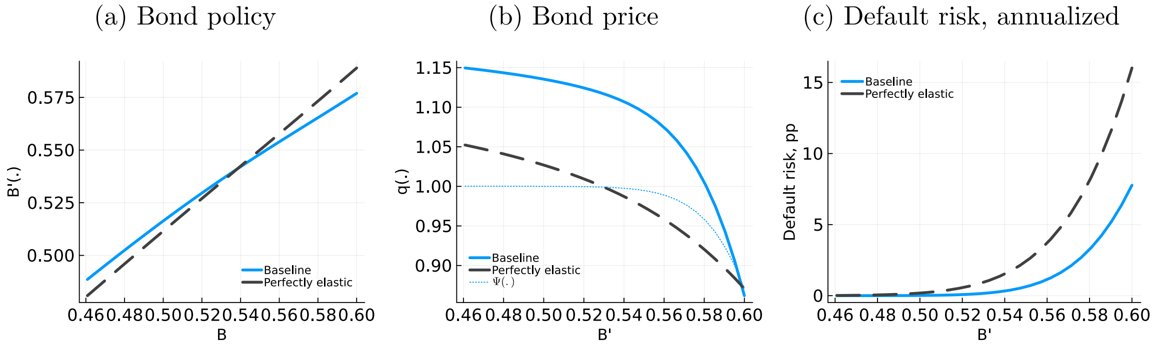
This section quantifies the effects of a downward-sloping demand on bond prices, default risk, and government policies. To this end, we compare our downward-sloping demand model with alternative scenarios where investors are perfectly elastic.

Bond spreads and default risk

Columns (i) and (ii) in Table 8 report a set of targeted and untargeted moments for our baseline model and for an alternative case with a perfectly elastic demand for which we set $\kappa = 0$—all the other model parameters remain the same. The first striking result from Table 8 is that the default frequency and average spreads are *lower* in the case of downward-sloping demand compared to the perfectly elastic scenario, even though the average debt-to-output ratio is *higher*.

There are two interconnected mechanisms that drive this result. First, a downward-sloping demand limits the maximum debt a government is willing to issue. Panel (a) of Figure 7 compares the optimal debt policy $B'(y, \tau, B)$ in our baseline model to the perfectly elastic case. The $B'(\cdot)$ function is flatter when demand is price elastic. In particular, when facing a downward-sloping demand, the government issues less debt when the current stock of debt B is large, relative to the perfectly elastic case. This is because each additional unit of B' lowers the bond price $q(.)$ not only due to higher default risk but also due to the negative

Figure 7: Comparison with perfectly elastic case: Policy functions and prices



Note: Figure compares policies and bond prices between our baseline model (blue lines) and a perfectly elastic demand counterfactual (black lines). Panel (a) presents bond policies as a function of B. Panel (b) shows bond prices and panel (c) shows annualized default risk. We evaluate all the functions at the mean value for output, y.

slope of the demand. This latter effect intensifies as B increases, since default risk and repayment variance grow, which ends up limiting bond issuances. Second, these changes in the optimal bond policy have important effects on the pricing of bonds—Figure 7, Panel (b). For small values of B' (low default risk), $q(.)$ is actually *higher* than in the perfectly elastic case. This larger bond price is not mechanically driven by a $\Psi(\cdot) > 1$—given our calibration, $\Psi(.)$ is typically smaller than one. Instead, the higher bond price results from a lower default risk—Panel (c)—, which is a direct consequence of the government's reduced incentives to issue large amounts of B'.

Overall, these results imply that a downward-sloping demand acts as a disciplining device that lowers default risk and simultaneously allows the government to increase its debt-to-output ratio, relative to the perfectly elastic case. As shown in Table 8, the effects are sizable: spreads are about 50% lower and debt-to-output is 1p.p. higher, compared to the perfectly elastic benchmark.

Role of default costs

In a standard sovereign debt model with perfectly elastic investors, higher default costs also act as a disciplining device by discouraging the government from defaulting, leading to lower spreads and default risk. The effects of this disciplining device, however, differ from those that emerge from facing a downward-sloping demand. To show this, we consider an alternative calibration for the perfectly elastic case, where we increase the output cost of default. Specifically, we raise the d_0 parameter to match the observed bond spreads, while keeping all other parameters unchanged. Under this calibration, even though average spreads and default frequency are comparable to our baseline model, the average debt is significantly higher, with the debt-to-output ratio close to 80%—column (iii) of Table 8. Our baseline model leads to a significantly lower average debt precisely because the disciplining mechanism operates through reduced incentives to issue additional debt—not through direct changes in default incentives. In Appendix C.4, we show that a perfectly elastic model with higher default costs can attain a debt-to-output ratio in line with that of our baseline specification, but only if we increase the government's discount factor.

Link with debt dilution

The disciplining mechanism created by a downward-sloping demand hinges on the well-known debt dilution issue faced by long-term risky bonds. When governments cannot commit to a future issuance path, if lenders anticipate additional borrowing in the future, they will offer a lower bond price to account for the higher default risk. By diminishing the government's incentives to increase future issuances, a downward-sloping demand curve dampens the debt dilution issue, and increases bond prices. In this section, we quantify how large these effects are.

We examine a counterfactual economy where investors are perfectly elastic, and either (i) debt dilution is entirely absent or (ii) it is partially mitigated. To this end, we follow Hatchondo et al. (2016) and introduce a debt covenant that specifies that if the government issues new bonds, it has to pay each holder of previously issued long-term bonds the difference between the counterfactual price that would have been observed without the new issuances and the observed bond price. That is,

$$\mathcal{C}\left(y, \tau, B, B'\right) = \chi \times \max\left\{0, \tilde{q}\left(y, \tau, (1-\lambda)B\right) - \tilde{q}\left(y, \tau, B'\right)\right\}, \tag{27}$$

where $\chi \in [0,1]$. In this alternative economy, the bond price $\tilde{q}(\cdot)$ is given by

$$\tilde{q}\left(y, \tau, B'\right) = \frac{1}{r^f}\mathbb{E}_{s'|s}\tilde{\mathcal{R}}\left(y', \tau', B'\right) = \mathbb{E}_{s'|s}\left[1 - d'(\cdot)\right]\left[\lambda + (1-\lambda)\left(\nu + \tilde{q}'(\cdot) + \mathcal{C}'(\cdot)\right)\right], \tag{28}$$

where $\tilde{d}'(\cdot) = \tilde{d}(y', \tau', B')$ is the next-period default, $\tilde{q}'(\cdot) = \tilde{q}(y', \tau', \tilde{B}''(\cdot))$ is the next-period price, with $\tilde{B}''(\cdot) \equiv \tilde{B}'(y', \tau', B')$, and $\mathcal{C}'(\cdot) = \mathcal{C}(y', \tau', B', B'')$ is the next-period covenant.

When not in default, and for a given choice of B', the budget constraint for the government is now

$$\tilde{c}\left(h = 0, B, y, \tau; B'\right) = y + \tilde{q}(\cdot)\left(B' - (1-\lambda)B\right) - \left(\lambda + (1-\lambda)\left(\nu + \mathcal{C}(\cdot)\right)\right)B. \tag{29}$$

All the other equations are analogous to that of our baseline model. Under this setup, the $\chi = 0$ case captures our perfectly elastic benchmark; Under $\chi = 1$, there is no debt dilution as investors are always compensated for any change in the bond price caused by additional issuances. Lastly, the case with $\chi \in (0,1)$ captures a "partial dilution" scenario, in which investors are still subject to future changes in bond prices due to future issuances, but those effects are dampened given the partial bond covenant.

Column (iv) in Table 8 shows the "no dilution" counterfactual ($\chi = 1$). Bond spreads decrease sharply—by about 90% relative to the perfectly elastic case and 80% relative to our baseline model.[27] Put differently, given our estimated demand elasticity, the disciplining effect of a downward-sloping demand is not strong enough to eliminate the debt dilution issue. To quantify how much of the smaller spreads observed with inelastic investors can be linked to debt dilution, we solve for $\chi \in (0,1)$ such that the average bond spread under perfectly elastic investors equals our targeted moment—the last column of Table 8. We find that for $\chi = 0.14$, this "partial dilution" counterfactual delivers similar average spreads to our baseline model.

To summarize these findings, a downward-sloping demand acts as a debt covenant that reduces the government's incentives to issue additional debt. Given our structural elasticity, while it does not fully eliminate the debt dilution issue—in the sense that spreads are higher relative to the no dilution counterfactual—it significantly lowers default risk and bond spreads. Our baseline economy still differs from these no-dilution counterfactuals across several dimensions, most notably in the volatility and cyclicality of issuances. We analyze these features in the following subsection.

4.4 Volatility and cyclicality of issuances

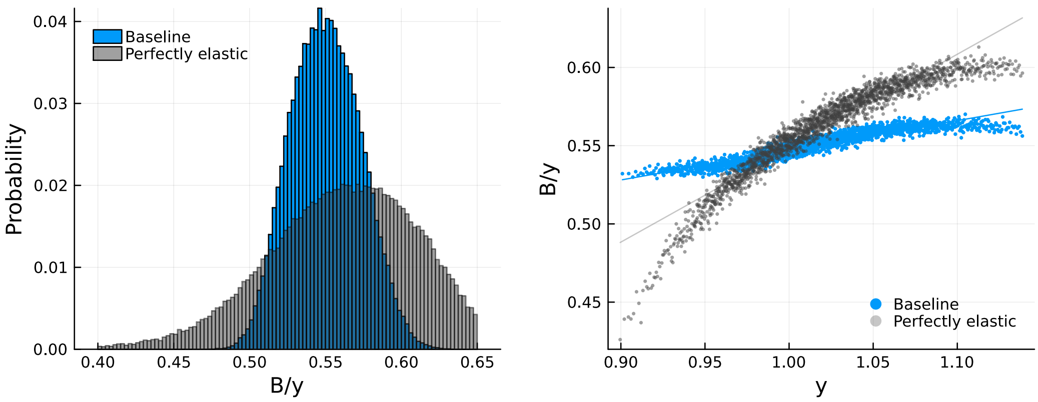
How does a downward-sloping demand affect the optimal government response to shocks? It is well-known that in models with limited commitment and endogenous default, the optimal bond policy is pro-cyclical (Arellano, 2008). While the government would like to issue more debt in "bad" times (i.e., when output is low) to smooth consumption, the resulting increase in spreads—due to higher default risk— leads the government to actually reduce its debt. On the other hand, in "good" times (when output is high and default risk is low), the government benefits from cheaper credit and increases its debt issuance. This standard mechanism in sovereign debt models explains the well-known excess volatility of consumption in emerging markets.

We find that this pro-cyclicality is significantly dampened in the presence of a downward-sloping demand. Table 8 shows that the correlation between issuances and output is

[27]These magnitudes are similar to the results in Hatchondo et al. (2016). Given the bond covenant, we compute bond spreads based on the internal quarterly return rate $\tilde{i}(y,\tau,B')$ that solves $\tilde{q}\left(\cdot\right) = \frac{\lambda+(1-\lambda)\left(\nu+\tilde{q}(\cdot)+\mathcal{C}'(\cdot)\right)}{\lambda+\tilde{i}(\cdot)}$.

Figure 8: Stock of sovereign debt under downward-sloping demand

(a) Distribution of B/y (b) Relation with output



Note: Panel (a) shows the model simulated distributions for debt-to-output. Panel (b) shows a binscatter plot between the debt-to-output ratio and output. Blue bars and dots are for the baseline model with downward-sloping demand. Orange bars and dots are for an alternative model in which investors are perfectly elastic.

significantly smaller relative to the perfectly elastic counterfactuals.[28] Figure 8 compares the unconditional distribution of debt-to-output ratios between our baseline model and the perfectly elastic case. Under a downward-sloping demand, this distribution is significantly less dispersed (Panel a), and the debt-to-output ratio as a function of output exhibits a much flatter relationship for every y (Panel b).

The lower cyclicality of debt issuances does not affect the cyclicality of the trade balance. Table 8 shows that the correlation between the trade balance and output in our baseline model is almost identical to that under a perfectly elastic demand. This seemingly puzzling result is explained by the fact that our baseline model also dampens the cyclicality of debt services, which counteracts the lower cyclicality of issuances—see Appendix C.4 for a detailed analysis. This is consistent with the well-documented fact that net exports are highly countercyclical in emerging economies (Aguiar and Gopinath, 2006; Neumeyer and Perri, 2005). A less elastic demand or larger frictions in bond markets faced by governments in emerging economies does not alter this empirical regularity.

