Inelastic Demand Meets Optimal Supply of Risky Sovereign Bonds*

Matías Moretti
University of Rochester

Lorenzo Pandolfi
University of Naples Federico II and CSEF

Sergio L. Schmukler
World Bank

Germán Villegas Bauer
International Monetary Fund

Tomás Williams
George Washington University

May 11, 2024

Abstract

We present evidence of inelastic demand in the market for risky sovereign bonds and examine how it affects government policies. We exploit monthly changes in the composition of a major emerging market bond index to identify flow shocks that shift the available bond supply, which are unrelated to country fundamentals. Our estimates imply an average inverse price demand elasticity of -0.30, higher in magnitude than estimates for advanced economies. This elasticity increases with default risk, suggesting that investors demand a premium as compensation for risk. We develop a sovereign debt model with endogenous default, and we discipline it based on our empirical estimates. Under inelastic investors, an additional unit of debt lowers bond prices even under constant default risk. Because governments internalize this effect, the inelastic demand becomes a commitment device that limits debt issuances. Our quantitative model shows that this mechanism significantly reduces default risk and bond spreads.

Keywords: emerging markets bond index, inelastic financial markets, institutional investors, international capital markets, small open economies, sovereign debt

JEL Codes: F34, F41, G11, G15

*We thank Mark Aguiar, Gaston Chaumont, Masao Fukui, Robin Greenwood, Rohan Kekre, Rishabh Kirpalani, Marco Pagano, Diego Perez, and Walker Ray for useful discussions and feedback. We also thank participants at the ASSA Annual Meetings, ifo Dresden Workshop on Macroeconomics and International Finance, and NBER IFM Spring Conference. We are grateful to Patricio Yunis for research assistance. The World Bank Chile Research and Development Center and Knowledge for Change Program (KCP) and George Washington University Facilitating Fund (GWU UFF) provided financial support for this paper. Lorenzo Pandolfi gratefully acknowledges financial support from the Unicredit Foundation. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the IMF or the World Bank, those of their Executive Directors, or the governments they represent. Moretti: matias.moretti@rochester.edu. Pandolfi: lorenzo.pandolfi@unina.it. Schmukler: sschmukler@worldbank.org. Villegas Bauer: gvillegasbauer@imf.org. Williams: tomaswilliams@email.gwu.edu.

1 Introduction

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

In this paper, we present novel evidence of downward-sloping demand curves in risky sovereign bond markets and analyze their impact on governments' optimal debt policies. We first estimate high-frequency bond price reactions to well-identified flow shocks, using monthly variation in the composition of the largest benchmark index for emerging economies dollar bonds. Changes in this index affect the demand of passive investors that seek to replicate its composition and imply a shift in the available supply of bonds to active investors. We find that bond prices significantly react to these shocks, even when they are orthogonal to country fundamentals. Our estimates imply an inverse price demand elasticity of -0.30, which we refer to as a reduced-form elasticity.

We then formulate a quantitative sovereign debt model that features endogenous bond issuances and default risk, and we discipline it based on our reduced-form estimates. The goal of the model is twofold. First, we use the model to isolate the part of our empirical estimates explained by endogenous responses in bonds' future payoffs and identify a structural elasticity. Our findings show that over one-third of the reduced-form elasticity is explained by these endogenous forces. Second, we analyze the aggregate implications of facing a downward-sloping demand. Under inelastic investors, an additional unit of debt leads to a decrease in bond prices even if default risk is constant, which increases government's borrowing costs. Since governments internalize this effect, an inelastic demand limits debt issuances and acts as a commitment device. Using our calibrated model, we show that this channel significantly reduces default risk and bond spreads.

We start our analysis with a simple framework to guide our identification strategy. This setup features heterogeneous investors who differ in how they allocate their funds across risky assets. Specifically, they exhibit differences in their levels of activism and passivism. We define the passive demand as the portion of investors' holdings aimed at replicating the composition of the index they follow. This demand is perfectly inelastic and shifts with changes in index weights. For any asset in fixed supply, a higher passive demand implies a leftward shift in the "effective supply," namely the quantity available to active investors. If this shift is exogenous, and under the assumption that future asset payoffs remain fixed, one can use that variation to examine whether demand curves for active investors slope downward (Pandolfi and Williams, 2019; Pavlova and Sikorskaya, 2022). Nevertheless, if expected payoffs endogenously respond to changes in the effective supply, any observed price variation resulting from the shift could over or underestimate the demand elasticity. Since asset prices and payoffs are jointly determined, this potential response motivates the need of a structural model in which prices, the bond supply, and expected payoffs are endogenous outcomes.

On the empirical front, we identify exogenous shifts in a country's effective supply of sovereign bonds by using monthly rebalancings in the J.P. Morgan Emerging Markets Bond Index Global Diversified (EMBIGD), the most widely tracked index by institutional investors for U.S. dollar-denominated sovereign bonds issued by emerging economies. Changes in the composition of this index affect the effective bond supply because they lead to similar rebalancings in the portfolios of passive investors who, due to potential tracking error costs, tend not to deviate from the index. Given the EMBIGD's popularity, these rebalancings can have market-wide effects and affect sovereign bond prices.

We derive a measure of flows implied by rebalancings (FIR) by combining the assets passively tracking the EMBIGD with the index's monthly rebalancings. Qualifying new bond issuances are incorporated into the EMBIGD each month, while maturing bonds are removed. These frequent adjustments lead to changes in country weights within the index, generating passive funds flows. To avoid endogeneity issues, we construct an instrument that exploits changes in the FIR generated by the issuance or retirement of bonds from other countries in the index. As such, these changes are orthogonal to a country's own fundamentals. In addition, we focus on changes in the face amount of the FIR (as opposed to market value) to exclude changes in index composition triggered by endogenous changes in bond prices. We combine this instrument with the specific timing of the reabalancings, which are effective on the last business day of each month. This identification strategy allows us to analyze how bond prices react to FIR shocks in a small window of time around the rebalancing date.

Our analysis reveals that a higher FIR leads to higher bond prices. On average, a 1 percentage point (p.p.) increase in the FIR corresponds to a 30 basis point increase in bond prices. These estimates imply a reduced-form inverse demand elasticity of -0.30. We find that these price reactions vary across countries with different levels of default risk. Specifically, for countries with higher default risk, a 1 p.p. FIR inflow can result in up to a 41 basis point increase in bond prices. In contrast, for safer countries, the estimates are smaller (imply a 11 basis point increase) and statistically not significant. Overall, these findings suggest that investors demand a premium as a compensation for holding risky bonds, which gives rise to an inconvenience yield.

On the quantitative front, we formulate a sovereign debt model where the government has limited commitment and can endogenously default on its debt obligations. Standard models of this nature typically assume a perfectly elastic demand for sovereign bonds, with changes in bond prices driven solely by variations in default risk (Arellano, 2008; Chatterjee and Eyigungor, 2012). We extend these models using a richer demand structure that includes both active and passive investors and a downward-sloping demand curve for active investors. We introduce an inelastic demand following Gabaix and Koijen (2021). Specifically, we assume that active investors have a mandate that specifies how they should allocate their funds. They can deviate from that mandate based on bonds' expected returns but are limited in the extent to which they can do so. To create a tight link with our empirical analysis, we introduce secondary markets in which bonds trade. In this way, by shocking the passive demand, we can replicate within the model our empirical reduced-form elasticity.

We use the calibrated model to decompose the channels behind our empirical elasticity. Since the FIR shock is persistent, part of the documented price reaction may be capturing changes in future bond issuances and expected payoffs. We find that these endogenous responses account for a third of the reduced-form elasticity, and that the effects are larger the higher the persistence of the shock. Overall, our results underscore the importance of accounting for issuers' endogenous responses and changes in the expected repayment of assets. These factors must be considered to avoid potential biases in estimating demand elasticities. Our FIR measure is inherently more temporary than other instruments used in the literature, such as index additions or deletions or index methodological recompositions. Still, we find that the bias can represent about one-third of the total price response.

More importantly, our model allows us to examine the impact of a downward-sloping demand on the optimal debt and default policies of governments. In the presence of an inelastic demand, we observe lower default risk and higher bond prices compared to a scenario with a perfectly elastic demand and similar debt levels. This outcome is not driven by a convenience yield (i.e., a higher price that investors are willing to pay for the bond) but rather by the inelastic demand serving as a commitment device for the government. The mechanism behind it is as follows: With a downward-sloping demand, issuing an additional unit of debt decreases bond prices even if default risk remains fixed. As a result, the government finds issuing large amounts of debt too costly and opts not to do so. An inelastic demand thus limits the maximum amount of debt the government is willing to issue. In our quantitative analysis, we find that this limit leads to a large reduction in default risk and bond spreads. Apart from the commitment device, an inelastic demand imposes some costs because it leads to a debt policy that is less responsive to shocks. Overall, we find that the benefits derived from the commitment device dominate and the government is better off in the presence of inelastic investors.

Our findings contribute to several strands of literature. First, we contribute to a long-standing literature using index rebalancings to estimate asset price reactions, demand elasticities, and changes in investors' portfolios across different asset classes (Harris and Gurel, 1986; Shleifer, 1986; Greenwood, 2005; Hau et al., 2010; Chang et al., 2014; Raddatz et al., 2017; Pandolfi and Williams, 2019; Pavlova and Sikorskaya, 2022).[1] Our contribution lies in showing that demand curves slope downward in one of the most relevant markets for government financing in emerging economies: the international U.S. dollar bond market.

An important contribution of our work is showing that, even in response to exogenous supply-shifting shocks, part of the price movement can be attributed to changes in assets' expected payoffs, rather than solely reflecting an inelastic demand component. Our analysis can be applied to any asset, beyond sovereign bonds, whose future cash flows or payoffs are affected by movements in the effective supply. As such, it can be extended to a vast literature that uses exogenous shifts in the effective supply as an instrument to estimate demand elasticities. Typical examples are sovereign and corporate bonds and equities from both developed and emerging economies.

Second, 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). Taking as given expected asset payoffs, this literature analyzes how an inelastic demand affects the pricing of risk-free U.S. Treasuries (Krishnamurthy and Vissing-Jorgensen, 2012; Greenwood et al., 2015; Mian et al., 2022; Jiang et al., 2021b) and international financial assets (Koijen and Yogo, 2020; Gourinchas et al.,

[1] Beyond index rebalancings, Droste et al. (2023) use high-frequency U.S. Treasury auctions to estimate the effect of demand shocks on Treasury yields.

2022; Greenwood et al., 2023).[2] Similar to our study, Choi et al. (2022) analyze the effects of a downward-sloping demand on the optimal issuance of safe government bonds. In contrast, we focus on the interplay between a downward-sloping demand curve, default risk, and the provision of risky bonds.[3] We show that the demand elasticity interacts with default risk and influences a government's supply of risky bonds.

Third, our study also connects to a body of work examining how changes in the investor base of government debt impact bond yields (Warnock and Warnock, 2009; Dell'Erba et al., 2013; Peiris, 2013; Arslanalp and Poghosyan, 2016; Ahmed and Rebucci, 2022). In related work, Fang et al. (2022) develop a demand system to quantify how changes in the composition of investors (domestic versus foreign, banks versus non-banks) affect government bond yields in international markets. Zhou (2024) focuses on emerging market sovereign debt and shows that differences in a country's foreign investor base can help explain the heterogeneous influence of the global financial cycle. In this paper, we exploit exogenous changes in the composition of the investor base (passive versus active funds) to provide evidence of downward-sloping demand curves for risky sovereign bonds.

Fourth, our paper relates 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, different investor types (active and passive), and secondary bond markets, which creates a tight link with our empirical analysis and allows us to discipline the model based on our reduced-form estimates.[4] Using this setup, we show that an inelastic demand serves as a commitment device that lowers default risk. In this regard, our paper connects to a broader literature on the use of fiscal rules as commitment devices (Alfaro and Kanczuk, 2017; Dovis and Kirpalani, 2020; Hatchondo et al., 2022; Bianchi et al., 2023). We show that if the demand for bonds is inelastic, the market by itself can create incentives that discourage borrowing and decrease default risk.

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

[2] A related literature focuses on U.S. and international corporate bond markets (Dathan and Davydenko, 2020; Bretscher et al., 2022; Calomiris et al., 2022; Kubitza, 2023).

[3] Kaldorf and Rottger (2023) analyze the implications of convenience yields on the pricing and optimal supply of risky sovereign bonds. In their setup, and similarly to Choi et al. (2022), investors are willing to pay a higher price for holding risky sovereign bonds due to their collateral services. In contrast, based on our empirical results, our model assumes that investors demand a premium (an inconvenience yield) for holding risky bonds.

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

(2016), and Arellano et al. (2017) analyze sovereign debt models with risk-averse investors. In these models, investors are inelastic because they must be compensated for each additional unit of risky debt they hold. There are several other mechanisms that can explain a downward-sloping demand. For example, it can be driven by regulatory limitations such as a Value-at-Risk (VaR) constraint (Gabaix and Maggiori, 2015; Miranda-Agrippino and Rey, 2020), by liquidity considerations (He and Milbradt, 2014; Moretti, 2020; Chaumont, 2021; Passadore and Xu, 2022), by investors' buy-and-hold strategies, or by fixed-share mandates specifying how investors should allocate their funds across assets (as in Gabaix and Koijen, 2021). Our setup relies on a flexible demand structure that can accommodate any of these potential drivers. Our aim is not to uncover the causes of investors' inelastic behavior but rather to examine its aggregate implications.

The rest of the paper is structured as follows. Section 2 introduces a simple framework to guide our analysis. Section 3 presents the empirical analysis, including details on the institutional setup of the EMBIGD index, data sources, identification strategy, and results. Section 4 formulates a sovereign debt model with endogenous default and inelastic investors, and Section 5 presents the quantitative analysis. Section 6 concludes.