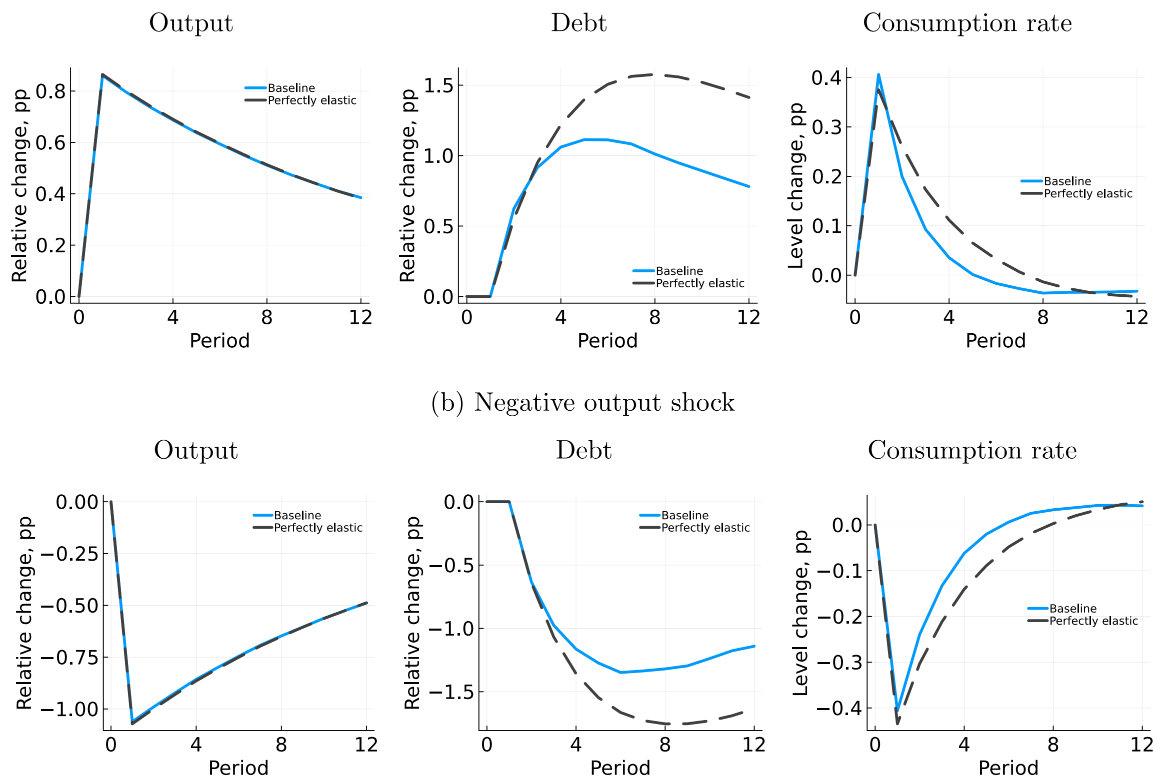
The previous unconditional patterns are also reflected in conditional responses. In Figure 9, we analyze impulse responses to endowment shocks. For a positive one-standard deviation shock (Panel a), the figure shows a greater increase in debt issuance when investors are perfectly elastic. Under a perfectly elastic demand, the government can take full advantage of the lower financing costs associated with the implied decrease in default risk. Under a downward-sloping demand, the response is muted, as the government internalizes that,

[28] The corollary of this lower debt pro-cyclicality is a larger correlation (in magnitude) between spreads and output.

despite the cheaper financing, an additional unit of debt reduces bond prices due to the demand's negative slope. In this sense, a demand that is not perfectly elastic imposes a cost: it prevents the government from issuing more during periods when financing is cheap, which lowers the expansion in consumption. For a negative endowment shock (Panel b), an analogous pattern emerges. A decrease in output increases borrowing costs, prompting the government to decrease its debt. When the demand is downward sloping, reducing the stock of debt decreases the inconvenience yield demanded by investors, which lowers spreads; hence, the contraction in debt is less pronounced.

Figure 9: Impulse responses to an output shock

(a) Positive output shock



Note: Figure shows the impulse response dynamics to a positive (panel a) and negative (panel b) endowment shock. Blue lines show the dynamics for our baseline model with downward-sloping demand. The orange dashed lines show the perfectly elastic case.

Welfare Implications

The effects on welfare are a priori ambiguous because there are two opposing mechanisms at play. First, for a given default risk and expected repayment function, a downward-sloping demand lowers the proceeds from issuing an additional unit of debt. Second, a downward-sloping demand lowers the pro-cyclicality of issuances and creates fiscal discipline, which lowers default risk and dampens the debt dilution issue associated with long-term bonds.

To quantify the overall welfare implications, we define certainty equivalent consumption (CEC) as the proportional increase in consumption under the perfectly elastic case, such that the household is indifferent between this scenario and the downward-sloping demand case.[29] We find a positive CEC, indicating that the disciplining device is sufficiently strong for the household to prefer a world with price-sensitive investors—Panel (a) of Figure 10. The CEC decreases as the stock of debt increases, which is explained by the higher inconvenience yield demanded by investors (as shown in Figure 7). For low debt levels, the inconvenience yield is negligible but the government still gets the benefits derived from the disciplining mechanism.[30]

While overall beneficial, a downward-sloping demand still poses some costs since, for a given expected repayment, it lowers the proceeds from an extra unit of debt. To illustrate this, in Panel (b) we compare our baseline model with a perfectly elastic case with higher default costs—same comparison as we did in column (iii) of Table 8. Overall, the CEC is negative which implies that the representative household would prefer to live in an economy with a perfectly elastic demand in which the disciplining device comes from higher default costs, not from price-elastic investors.

4.5 Changes in Investor Composition: A Rise in Passive Demand

So far, we have used passive demand merely as an instrument to estimate the demand elasticity for active investors. We now turn to the aggregate implications of an increase in the passive demand share, which, in turn, depends on the demand elasticity of active investors. As shown in our main pricing equation (13), a larger passive demand, $\mathcal{T}$, affects bond prices only if the active demand is not perfectly elastic (i.e., $\kappa \neq 0$). If active investors were perfectly elastic, the composition of investors would have no effect on bond prices or government policies.

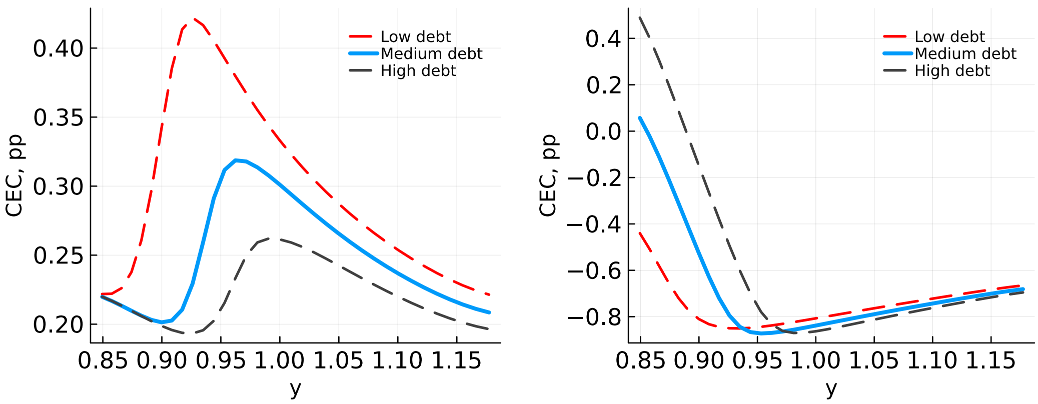
We start by analyzing the impulse responses to a temporary two-standard-deviation increase in passive demand—Figure 11. The shock implies a 4 p.p on-impact increase in the passive demand share $\mathcal{T}/B$—as shown in Panel (a). Despite the larger demand, bond prices slightly increase on impact and subsequently decrease—the blue line in Panel (b). This is

[29] The CEC is implicitly defined as the value of $\tilde{x}$ such that $\sum_{t=0}^{\infty} \beta^t \mathbb{E}_t u(c_t) = \sum_{t=0}^{\infty} \beta^t \mathbb{E}_t u\left((1+\tilde{x})\, \tilde{c}_t\right)$, where c_t denotes the consumption under a downward-sloping demand and $\tilde{c}_t$ denotes the consumption under a perfectly elastic case. By exploiting the power utility function, the CEC is given by: $\tilde{x} = \left[\frac{V(y,\tau,B)}{\tilde{V}(y,\tau,B)}\right]^{\frac{1}{1-\gamma}} - 1$, where $\tilde{V}(.)$ is the government's value function under the perfectly elastic case.

[30] The welfare gains from a downward-sloping demand echo the no-dilution results in Hatchondo et al. (2016), where governments prefer compensating bondholders under the debt covenant of Equation (27). Welfare gains are up to three times higher than in our study, reflecting that a downward-sloping demand does not fully resolve the debt dilution problem.

Figure 10: Welfare analysis, Certainty equivalent consumption

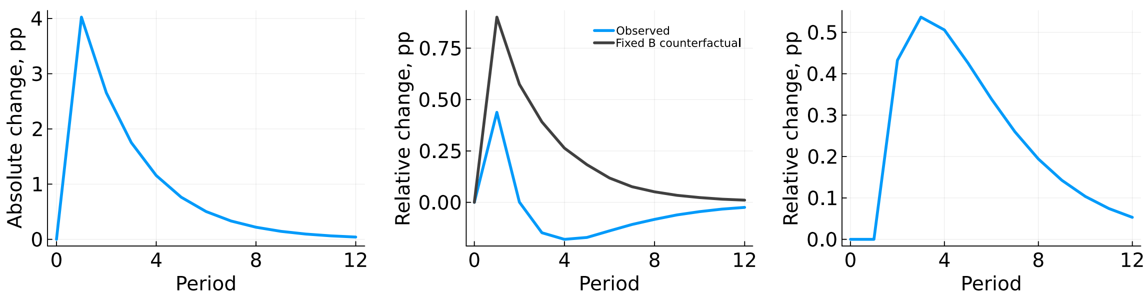
(a) Perfectly elastic (b) Perfectly elastic with higher def. costs



Note: The figure shows the certainty equivalent consumption (CEC) defined as the proportional increase in consumption under the perfectly elastic counterfactual such that the household is indifferent between that case and the downward-sloping demand scenario. Panel (a) shows the CEC across different levels of B. The blue dots in Panel (b) show the the relation between the CEC and debt-to-output ratio B/y, based on model simulations. The gray bars show the histogram for the distribution of B/y.

Figure 11: Impulse response to an increase in the passive demand

(a) Passive demand, $\Delta\mathcal{T}'/B$ (b) Bond price, $\Delta q/q$ (c) Stock of debt, $\Delta B'/B$



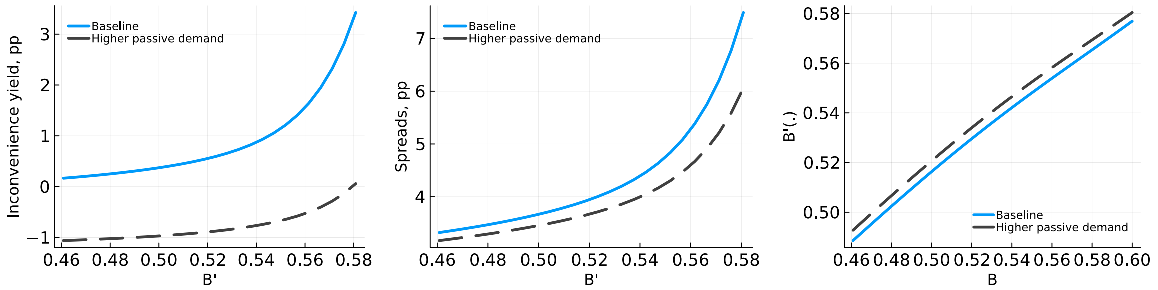
Note: The top panel shows impulse responses to an increase in the passive demand. The bottom panel shows a decomposition for bond price changes across time, in a counterfactual in which the stock of debt remains fixed.

because the government optimally responds to the shock by increasing bond supply—Panel (c)—which raises default risk and lowers the bond's expected repayment and price. The government's response is not one-to-one, as the overall increase in bond supply is less than one-fifth of the demand shock. The black line in Panel (b) provides a counterfactual in which we compute bond prices under the assumption that bond supply does not react to the passive demand shock. In this case, bond prices increase by almost 1% on impact, which is explained by a larger convenience yield. To sum up, the government optimally chooses to increase its debt supply despite a lower bond price—see Appendix C.3 for a more detailed analysis.

Next, we quantify the effects of a permanent increase in the passive share, $\tau^\star$. We solve our baseline model under a different calibration in which we increase $\tau^\star$ by 50%—all other

Figure 12: Permanent increase in passive demand

(a) Inconvenience yield, $\varphi(\cdot)$ (b) Bond spread (c) Bond policy, $B'(\cdot)$



Note: The figure shows the certainty equivalent consumption (CEC) defined as the proportional increase in consumption under the perfectly elastic counterfactual such that the household is indifferent between that case and the downward-sloping demand scenario. Panel (a) shows the CEC across different levels of B. The blue dots in Panel (b) show the the relation between the CEC and debt-to-output ratio B/y, based on model simulations. The gray bars show the histogram for the distribution of B/y.

parameters remain the same.[31] This simple exercise is aimed at capturing the long-term trend behind the rise of passive investors in emerging economies (Chari et al., 2022).

As shown in Figure 12, a permanent increase in the passive share implies a downward shift in the bond spread schedule (i.e., an upward shift in the bond price function) because it reduces the inconvenience yield demanded by investors for every B'. In fact, given our baseline calibration and elasticity for active investors, the considered 50% increase in the passive share leads to positive *convenience* yield. That is, it generates a bond spread that is lower than the one implied by the bond's discounted expected repayment.

When simulating the model, however, we find that the average bond spread and its volatility are largely unaffected—Table 9. This is because the larger passive share also influences the government's debt policy—Panel (c) in Figure 12. From our simulations, the government optimally increases its average debt-to-output ratio by 2 p.p., which increases default risk almost 1 p.p. This larger default risk, in turn, offsets a large average *convenience* yield of 1.6 p.p. attained under the larger passive demand case.

Since the government is able to increase the external debt without increasing its financing costs, the representative household prefers this counterfactual scenario with higher passive demand over the baseline model. The average CEC is 0.10%, which is about one-third of the welfare gains observed between our baseline model and the perfectly elastic counterfactual—as shown in Figure 10. This result highlights the significant implications of a downward-sloping demand: the associated disciplining device generates welfare gains three times higher than those obtained by merely shifting down the bond spread schedule for every choice of B'.

[31] Despite its relative magnitude, the shock implies a modest absolute increase in the passive share $\tau^\star$ of about 6 p.p.

Table 9: Comparison with higher passive demand case

Moment	Description	Baseline model (i)	Higher passive demand (ii)
$\mathbb{E}(SP)$	Bond spreads (%)	4.69	4.57
$\sigma(SP)$	Std of spreads (%)	1.58	1.58
$\mathbb{E}(B/y)$	Debt to output (%)	52.8	54.4
$\mathbb{E}(d)$	Default frequency (%)	3.08	3.80
$\mathbb{E}(\vartheta)$	Inconvenience yield (%)	0.09	-1.65
$\mathbb{E}(CEC)$	Certainty equivalent consumption (%)	-	0.10

Note: The table compares a set of moments between our baseline model with price-elastic investors and a counterfactual scenario in which investors are perfectly elastic ($\kappa = 0$).

5 Conclusion

In this paper, we provide a sovereign default model with a rich yet flexible investor base, comprising passive and active investors with asset allocation mandates. In our model, bond prices depend not only on government policies and default risk but also on the composition of the investor base and its price elasticity. We estimate a demand elasticity for sovereign bonds by combining our model with a novel identification strategy that exploits variation in the composition of the largest global index for dollar-denominated sovereign bonds. Changes in the composition of the index influence the demand of passive investors tracking it, shifting the available bond supply for active investors. While price changes around these index rebalancings are informative about the responsiveness of active investors to changes in quantities, we show that they are not enough to pin down a demand elasticity, as they may also reflect expected changes in future bond issuances and payoffs—which affect current prices. By endogenizing the issuer's problem, our methodology isolates these endogenous forces and allows us to identify a structural demand elasticity.

Based on these estimates, we show that a downward-sloping demand has non-trivial implications for bond prices, default risk, and optimal debt issuance. In particular, by diminishing the government's incentives to issue additional units of debt, a downward-sloping demand acts as a disciplining device that reduces both default risk and borrowing costs. We show that this disciplining mechanism is strong enough that the government ultimately issues more debt relative to a perfectly elastic counterfactual. Lastly, we find that the pro-cyclicality of debt policy is dampened in the presence of price-sensitive investors.

Our results highlight the importance of considering issuers' endogenous responses and the resulting changes in expected asset payoffs. Failing to account for these responses can introduce significant biases when estimating demand elasticities, particularly for long-term risky assets. Our paper opens avenues for further research along several dimensions. For instance, given the model's predictions, it would be interesting to empirically study the impact of a downward-sloping demand on government debt issuance. More importantly, our framework can be extended to other assets and markets, notably equity and corporate bonds. The endogenous responses we emphasize in this paper can be applied to other issuers of risky assets, which we leave for future research.

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Supplemental Appendix for Inelastic Demand Meets Optimal Supply of Risky Sovereign Bonds

A Model Appendix

In this appendix, we first provide additional derivations for the investors' block. In Section A.2, we then present two microfoundations for the assumed demand structure. Lastly, Section A.3 defines the equilibrium of the model, and Section A.4 provides the derivation for the government's optimal debt issuance.

A.1 Investors' Block: Additional Derivations

Following the notation used in the main text, let $x^i_{j,t} = \frac{q^i_t B^i_{j,t}}{W_{j,t}}$ be the share of its wealth that investor j invest in bond i at time t. We have assumed that:

$$x^i_{j,t} = \theta_{j,t}\xi^i_{j,t} e^{\Lambda_j \pi^i_t \left(r^i_{t+1}\right)} + \left(1-\theta_{j,t}\right) w^i_t,$$

where r^i_{t+1} is the next-period excess return. This is defined as $r^i_{t+1} \equiv \frac{\mathcal{R}^i_{t+1}}{q^i_t} - r^f$, where r^f denotes the gross risk-free rate. Purely passive funds are those with $\theta_j = 0$ and they just replicate the weight of country i in the index $\mathcal{I}$, w^i_t. Active funds—i.e. those with $\theta_j \in (0,1]$—, have mandate to invest a share $\xi^i_{j,t}$ of their wealth on bond i. Those funds may also change the composition of their portfolios, depending on the π^i_t function, which is a function of expected excess returns. We assume that this function is given by:

$$\pi^i_t\left(r^i_{t+1}\right) \equiv \frac{\mathbb{E}_t\left(r^i_{t+1}\right)}{\mathbb{V}_t\left(r^i_{t+1}\right)} = q^i_t \frac{\mathbb{E}_t\left(\mathcal{R}^i_{t+1}\right) - q^i_t r^f}{\mathbb{V}_t\left(\mathcal{R}^i_{t+1}\right)} \tag{C1}$$

The market clearing condition for bond i is $B^i_t = \frac{1}{q^i_t}\sum_j W_{j,t} x^i_{j,t}$, which can be decomposed into an active, $\mathcal{A}^i_t$, and passive, $\mathcal{T}^i_t$, component:

$$B^i_t = \frac{1}{q^i_t}\sum_j W_{j,t}\theta_{j,t}\xi^i_{j,t} e^{\Lambda_j \pi^i_t} + \frac{1}{q^i_t}\sum_j W_{j,t}\left(1-\theta_{j,t}\right) w^i_t$$

For the remainder of the analysis, we will impose that $\xi^i_{j,t} = \xi^i_j q^i_t$, so that ξ^i_j captures a fix component of investors' mandates. For a purely active investor and for a case in which there are no expected excess returns, $\pi^i_t\left(r^i_{t+1}\right) = 0$, this specification implies that the investor does not change her holdings of bond i, unless her wealth changes—i.e., $B^i_{j,t} = W_{j,t}\xi^i_j$.

We let $\overline{\mathcal{A}^i}_{j,t} \equiv W_{j,t}\theta_{j,t}\xi^i_j$ to capture active investor j's wealth targeted towards country i, as implied by their degree of activeness and fixed mandates. Adding up all the individual demands, we get $\overline{\mathcal{A}^i}_t \equiv \sum_j \overline{\mathcal{A}^i}_{j,t}$. Similarly, we define $\mathcal{W}_{j,t} = \sum_j W_{j,t}\left(1-\theta_{j,t}\right)$ as the assets under management tracking the $\mathcal{I}$ index. With these definitions at hand, we can rewrite the market clearing condition as follows:

$$B_t^i = \sum_j \overline{\mathcal{A}^i}_{j,t} e^{\Lambda_j \pi_t^i} + \frac{1}{q_t^i} \mathcal{W}_t \, w_t^i.$$

To get a closed-form solution for the bond price, q_t^i, we start by approximating each investor j's active demand around $\overline{\mathcal{A}^i}_{j,t} = \overline{\mathcal{A}^i}_j$, and around a no-excess return case, $\pi_t^i = 0$. We can then write the active demand as:

$$\mathcal{A}_t^i \approx \overline{\mathcal{A}^i} + \mathbf{\Lambda}^i \, \pi_t^i + \Delta \overline{\mathcal{A}^i}_t, \tag{C2}$$

where $\overline{\mathcal{A}^i} \equiv \sum_j \overline{\mathcal{A}^i}_j$ captures investors' active wealth targeting country i. The term $\mathbf{\Lambda}^i$ denotes the aggregate demand elasticity for active investors, and it is given by a weighted average of investors' elasticities, $\mathbf{\Lambda}^i \equiv \overline{\mathcal{A}^i} \sum_j s_j^i \Lambda_j$, with $s_j^i \equiv \overline{\mathcal{A}^i}_j / \overline{\mathcal{A}^i}$. Lastly, $\Delta \overline{\mathcal{A}^i}_t \equiv \overline{\mathcal{A}^i}_t - \overline{\mathcal{A}^i}$ captures shifts in the active demand driven by changes in active investors' aggregate wealth targeted towards country i.

As for the demand of passive investors, we let $M_t^{\mathcal{I}} = q_t^{\mathcal{I}} \times Q_t^{\mathcal{I}}$ to denote the market value of the index $\mathcal{I}$, where $q_t^{\mathcal{I}}$ is the unit price of one unit of the index and $Q_t^{\mathcal{I}}$ are the number of index units. We further assume that S_t^i units of bond i are included in the index. Then, $w_t^i = \frac{S_t^i q_t^i}{M_t^{\mathcal{I}}}$ and we can rewrite the passive demand as follows:

$$\mathcal{T}_t^i = \alpha_t^i \times \mathcal{W}_t^{\mathcal{I}},$$

where $\alpha_t^i \equiv \frac{S_t^i}{Q_t^{\mathcal{I}}}$ captures the face-value share of bond i in the index and $\mathcal{W}_t^{\mathcal{I}} \equiv \frac{1}{q_t^{\mathcal{I}}} \mathcal{W}_t$ are the assets under managements tracking the benchmark index, in units of the index.

In our baseline analysis, we have focused on variation in the passive demand. In particular, we assumed that active funds targeted toward country i are constant—$\Delta \overline{\mathcal{A}^i}_t = 0$. Replacing with all these expressions, the market clearing condition boils down to:

$$B_t^i = \left(\overline{\mathcal{A}^i} + \mathbf{\Lambda}^i \, \pi_t^i \right) + \mathcal{T}_t^i.$$

From the previous expression, after replacing with the π_t^i term in Equation (C1) and solving for the bond price, we get our baseline pricing function:

$$q_t^i = \frac{1}{r^f} \mathbb{E}_t \left(\mathcal{R}_{t+1}^i \right) \left[1 - \kappa^i \frac{\mathbb{V}_t \left(\mathcal{R}_{t+1}^i \right)}{\mathbb{E}_t \left(\mathcal{R}_{t+1}^i \right)} \left(B_t^i - \mathcal{T}_t^i - \overline{\mathcal{A}^i} \right) \right], \tag{C3}$$

where $\kappa^i \equiv / \mathbf{\Lambda}^i$, parameterizes the inverse demand elasticity for active investors.