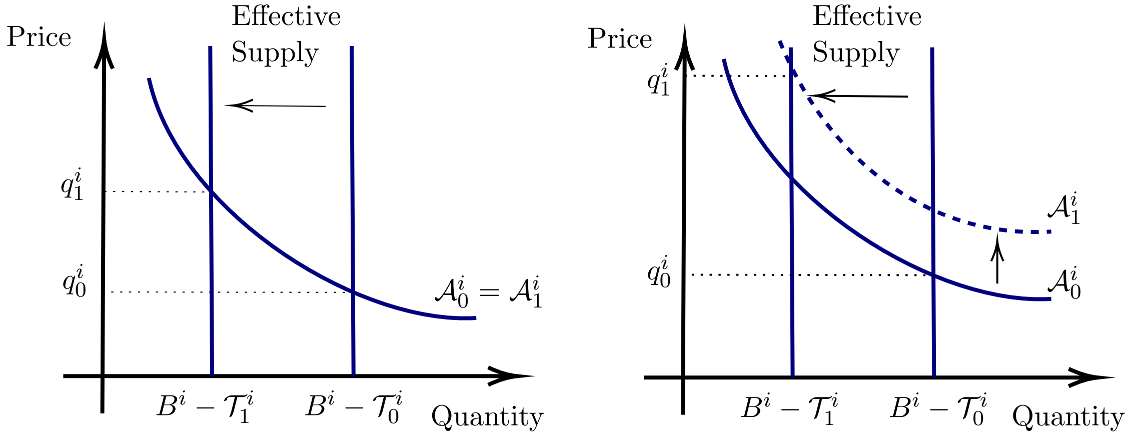
2 Index Rebalancings as Passive Demand Shocks

We introduce a simple framework featuring active and passive investors to guide our empirical analysis. The setup follows Pavlova and Sikorskaya (2022) and illustrates how one can use index rebalancings to identify changes in the passive demand which, in turn, imply a shift in the available bond supply. These shifts can then be utilized to estimate reduced-form price demand elasticities. Although we focus on the case of sovereign bonds, the same methodology can be applied to any asset (e.g., equities).

Consider a bond i that is part of a benchmark index $\mathcal{I}$. Investors are heterogeneous in their degree of activism or pasivism. In particular, investors track the composition of the $\mathcal{I}$ index but differ in how actively or passively they do so. The underlying mechanism is that, due to potential tracking error costs, passive investors do not want to deviate from the composition of the index they follow. Let $\boldsymbol{w}_t = \{w_t^1, ..., w_t^N\}$ denote the vector of time-varying index weights for each constituent bond of $\mathcal{I}$. We define the passive demand, $\mathcal{T}_t^i(w_t^i)$, as the portion of investors' holdings aimed at replicating the composition of the $\mathcal{I}$ index. We explicitly write $\mathcal{T}_t^i(w_t^i)$ as a function of w_t^i to emphasize its dependence on the index weights. This demand captures the holdings of both semi- and fully passive investors, it is perfectly inelastic, and

Figure 1
Index rebalancing and the demand elasticity

(a) Fixed Expected Payoffs (b) Higher Expected Payoffs



Note: The figure depicts a decrease in the effective supply driven by an increase in $\mathcal{T}^i$. Panel (a) considers the case when the expected payoffs do not change as a consequence of the lower effective supply. Panel (b) considers a case in which the expected payoffs increase.

shifts with changes in the index.

Let B^i denote the supply for bond i, which we assumed fixed for now. By decomposing the demand into an active and passive component, we can write the market-clearing condition for bond i as $B^i = \mathcal{A}_t^i + \mathcal{T}_t^i \left(w_t^i\right)$, where $\mathcal{A}_t^i$ denotes the active demand. For any bond i in fixed supply, an increase in the passive demand implies a decrease in the supply of bonds available to active investors (i.e., a leftward shift in the effective or residual supply). If this increase is exogenous, one can use that variation to analyze whether the demand curves for active investors slope downward. Panel (a) of Figure 1 illustrates this point. If the active demand is inelastic, an exogenous increase in $\mathcal{T}_t^i(w_t^i)$ should lead to a higher bond price.

Based on this graphical intuition, one could exploit changes in index weights w_t^i to compute shifts in the passive demand, $\Delta\mathcal{T}_t^i \equiv \mathcal{T}_{t+1}^i(w_{t+1}^i) - \mathcal{T}_t^i(w_t^i)$, and estimate bond price responses around those shifts, Δq_t^i. With this, one can then estimate the following reduced-form (inverse) demand elasticity:

$$\hat{\eta}^i = (-)\frac{\Delta q_t^i}{\Delta\mathcal{T}_t^i}\,\frac{B^i - \mathcal{T}_t^i}{q_t^i}. \tag{1}$$

Exploiting observed variations in index weights w_t^i can still pose challenges. First, changes in w_t^i might be driven by endogenous changes in asset prices or can coincide with large issuances or redemptions. Second, the estimated price reactions in Equation (1) might capture not only an inelastic demand component but also potential (endogenous) changes in expected payoffs. Put differently, to directly map Equation (1) into a structural elasticity (η^i), we would need to assume that the intrinsic value of asset i is unaffected by the $\Delta\mathcal{T}_t^i$ shock. However, the shock itself might influence the expected payoffs. For example, for long-term bonds, a larger $\Delta\mathcal{T}_t^i$ may affect next-period payoffs if the shock is persistent. Moreover, the issuer can react to the shock (for instance, by increasing its supply), which may also affect the expected payoffs from holding the asset. If investors anticipate these responses, they should price them.

Panel (b) of Figure 1 provides a graphical illustration of this case. If a positive $\Delta\mathcal{T}_t^i$ raises the next-period expected repayment, investors should be willing to pay a higher price for any given quantity of the bond, leading to an upward shift in the active demand. Failing to account for this effect might lead to the conclusion that the demand curve is steeper (more inelastic) than it truly is. Conversely, if a positive $\Delta\mathcal{T}_t^i$ lowers the next-period expected repayment, it would cause the active demand to shift downward. This shift might lead to the demand curve being estimated as flatter (more elastic) than it truly is. Since bond prices and payoffs are jointly determined, it is challenging to disentangle the effects on bond prices due to the downward-sloping demand from those resulting from changes in expected payoffs.

Given these two challenges we proceed in two steps. In Section 3 we detail a novel identification strategy, based on exogenous index rebalancings, to estimate reduced-form elasticities for risky sovereign bonds. Then, to formally map these price reactions to structural elasticities, we formulate in Section 4 a sovereign default model in which bond prices, the bond supply, and bond payoffs are endogenous and determined simultaneously.

3 Empirical Analysis

3.1 Identifying Exogenous Shifts in Bond Supply

We exploit monthly rebalancings in the EMBIGD to identify exogenous shifts in the available bond supply for active investors (i.e., the effective supply). The EMBIGD tracks the performance of emerging market sovereign and quasi-sovereign bonds in U.S. dollars issued in international markets.[5] Among bond indexes for emerging economies, the EMBIGD is the most widely tracked, followed by funds with combined assets under management (AUM) of around US$300 billion in 2018 (Appendix Figure D2).[6] Unlike other indexes that use a traditional market capitalization-based weighting scheme, the EMBIGD restricts the weights

[5]The index includes bonds with a maturity 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.

[6]Appendix Figures D3 and D4 show the high preponderance of U.S. dollar-denominated sovereign debt issued by emerging economies in international markets.

of countries with above-average bonds outstanding (relative to other countries in the index) by including only a fraction of their face amount. We refer to this methodology as a "cap rule."[7]

Rebalancings in the EMBIGD index, triggered by bond inclusions and exclusions, occur on the last business day of each month in the United States. J.P. Morgan announces these updates through a report detailing the updated index composition. Consequently, passive investors tracking the index adjust their portfolios by buying or selling bonds to match the new index weights.

Following Pandolfi and Williams (2019), we construct the flows implied by the rebalancings (FIR) measure for each country c at each rebalancing date. The FIR quantitatively measures the relative change in passive demand for a country's sovereign bonds resulting from an index rebalancing. A 1% FIR can be interpreted as a 1% reduction in the available bond supply in the market. More precisely, the FIR measure is constructed as follows:

$$\text{FIR}_{c,t} \equiv \frac{\Delta\tilde{\mathcal{T}}_{c,t}}{q_{c,t-1}B_{c,t-1} - w_{c,t-1}\mathcal{W}_{t-1}}. \tag{2}$$

The $\Delta\tilde{\mathcal{T}}_{c,t}$ term captures the change in passive demand implied by the index rebalancing. It measures the amount of funds that, on a given rebalancing date, enter or leave a country due to the rebalancing in the portfolio of passive investors tracking the EMBIGD index. For convenience, we normalize $\Delta\tilde{\mathcal{T}}_{c,t}$ by the market value of the bonds available to active investors, $q_{c,t-1}B_{c,t-1} - w_{c,t-1}\mathcal{W}_{t-1}$, where $\mathcal{W}$ denotes the AUM passively tracking the EMBIGD.

We define the implied change in the passive demand as $\Delta\tilde{\mathcal{T}}_{c,t} \equiv (w_{c,t} - w_{c,t}^{BH})\mathcal{W}_t$. The term $w_{c,t}$ is the benchmark weight for country c, at time t. It is defined as $w_{c,t} \equiv \frac{q_{c,t}B_{c,t}f_{c,t}}{q_tI_t}$, 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 outstanding. We define the diversified face amount (DFA) as $f_{c,t}B_{c,t}$, where $f_{c,t}$ denotes the face-amount share of country c's bonds in the index. To preserve diversification, the EMBIGD applies a scheme that entails a country-level cap to the index weight for countries with total greater-than-average face value bonds. For these caped countries, the diversification coefficient is smaller than one, $f_{c,t} < 1$, which efectively reduces its index share.[8]

[7]The J.P. Morgan Emerging Markets Bond Index Global (EMBIG) has the same bond inclusion criteria as the EMBIGD. The only difference between them is that while the EMBIG uses a market capitalization weighting scheme, the EMBIGD modifies this scheme to limit the weights of countries with above-average debt outstanding. Appendix Figure D1 plots the EMBIG country weights of both the EMBIG (a more traditional market-based index) and EMBIGD versions for December 2018.

[8]Appendix A describes the rules that the EMBIGD uses to compute the weights of the instruments included in the index. In a purely market capitalization-weighted indexes, $f_{c,t} = 1$ for every country that is part of the index.

The term $q_t I_t$ 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. Consequently, $w_{c,t}$ captures the relative market capitalization of country c's sovereign bonds included in the index. Lastly, the term $w^{BH}_{c,t}$ denotes a "buy-and-hold weight," defined as the weight country c would have had at time t if the index composition had remained unchanged. That is, $w^{BH}_{c,t} \equiv w_{c,t-1} \frac{q_{c,t}/q_{c,t-1}}{q_t/q_{t-1}}$.[9]

Although index changes drive the FIR, this measure might not necessarily be orthogonal to a country's fundamentals, for two reasons. First, the FIR is affected by countries' sovereign bond issuances. When a country issues new bonds that become part of the index (or redeems existing bonds), its weight changes, leading to changes in the FIR. Second, even for countries whose $B_{c,t}$ and $f_{c,t}$ remain constant, the FIR can be mechanically correlated to present or past bond price changes. Given that we aim to isolate the impact of passive demand shocks on bond prices, the potential endogeneity of the FIR could bias our estimates.

We address the potential FIR endogeneity in two ways. First, for each rebalancing event, we consider only countries whose amount outstanding of bonds, $B_{c,t}$, does not change relative to the previous month. In other words, we focus only on countries that experience no new issuances, bond repurchases, or the removal of bonds from the index due to maturity on a given month.

Second, we exploit the fact that the EMBIGD's weighting scheme is based on the diversified face amount of outstanding bonds. This is important as it allows us to net out the variation potentially correlated with current or past bond price changes. In particular, 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 outstanding of bonds included in the index, $\tilde{w}_{c,t} \equiv \frac{f_{c,t}B_{c,t}}{\sum_c f_{c,t}B_{c,t}}$. We then compute the fractional change in the synthetic index:

$$\frac{\Delta \tilde{w}_{c,t}}{\tilde{w}_{c,t-1}} = \left(\frac{f_{c,t}B_{c,t}}{\sum_c f_{c,t}B_{c,t}} - \frac{f_{c,t-1}B_{c,t-1}}{\sum_c f_{c,t-1}B_{c,t-1}} \right) / \left[\frac{f_{c,t-1}B_{c,t-1}}{\sum_c f_{c,t-1}B_{c,t-1}} \right]. \tag{3}$$

Focusing on countries whose debt outstanding in the index remains unchanged ($B_{c,t} = B_{c,t-1}$), the instrument becomes

$$Z_{c,t} \equiv \left(\frac{f_{c,t}}{\sum_c f_{c,t}B_{c,t}} - \frac{f_{c,t-1}}{\sum_c f_{c,t-1}B_{c,t-1}} \right) \ / \left[\frac{f_{c,t-1}}{\sum_c f_{c,t-1}B_{c,t-1}} \right]. \tag{4}$$

By instrumenting the FIR with $Z_{c,t}$, we can isolate the variation in the FIR that is solely attributable to changes in the outstanding amount of bonds from other countries. These

[9] This buy-and-hold weight is computed as if no bonds had entered or exited the index at time t. Note that $w^{BH}_{c,t} = \frac{q_{c,t} f_{c,t-1} B_{c,t-1}}{q_t I_{t-1}}$. Absent any change in the index composition (i.e., inclusions or exclusions of new bonds or countries), if the price of a country's sovereign bonds increases more than that of other countries in the index, the weight of that country in the index increases. Nevertheless, investors do not need to rebalance their portfolios as the "buy-and-hold weight" coincides with the new weight in the index, $w_{c,t}$.

changes are a result of fluctuations in the relative size of other countries' sovereign bond markets or alterations in the diversification coefficient, $f_{c,t}$. Because $f_{c,t}$ is not a function of bond prices, and because we only consider countries where $B_{c,t}$ is fixed, $\frac{\partial Z_{c,t}}{\partial q_{c,t}} = \frac{\partial Z_{c,t}}{\partial q_{c,t-1}} = 0$. Importantly, as we illustrate next based on a simple example, due to the cap rule the instrument $Z_{c,t}$ is heterogeneous across countries.

In our main analysis, we use the $Z_{c,t}$ instrument to estimate the effect of exogenous demand changes induced by passive flows on sovereign bond prices. We take advantage of the specific timing of the rebalancings: index changes always occur on the last business day of each month. For each rebalancing date, we can therefore distinguish between pre- and post-rebalancing days and estimate price reactions when the rebalancings occur.