A.2 Microfoundations for Investors' Mandates

In this section, we provide some microfoundations for investors' mandates. We show that one can obtain an analogous pricing kernel to the one in Equation (C3) under risk-averse investors or under risk-neutral investors subject to a standard VaR constraint.

Risk-averse Investors

Consider first a case where investors are risk averse and have mean-var preferences. They care about both the total return of their portfolio and their return relative to a benchmark index $\mathcal{I}$ they track. Additionally, they are heterogeneous and differ in their degree of risk aversion and 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 $\boldsymbol{r}_{t+1} = \left\{r_{t+1}^1, ..., r_{t+1}^N\right\}$ denotes the next-period (gross) returns (i.e., the bond gross return in excess of the risk-free rate, r^f). Last, let $\boldsymbol{B}_t = \left\{B_t^1, ..., B_t^N\right\}$ denote the bond supply.

For an investor j, their total compensation is a convex combination between the return of their 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 investor j's vector of portfolio weights. The investor's 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 θ_j captures the weight of relative returns on the compensation.

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 σ_j captures the investor's risk aversion. In matrix form, we can write this problem as follows:

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

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. The optimal portfolio allocation for investor j is given by

$$\boldsymbol{x}_{j,t} = \frac{1}{\sigma_j}\boldsymbol{\Sigma}_t^{-1}\boldsymbol{\mu}_t + \left(1 - \theta_j\right) \boldsymbol{w}_t. \tag{C4}$$

The first term on the right-hand side of Equation (C4) captures the usual mean-variance portfolio. An analogous expression can also be derived under CARA preferences (see, e.g., Pavlova and Sikorskaya, 2022). The second term reflects the reluctance of some investors to deviate from the benchmark portfolio, $\boldsymbol{w}$, indicating an inherently inelastic demand. It is not a function of the expected return or riskiness of the bonds; rather, it 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 $B^i_{j,t} = \frac{W_{j,t} x^i_{j,t}}{q^i_t}$ are investor j's purchases of bond i, where q^i_t denotes the bond price. For each bond i, its market-clearing condition is $q^i_t B^i_t = \sum_j W_{j,t} x^i_{j,t}$. After replacing these with the investors' optimal portfolio weights, the market-clearing conditions are given by

$$\begin{aligned} \begin{bmatrix} q^1_t B^1_t \\ \vdots \\ q^N_t B^N_t \end{bmatrix} &= \sum_j W_{j,t} \left[\frac{1}{\sigma_j} \boldsymbol{\Sigma}^{-1}_t \boldsymbol{\mu}_t + (1 - \theta_j)\, \boldsymbol{w}_t \right] \\ &= \tilde{\boldsymbol{\mathcal{A}}}_t + \tilde{\boldsymbol{\mathcal{T}}}_t, \end{aligned} \tag{C5}$$

where $\tilde{\boldsymbol{\mathcal{A}}}_t \equiv \sum_j W_{j,t} \frac{1}{\sigma_j} \boldsymbol{\Sigma}^{-1}_t \boldsymbol{\mu}_t$ denotes the active component of investors' demand (at market value). Since investors are risk averse, $\tilde{\mathcal{A}}^i_t$ is downward sloping and is a function of the expected return of bond i and 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 (C5), and assume for simplicity only two assets. For ease of exposition, consider that bond i is risky and bond $-i$ is not. Under these assumptions, the price for bond i is given by

$$q^i_t = \frac{\mathbb{E}_t \left(\mathcal{R}^i_{t+1} \right)}{r^f} \times \Psi^i_t, \tag{C6}$$

where $\mathcal{R}^i_{t+1}$ denotes the bond's next-period repayment per unit and Ψ^i_t captures the downward-sloping nature of the demand. Ψ^i_t is given by

$$\Psi^i_t \equiv 1 - \kappa^{\mathrm{RA}}_t \frac{\mathbb{V}_t \left(\mathcal{R}^i_{t+1} \right)}{\mathbb{E}_t \left(\mathcal{R}^i_{t+1} \right)} \left(B^i_t - \mathcal{T}^i_t \right), \tag{C7}$$

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

Note that the bond price in Equation (C7) is analogous to our baseline pricing equation. The key difference is that with risk-averse lenders, the price elasticity is captured only by investors' risk aversion parameter, κ^{RA}_t. In our main analysis, we do not specify the underlying mechanism driving this elasticity.

Value-at-risk Constraint

An identical expression can also be derived for investors who are risk neutral and subject to a VaR constraint. These constraints are common both in the literature and in the regulatory sphere (e.g., Miranda-Agrippino and Rey, 2020).[32]

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

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

where the parameter $\varPhi^2$ captures the intensity of the risk constraint. We view $\varPhi^2$ as a regulatory parameter that limits the amount of risk that an investor can take. Let ϱ_j denote the Lagrange multiplier associated with the VaR constraint. It can be shown that the optimal portfolio is given by

$$\boldsymbol{x}_{j,t} = \frac{1}{\varrho_j \varPhi^2} \boldsymbol{\Sigma}_t^{-1} \boldsymbol{\mu}_t + (1-\theta_j)\, \boldsymbol{w}_t. \tag{C8}$$

The previous optimal portfolio is identical to that of Equation (C4), with the only difference being that the risk-aversion parameter σ has been replaced by the product of the Lagrange multiplier ϱ_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 (C6) and (C7). That is,

$$q^i_t = \frac{\mathbb{E}_t\left(\mathcal{R}^i_{t+1}\right)}{r^f} \left[1 - \kappa^{\text{VaR}}_t \frac{\mathbb{V}_t\left(\mathcal{R}^i_{t+1}\right)}{\mathbb{E}_t\left(\mathcal{R}^i_{t+1}\right)} \left(B^i_t - \mathcal{T}^i_t\right) \right], \tag{C9}$$

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

A.3 Definition of Equilibrium

A Recursive Markov Equilibrium is a collection of value functions $\left\{V(\cdot), V^r(\cdot), V^d(\cdot)\right\}$; policy functions $\{d(\cdot), B'(\cdot)\}$; and bond prices $q(\cdot)$ such that:

1. Taking as given the bond price function $q(.)$, the government's policy functions $B'(\cdot)$ and $d(\cdot)$ solve the optimization problem in Equations (10), (11), and (12), and $V(\cdot)$, $V^r(\cdot)$, and $V^d(\cdot)$ are the associated value functions.

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

2. Given $B'(\cdot)$ and $d(\cdot)$, the repayment function $\mathcal{R}'(.)$ satisfies Equation (14).

3. Taking the repayment function as given, bond prices $q(.)$ are consistent with Equation (13).

A.4 Derivation of the Optimality Condition for Debt Issuance

In this appendix, we derive the first-order condition for B' in Equation (18). We start with the government's problem in case of repayment—Equation (11)—, which we rewrite here for convenience:

$$V^r(y,\tau,b) = max_{B'} u(c) + \beta \mathbb{E}_{s'|s} \text{Max}_{d=\{0,1\}} \left\{ V^r(y',\tau',B'), V^d(y') \right\},$$
$$\text{subject to: } c = y + q\left(y,\tau,B'\right)\left(B' - (1-\lambda)B\right) - \left((1-\lambda)\nu + \lambda\right)B.$$

We define $V^e(y,\tau,B') \equiv \mathbb{E}_{s'|s}\text{Max}_{d=\{0,1\}}\left\{V^r(y',\tau',B'),V^d(y')\right\}$ as the expected continuation value. Let $u_c(c) \equiv \frac{\partial u(c)}{\partial c}$, $q_{B'}(y,\tau,B') \equiv \frac{\partial q(y,\tau,B')}{\partial B'}$, and $V^e_{B'}(y,\tau,B') \equiv \frac{\partial V^e(y,\tau,B')}{\partial B'}$ denote the derivatives with respect to B'. With this notation, the first-order condition with respect to B' is given by

$$u_c(c)\left[q\left(y,\tau,B'\right) + q_{B'}\left(y,\tau,B'\right)\left(B' - (1-\lambda)B\right)\right] + \beta V^e_{B'}\left(y',\tau',B'\right) = 0. \tag{C10}$$

For a given optimal default policy, $d(y,\tau,B)$, we can write the expected continuation value as follows:

$$\begin{aligned} V^e(y',\tau',B') \equiv & \mathbb{E}_{s'|s}\text{Max}_{d=\{0,1\}}\left\{V^r(y',\tau',B'), V^d\left(y'\right)\right\} \qquad \text{(C11)} \\ = & \mathbb{E}_{s'|s}\left[V^r\left(y',\tau',B'\right)\times\left(1-d\left(y',\tau',B'\right)\right)\right] + \mathbb{E}_{s'|s}\left[V^d\left(y'\right)\times d\left(y',\tau',B'\right)\right]. \end{aligned}$$

Based on this last expression, and taking derivatives with respect to B', we can write the last term in Equation (C10) as

$$\begin{aligned} V^e_{B'}\left(y',\tau',B'\right) = & \mathbb{E}_{s'|s}\left[V^r_{B'}\left(y',\tau',B'\right)\left(1-d\left(y',\tau',B'\right)\right)\right] + \\ & + \mathbb{E}_{s'|s}\left[\left(V^d\left(y'\right) - V^r(y',\tau',B')\right)d_{B'}\left(y',\tau',B'\right)\right]. \end{aligned}$$

In what follows, and to simplify the analysis, we will omit the last term of the previous equation, which captures how changes in B' affects the outside option value of defaulting. Replacing with this in the first order condition, we get:

$$u_c(c)\left[q\left(y,\tau,B'\right) + q_{B'}\left(y,\tau,B'\right)\left(B'-(1-\lambda)B\right)\right] = -\beta\mathbb{E}_{s'|s}\left[V^r_{B'}\left(y',\tau',B'\right)\left(1-d\left(y',\tau',B'\right)\right)\right]. \tag{C12}$$

From the envelope condition, we have that $V^r_B(y,b,\tau) \equiv \frac{\partial V^r(y,\tau,B)}{\partial B}$ is given by:

$$V^r_B(y,\tau,B) = -u_c(c)\left((1-\lambda)\left(\nu + q\left(y,\tau,B'\right)\right) + \lambda\right). \tag{C13}$$

Evaluating at (y',τ',B'), multiplying by $1-d' \equiv 1-d(y',\tau',B')$ and taking expectations, the previous expression can be written as:

$$\begin{aligned}\mathbb{E}_{s'|s}\left[V^r_{B'}\left(y',\tau',B'\right)\left(1-d'\right)\right] &= -\mathbb{E}_{s'|s}\left[u_c\left(c'\right)\left((1-\lambda)\left(\nu+q'\right)+\lambda\right)\left(1-d'\right)\right] \\ &= -\mathbb{E}_{s'|s}\left[u_c\left(c'\right)\mathcal{R}\left(y',\tau',B'\right)\right]\end{aligned} \tag{C14}$$

where $B'' \equiv B'(y',\tau',B')$ and $q' \equiv q(y',\tau',B'')$ are the next period bond supply and prices, respectively. In the last step of the previous expression, we replaced with the repayment function—as defined in Equation (14). After replacing with this expression in Equation (C12), we get:

$$u_c(c)\left[q\left(y,\tau,B'\right) + q_{B'}\left(y,\tau,B'\right)\left(B'-(1-\lambda)B\right)\right] = \beta\mathbb{E}_{s'|s}\left[u_c\left(c'\right)\mathcal{R}\left(y',\tau',B'\right)\right]. \tag{C15}$$

In our model the derivative of the pricing function with respect to an additional unit of debt is

$$q_{B'}\left(y,\tau,B'\right) \equiv \frac{\partial q\left(y,\tau,B'\right)}{\partial B'} = \frac{1}{r^f}\frac{\partial \mathbb{E}_{s'|s}\mathcal{R}\left(y,\tau,B'\right)}{\partial B'} + \mathcal{S}\left(y,\tau,B';\kappa\right). \tag{C16}$$

Replacing with this expression in Equation (C15) and rearranging terms, we get Equation (18) in the main text.

B Empirical Appendix

In this appendix, we provide additional details, tables, and figures to complement our main empirical analysis.

B.1 Diversification Methodology and Timeline

Relative to a market capitalization-weighted index, the EMBIGD employs a diversification methodology to produce a more even distribution of country weights. This ensures that countries with large market capitalization do not dominate the index. To achieve this goal, the methodology restricts the weights of countries with above-average debt levels by including only a portion of their outstanding debt.

The methodology is anchored on the average country face amount in the index, called

Index Country Average (ICA), and defined as:

$$ICA_t = \sum_{c=1}^{C} \frac{FA_{c,t}}{C},$$

where $FA_{c,t}$ denotes country c's bond face amount included in the index at time t, and C denotes the number of countries in the index.

The diversified face amount for any country in the index is derived according to the following rule:

1. The maximum threshold is determined by the country with the largest face amount (FA_{max}), capped at twice the ICA ($ICA \times 2$).

2. If a country's face amount is between the ICA and FA_{max}, its diversified face amount is linearly interpolated.

3. If a county's face amount is below the ICA, the entire face amount is eligible for inclusion.

The diversified country face amount ($DFA_{c,t}$) is calculated as follows:

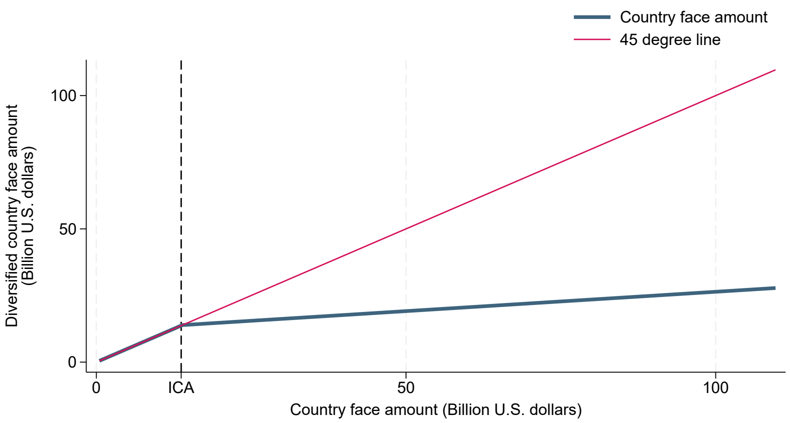
$$DFA_{c,t} = \begin{cases} ICA_t \times 2 & \text{if } FA_{c,t} = FA_{max,t} \\ ICA_t + \frac{ICA_t}{FA_{max_t} - ICA_t} \left(FA_{c,t} - ICA_t\right) & \text{if } FA_{c,t} > ICA_t \\ FA_{c,t} & \text{if } FA_{c,t} \leq ICA_t \end{cases} \tag{B1}$$

For countries with a restricted face amount in the EMBIGD, the proportional decrease applied to the country-level face amount is also applied to their respective bonds. The diversified market value is calculated by multiplying the diversified face amount by the bond price. The diversified weight of each bond is determined by its share of the total diversified market capital in the index.

Additionally, country weights are capped at 10%. Any excess weight above this cap will be redistributed pro rata to smaller countries below the cap, across all bonds from countries not capped at 10%. Appendix Figure B1 compares the country-level diversified and non-diversified face amount for December 2018.

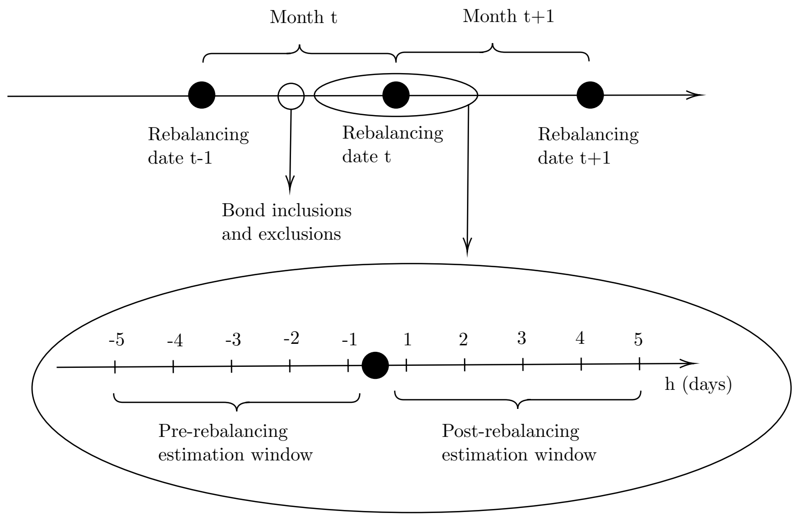
Figure B2 illustrates the timeline of events within each rebalancing event. As explained in the main text, changes in the EMBIGD weights occur on the last U.S. business days of each month. In our regressions, we focus on small 5-day windows around each rebalancing day.

Appendix Figure B1: Effect of the diversification methodology on the country face amount



Note: The figure illustrates the differences between the country-level face amount and their diversified versions, which the EMBIGD uses to generate the diversified bond weights. The data are for December 2018.

Appendix Figure B2: Timeline of events



B.2 Data

As described in the main text, we collect data from three main sources: Datastream, J.P. Morgan, and Morningstar. Datastream provides daily bond price data for bonds included in the EMBIGD. From J.P. Morgan Markets, we obtain index weights, the face amounts of bonds included in the index, and various bond characteristics, such as maturity and duration.

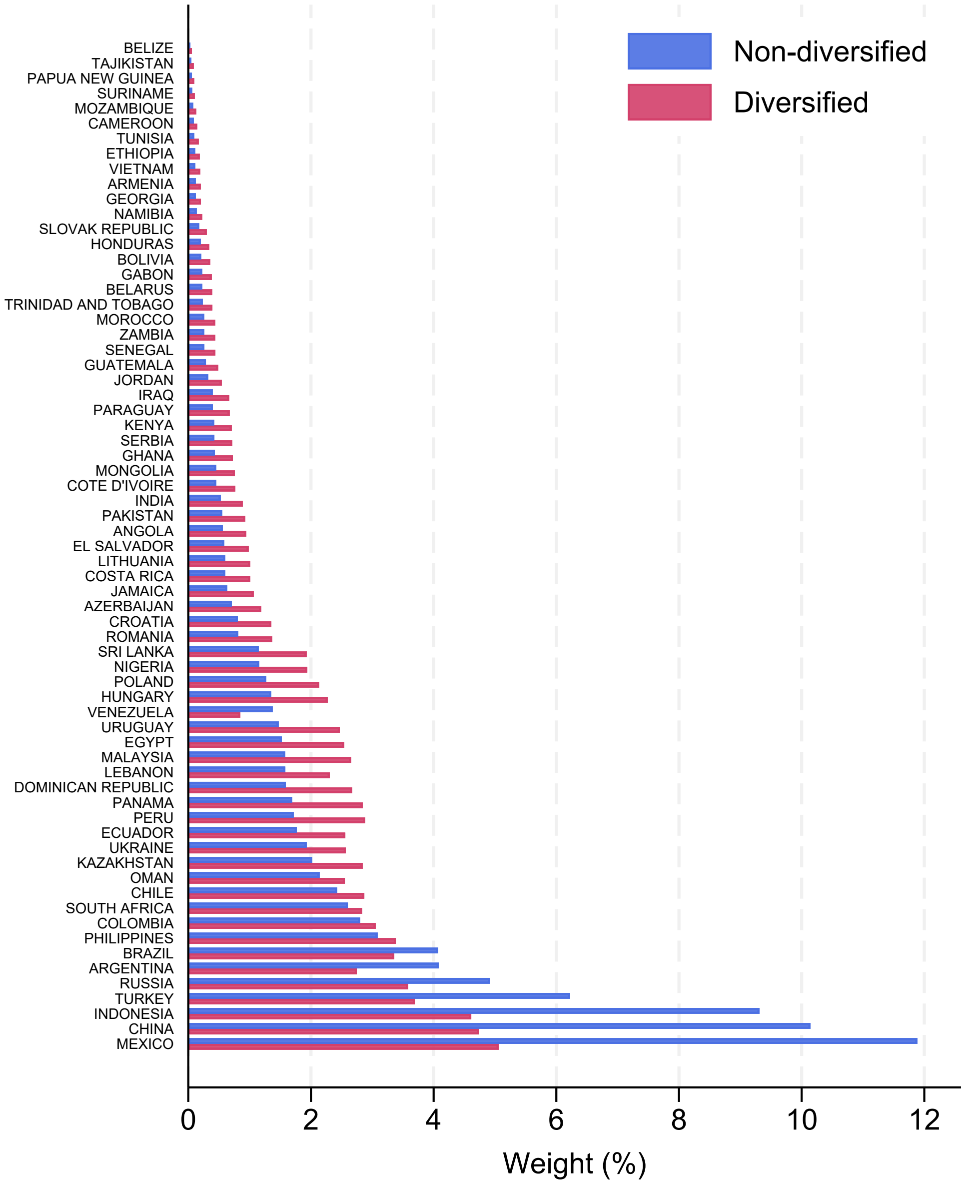
Figure B3 list the countries included in the EMBIGD and the associated index weights (red bars). As a comparison, it also shows the weights for the EMBI Global (EMBIG). The EMBIGD includes bonds with a maturity (at issuance) of at least 2.5 years and a face amount outstanding of at least US$500 million. To be classified as an emerging economy, a country's gross national income (GNI) per capita must be below an Index Income Ceiling (IIC) for three consecutive years. The IIC is defined by J.P. Morgan and adjusted every year by the growth rate of the World GNI per capita, Atlas method (current US$), provided by the World Bank. Bonds in the index must settle internationally and have accessible and verifiable bid and ask prices. Once included, they can remain in the index until 12 months before maturity. Local law instruments are not eligible. As for the EMBIG, it has the same bond inclusion criteria as the EMBIGD. The only difference between the EMBIG and the EMBIGD is that while the former uses a market capitalization weighting scheme, the latter adopts the cap rule to limit the weights of countries with above-average debt outstanding.

Figure B4 shows the assets under managements (AUM) tracking the EMBIGD, the EMBIG, and other well mayor indexes. Among bond indexes for emerging economies, the EMBIGD is the most widely used as benchmark and is tracked by funds with combined assets under management (AUM) of around US$300 billion in 2018.

To get a sense of the magnitude of the numbers shown in Figure B4, Figure B5 shows the U.S. dollar-denominated sovereign debt in the EMBI as a percentage of each country's general government debt securities issued in international markets. For most countries, the share is above 60%, which highlights the mayor role played by this index.

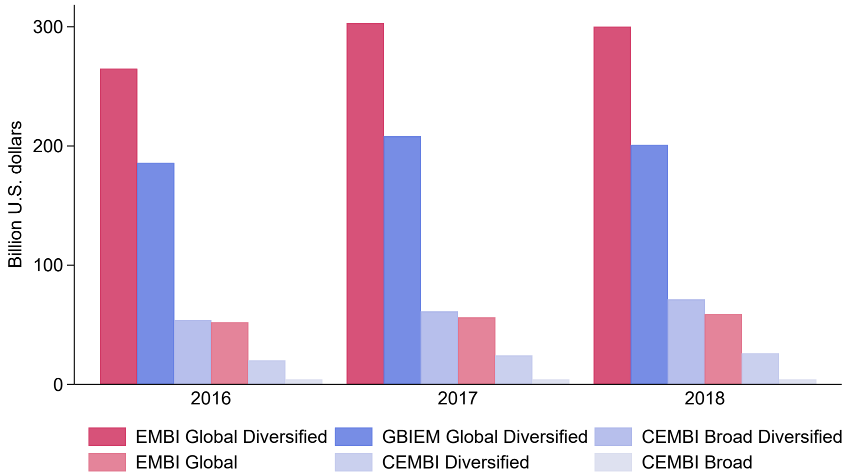
Data cleaning. For our main analysis, we apply the following data cleaning procedures. We exclude extreme values of daily returns, stripped spreads, and $Z_{c,t}$. We drop stripped spreads below 0 or above $5,000$ basis points as well as observations below the 5th or above the 95th percentiles in terms of the distribution of $Z_{c,t}$. The reason for the latter is that extreme values of $Z_{c,t}$ could be driven by large, pre-announced changes in the EMBIGD and thus are not appropriate for our identification strategy, which relies on the assumption that most

Appendix Figure B3: EMBI Global country-level weights



Note: The figure illustrates the EMBI Global 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 each country included in the index. Sources: J.P. Morgan Markets, and authors' calculations.