3.2 The Rebalancing and Cap Rule in Practice

To illustrate how the rebalancings and the cap rule work in practice, we consider an example involving 5 countries ($c = \{A, B, C, D, E\}$) with qualifying bonds in the index in month $t-1$. For simplicity, each of these countries has only one qualifying bond and does not issue (nor redeem) bonds during month t. We assume that country F issues an eligible bond for the first time during month t. This bond is included in the index on the rebalancing date at the end of month t.

Table 1
The cap rule: Face amount vs diversified face amount

Country	Before Rebalancing		After Rebalancing	
	$FA_{c,t-1}$	$DFA_{c,t-1}$	$FA_{c,t}$	$DFA_{c,t}$
A	1,000	1,000	1,000	1,000
B	2,000	2,000	2,000	2,000
C	3,000	3,000	3,000	3,000
D	7,000	6,429	7,000	6,769
E	12,000	10,000	12,000	11,000
F	-	-	8,000	7,615
ICA	5,000		5,500	
FA_{max}	12,000		12,000	

Note: The table assumes values for the face amount for each country. It then computes the diversified face amount following Equation (A1).

Table 1 shows the face amount FA_c for each bond included in the index before and after the rebalancing date t. Columns DFA_c show the diversified face amount (i.e., $f_c B_c$) calculated based on the methodology described in Appendix A. The EMBIGD methodology caps the face amount outstanding included in the index for countries with above-average

Table 2
Flows Implied by Rebalancing (FIR)

c	$DFA_{c,t-1}$	$DFA_{c,t}$	$q_{c,t}$	$MV^{BH}_{c,t}$	$MV_{c,t}$	$w_{c,t}$	$w^{BH}_{c,t}$	$FIR_{c,t}$
A	1,000	1,000	0.90	900	900	2.85%	3.97%	-1.12%
B	2,000	2,000	1.25	2,500	2,500	7.91%	11.03%	-3.12%
C	3,000	3,000	0.85	2,550	2,550	8.07%	11.25%	-3.18%
D	6,429	6,769	1.20	7,714	8,123	25.72%	34.04%	-8.32%
E	10,000	11,000	0.90	9,000	9,900	31.34%	39.71%	-8.37%
F	-	7,615	1.00	-	7,615	24.11%	0.00%	24.11%

Note: Market values $MV^{BH}_{c,t}$ and $MV_{c,t}$ are based on the diversified face amount (DFA) and bond price (q) information. They are computed as $MV^{BH}_{c,t} \equiv DFA_{c,t-1} \times q_{c,t}$ and $MV_{c,t} \equiv DFA_{c,t} \times q_{c,t}$. Observed and buy-and-hold index weights are given by $w_{c,t} = \frac{MV_{c,t}}{\sum_c MV_{c,t}}$ and $w^{BH}_{c,t} = \frac{MV^{BH}_{c,t}}{\sum_c MV^{BH}_{c,t}}$. The FIR measure is computed based on Equation (2), assuming a scaling factor of one (i.e., for each country, total assets under management divided by the available bond supply equals one).

Table 3
Heterogeneity induced by the cap rule

c	$\tilde{w}_{c,t-1} = \frac{DFA_{c,t-1}}{\sum_c DFA_{c,t-1}}$	$\tilde{w}_{c,t} = \frac{DFA_{c,t}}{\sum_c DFA_{c,t}}$	$Z_t = \frac{\tilde{w}_{c,t} - \tilde{w}_{c,t-1}}{\tilde{w}_{c,t-1}}$
A	4.46%	3.19%	-28.54%
B	8.92%	6.37%	-28.54%
C	13.38%	9.56%	-28.54%
D	28.66%	21.57%	-24.75%
E	44.59%	35.05%	-21.39%
F	-	24.26%	-

Note: The table shows the theoretical index weights calculated based on the diversified face amount. The last column shows the percentage change in the theoretical weights, Z.

debt levels (denoted as ICA). The example assumes that countries D and E are capped in periods $t-1$ and t, while country F is also capped in t.

Table 2 (last column) shows our FIR measure for this example. To compute the FIR, we first calculate each country's market value ($MV_{c,t}$), the *buy-and-hold* market value ($MV^{BH}_{c,t}$), the (observed) weight ($w_{c,t}$), and the *buy-and-hold* weight ($w^{BH}_{c,t}$). From this analysis, it is clear that the FIR measure depends on current bond prices and is affected by changes in the (diversified) face amount of each country. Country F, for instance, exhibit a large FIR because it is issuing new qualifying bonds that enter the index.

In Table 3, we exclude country F and restrict our attention to the subset of countries whose face value remained unchanged. The table reports the theoretical weights $\tilde{w}$, which are only a function of the diversified fave amount, and our Z instrument —computed based on Equation (4). Since we only consider countries with a constant face value, changes in $\tilde{w}$ are driven exclusively by country F's new issuances and the application of the EMBIGD cap rule.

In our example, the issuance of new bonds by F reduces the weights for all other countries. In the absence of a cap rule, the relative decrease is homogeneous across all countries. However, due to the cap rule, the percentage change in the theoretical weights Z varies across countries. This variation arises because the diversified face amount (used to calculate $\tilde{w}$) is capped for countries with above-average amounts of outstanding bonds, and the cap changes after the new issuances by country F. [10] The new bonds issued by F relax the index cap for countries with above-average face amounts (D and E), resulting in a smaller relative drop in their theoretical weights. In the next section, we exploit this variation across countries to estimate bond price demand elasticities.

3.3 Estimation Strategy

We adopt an instrumented difference-in-differences (DDIV) design and estimate the following main specification using two-stage least squares (2SLS):

$$\log(q_{i,t,h}) = \theta_{c(i),t} + \theta_{b(i),t} + \gamma \mathbb{1}_{h \in Post} + \beta(\widehat{FIR}_{c(i),t} \times \mathbb{1}_{h \in Post}) + \mathbf{X}_{i,t} + \varepsilon_{i,t,h}, \qquad (5)$$

where $q_{i,t,h}$ is the price of bond i at rebalancing event t, h trading days before or after the rebalancing information is confirmed.[11] For example, $h = 1$ indicates the first trading day after J.P. Morgan releases the EMBIGD's new composition. This happens during the trading hours on the last business day of each month, meaning that $h = 1$ falls on this day. For each rebalancing event t, we consider a symmetric h-day window around it. $\theta_{c(i),t}$ 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). $\widehat{FIR}_{c(i),t}$ represents the flows implied by the rebalancing, instrumented with the percentage change in the theoretical index weights, $Z_{c,t}$. We obtain $\widehat{FIR}_{c(i),t}$ by regressing $FIR_{c,t}$ on $Z_{c,t}$ (first stage). $\mathbb{1}_{h \in Post}$ is an indicator function equal to 1 in the h days after the rebalancing and equal to 0 in the h days before. $\mathbf{X}_{i,t}$ is a vector of monthly bond controls, including the bond's face amount and (beginning-of-month) spread. The coefficient of interest is β, which captures the FIR's effect on bond prices. Specifically, it measures how much the average bond log price changes with a 1 p.p. increase in $\widehat{FIR}_{c(i),t}$ around the rebalancing day.

Our preferred specification replaces the country-month fixed effects, bond characteristics-month fixed effects, and bond controls with bond-month fixed effects. This specification

[10] The inclusion of bonds 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.

[11] Appendix Figure D5 provides a visual timeline of these events.

exploits both within and across rebalancing variation in $Z_{c,t}$. Additionally, we present results that only exploit cross-sectional variation in $Z_{c,t}$ by including month-$\mathbb{1}_{h \in Post}$ fixed effects.

We also estimate a leads and lags regression in which the instrumented FIR is interacted with trading-day dummies around the rebalancing event. This analysis allows us to both explore the dynamic effect of the FIR and test for parallel trends before the rebalancing. We estimate the following regression:

$$\log(q_{i,t,h}) = \theta_{c(i),t} + \theta_{b(i),t} + \sum_{h \notin -2} \gamma_h \mathbb{1}_h + \sum_{h \notin -2} \beta_h (\widehat{FIR}_{c(i),t} \times \mathbb{1}_h) + \mathbf{X}_{i,t} + \varepsilon_{i,t,h}, \tag{6}$$

where $\mathbb{1}_h$ are dummy variables equal to 1 for the h trading day in our $[-5:+5]$ estimation window and 0 otherwise.

3.4 Data and Summary Statistics

We collect data from different sources to compute the FIR and our instrument. Most of the variables used in the analysis come directly from J.P. Morgan. However, one variable is not straightforward to measure: the AUM of funds that passively track the EMBIGD, $\mathcal{W}_t$. While J.P. Morgan provides data on the amount of assets benchmarked against their indexes, it does not distinguish between passive and active funds. Additionally, even if these data were available, many active funds might passively manage a significant share of their portfolios, as highlighted by Pavlova and Sikorskaya (2022).

To compute $\mathcal{W}_t$, we start with J.P. Morgan data on assets tracking the EMBIGD, which we then adjust based on an estimate of the share of passive funds. The estimation of this share involves the following steps. We retrieve data from Morningstar on the asset holdings of funds benchmarked against the EMBIGD and EMBI Global Core for 2016–2017.[12,13] For each fund, we compute their $Passive\ Share = 100 - Active\ Share$, where $Active\ Share$ is the measure developed by Cremers and Petajisto (2009). We first estimate this variable at the country level, which is the level of the FIR measure.[14] This allows us to separate, even for active funds, the fraction of a fund's portfolio that might be passive or active. We then compute the average $Passive\ Share$ weighted by each fund's AUM. With this strategy, we

[12]The EMBI Global Core uses the same diversification methodology as the EMBIGD to calculate the bond weights, as described in Appendix A. The criteria for including bonds in the EMBI Global Core is the same as that for the EMBIGD (and the EMBI Global), except 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.
[13]The data sample periods utilized in the paper are determined by data access constraints.
[14]We compute the *Active Share* at the country level by using the country weights in the index and in the funds' portfolios rather than bond weights. For the portfolios, we only assign bonds to a given country if they are included in the EMBIGD. Specifically, 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.

Table 4
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
Instrumented FIR (%)	-0.15	0.20	-0.32	0.00	-0.66	0.23
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
CDS (bps)	300	698	104	282	42	6171

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, and *CDS* denotes the five-year credit default swap spread of USD-denominated sovereign bonds. Sources: Bloomberg, Datastream, J.P. Morgan Markets, Morningstar Direct, and authors' calculations.

obtain an estimated passive fund share of 50%.[15] We calculate $\mathcal{W}_t$ by adjusting the AUM tracking the EMBIGD index, using a rescaling factor of 50%, thus obtaining the estimated passive funds tracking the index we use to compute the FIR.[16]

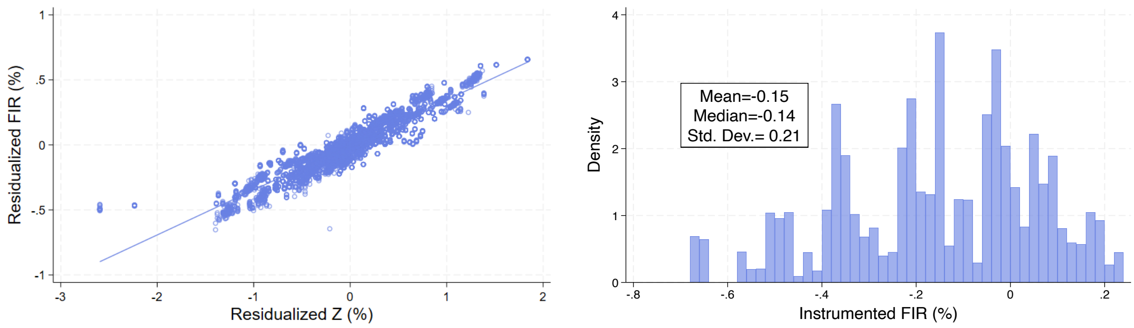
We gather data on individual bond prices from Datastream and obtain several bond characteristics (maturity and duration, among others) directly from J.P. Morgan Markets. To clean our dataset, we drop extreme values of daily returns, stripped spreads, and $Z_{c,t}$.[17] We drop stripped spreads below 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 information is known on the last business day of the month. Finally, we exclude bond-month observations that experience daily returns below (above) the 1st (99th) percentile in terms of the daily return distribution.

Our final dataset comprises 131,820 bond-time observations for 751 bonds in 68 countries. Table 4 displays summary statistics for our main measure of the instrumented flows implied by the rebalancing, $\widehat{FIR}_{c,t}$, as well as for the other key variables in our database. Bonds in our sample have an average stripped spread of 278 basis points, an average maturity of 10

[15] Appendix Table D1 provides results using alternative shares of passive funds used to construct the FIR measure. Although our quantitative estimates change slightly, the qualitative implications remain the same.
[16] For comparison, we construct *Active Share* at the bond level, obtaining a value-weighted average of 72%. Cremers and Petajisto (2009) show an average value-weighted *Active Share* that fluctuates between 55% and 80%.
[17] Stripped spread is defined in the notes of Table 4.

Figure 2
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 in Equation (2) and Z as in Equation (4). Panel (b) shows a histogram of the FIR instrumented with Z. For both panels, the sample period is 2016–2018.

years, and an average face amount of US$1.3 billion.

Figure 2, Panel (a) presents the results of our first stage. It shows a scatter plot of the FIR and the $Z_{c,t}$ instrument after both variables have been residualized with rebalancing-month and country fixed effects. The two variables have a clear positive relation, and the R-squared is 86%. Panel (b) presents the distribution of our instrumented FIR measure. The values range from -0.7% to around 0.25%, with more negative than positive observations. This is consistent with the fact that over time, the number of bonds included in the EMBIGD increased. Given that we restrict our analysis to countries whose face amount remains constant, including bonds from other countries typically reduces the weight of sample countries (i.e., a negative FIR).[18]

3.5 Results

Table 5 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 our preferred specification, with bond-rebalancing 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.

[18] When a bond is added to the index, it generally reduces the weight of other bonds in terms of their total face amount. However, in certain situations, it could increase the weight of certain countries through a relaxation of face amount caps, as the EMBIGD sets limits on the included face amount of countries to maintain a diversified portfolio.

[19] Appendix Table D2 shows that our results are robust to alternative windows around the rebalancing events. The results are also robust to excluding quasi-sovereign bonds from the analysis (Appendix Table D3).