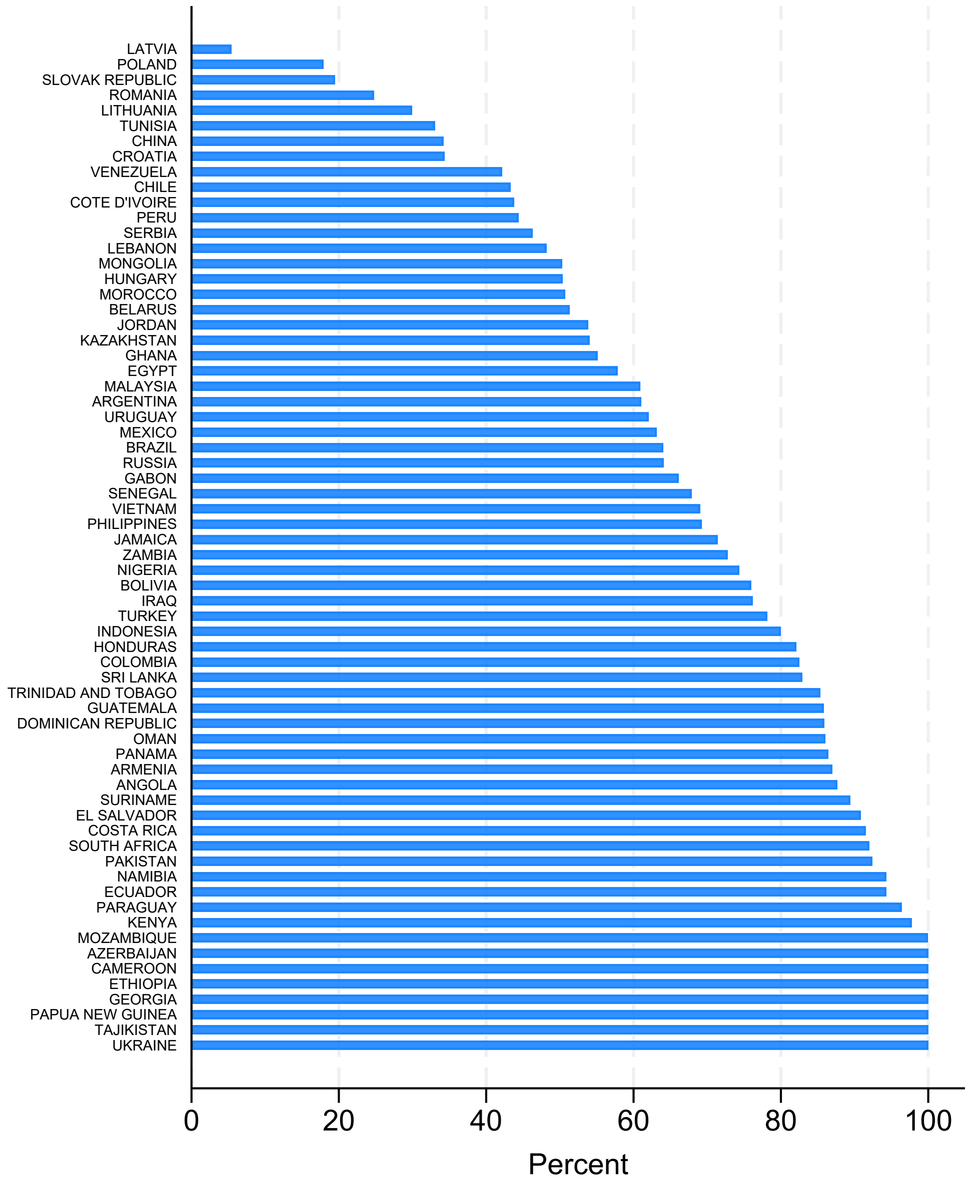
Appendix Figure B4: AUM benchmarked to emerging economies bond indexes



Note: The figure shows assets under management, in billions of U.S. dollars, benchmarked to emerging economies bond indexes for 2018. Sources: J.P. Morgan Markets, and authors' calculations.

information is known on the last business day of the month. Finally, we exclude bond-month observations that experience daily returns below the 1st and above the 99th percentiles.

Appendix Figure B5: Share of U.S. dollar-denominated emerging economies sovereign debt



Note: The bars show the U.S. dollar-denominated sovereign debt in the EMBI Global index as a percentage of each country's general government debt securities issued in international markets. The averages are derived by calculating this percentage for each country and year, and then averaging these values across the years 2016–2022. Sources: BIS, J.P. Morgan Markets, and authors' calculations.

B.3 Robustness Analysis

We present in this section different robustness checks that complements our main analysis. First, Table B1 displays the estimates based on an OLS regression, in which we do not instrument the FIR. Table B2 shows the results for an alternative specification in which we held bond prices constant when constructing the FIR. In both cases. More specifically, we estimate an OLS regression with an alternative measure of the FIR that holds prices constant, using previous rebalancing period prices. Results are similar to our main estimates.

Appendix Table B1: OLS regression

Dependent Variable: Log Price						
		[-5:+5]			No h=-1	
Post	0.000*	0.001*	0.000*		0.001**	
	(0.000)	(0.000)	(0.000)		(0.000)	
FIR	1.160*					
	(0.643)					
FIR X Post	0.197***	0.198**	0.197***	0.134	0.236***	0.167*
	(0.076)	(0.077)	(0.076)	(0.086)	(0.076)	(0.092)
Bond FE	Yes	Yes	No	No	No	No
Month FE	Yes	No	No	No	No	No
Bond Characteristics-Month FE	No	Yes	No	No	No	No
Country-Month FE	No	Yes	No	No	No	No
Bond-Month FE	No	No	Yes	Yes	Yes	Yes
Month-Post FE	No	No	No	Yes	No	Yes
Bond Controls	No	Yes	No	No	No	No
Observations	105,548	105,508	105,548	105,548	84,433	84,433
N. of Bonds	738	738	738	738	738	738
N. of Countries	68	68	68	68	68	68
N. of Clusters	1,576	1,575	1,576	1,576	1,576	1,576

Note: The table presents OLS estimates of log bond prices on the FIR measure, around rebalancing events. Standard errors are clustered at the country-month level, and the sample period is 2016–2018. *, **, and *** denote statistically significant at the 10%, 5%, and 1% level, respectively. See footnote in Table 3 for additional details.

Appendix Table B2: OLS regression - Fixed bond prices

Dependent Variable: Log Price						
		[-5:+5]			No h=-1	
Post	0.001*	0.001*	0.001*		0.001**	
	(0.000)	(0.000)	(0.000)		(0.000)	
FIR	1.112*					
	(0.644)					
FIR X Post	0.230***	0.232***	0.231***	0.142*	0.266***	0.177*
	(0.075)	(0.076)	(0.075)	(0.086)	(0.075)	(0.092)
Bond FE	Yes	Yes	No	No	No	No
Month FE	Yes	No	No	No	No	No
Bond Characteristics-Month FE	No	Yes	No	No	No	No
Country-Month FE	No	Yes	No	No	No	No
Bond-Month FE	No	No	Yes	Yes	Yes	Yes
Month-Post FE	No	No	No	Yes	No	Yes
Bond Controls	No	Yes	No	No	No	No
Observations	105,548	105,508	105,548	105,548	84,433	84,433
N. of Bonds	738	738	738	738	738	738
N. of Countries	68	68	68	68	68	68
N. of Clusters	1,576	1,575	1,576	1,576	1,576	1,576

Note: The table presents OLS estimates (around rebalancing events) of log bond prices on an alternative FIR measure that holds bond prices constant —based on the previous rebalancing event. Standard errors are clustered at the country-month level, and the sample period is 2016–2018. *, **, and *** denote statistically significant at the 10%, 5%, and 1% level, respectively. See footnote in Table 3 for additional details.

Additionally, our results remain robust to alternative time windows around the rebalancing events (Table B3). Consistent with the findings in Figure 4, the estimates decrease in magnitude for shorter windows and increase as the window is extended. The robustness of our results also holds when quasi-sovereign bonds are excluded from the analysis, as shown in Table B4).

Appendix Table B3: Log price and FIR: different event windows

Panel A-Dependent Variable: Log Price				
	[-2:+2]	[-3:+3]	[-4:+4]	[-5:+5]
FIR X Post	0.146***	0.197***	0.221**	0.231**
	(0.053)	(0.071)	(0.086)	(0.099)
Bond-Month FE	Yes	Yes	Yes	Yes
Observations	42,217	63,327	84,435	105,548
N. of Bonds	738	738	738	738
N. of Countries	68	68	68	68
N. of Clusters	1,576	1,576	1,576	1,576
F (FS)	1,660	1,662	1,664	1,666

Panel B-Dependent Variable: Log Price (Excl. h=-1)				
	[-2:+1]	[-3:+2]	[-4:+3]	[-5:+4]
FIR X Post	0.220***	0.257***	0.271***	0.263***
	(0.056)	(0.074)	(0.087)	(0.098)
Bond-Month FE	Yes	Yes	Yes	Yes
Observations	21,106	42,216	63,325	84,433
N. of Bonds	738	738	738	738
N. of Countries	68	68	68	68
N. of Clusters	1,576	1,576	1,576	1,576
F (FS)	1,667	1,667	1,669	1,670

Note: The table presents 2SLS estimates of log bond prices on the instrumented FIR measure, around rebalancing events. Each column reports the estimates for different h-day symmetric windows. Standard errors are clustered at the country-month level, and the sample period is 2016–2018. *, **, and *** denote statistically significant at the 10%, 5%, and 1% level, respectively. See footnote in Table 3 for additional details.

Appendix Table B4: Log price and FIR: dropping quasi-sovereign bonds

Dependent Variable: Log Price				
FIR X Post	0.249**	0.249**	0.249**	0.175*
	(0.107)	(0.108)	(0.107)	(0.103)
[1em] Bond FE	Yes	Yes	No	No
Month FE	Yes	No	No	No
Bond Characteristics-Month FE	No	Yes	No	No
Country-Month FE	No	Yes	No	No
Bond-Month FE	No	No	Yes	Yes
Month-Post FE	No	No	No	Yes
Bond Controls	No	Yes	No	No
Observations	73,140	73,100	73,140	73,140
N. of Bonds	430	430	430	430
N. of Countries	65	65	65	65
N. of Clusters	1,513	1,512	1,513	1,513
F (FS)	0	3,151	3,231	1,099

Note: The table presents 2SLS estimates of log bond prices on the instrumented FIR measure, around rebalancing events. We exclude from the analysis quasi-sovereign bonds. Results correspond to a 5-day symmetric window. The coefficients for *Post* and FIR are included in the estimation but not reported for brevity. Standard errors are clustered at the country-month level, and the sample period is 2016–2018. *, **, and *** denote statistically significant at the 10%, 5%, and 1% level, respectively. See footnote in Table 3 for additional details.

Appendix Table B5: Log price and FIR: varying the share of passive holdings

Dependent Variable: Log Price					
	25%	30%	35%	40%	45%
FIR X Post	0.547***	0.442**	0.367**	0.310**	0.266**
	(0.190)	(0.188)	(0.156)	(0.132)	(0.114)
Bond-Month FE	Yes	Yes	Yes	Yes	Yes
Observations	105,548	105,548	105,548	105,548	105,548
N. of Bonds	738	738	738	738	738
N. of Countries	68	68	68	68	68
N. of Clusters	1,576	1,576	1,576	1,576	1,576
F (FS)	419	1,862	1,813	1,764	1,715

Note: The table presents 2SLS estimates of log bond prices on the instrumented FIR measure, around rebalancing events. Each columns reports the estimates for different share of passive holdings. Results correspond to a 5-day symmetric window. Standard errors are clustered at the country-month level, and the sample period is 2016–2018. *, **, and *** denote statistically significant at the 10%, 5%, and 1% level, respectively. See footnote in Table 3 for additional details.