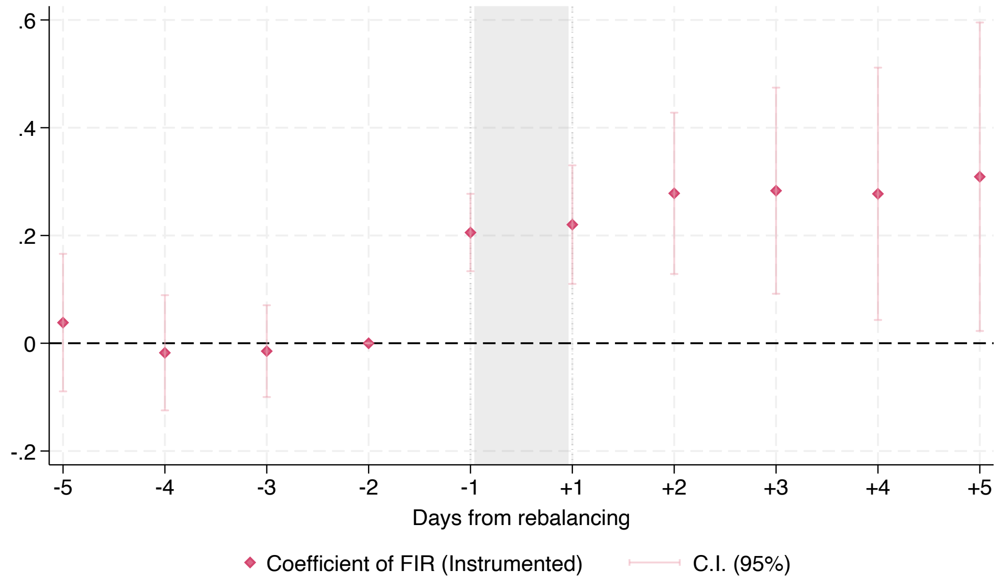
Table 5
Log price and FIR

Dependent Variable: Log Price						
		[-5:+5]			No 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: This table presents 2SLS estimates of log bond prices on the FIR measure (Equation (2)), instrumented by Z (Equation (4)), around rebalancing dates. The first- and second-stage equations are described in Equation (5). 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) in Columns 1-4. Month fixed effects are dummy variables equal to 1 for each rebalancing month (0 otherwise), and bond characteristics are fixed effects that interact maturity, ratings, and bond type fixed effects. Maturity fixed effects 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). Ratings from each bond are from Moody's. Bond type differentiates sovereign from quasi-sovereign bonds. Bond controls indicate whether the estimation includes the log face amount and log stripped spread of the bond. The last two columns in the analysis drops the trading day before rebalancing and the trading day $h = +5$ to have a four-trading-day symmetrical window around the rebalancing. 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.

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 show that this is not the case, we use the specification with leads and lags described in Equation (6). The estimated β_h coefficients are reported in Figure 3.

Figure 3
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 5. The estimation includes bond characteristics-month fixed effects (maturity, rating, and bond type). The shaded area indicates the rebalancing on the month's last business day, with $h = +1$ for returns on that day and $h = -1$ for returns on the preceding business day. The vertical red lines show a 95% confidence interval for each horizon. Standard errors are clustered at the country-month level.

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. For example, this is consistent with the patterns of portfolio rebalancings by different institutional investors highlighted in Escobar et al. (2021), who show that institutional investors could move in the day before the actual index rebalancing event. In the last two columns of Table 5, we show the estimates based on our preferred specification of Equation (5) 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.

One related concern is the potential for increased 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 traded on this information before the actual index rebalancing date,

Table 6
Log price and FIR: Role of default risk

Dependent Variable: Log Price				
	High Spread		Low Spread	
FIR X Post	0.406***	0.406***	0.116	0.115
	(0.147)	(0.146)	(0.097)	(0.097)
Bond FE	Yes	No	Yes	No
Month FE	Yes	No	Yes	No
Bond-Month FE	No	Yes	No	Yes
Observations	42,169	42,166	42,267	42,267
N. of Bonds	500	500	494	494
N. of Countries	62	62	51	51
N. of Clusters	1,217	1,217	869	869
F (FS)	544	1,889	421	820

Note: This table presents 2SLS estimates of bond log prices on the FIR measure, instrumented by Z, across rebalancing dates. The sample is divided into high-spread bonds in Columns 1 and 2, above the median stripped spread, and low-spread bonds in Columns 3 and 4, below the median. The sample period and the 2SLS procedure are identical to those described in Table 5. The estimation excludes the trading day before rebalancing and the trading day $h = +5$ to have a four-trading-day symmetrical window around the rebalancing. 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.

our data do not support 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). Lastly, 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.[20]

The documented effects are heterogeneous across bonds with varying levels of default risk. To show this heterogeneity, we divide our sample into high- and low-spread bonds, those

[20] Appendix Table D1 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.

above and below the median spread in our sample, respectively. We estimate Equation (5) for each of these subsamples and report the results in Table 6. The table shows that the price of high-spread bonds is more sensitive to rebalancing shocks, with a 1 p.p. increase in the FIR associated with a 0.41 p.p. increase in bond returns. In contrast, for low-spread bonds, the effect is smaller (around 0.11 p.p.) and not statistically significant.[21] Overall, these findings suggest that investors demand a premium as compensation for holding risky bonds, that is, an inconvenience yield.

We can directly map the estimated bond price reactions to a reduced-form demand elasticity. Based on our FIR measure, we can rewrite Equation (1) as $\hat{\eta} = (-)\frac{\Delta \log(q_t^i)}{FIR_{c,t}}$, which is precisely what the β coefficient in Equation (5) captures. Based on the estimates in Table 5 (last columns), the inverse demand elasticity is around -0.3, implying a demand elasticity of -3. Our inverse demand elasticity estimate is higher (in magnitude) than those for sovereign bonds issued in advanced economies, but smaller relative to other asset classes, such as equities. In Appendix Figure D6, we compare our estimates with other studies.

[21] Appendix Table D4 divides bonds into three groups according to their spreads. We find that bond prices are positively associated with the FIR for both high (above 302 basis points) and medium (between 158 and 302 basis points) spread bonds. Instead, for low spread bonds (below 158 basis points), the relationship is statistically insignificant. Additionally, the estimated coefficient increases with the risk profile of the bonds.

4 A Sovereign Debt Model with Inelastic Investors

We next formulate a quantitative sovereign debt model to study the impact of a downward-sloping demand on a government's supply of risky bonds. The model features a risk-averse government that lacks commitment and issues long-term debt in international debt markets. We introduce a rich demand structure, allowing us to capture a downward-sloping demand for government bonds that we discipline based on our empirical estimates.

4.1 Model Setup

We consider a small open economy with incomplete markets and limited commitment. Output y is exogenous and follows a continuous Markov process with a transition function $f_y(y_{t+1} \mid y_t)$. Preferences of the representative consumer are given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t), \tag{7}$$

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

An infinite-lived, risk-averse government issues long-term bonds in international markets. Let B_{t-1} denote the beginning-of-period stock of government debt. The government has limited commitment and can default on its debt. Each unit of B 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 (7), subject to the economy's resource constraint.

International markets are competitive, and investors discount payoffs at the risk-free rate. These markets are populated by a large number of heterogeneous investors (J) who differ in how they allocate their funds across bonds. As in Gabaix and Koijen (2021), we introduce a downward-sloping demand by assuming that each investor j has a mandate or rule that specifies how they should allocate their funds across the N bonds (each issued by a different country). A fraction of these investors are passive and track the composition of a benchmark bond index $\mathcal{I}$, of which the government's bonds (B) are part of it.

4.2 Inelastic Investors

Let $j = \{1, ..., J\}$ denote the investor. Let $i = \{1, ..., N\}$ denote the set of bonds in which investors can invest and let $\boldsymbol{w}_t = \left\{w_t^1, ..., w_t^N\right\}$ denote the vector of time-varying index weights for each constituent bond of index $\mathcal{I}$. We define $x_{jt}^i = \frac{q_t^i B_{jt}^i}{W_{jt}}$ as the share of wealth that investor j invests in bond i at time t. The term q_t^i denotes the unit price of bond i, $B_{j,t}^i$ denotes the holdings of investor j in bond i, and $W_{j,t}$ denotes their wealth. The share x_{jt}^i is given by the following exogenous mandate:

$$x_{jt}^i = \theta_j \left(\xi_j^i e^{\Lambda_j \hat{\pi}_{i,t}\left(r_{t+1}^i\right)}\right) + (1 - \theta_j)\, w_t^i, \tag{8}$$

where θ_j parameterizes the degree of activeness or passiveness of investor j. Purely passive investors can be characterized by $\theta_j = 0$, indicating that their portfolio simply replicates the benchmark index $\mathcal{I}$. Conversely, active and semi-active investors are those with $\theta_j \in (0, 1]$, which captures the fraction of their portfolio that is not linked to index $\mathcal{I}$. Within their active allocation, investors apportion a fixed fraction, ξ_j^i, of their wealth to bond i and a varying component determined by $\Lambda_j \hat{\pi}_{i,t}\left(r_{t+1}^i\right)$, where $\Lambda_j > 0$ parameterizes their demand elasticity and $\hat{\pi}_{i,t}$ is an arbitrary function of the next-period excess return of bond i, r_{t+1}^i. For instance, if $\hat{\pi}_{i,t}\left(r_{t+1}^i\right) = \mathbb{E}_t\left(r_{t+1}^i\right)$, investors allocate a higher share of their wealth to bonds with higher expected excess returns.

The reduced-form mandate in Equation (8) allows us to introduce an aggregate demand elasticity for bond i that can be parameterized by $\boldsymbol{\Lambda} \equiv \{\Lambda_1, .., \Lambda_J\}$. While this mandate can have different microfoundations (as shown in Appendix B), we take it as given for our analysis. Our goal is not to explain the reasons behind the inelastic demand for risky bonds but rather to examine its implications. After adding up all the individual demands, we can write the market-clearing condition as follows:

$$q_t^i B_t^i = \tilde{\mathcal{A}}_t^i + \tilde{\mathcal{T}}_t^i(w_t^i), \tag{9}$$

where B_t^i is the end-of-period bond supply, and $\tilde{\mathcal{A}}_t^i \equiv \sum_j W_{j,t}\theta_j \left(\xi_j^i e^{\Lambda_j \hat{\pi}_{i,t}}\right)$ and $\tilde{\mathcal{T}}_t^i(w_t^i) \equiv \sum_j W_{j,t}\left(1 - \theta_j\right) w_t^i$ denote the market-value active and passive demands, respectively. The passive demand, $\tilde{\mathcal{T}}_t^i(w_t^i)$, is the portion of investors' holdings aimed at replicating the index composition they follow. It captures the holdings of both semi- and fully- passive investors. We write $\tilde{\mathcal{T}}_t^i(w_t^i)$ as a function of w_t^i to emphasize its dependence on the index weights.

We now put more structure behind the investor demand, allowing us to derive a closed-form solution for the price. We assume that $\hat{\pi}_{i,t}(r_{t+1}^i) = \frac{\mathbb{E}_t\left(r_{t+1}^i\right)}{\mathbb{V}_t\left(r_{t+1}^i\right)}$ so that the active demand is a function of the bond's expected excess return and its variance (the Sharpe ratio).[22] 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 risk-free rate. Based on these definitions and the market-clearing condition in Equation (9), the equilibrium bond price is given by

$$q^i_t = \frac{\mathbb{E}_t\left(\mathcal{R}^i_{t+1}\right)}{r^f}\,\Psi^i_t. \tag{10}$$

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, the Ψ^i_t function captures the demand's downward-sloping nature and is given by

$$\Psi^i_t \equiv 1 - \kappa^i_t\left(\mathbf{\Lambda}\right)\frac{\mathbb{V}_t\left(\mathcal{R}^i_{t+1}\right)}{\mathbb{E}_t\left(\mathcal{R}^i_{t+1}\right)}\left(B^i_t - \mathcal{T}^i_t - \bar{\mathcal{A}}^i_t\right). \tag{11}$$

The term $\kappa^i_t\left(\mathbf{\Lambda}\right) \equiv \frac{1}{\sum_j \Lambda_j W_{j,t}\theta_j \xi^i_j}$ characterizes the elasticity of the active demand for bond i. The $B^i_t - \mathcal{T}^i_t$ component is what we have referred to as the residual supply, and $\bar{\mathcal{A}}^i_t$ captures the inelastic portion of the active demand, which depends on the fixed component of investors' mandates, ξ^i_j (see Appendix B for the details and derivations). Notice that when $\kappa^i_t\left(\mathbf{\Lambda}\right) = 0$, the active demand is perfectly elastic and the price for bond i only depends on its expected repayment. When $\kappa^i_t\left(\mathbf{\Lambda}\right) > 0$, the demand is inelastic and differs across bonds with different repayment variances (i.e., default risk), which is consistent with our empirical findings. We view the Ψ^i_t term as capturing an inconvenience yield, that is, a premium demanded by investors as compensation for holding the bond.

4.3 Government Problem: 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 C.2 for the equilibrium definition).

We introduce the pricing equations derived in the previous subsection into the problem of the sovereign government, who issues a risky bond that is part of the index $\mathcal{I}$. For simplicity, we will omit the i subindex in what follows. In order to have a recursive formulation of the problem, we assume that the passive demand is given by $\mathcal{T}' = \mathcal{T}\left(\tau, B'\right)$ where B' denotes the end-of-period stock of government bonds and τ is a (time-varying) index weight. We assume that τ is exogenous and follows a continuous Markov process with a transition function $f_\tau\left(\tau' \mid \tau\right)$. Given an end-of-period bond supply B', the market-clearing condition can we

[22] This is a similar specification to the one in Gabaix and Koijen (2021), which is a function of expected excess returns and a shock to tastes or perceptions of risk.

written as $B' = \mathcal{A}'(.) + \mathcal{T}(\tau, B')$, where $\mathcal{A}'(.)$ denotes the (end-of-period) active demand.

Under these 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

$$c(h=0, B, y, \tau; B') = y + q\left(y, \tau, B'\right)\left(B' - (1-\lambda)B\right) - \left(\lambda + (1-\lambda)\nu\right)B, \qquad (12)$$
$$c(h=1) = y - \phi_j(y),$$

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

$$V(y, \tau, B) = \text{Max}_{d=\{0,1\}} \left\{V^r(y, \tau, B), V^d(y)\right\}, \qquad (13)$$

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

$$V^r(y, \tau, B) = \text{Max}_{B'} \; u(c) + \beta\, \mathbb{E}_{s'|s} V\left(y', \tau', B'\right), \qquad (14)$$
$$\text{subject to} \quad c = y + q(y, \tau, B')\left(B' - (1-\lambda)B\right) - \left(\lambda + (1-\lambda)\nu\right)B.$$

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. We further assume that the demand from passive investors is zero while the government is in default. Under these assumptions, the value function in case of default is given by

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

Based on the analysis in Section 4.2, given an exogenous state $\{y, \tau\}$ we can write the bond price function that the government faces as a function of B' as follows:

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

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

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

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 policy, $B'' \equiv B'(y', \tau', B')$.

From Equations (16) and (17), 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 $\Psi(y, \tau, B')$ term introduces another mechanism for the bond price to be decreasing in B': the downward-sloping demand of active investors.

When choosing its optimal debt policy, the government internalizes the effects of changes in B' on the bond price $q(y, \tau, B')$ through both changes in the expected repayment and the downward-sloping component of the demand. Let $\varepsilon \equiv \frac{\partial \log q(.)}{\partial \log B'}$ denote the (inverse) supply elasticity, which can be expressed as

$$\epsilon = \frac{\partial \log \mathbb{E}_{s'|s} \mathcal{R}'(.)}{\partial \log B'} + \frac{\partial \log \Psi(.)}{\partial \log B'}. \tag{18}$$

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 typically negative because a larger B' increases default risk and reduces the expected bond payoff. The second term captures the additional decline in the bond price due to the downward-sloping demand. As we show in our quantitative analysis, this mechanism limits the government's debt and acts as a commitment device.

4.4 Secondary Markets and Link with Empirical Analysis

We have introduced a passive demand in the model in order to compute the same reduced-form elasticity of our empirical analysis in Section 3. Notice, however, that the empirical elasticity relies on high-frequency (daily) data. Specifically, we estimated such elasticity in a short window around the rebalancing of the $\mathcal{I}$ index. To address this frequency disconnect, we introduce secondary markets in order to capture the high-frequency nature of our empirical elasticity. 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. 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.*

Under this simple extension, we can compute "high-frequency" bond price reactions to exogenous changes in index weights, just as we did in our empirical setup (i.e., price changes during a rebalancing event). Notice that, the only difference between $q^{SM,1}$ and $q^{SM,0}$ is due to the update of τ since both the endowment and the stock of debt are fixed while the secondary market is 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.

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 elasticity $\hat{\eta}$ of our empirical analysis:

$$\hat{\eta} = (-)\frac{\Delta q}{\Delta\mathcal{T}'}\frac{B' - \mathcal{T}(\tau, B')}{q^{SM,0}(y, \tau, B')}, \tag{19}$$

where $\Delta q \equiv q^{SM,1}(y, \tau', B') - q^{SM,0}(y, \tau, B')$. We can then use the model to decompose $\hat{\eta}$ into a structural demand elasticity η and changes in expected repayment α. That is,

$$\hat{\eta} = \underbrace{(-)\frac{\Delta\Psi}{\Delta\mathcal{T}}\frac{B' - \mathcal{T}(\tau, B')}{\Psi^{SM,0}(y, \tau, B')}}_{\equiv\eta} + \underbrace{(-)\frac{\Delta\mathbb{E}\mathcal{R}'}{\Delta\mathcal{T}'}\frac{B' - \mathcal{T}(\tau, B')}{\mathbb{E}_{y',\tau'|y,\tau}\mathcal{R}(y', \tau', B')}}_{\equiv\alpha}, \tag{20}$$

where $\Delta\Psi \equiv \Psi^{SM,1}(y, \tau', B') - \Psi^{SM,0}(y, \tau, B')$ is the difference in the bond price driven by the inelastic demand component before and after the new index weight τ' is realized. Similarly, $\Delta\mathbb{E}\mathcal{R}' \equiv \mathbb{E}_{y'|y}\mathcal{R}(y', \tau', B') - \mathbb{E}_{y',\tau'|y,\tau}\mathcal{R}(y', \tau', B')$ captures the change in the bond's expected repayment once the new τ' is realized.

There are two mechanisms underlying $\mathbb{E}\mathcal{R}'$ that are worth emphasizing. First, if the τ process is persistent, an increase in τ today will have an effect on future $\Psi(.)$ terms and, thus, on future prices and expected payoffs (as shown in Equations 16 and 17). Second, through its effects on current and future bond prices, changes in τ affect the government's value function $V^r(.)$ (Equation 14) and thus influence its debt and default policies, $B'(.)$ and $d(.)$, respectively. Changes in these policies, in turn, impact expected payoff and the bond price (Equations 16 and 17). These two mechanisms are interconnected, since chances in $B'(.)$, for instance, may significantly impact future $\Psi(.)$ terms. In summary, part of the price reaction captured in $\hat{\eta}$ is reflecting these endogenous forces rather than a downward-sloping demand component.

5 Quantitative Analysis

5.1 Calibration

We calibrate the model at a quarterly frequency using data on Argentina, a benchmark case commonly studied in the sovereign debt literature. 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.

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. 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. Specifically, $\mathcal{T}' = \mathcal{T}(\tau, B') = \tau \times B'$. We let τ follow an AR(1) process given by $\log(\tau') = (1-\rho_\tau)\log(\tau^\star) + \rho_\tau \log(\tau) + \epsilon'_\tau$, where $\epsilon'_\tau \sim N(0, \sigma_\tau)$.

Based on the analysis in Section 4.2, we consider the following functional form for the downward-slopping $\Psi(.)$ term:

$$\Psi\left(y, \tau, B'\right) = \exp\left\{-\kappa \frac{\mathbb{V}_{s'|s}\left(\mathcal{R}'(.)\right)}{\mathbb{E}_{s'|s}\left(\mathcal{R}'(.)\right)} \times \left(B' - \mathcal{T}' - \bar{\mathcal{A}}\right)\right\}, \tag{21}$$

where $\kappa \geq 0$ characterizes the elasticity of the demand function and $\bar{\mathcal{A}}$ denotes the average holdings of active investors (as determined by the fixed component of their mandates, ξ^i_j). For tractability, we assume time-invariant values for both κ and $\bar{\mathcal{A}}$.[23] This specification introduces a wedge in the price of risky bonds (i.e., those with $\mathbb{V}_{s'|s}\left(\mathcal{R}'(.)\right) > 0$). As we show next, it allows us to capture the two key features of our empirical analysis: a downward-sloping demand for active investors and a demand elasticity that increases (in magnitude) with default risk.

Table 7 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

[23] As shown in Section 4.2, these terms could be, in principle, time-varying functions. We also use an exponential specification purely for computational reasons: to avoid having a negative price.

Table 7
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	0.949
r	Risk-free interest rate	0.01	$\bar{d}_0$	Default cost—level	−0.24
λ	Debt maturity	0.05	$\bar{d}_1$	Default cost—curvature	0.29
z	Debt services	0.03	κ	Slope parameter	60.0
θ	Reentry probability	0.0385	$\bar{\mathcal{A}}$	Active investors demand	0.526
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			

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 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 of Argentina. All these parameters are taken from Morelli and Moretti (2023). Last, we set $\tau^{\star}$ to match the average share of Argentina's external debt tracked by passive investors, and calibrate $\rho_{\mathcal{T}}$ and $\sigma_{\mathcal{T}}$ to match the persistence and volatility of our FIR measure.

We internally calibrate the remaining parameters (Table 7, Panel b). We jointly calibrate the default cost level and curvature, $\{d_0, d_1\}$, 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.[24] Additionally, we calibrate κ to match the estimated (inverse) reduced-form demand elasticity, $\hat{\eta}$. Last, we set $\bar{\mathcal{A}}$ to match the average holdings of active investors. That is, $\bar{\mathcal{A}} = \bar{B} - \bar{\mathcal{T}}$, where $\bar{B}$ denotes the average debt stock and $\bar{\mathcal{T}}$ denotes passive investors' average holdings. Given Equation (21), this is equivalent to targeting an average $\Psi(.)$ of one, which implies that the (in)convenience yield is zero on average. The introduction of $\Psi(.)$ thus only affects the sensitivity of the pricing kernel to changes in B' around the $\{\bar{B}, \bar{\mathcal{T}}, \bar{\mathcal{A}}\}$ point.

Figure 4 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. Panel (b) shows that, as a consequence, the bond price is decreasing in B' and increasing in y. The dashed lines in Panel (b) show the bond prices under a counterfactual in which we

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

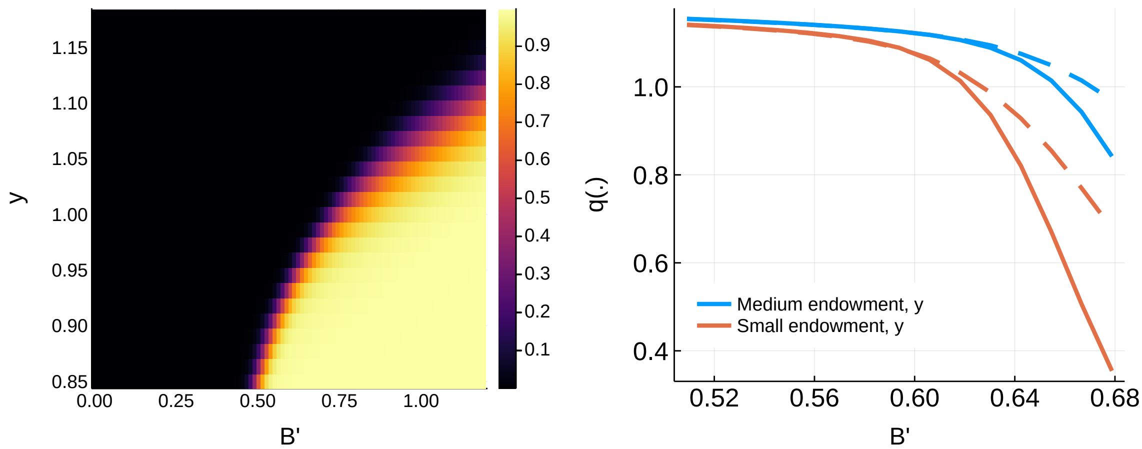
Table 8
Targeted moments

Target	Description	Data	Model
$\mathbb{E}[SP]$	Bond spreads	472bp	462bp
$\sigma(SP)$	Volatility of spreads	200bp	145bp
$\mathbb{E}[D/Y]$	Debt to output	55%	62%
$\mathbb{E}[\Psi]$	Inconvenience yield	1.0	1.005
$\hat{\eta}$	Reduced-form elasticity	-0.30	-0.31

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

Figure 4
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 solid lines show the bond pricing kernel $q(y, \tau, B')$ for different values of B' and for two values of output. The dashed lines show the bond price under a perfectly elastic demand, taking as given the same bond and repayment policies as in our baseline model (i.e., $q(.)/\Psi(.)$).

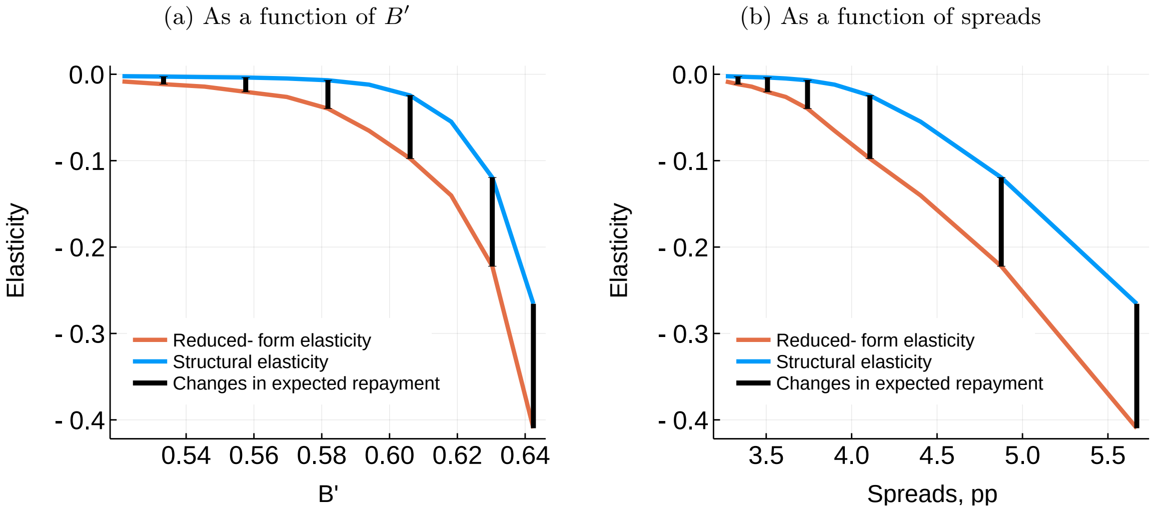
take the baseline $B'(.)$ policy but assume that the demand is perfectly elastic (i.e., it shows the $q(.)/\Psi(.)$ function). At lower B' levels, where default risk is minimal, bond prices remain largely unaffected by the downward-sloping demand. However, as B' increases, increased return volatility decreases Ψ, subsequently lowering the bond price q.

5.2 Decomposing the Reduced-form Demand Elasticity

We formally disentangle the different channels through which changes in $\mathcal{T}$ affect bond prices. As shown in Equation (20), index rebalancing affects bond prices through two mechanisms: (i) the (inverse) structural demand elasticity of active investors, η, and (ii) changes in expected repayment, α. Using the calibrated model, we can isolate the effects driven by changes in expected repayment to properly identify the structural demand elasticity.

Figure 5 decomposes the channels outlined in Equation (20). The black line shows the

Figure 5
Disentangling the demand elasticity



Note: The figure shows the reduced-form inverse demand elasticity $\hat{\eta}$ (black lines) and the structural one η (blue lines). The vertical differences between the two lines (represented by the red lines) capture the endogenous changes in bonds' expected repayment, α. Panel (a) shows the results as a function of B', while Panel (b) shows the results as a function of annualized bond spreads.