B.4 FIR and Changes in Credit Default Swap

Appendix Table B6: Log CDS and FIR

Dependent variable: log CDS			
FIR	6.643 **	-7.013	
	(2.889)	(5.453)	
FIR X Post	-0.796 *	-0.796 *	-0.796 *
	(0.448)	(0.449)	(0.448)
Post	-0.006 ***	-0.006 ***	-0.006 ***
	(0.002)	(0.002)	(0.002)
Country FE	Yes	Yes	No
Month FE	No	Yes	No
Country-month FE	No	No	Yes
Observations	10,160	10,160	10,160
N. of Countries	44	44	44
N. of Clusters	1,016	1,016	1,016
F (first stage)	1,398	.	2,797

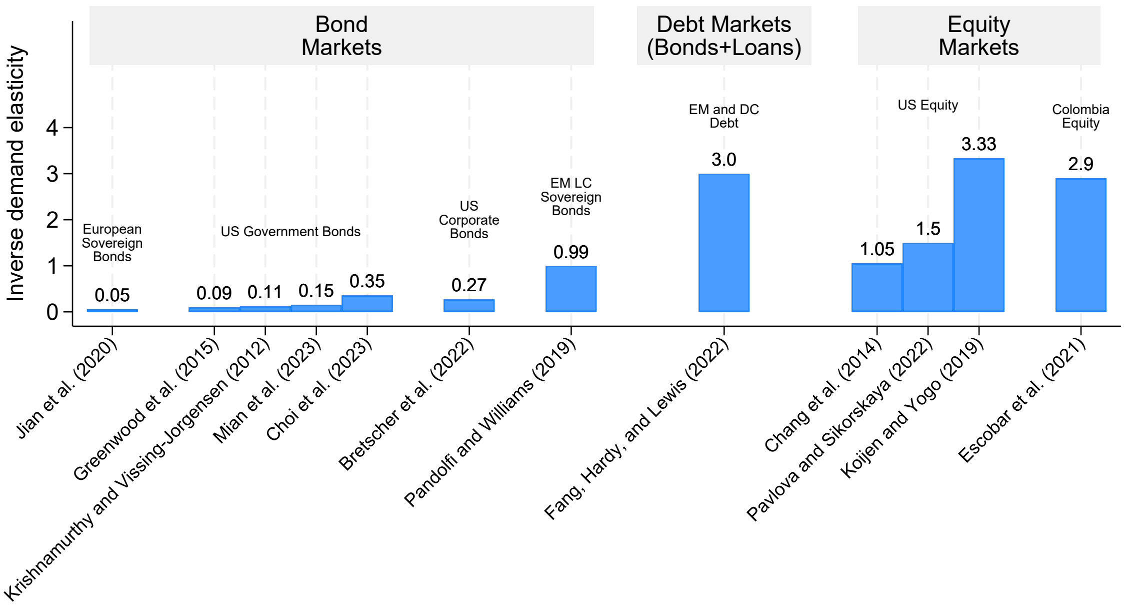
Note: This table shows 2SLS estimates of five-year log CDS of countries on the FIR measure (Equation (21)), instrumented by Z (Equation (22)), around rebalancing dates. The first- and second-stage equations are described in Equation (24). The estimations use a symmetric five-trading-day window, with *Post* as an indicator variable (equal to 1 for the five trading days after rebalancing, and 0 otherwise). Month fixed effects are dummy variables equal to 1 for each rebalancing month, and 0 otherwise. Standard errors are clustered at the country-month level, and the sample period is 2016–2018. *, **, and *** denote statistically significant at the 10%, 5%, and 1% level, respectively.

B.5 Comparison with Other Estimates in the Literature

To put our estimates in context, Figure B6 lists the (inverse) demand elasticity across different assets and markets. These comparisons should be interpreted with caution, as some estimates reflect the elasticity for active investors only, while others capture the market-wide elasticity.

The elasticities in Jiang et al. (2021), Krishnamurthy and Vissing-Jorgensen (2012), and Greenwood et al. (2015) are taken from the review Table 2 of 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. (2024), we take the midpoint elasticity from the IV estimates. For the emerging economies local currency sovereign bonds, we take the estimated number in Table 15, Panel D of Pandolfi and Williams (2019) for GBI bonds, which we adjust by the share of AUM (23.6%) that behave de facto in a passive way. For that, we compute the asset share in EPFR tracking the GBI-EM Global Diversified with an R^2 exceeding that of

Appendix Figure B6: Inverse demand elasticities; comparison



Note: EM IUSD Sovereign Bonds stands for emerging economies sovereign bonds issued internationally in U.S. dollars, while EM LC Sovereign Bonds stands for those issued in local currency.

ETFs tracking the same index. We determine the average R^2 for ETFs by using a weighted average (based on assets) of the R^2 of the ETFs. The elasticity in Fang et al. (2025) is from transforming their response of yield to outstanding debt into a price response. They report that a 1% increase in debt leads to an increase in yields of 58 basis points. We take their average maturity of 5 years as the modified duration to convert the yield response into prices. This leads to a decrease in prices of 3%.

C Quantitative Appendix

In this appendix, we provide additional details for our quantitative analysis in Section 4.

C.1 Secondary Markets

The empirical elasticity computed in Section 3 exploits exogenous variation in the passive demand in a small window around announcements of changes in the EMBIGD weights. To tightly link our model with the empirical analysis, our baseline model in Section 2 already incorporates a passive demand and exogenous changes in index weights, τ. There is, however, a frequency disconnect in the sense that the model is calibrated at quarterly frequency, making it unsuitable for quantifying high-frequency price reactions to changes in τ.

To address this frequency disconnect, we introduce secondary markets in the model. This extension allows us to capture the high-frequency nature of our empirical elasticity. We consider two instances of trading in secondary markets within each period: before and after the realization of the index weights, τ'. The timing assumption is as follows:

1. *The endowment y is realized. The initial states are:* $\{y, \tau, B\}$
2. *The government chooses* $d(y, \tau, B)$ *and* $B'(y, \tau, B)$.
3. *The primary and secondary market open. Let* $q^{SM,0}(y, \tau, B')$ *denote the opening price.*
4. *The next-period index weights* τ' *are realized.*
5. *The secondary market closes. Let* $q^{SM,1}(y, \tau', B')$ *denote the bond closing price.*

The first trading instance (SM_0) occurs at the beginning of the period, immediately after the government announces its default and debt choices. The bond price in this instance is given by

$$q^{SM,0}(y, \tau, B') = \beta^{\star}\mathbb{E}_{y',\tau'|y,\tau}\mathcal{R}\left(y', \tau', B'\right)\ \Psi^{SM,0}\left(y, \tau, B'\right). \tag{D1}$$

The term $\mathbb{E}_{y',\tau'|y,\tau}\mathcal{R}(y', \tau', B')$ represents the expected next-period repayment of the bond, conditional on the information available when the secondary market opens. Following the derivation in Section 2.2 (see Equation (8)), the downward-sloping component of the price function is

$$\Psi^{SM,0}\left(y, \tau, B'\right) = 1 - \kappa_0 \frac{\mathbb{V}_{\{y',\tau'\}|\{y,\tau\}}\mathcal{R}\left(y', \tau', B'\right)}{\mathbb{E}_{\{y',\tau'\}|\{y,\tau\}}\mathcal{R}\left(y', \tau', B'\right)}\left(B' - \mathcal{T}\left(\tau, B'\right) - \bar{\mathcal{A}}\right) \tag{D2}$$

Notice that $q^{SM,0}(y, \tau, B')$ coincides with the price in the primary market $q(y, \tau, B')$, which is the price relevant to the government.

The second trading instance (SM_1) occurs at the end of the period, when the secondary markets closes and after the new index weights τ' are realized. In this case, the bond price is

$$q^{SM,1}\left(B', y, \tau'\right) = \beta^{\star}\mathbb{E}_{y'|y}\mathcal{R}\left(y', \tau', B'\right)\Psi^{SM,1}\left(y, \tau', B'\right). \tag{D3}$$

The term $\mathbb{E}_{y'|y}\mathcal{R}\left(y', \tau', B'\right)$ is the expected next-period repayment of the bond, conditional on the information available when the secondary market closes. This term is analogous to the one in Equation (D1), but incorporates the information provided by the realization of τ'. Similarly, the downward-sloping component of the price function is given by

$$\Psi^{SM,1}\left(y, \tau', B'\right) \equiv 1 - \kappa_0 \frac{\mathbb{V}_{y'|y}\mathcal{R}\left(y', \tau', B'\right)}{\mathbb{E}_{y'|y}\mathcal{R}\left(y', \tau', B'\right)}\left(B' - \mathcal{T}\left(\tau', B'\right) - \bar{\mathcal{A}}\right). \tag{D4}$$

Notice that, the only difference between $q^{SM,1}$ and $q^{SM,0}$ arises from the update of τ' since both the endowment and the stock of debt remain fixed while the secondary market is open. Moreover, in the absence of secondary markets, the timing assumption is exactly the same as in the baseline model.

C.2 Solution Method

We employ a global solution method to solve our quantitative model. We discretize the output process y and the process for the passive demand share τ using Tauchen's method. We select 41 gridpoints for y and 15 for τ. As for B, we construct a grid consisting of 250 equally spaced points between $\underline{B} = 0$ and $\overline{B} = 1.2$. We ensure that $\overline{B}$ is sufficiently large (approximately three times the average stock of debt) so that it never binds in our simulations. The steps of the algorithm are as follows:

1. We start with a guess for the value functions $V^r\left(y, \tau, B\right)$ and $V^d\left(y\right)$. We also guess the bond price function $q\left(y, \tau, B'\right)$ as a function of the end-of-period stock of debt, B'.

2. Based on these guesses, we solve for the optimal bond policy $B'\left(y, \tau, B\right)$, as described in Equation (11). To this end, we use an optimizing algorithm based on Brent's method and employ cubic splines to interpolate the value functions and bond prices when evaluating off-grid points. Given $B'\left(y, \tau, B\right)$, we then update $V^r\left(y, \tau, B\right)$.

3. We compute the value function for the case in which the government defaults in the current period, $V^d\left(y\right)$, as given by Equation (12).

4. We solve for the government's optimal default choice, as shown in Equation (10). As standard in the literature, we convexify the default decision to achieve convergence.

In particular, we assume that in each period, the government's value function $V^d(y)$ is subject to an i.i.d. shock $\epsilon_V \sim \mathcal{N}(1, \sigma_v^2)$ so that the government defaults if $V^r(\cdot) < V^d(\cdot) \times \epsilon_v$. We choose σ_v^2 to be small enough ($\sigma_v^2 = 2.25 \times 10^{-6}$) so that the convexified solution does not significantly differ from the "true" solution of the model. Let $d(y, \tau, B)$ denote the optimal default choice.

5. Taking the policy functions $B'(y, \tau, B)$ and $d(y, \tau, B)$ as given, we update $q(y, \tau, B')$ according to Equation (13). We use cubic splines to evaluate the right-hand side of the pricing equation at $B'' \equiv B'(y', \tau', B')$.

6. We iterate over the previous steps until convergence of the value functions and the bond price function.

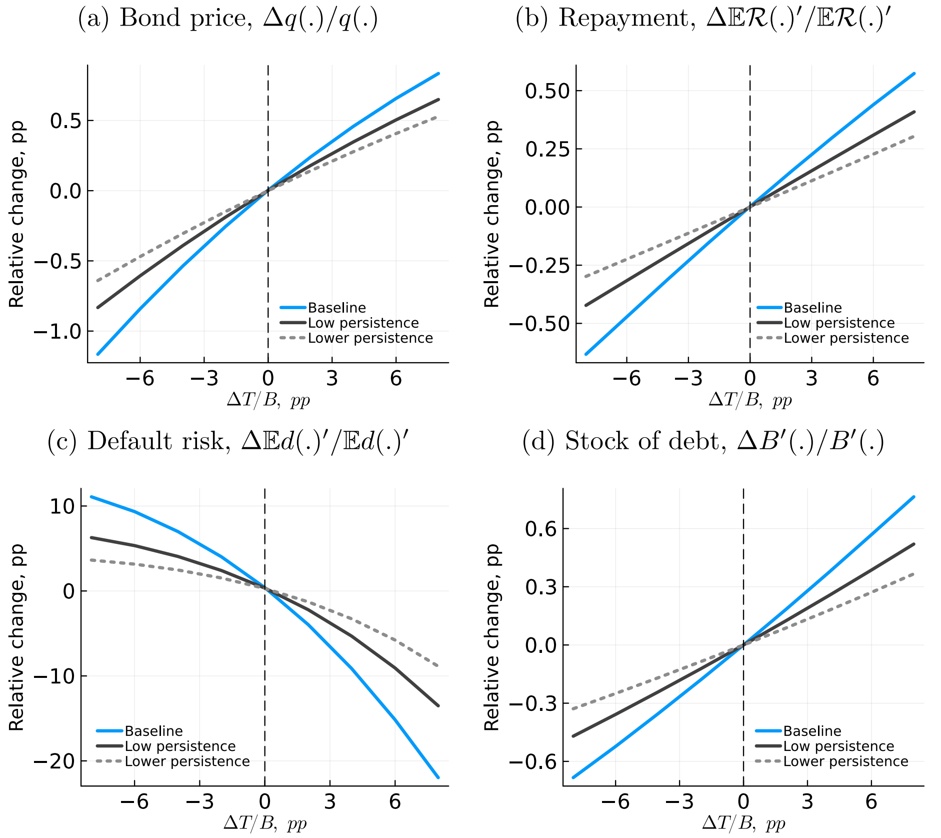
C.3 Structural Demand Elasticity

What explains the difference between the reduced-form and structural elasticity? To address this question, we analyze the mechanisms behind changes in the expected repayment function as a results of a shift in τ.