Table 9
Persistence of shocks and demand elasticity

Moment	Baseline	Lower persistence	Low persistence	Higher persistence
Reduced-form $\hat{\eta}$	-0.31	-0.26	-0.29	-0.35
Structural η	-0.19	-0.2	-0.19	-0.18
Bias, $1-\eta/\hat{\eta}$	41%	25%	34%	48%

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 $\rho_\tau = 0.50$. The "Higher persistence" column shows the results for $\rho_\tau = 0.80$.

reduced-form (inverse) demand elasticity $\hat{\eta}$, while the blue line depicts the model-implied structural elasticity, η. The vertical differences between these two curves (red lines) indicate the portion of the reduced-form elasticity attributable to endogenous changes in the repayment function, α. We find that the magnitude of $\hat{\eta}$ is always higher than that of η. The difference can be substantial, particularly for larger values of B' and for higher bond spreads. The first column of Table 5 shows the unconditional average for both the reduced-form elasticity, $\hat{\eta}$, and the structural elasticity, η. On average, the structural elasticity accounts for less than two-thirds of the reduced-form elasticity.

The magnitudes of the documented biases critically depend on the persistence of the τ process. The last two columns of Table 9 compare the reduced-form and structural elasticities for different persistence values for the $\{\tau\}$ process (i.e., ρ_τ). When the process is more (less) persistent, a smaller (larger) share of the total price response is accounted by the inelastic component of the investors' demand. In Appendix C.3, we analyze these biases in more

Table 10
Comparison with perfectly elastic case: Unconditional moments

Moment	Description	Baseline	Perfectly elastic
$\mathbb{E}(SP)$	Bond spreads	462bp	817bp
$\sigma(SP)$	Volatility of spreads	145bp	456bp
$\mathbb{E}(B/y)$	Debt to output	62%	59%
$\mathbb{E}(d)$	Default frequency	3.73%	4.39%
$\sigma(B)/\sigma(y)$	Standard deviation of debt, relative to output	1.41	1.99
$\rho(SP, y)$	Correlation between spreads and output	-0.78	-0.57

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

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 repayment. Neglecting these factors can introduce significant biases into the estimated demand elasticity, particularly if the shock is persistent. As argued in Section 3, our FIR measure is inherently more temporary than other supply-shifting instruments used in the literature, such as index additions or deletions. However, even in that case, the bias can represent over one-third of the reduced-form elasticity.

5.3 Implications of a Downward-sloping Demand

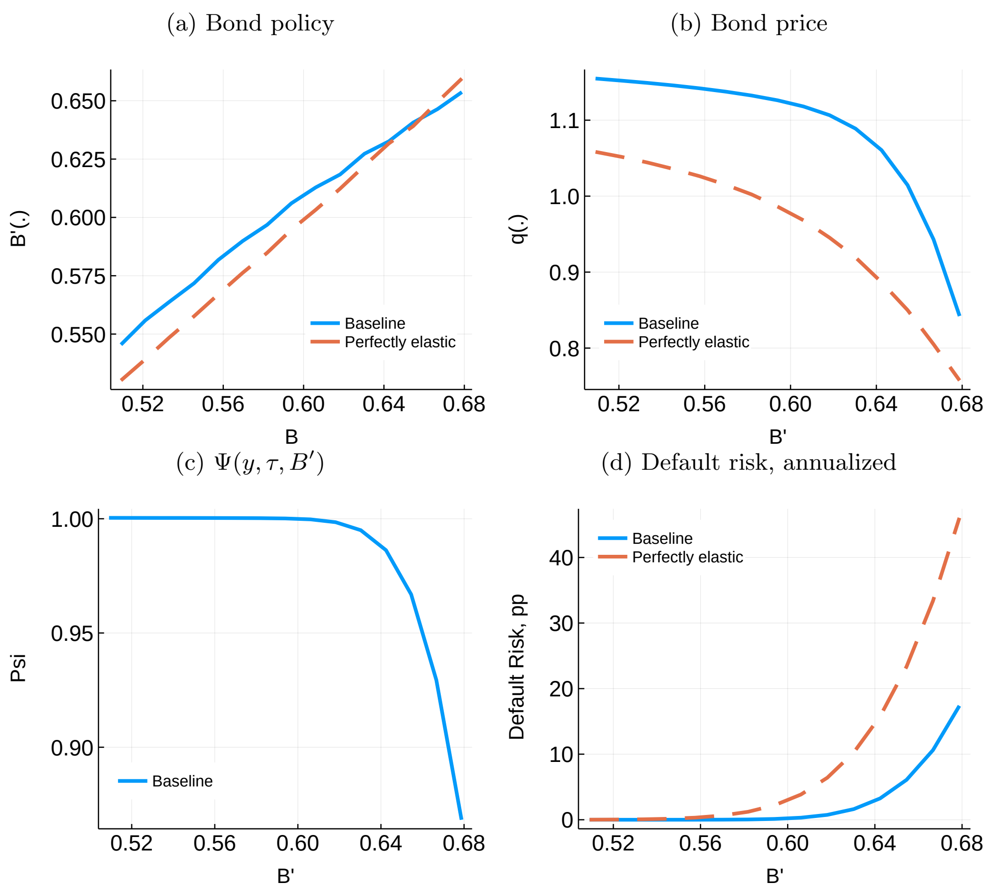
As shown in Equation (18), in determining its optimal debt policy, the government internalizes not only the effects of a higher B' on $q(.)$ through changes in its default probability but also its effects through the inelastic demand. This section quantifies the implications of a downward-sloping demand on bond prices, default risk, and government policies. To this end, we compare our downward-sloping demand model with an alternative scenario where investors are perfectly elastic.

Table 10 reports a set of targeted and untargeted moments for our baseline model and for an alternative case with a perfectly elastic demand ($\kappa = 0$). All the other model parameters remain the same. Despite similar values of debt, we find that the default frequency and average spreads are *lower* relative to the perfectly elastic case when facing an inelastic demand.

Two factors explain the lower default rate and bond spreads. First, the government debt policy is significantly affected by a downward-sloping demand. Panel (a) of Figure 6 shows the optimal debt policy $B'(y, \tau, B)$ in our baseline model and in the perfectly elastic case. For large values of B (in states where $\mathbb{V}(\mathcal{R}'(.))$ is high), an additional unit of B' reduces the bond price $q(.)$ due to both higher default risk and investors' inelastic behavior. As a result, the government does not find it optimal to issue large amounts of debt because it is too costly to do so. An inelastic demand thus introduces a limit to the maximum amount of debt that a government is willing to issue.

Second, these changes in the optimal bond policy have important effects on the pricing of bonds (Figure 6, Panel (b)). For small values of B' (low default risk), $q(.)$ is actually *higher* than under the perfectly elastic case. As shown in Panel (c), this larger bond price is not driven by a convenience yield because, given our calibration, $\Psi(.)$ is typically smaller than one. Instead, the higher bond price is explained by a lower default risk (Panel (d)), which is a direct consequence of the government's lower incentives to issue large values of B'.

Figure 6
Comparison with perfectly elastic case: Policy functions and prices



Note: The top panel presents bond policies and prices as a function of B. We evaluate all the functions at the mean value for output, y. Blue solid lines show the results for our baseline model with inelastic investors and the orange dashed lines shows the results in an alternative model in which investors are perfectly elastic. The bottom panel depicts the $\Psi(y, \tau, B')$ function and the annualized default risk.

Overall, an inelastic demand diminishes a government's incentives to issue additional units of debt, acting as a commitment device that reduces default risk and increases bond prices.

How does an inelastic 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 debt more in "bad" times (i.e., when output is low) to smooth its consumption, the resulting increase in spreads, due to higher default risk, leads the government to actually decrease 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 issuances. This standard mechanism in sovereign debt models explains the well-known excess volatility of consumption in emerging markets.

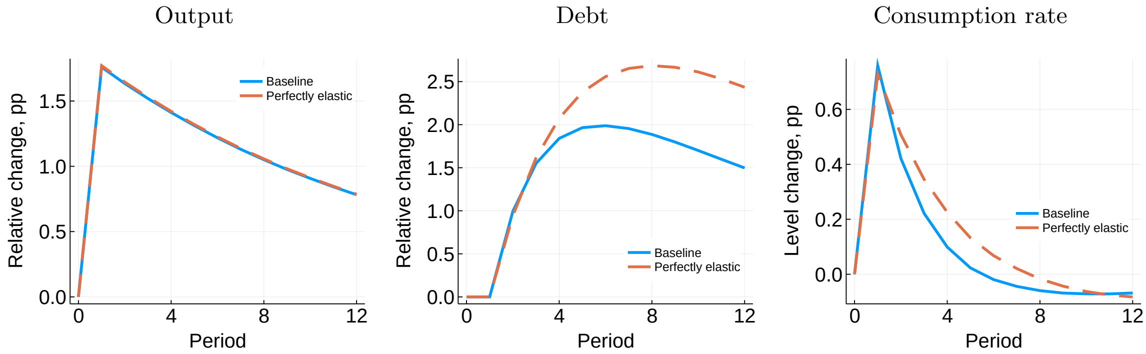
We find that this pro-cyclicality is dampened in the presence of inelastic investors. In Figure 7, we analyze the impulse responses to endowment shocks. For a positive shock (Panel a), the figure shows a higher increase in debt issuance when investors are perfectly elastic. Under a perfectly elastic demand, the government can take full advantage of the lower financing costs due to the implied decrease in default risk. Under inelastic demand, however, the government response is muted since it internalizes that, despite the cheaper financing, an additional unit of debt decreases bond prices due to the downward-sloping demand. In this sense, the inelasticity of the demand imposes a cost: it prevents the government from issuing more in periods in which debt is cheap. The right panel shows a smaller increase in the consumption rate (c/y) under inelastic demand. For a negative shock (Panel b), the story is analogous. A lower output increases borrowing costs, and the government finds it optimal to decrease its debt. Under an inelastic demand, however, reducing the stock of debt decreases the inconvenience yield demanded by investors, which lowers spreads; hence, the contraction in debt is muted.

Overall, the previous analysis implies that the government debt policy is less responsive to shocks. Figure 8 compares the unconditional distribution for the debt-to-output ratios between our baseline model and the perfectly elastic case. Under an inelastic demand, this distribution is significantly less dispersed (Panel a). In fact, the standard deviation of debt is about 30% smaller under inelastic investors (as shown in Table 10). In line with the impulse response dynamics, the debt-to-output ratio exhibits a smaller unconditional correlation with output when investors are inelastic (Panel b). This, in turn, leads to a larger correlation (in magnitude) between spreads and output (Table 10).

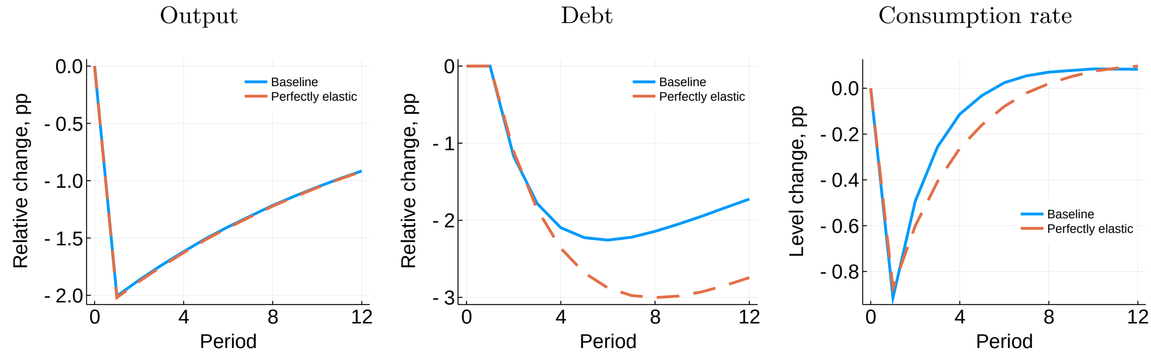
We conclude our analysis by examining the welfare implications of an inelastic demand. We define the certainty equivalent consumption (CEC) as the proportional increase in consumption under the perfectly elastic case, such that the household is indifferent between

Figure 7
Impulse responses to an output shock

(a) Positive output shock



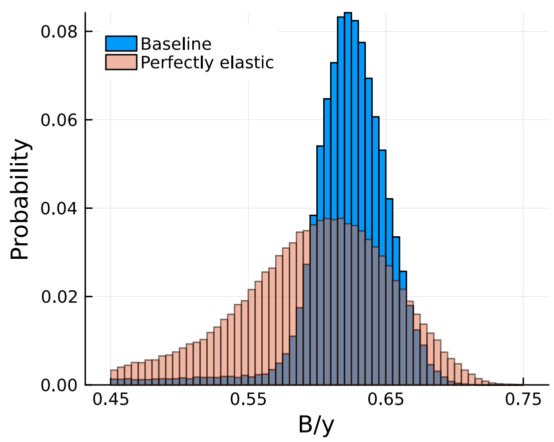
(b) Negative output shock



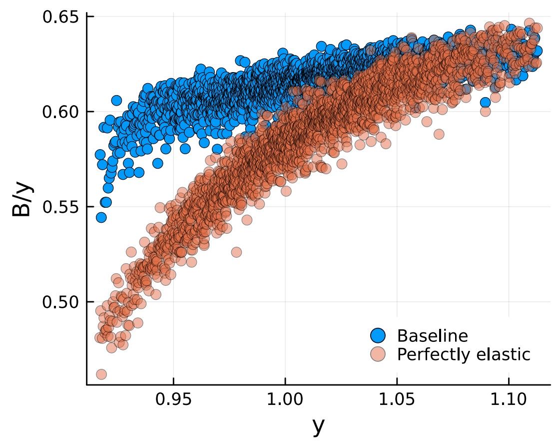
Note: Figure shows the impulse response dynamics to a positive (panel a) and negative (panel b) endowment shock. Blue lines show the dynamics for our baseline model with inelastic investors. The orange lines show the perfectly elastic case.

Figure 8
Stock of sovereign debt under inelastic investors

(a) Distribution of B/y

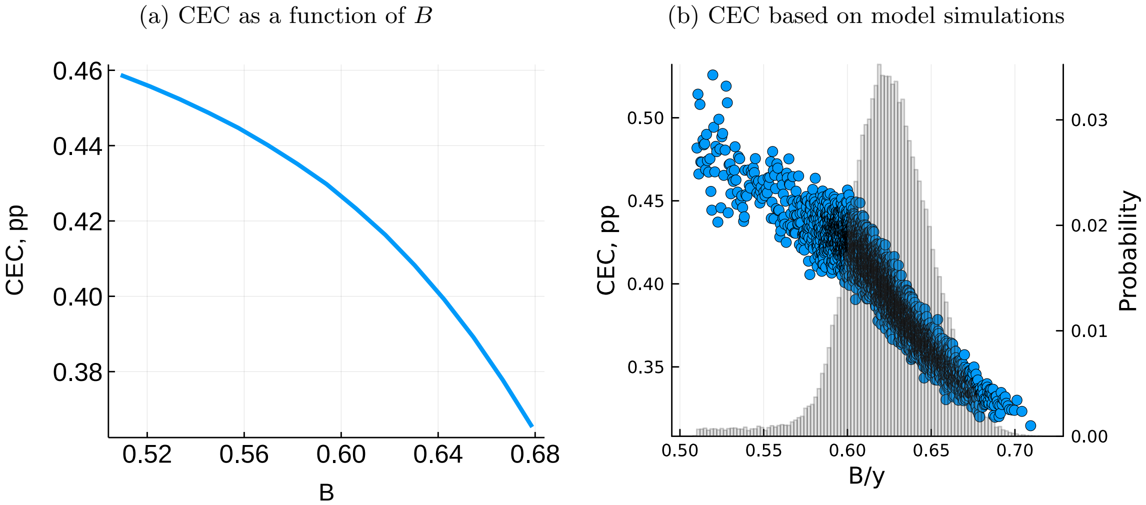


(b) Relation with output



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 inelastic investors. Orange bars and dots are for an alternative model in which investors are perfectly elastic.

Figure 9
Inelastic investors: Welfare analysis



Note: Figure shows the CEC defined as the proportional increase in consumption under the perfectly elastic counterfactual such that the household is indifferent between that case and the inelastic one. 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 distribtuion of B/y.

that scenario and the inelastic one.[25] Figure 9 shows the results. We find a positive CEC, which implies that the commitment device is strong enough so that the household prefers a world with inelastic investors. The CES decreases with a larger stock of debt, due to the large inconvenience yield demanded by investors (as shown in Figure 6).

6 Conclusion

In this paper, we present evidence of downward-sloping demand curves in risky sovereign debt markets and analyze their implications for the optimal supply of sovereign bonds. Our approach combines evidence from high-frequency bond-level price reactions to well-identified shocks with a structural model featuring endogenous debt issuances and default risk. This methodology allows us to isolate endogenous changes in expected bond payoffs behind the estimated price reactions and to back out a structural demand elasticity. Empirically, we find that a 1 p.p. exogenous reduction in the effective bond supply leads to a 30 basis point increase in bond prices. Our structural model reveals that over one-third of this response is due to endogenous changes in the expected repayment of bonds. We show that an inelastic demand can have important macroeconomic effects. In particular, we find that the inelastic demand influences and shapes the governmental policies on optimal debt and default. By

[25] 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 an inelastic demand and $\tilde{c}_t$ denotes the consumption under a perfectly elastic case. 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.

diminishing the government's incentives to issue additional units of debt, an inelastic demand acts as a commitment device that reduces default risk and borrowing costs. Moreover, we find that the pro-cyclicality of the debt policy is dampened in the presence of inelastic 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 risky assets. Our paper can lead to further research along several dimensions. For example, given the model predictions, it would be interesting to empirically study the impact of inelastic demand on government debt issuances. More importantly, our framework can be extended to other assets and markets, notably equity and corporate bonds. The endogenous responses that we emphasize in this paper can be applied to other issuers' of risky assets, which we leave for future research.

References

Adrian, T. and H. Shin (2014). Procyclical leverage and value-at-risk. *Review of Financial Studies 27*, 373–403.

Aguiar, M. and G. Gopinath (2006). Defaultable debt, interest rates, and the current account. *Journal of International Economics 69*(1), 64–83.

Ahmed, R. and A. Rebucci (2022). Dollar reserves and U.S. yields: Identifying the price impact of official flows. NBER Working Paper 30476.

Alfaro, L. and F. Kanczuk (2017). Fiscal rules and sovereign default. NBER Working Papers 23370, National Bureau of Economic Research, Inc.

Arellano, C. (2008). Default risk and income fluctuations in emerging economies. *American Economic Review 98*(3), 690–712.

Arellano, C., Y. Bai, and S. Lizarazo (2017). Sovereign risk contagion. NBER Working Paper 24031.

Arslanalp, S. and T. Poghosyan (2016). Foreign investor flows and sovereign bond yields in advanced economies. *Journal of Banking and Financial Economics 2*(6), 45–67.

Bianchi, J., P. Ottonello, and I. Presno (2023). Fiscal stimulus under sovereign risk. *Journal of Political Economy 131*(9), 2328–2369.

Borri, N. and A. Verdelhan (2010). Sovereign risk premia. AFA 2010 Atlanta Meetings Paper.

Bretscher, L., L. Schmid, I. Sen, and V. Sharma (2022). Institutional corporate bond pricing. Swiss Finance Institute Research Paper 21-07.

Calomiris, C., M. Larrain, S. Schmukler, and T. Williams (2022). Large international corporate bonds: Investor behavior and firm responses. *Journal of International Economics 137*(C).

Chang, Y., H. Hong, and I. Liskovich (2014). Regression discontinuity and the price effects of stock market indexing. *Review of Financial Studies 28*(1), 212–246.

Chatterjee, S. and B. Eyigungor (2012). Maturity, indebtedness, and default risk. *American Economic Review 102*(6), 2674–2699.

Chaumont, G. (2021). Sovereign debt, default risk, and the liquidity of government bonds. Working paper.

Choi, J., R. Kirpalani, and D. Perez (2022). The macroeconomic implications of U.S. market power in safe assets. NBER Working Paper 30720.

Costain, J., G. Nuño, and C. Thomas (2022). The term structure of interest rates in a heterogeneous monetary union. Banco de Espana Working Paper 2223.

Cremers, M. and A. Petajisto (2009). How active is your fund manager? A new measure that predicts performance. *Review of Financial Studies 22*(9), 3329–3365.

Dathan, M. and S. Davydenko (2020). Debt issuance in the era of passive investment. University of Toronto Working Paper.

Dell'Erba, S., R. Hausmann, and U. Panizza (2013). Debt levels, debt composition, and sovereign spreads in emerging and advanced economies. *Oxford Review of Economic Policy 29*(3), 518–547.

Dovis, A. and R. Kirpalani (2020, March). Fiscal rules, bailouts, and reputation in federal governments. *American Economic Review 110*(3), 860–88.

Droste, M., Y. Gorodnichenko, and W. Ray (2023). Unbundling quantitative easing: Taking a cue from Treasury auctions. NBER Working Paper 24122.

Escobar, M., L. Pandolfi, A. Pedraza, and T. Williams (2021). The anatomy of index rebalancings: Evidence from transaction data. CSEF Working Paper 621.

Fang, X., B. Hardy, and K. Lewis (2022). Who holds sovereign debt and why it matters. NBER Working Paper 30087.

Gabaix, X. and R. Koijen (2021). In search of the origins of financial fluctuations: The inelastic markets hypothesis. NBER Working Paper 28967.

Gabaix, X. and M. Maggiori (2015). International liquidity and exchange rate dynamics. *Quarterly Journal of Economics 130*(3), 1369–1420.

Gourinchas, P., W. Ray, and D. Vayanos (2022). A preferred-habitat model of term premia, exchange rates, and monetary policy spillovers. NBER Working Paper 29875.

Greenwood, R. (2005). Short- and long-term demand curves for stocks: Theory and evidence on the dynamics of arbitrage. *Journal of Financial Economics 75*(3), 607–649.

Greenwood, R., S. Hanson, and J. Stein (2015). A comparative-advantage approach to government debt maturity. *Journal of Finance 70*(4), 1683–1722.

Greenwood, R., S. Hanson, J. Stein, and A. Sunderam (2023). A quantity-driven theory of term premia and exchange rates. *Quarterly Journal of Economics 138*(4), 2327–2389.

Harris, L. and E. Gurel (1986). Price and volume effects associated with changes in the S&P 500 list: New evidence for the existence of price pressures. *Journal of Finance 41*(4), 815–29.

Hatchondo, J. C., L. Martinez, and F. Roch (2022, October). Fiscal rules and the sovereign default premium. *American Economic Journal: Macroeconomics 14*(4), 244–73.

Hau, H., M. Massa, and J. Peress (2010). Do demand curves for currencies slope down? Evidence from the MSCI Global Index change. *Review of Financial Studies 23*(4), 1681–1717.

He, Z. and K. Milbradt (2014). Endogenous liquidity and defaultable bonds. *Econometrica 82*(4), 1443–1508.

Jiang, Z., H. Lustig, S. Van Nieuwerburgh, and M. Xiaolan (2021a). Bond convenience yields in the eurozone currency union. Stanford University Graduate School of Business Research Paper 3976.

Jiang, Z., H. Lustig, S. Van Nieuwerburgh, and M. Xiaolan (2021b). The U.S. public debt valuation puzzle. CEPR Discussion Paper DP16082.

Kaldorf, M. and J. Rottger (2023). Convenient but risky government bonds. Deutsche bundesbank discussion paper 15/2023.

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

Koijen, R. and M. Yogo (2020). Exchange rates and asset prices in a global demand system. NBER Working Paper 27342.

Krishnamurthy, A. and A. Vissing-Jorgensen (2012). The aggregate demand for Treasury debt. *Journal of Political Economy 120*(2), 233–267.

Kubitza, C. (2023). Investor-driven corporate finance: Evidence from insurance markets. ECB Working Paper 2816.

Lizarazo, S. (2013). Default risk and risk averse international investors. *Journal of International Economics 89*(2), 317–330.

Mian, A., L. Straub, and A. Sufi (2022). A Goldilocks theory of fiscal deficits. NBER Working Paper 29707.

Miranda-Agrippino, S. and H. Rey (2020). U.S. monetary policy and the global financial cycle. *Review of Economic Studies 87*, 2754–2776.

Morelli, J. and M. Moretti (2023). Information frictions, reputation, and sovereign spreads. *Journal of Political Economy 131*(11), 3066–3102.

Moretti, M. (2020). Financial innovation and liquidity premia in sovereign markets: The case of gdp-linked bonds. Working paper.

Pandolfi, L. and T. Williams (2019). Capital flows and sovereign debt markets: Evidence from index rebalancings. *Journal of Financial Economics 132*(2), 384–403.

Passadore, J. and Y. Xu (2022). Illiquidity in sovereign debt markets. *Journal of International Economics 137*, 103618.

Pavlova, A. and T. Sikorskaya (2022). Benchmarking intensity. *Review of Financial Studies 36*(3), 859–903.

Peiris, S. (2013). Foreign participation in local currency bond markets of emerging economies. *Journal of International Commerce, Economics and Policy 04*(03), 1–15.

Pouzo, D. and I. Presno (2016). Sovereign default risk and uncertainty premia. *American Economic Journal: Macroeconomics 8*(3), 230–266.

Raddatz, C., S. Schmukler, and T. Williams (2017). International asset allocations and capital flows: The benchmark effect. *Journal of International Economics 108*(C), 413–430.

Shleifer, A. (1986). Do demand curves for stocks slope down? *Journal of Finance 41*(3), 579–90.

Vayanos, D. and J. Vila (2021). A preferred-habitat model of the term structure of interest rates. *Econometrica 89*(1), 77–112.

Warnock, F. and V. Warnock (2009). International capital flows and U.S. interest rates. *Journal of International Money and Finance 28*, 903–919.

Zhou, H. (2024). The fickle and the stable: Global financial cycle transmission via heterogeneous investors. Working paper.

A Diversification Methodology

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.

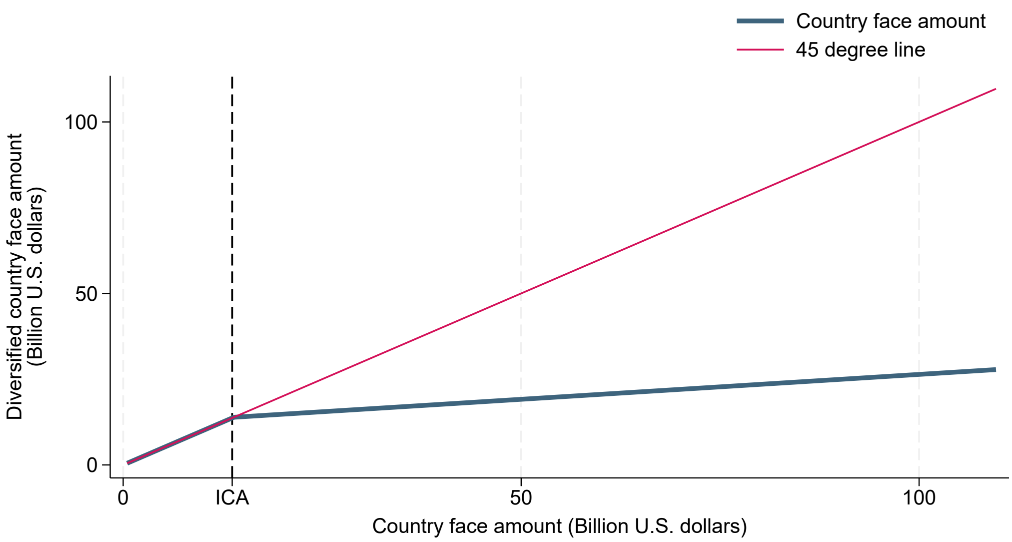
The diversified country face amount ($DFA_{c,t}$) is calculated as follows:

$$DFA_{c,t} \begin{cases} ICA_t \times 2 & \text{if } FA_{c,t} = FA_{max,t} \\ ICA_t + \frac{ICA_t}{FA_{max_t} - ICA_t} \left(FA_{c,t} - ICA_t \right) & \text{if } FA_{c,t} > ICA_t \\ FA_{c,t} & \text{if } FA_{c,t} \leq ICA_t \end{cases} \tag{A1}$$

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 A1 compares the country-level diversified and non-diversified face amount for December 2018.

Appendix Figure A1
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 used are from December 2018. Sources: J.P. Morgan Markets, and authors' calculations.

B Appendix: A Model of Inelastic Investors

In this appendix, we first provide additional material and derivations for the analysis in Section 4.2. We then describe microfoundations for the assumed demand structure, analyzing two related cases. In the first one, the inelasticity comes from investor risk aversion, while the second case is rooted in a Value-at-Risk (VaR) constraint to which investors are subject.