The first three panels of Figure D1 show the within-period effects resulting from shifts in the passive demand. To this end, we shock τ', and analyze the responses of bond prices, expected repayment, and default risk from the opening to the closing of the secondary market. The blue lines show the results under our baseline parameterization, while the solid and dotted gray lines indicate outcomes for scenarioes where the $\{\tau\}$ process is less persistent. Panels (a) and (b) show that there is a monotone relation between changes in the passive demand, bond prices, and expected repayment. For a 5% increase in the passive demand (as a share of the total stock of debt), bond prices increase by 1% and about half of that increase is explained by an increase in expected repayment. Panel (c) shows the change in one-period ahead default risk. For a 5% increase in the passive demand, default risk decreases more than 10%. Importantly, as the persistence of the τ process decreases, the implied changes on bond prices, expected repayment, and default risk decrease.

While the one-period ahead default risk decreases on impact, one cannot directly map that reaction into higher bond prices. This is because, lenders' anticipate that the government will increase its debt supply as a response to the passive demand shock. To see this, Panel (d) shows how the government's current choice of debt responds to the τ' shock. The government finds it optimal to adjust its stock of debt in response to a change in the passive demand. The response, however, is not one-to-one: for a 5% increase (decrease) in the passive demand

Appendix Figure D1: Effects of Changes in demand on prices and policies

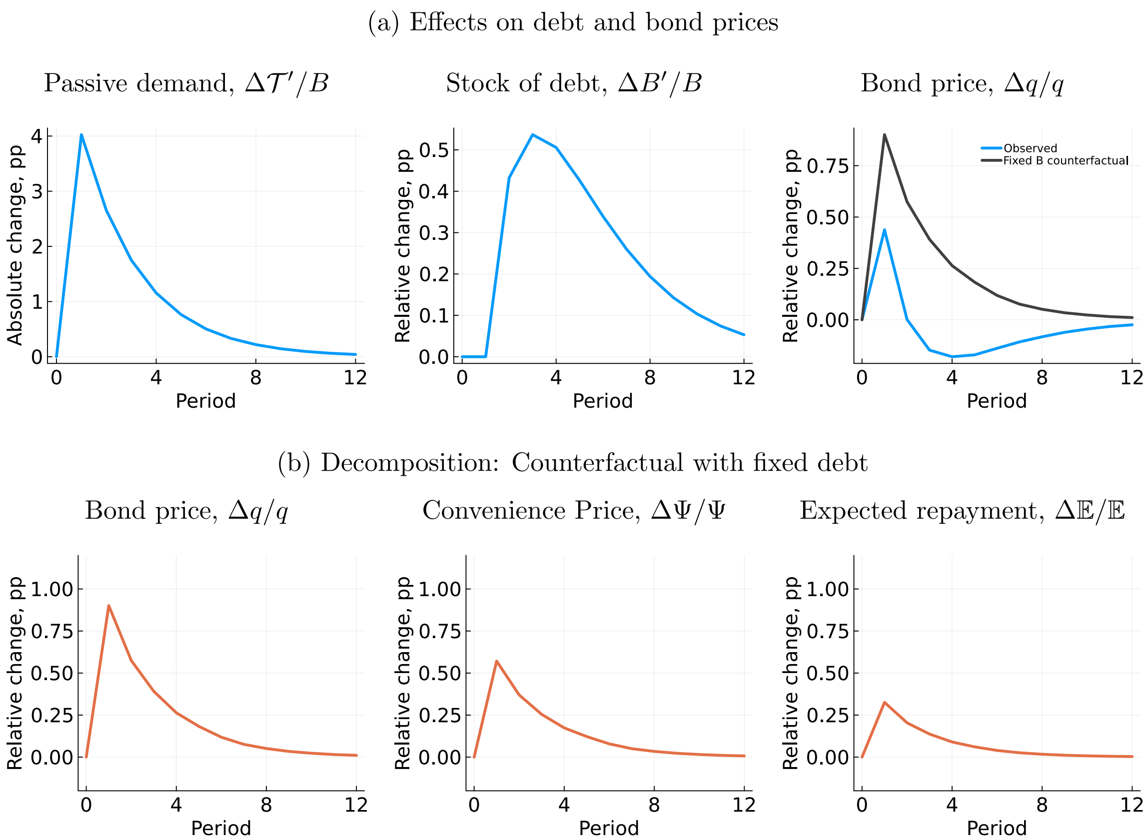


Note: The figure shows how changes in the passive demand (i.e., FIR) affect bond prices, expected repayment, default risk, and the bond supply. The blue lines show results under our baseline calibration. The gray lines show results for parameterizations in which we decrease the persistence of the FIR. For these cases, we set $\rho_{\mathcal{T}} = 0.50$ and $\rho_{\mathcal{T}} = 0.25$. In all cases, we evaluate these changes at the mean value for endowment and debt.

(as a share of the stock of debt), the government raises (lowers) its debt by less than 1%.

To shed further light on the dynamics of bond prices and policies, Figure D2 shows the impulse response to an increase in the passive demand. The top panel depicts the responses of debt and bond prices. The government increases its debt upon the shock and the effects are quite persistent. Since the increase is not one-to-one with respect to the passive demand shock, bond prices increase as result of the larger demand —approximately 0.50%. The initial increase in bond prices is reversed after the first two quarters, as the passive demand shock fades, but the stock of debt (and thus default risk) remains higher. As a comparison, the orange line shows a counterfactual in which we keep the bond policy fixed. In this case, the bond price increases significantly more —about 1%. The bottom panel decomposes the change in bond prices under the counterfactual scenario in which debt is fixed. Since the passive demand shock is persistent, the convenience price term $\Psi(.)$ increases initially, and its effects gradually fade over time. The expected future trajectories of $\Psi(.)$, as well as $B'(.)$ and $d(.)$, influence current and future expected repayments, as shown in the right panel.

Appendix Figure D2: Impulse response to an increase in the passive demand



Note: The top panel shows impulse responses to an increase in the passive demand. The bottom panel shows a decomposition for bond price changes across time, in a counterfactual in which the stock of debt remains fixed.

C.4 Comparisons with Perfectly-elastic Benchmark

In the main text, we compared our baseline model with (i) a perfectly elastic counterfactual and (ii) a perfectly elastic case with higher default costs—higher d_0 parameter. We showed that the former leads to much larger spreads, while the latter attains a much larger debt-to-output ratio relative to that of our baseline model.

In this section, we consider an alternative calibration in which we set $\{d_0, d_1, \beta\}$ to match average spreads, their volatility, and the debt-to-output ratio of our baseline model. Results are displayed in column (iv) of Table D1. Columns (i)–(iii) are identical to those reported in the main text. As expected, after recalibrating $\{d_0, d_1, \beta\}$, the model with perfectly elastic investors is able to match the three targeted moments.

There are two important differences with respect to our baseline. First, the perfectly elastic model with higher default costs can attain a debt-to-output ratio in line with that of our baseline specification, but only if we increase the government's discount factor. That is, when demand is perfectly elastic, the model requires a larger government discount factor to disincentivize debt issuance. Second, and more importantly, the recalibrated perfectly elastic case still delivers a larger correlation between debt issuances and output. As shown in the bottom panel of Table D1, this effect is particularly pronounced when output is low (i.e., when default risk is high), as demand is less elastic in that case—so that an additional unit of debt sharply decreases the bond price.

Appendix Table D1: Role of default costs

Moment	Description	Baseline model (i)	Perfectly elastic (ii)	Δ Def. cost (iii)	Perf. elast. recal. (iv)
$\mathbb{E}(SP)$	Bond spreads (%)	4.69	8.48	4.77	4.74
$\sigma(SP)$	Std of spreads (%)	1.58	5.03	2.00	1.94
$\mathbb{E}(B/y)$	Debt to output (%)	52.8	51.3	82.1	52.8
$\mathbb{E}(d)$	Default frequency (%)	3.08	4.57	3.17	3.24
$\sigma(\Delta B'/y)$	Std of issuances (%)	0.80	0.84	1.08	0.73
$\rho(\Delta B'/y, y)$	Corr issuances & output	0.48	0.64	0.57	0.56
$\rho(\Delta B'/y, y)$, by level of output					
	Medium y	0.22	0.31	0.25	0.24
	Large y	0.20	0.33	0.25	0.22
	Low y	0.11	0.26	0.28	0.29

Note: The top panel compares a set of moments between our baseline model (column i) and alternative counterfactual scenarios. The bottom panel shows correlations between debt issuances and output for different levels of output. Column (ii) shows the results for a case in which investors perfectly elastic ($\kappa = 0$). Column (iii) shows a perfectly elastic case, but in which we change the default cost parameter d_0 to match the average bond spreads of our baseline. Columns (iv) shows an alternative calibration in which we set $\{\beta, d_0, d_1\}$ to math average spreads and their volatility and the debt-to-output ratio of our baseline model.

Decomposition of correlation between trade balance and output

In Table 8 in the main text, we showed that the correlation between the trade balance and output was not affected by changes in the procyclicality of the debt policy across the considered counterfactuals. This is because, even though the model with downward-sloping demand dampens the procyclicality of bond issuances, it also dampens the procyclicality of debt services. Equation (D5) provides a decomposition of these forces:

$$\rho\left(\frac{tb}{y}, y\right) = (-)\rho\left(\frac{q\,\Delta B'}{y}, y\right) \times \frac{\sigma\left(\frac{q\,\Delta B'}{y}\right)}{\sigma\left(\frac{tb}{y}\right)} + \rho\left(\frac{\mathcal{B}}{y}, y\right) \times \frac{\sigma\left(\frac{\mathcal{B}}{y}\right)}{\sigma\left(\frac{tb}{y}\right)} \tag{D5}$$

The results are displayed in Table D2. The correlation between the trade balance and output remains mostly unchanged. On the one hand, the proceeds from issuing debt, $q\Delta B'$, are much less correlated with output in our baseline model, which dampens the cyclicality of the trade balance. On the other hand, debt services are also less correlated with output and exhibit lower volatility, further dampening the cyclicality of the trade balance.

Appendix Table D2: Role of default costs

Moment	Baseline model (i)	Perfectly elastic (ii)	Δ Def. cost (iii)	Perf. elast. recal. (iv)
$\rho\,(\Delta tb/y, y)$	-0.41	-0.41	-0.41	-0.42
$\sigma(tb/y)$, in %	1.10	1.10	1.50	1.00
Decompositon:				
$\rho\,(q\Delta B'/y, y)$	0.53	0.68	0.60	0.60
$\sigma(q\Delta B'/y)/\sigma(tb/y)$	0.90	0.88	0.88	0.89
$\rho\,(\mathcal{B}/y, y)$	0.37	0.56	0.46	0.48
$\sigma(\mathcal{B}/y)/\sigma(tb/y)$	0.17	0.34	0.25	0.24

Note: The table decomposes the correlation of the trade balance with output, following Equation (D5). Column (i) shows the results for out baseline model. Column (ii) shows the results for a case in which investors perfectly elastic ($\kappa = 0$). Column (iii) shows a perfectly elastic case, but in which we change the default cost parameter d_0 to match the average bond spreads of our baseline. Columns (iv) shows an alternative calibration in which we set $\{\beta, d_0, d_1\}$ to math average spreads and their volatility and the debt-to-output ratio of our baseline model.