B.1 Additional Derivations

From Equation (8) in the main text, and based on a first-order approximation for the elastic component of the demand $e^{\kappa_j \hat{\pi}_{i,t}}$ around $\bar{\pi}_i$, we can write the market-value demand of active investors as follows:

$$\tilde{\mathcal{A}}_t^i = \sum_j \left(1 - \Lambda_j \bar{\pi}_i\right) W_{j,t} \theta_j \xi_j^i e^{\Lambda_j \bar{\pi}_i} + \hat{\pi}_{i,t} \sum_j \Lambda_j W_{j,t} \theta_j \xi_j^i e^{\Lambda_j \bar{\pi}_i}. \tag{B1}$$

The first term captures investors' average purchases of bond i, which are given by their exogenous mandates ξ_j^i. The second term captures deviations from those purchases (i.e., the elastic component of the demand), which is a function of $\hat{\pi}_{i,t}$.

For the remainder of the analysis, we focus on the case in which $\hat{\pi}_{i,t}\left(r_{t+1}^i\right) = \frac{\mathbb{E}_t\left(r_{t+1}^i\right)}{\mathbb{V}_t\left(r_{t+1}^i\right)}$. Define $\mathcal{R}_{t+1}^i$ as the next-period repayment per unit of the bond so that $r_{t+1}^i \equiv \frac{\mathcal{R}_{t+1}^i}{q_t^i} - r_f$, where r_f denotes the risk-free rate. We can then write $\hat{\pi}_{i,t}\left(r_{t+1}^i\right) = q_t^i \frac{\mathbb{E}_t \mathcal{R}_{t+1}^i - q_t^i r_f}{\mathbb{V}_t \mathcal{R}_{t+1}^i}$. Without loss of generality, consider a case where $\bar{\pi}_i$ is close to zero. After substituting these expressions into the equation, we can rewrite Equation (B1) as follows:

$$\tilde{\mathcal{A}}_t^i = q_t^i \bar{\mathcal{A}}_t^i + q_t^i \left(\frac{\mathbb{E}_t \mathcal{R}_{t+1}^i - q_t^i r_f}{\mathbb{V}_t \mathcal{R}_{t+1}^i}\right) \sum_j \Lambda_j W_{j,t} \theta_j \xi_j^i, \tag{B2}$$

where $\bar{\mathcal{A}}_t^i$ is defined such that $q_t^i \bar{\mathcal{A}}_{t+1}^i = \sum_j W_{j,t} \theta_j \xi_j^i$. We can interpret $\bar{\mathcal{A}}_t^i$ as active investors' holdings aimed at satisfying the fixed part of their mandates.

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

$$\tilde{\mathcal{T}}_t^i = q_t^i S_t^i \sum_j \frac{W_{j,t}\left(1 - \theta_j\right)}{M_t} = q_t^i \mathcal{T}_t^i, \tag{B3}$$

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

After replacing Equations (B2) and (B3) in the market-clearing condition (Equation (9) in the main text), we obtain a closed-form solution for the bond price:

$$q_t^i = \frac{\mathbb{E}_t\left(\mathcal{R}_{t+1}^i\right)}{r_f}\left[1 - \kappa_t^i \frac{\mathbb{V}_t\left(\mathcal{R}_{t+1}^i\right)}{\mathbb{E}_t\left(\mathcal{R}_{t+1}^i\right)}\left(B_t^i - \mathcal{T}_t^i - \bar{\mathcal{A}}_t^i\right)\right], \tag{B4}$$

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

Next, we show that we can obtain an analogous pricing kernel under risk-averse investors or under risk-neutral investors subject to a standard VaR constraint.

B.2 Microfoundation Based on Risk-Averse Investors

Consider 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

$$\boldsymbol{x}_{j,t} = \frac{1}{\sigma_j}\boldsymbol{\Sigma}_t^{-1}\boldsymbol{\mu}_t + (1-\theta_j)\,\boldsymbol{w}_t. \tag{B5}$$

The first term on the right-hand side of Equation (B5) 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

$$\begin{aligned}\begin{bmatrix} q^1_t B^1_t \\ \vdots \\ q^N_t B^N_t \end{bmatrix} &= \sum_j W_{j,t}\left[\frac{1}{\sigma_j}\boldsymbol{\Sigma}_t^{-1}\boldsymbol{\mu}_t + (1-\theta_j)\,\boldsymbol{w}_t\right] \\ &= \tilde{\boldsymbol{\mathcal{A}}}_t + \tilde{\boldsymbol{\mathcal{T}}}_t, \end{aligned} \tag{B6}$$

where $\tilde{\boldsymbol{\mathcal{A}}}_t \equiv \sum_j W_{j,t}\frac{1}{\sigma_j}\boldsymbol{\Sigma}_t^{-1}\boldsymbol{\mu}_t$ denotes the active component of investors' demand (at market value). Since investors are risk averse, $\tilde{\mathcal{A}}^i_t$ 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 (B6), 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

$$q^i_t = \frac{\mathbb{E}_t\left(\mathcal{R}^i_{t+1}\right)}{r^f} \times \Psi^i_t, \tag{B7}$$

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

$$\Psi^i_t \equiv 1 - \kappa^{\mathrm{RA}}_t \frac{\mathbb{V}_t\left(\mathcal{R}^i_{t+1}\right)}{\mathbb{E}_t\left(\mathcal{R}^i_{t+1}\right)}\left(B^i_t - \mathcal{T}^i_t\right), \tag{B8}$$

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 (B8) is analogous to the one in Equation (B4). The key difference is that with risk-averse lenders, the price elasticity is captured only by investors' risk aversion. In our main analysis, we do not specify the underlying mechanism driving this elasticity.

B.3 Microfoundation Based on a VaR 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).[26]

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

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

where the parameter Φ^2 captures the intensity of the risk constraint. We view Φ^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

$$\boldsymbol{x}_{j,t} = \frac{1}{\varrho_j \Phi^2} \boldsymbol{\Sigma}_t^{-1} \boldsymbol{\mu}_t + (1-\theta_j)\,\boldsymbol{w}_t. \tag{B9}$$

The previous optimal portfolio is identical to that of Equation (B5), 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 Φ^2. Following the same steps as before, we can then derive an analogous pricing kernel to that of Equations (B7) and (B8). That is,

$$q_t^i = \frac{\mathbb{E}_t\left(\mathcal{R}^i_{t+1}\right)}{r^f}\left[1 - \kappa_t^{\text{VaR}} \frac{\mathbb{V}_t\left(\mathcal{R}^i_{t+1}\right)}{\mathbb{E}_t\left(\mathcal{R}^i_{t+1}\right)}\left(B_t^i - \mathcal{T}_t^i\right)\right], \tag{B10}$$

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

[26] 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.

C Appendix: Quantitative Model

In this appendix, we provide additional details for the quantitative model of sections 4 and 5.

C.1 Secondary Markets

The empirical elasticity computed in Section 3 exploits exogenous variation in the passive demand in a small window around announcement about changes in the EMBIGD index weights. To tightly link our model with the empirical analysis, our baseline model in Section 4 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 so it is not suitable to quantify high-frequency price reactions to changes in τ.

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

1. *The endowment y is realized. 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) is at the beginning of the period, just after the government announces its default and debt choices. The bond price in this instance is given by

$$q^{SM,0}(y, \tau, B') = \beta^{\star}\mathbb{E}_{y',\tau'|y,\tau}\mathcal{R}\left(y', \tau', B'\right) \; \Psi^{SM,0}\left(y, \tau, B'\right). \tag{C1}$$

The term $\mathbb{E}_{y',\tau'|y,\tau}\mathcal{R}(y', \tau', B')$ is the expected next-period repayment of the bond, conditional on the information available when the secondary market opens. Following the derivation in Section 4.2 (see Equation (11)), the downward-sloping component of the price function is

$$\Psi^{SM,0}\left(y, \tau, B'\right) = 1 - \kappa_0 \frac{\mathbb{V}_{\{y',\tau'\}|\{y,\tau\}}\mathcal{R}\left(y', \tau', B'\right)}{\mathbb{E}_{\{y',\tau'\}|\{y,\tau\}}\mathcal{R}\left(y', \tau', B'\right)}\left(B' - \mathcal{T}\left(\tau, B'\right) - \bar{\mathcal{A}}\right) \tag{C2}$$

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

$$q^{SM,1}\left(B', y, \tau'\right) = \beta^{\star}\mathbb{E}_{y'|y}\mathcal{R}\left(y', \tau', B'\right)\Psi^{SM,1}\left(y, \tau', B'\right). \tag{C3}$$

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 (C1), but incorporates the information provided by the realization of τ'. Similarly, the downward-sloping component of the price function is given by

$$\Psi^{SM,1}\left(y, \tau', B'\right) \equiv 1 - \kappa_0 \frac{\mathbb{V}_{y'|y}\mathcal{R}\left(y', \tau', B'\right)}{\mathbb{E}_{y'|y}\mathcal{R}\left(y', \tau', B'\right)}\left(B' - \mathcal{T}\left(\tau', B'\right) - \bar{\mathcal{A}}\right). \tag{C4}$$

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

C.2 Definition of Equilibrium

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

1. Taking as given the bond price function $q(.)$, the government's policy functions $b'\left(\cdot\right)$ and $d\left(\cdot\right)$ solve the optimization problem in Equations (13), (14), and (15), and $V\left(\cdot\right)$, $V^r\left(\cdot\right)$, and $V^d\left(\cdot\right)$ are the associated value functions.

2. Given $b'\left(\cdot\right)$ and $d\left(\cdot\right)$, the next-period repayment function $\mathcal{R}'(.)$ satisfies Equation (17).

3. Taking the repayment function as given, bond prices $q(.)$ are consistent with Equation (16).

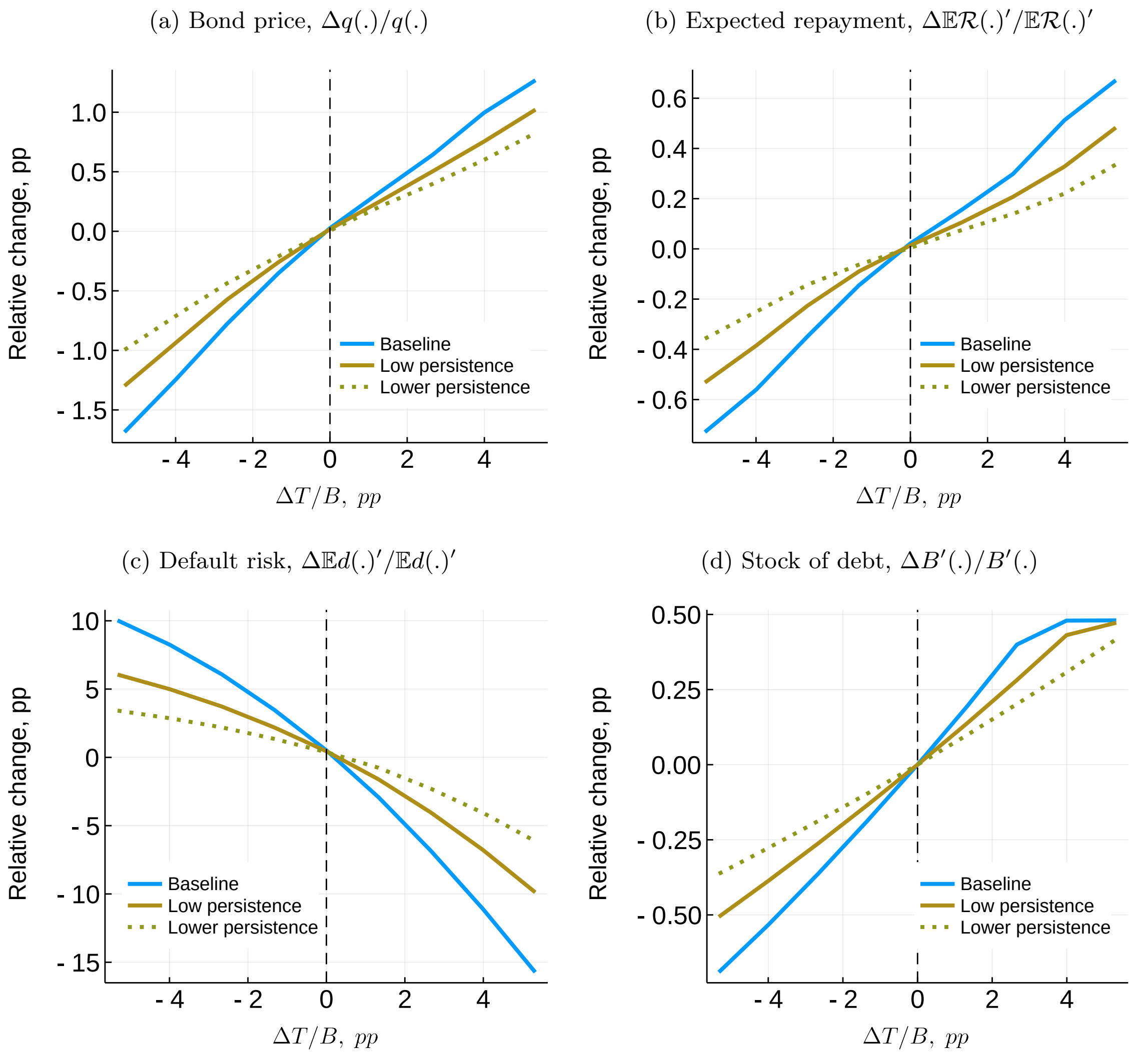
C.3 Understanding the Source of the Biases

What does explain the difference between the reduced-form and structural elasticity? To answer this question, we analyze the mechanisms behind changes in the expected repayment function due to a change in τ.

The first three panels of Figure C1 show the "high-frequency" effects (i.e., changes within the same period) of shifts in the passive demand on bond prices, expected repayment, default risk, and debt. 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.[27] The blue lines shows the results under our baseline parameterization. The solid and dotted brown lines show the results for cases in which the τ process is less persistent. Panels (a) and (b) show that there is a monotone relation between changes in the passive demand and bond

[27] In all cases, we evaluate these changes at the mean value for endowment y and end-of-period debt B'.

Appendix Figure C1
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 brown lines show results for parameterizations in which we decrease the persistence of the FIR. For these cases, we set $\rho_\tau = 0.50$ and $\rho_\tau = 0.25$.

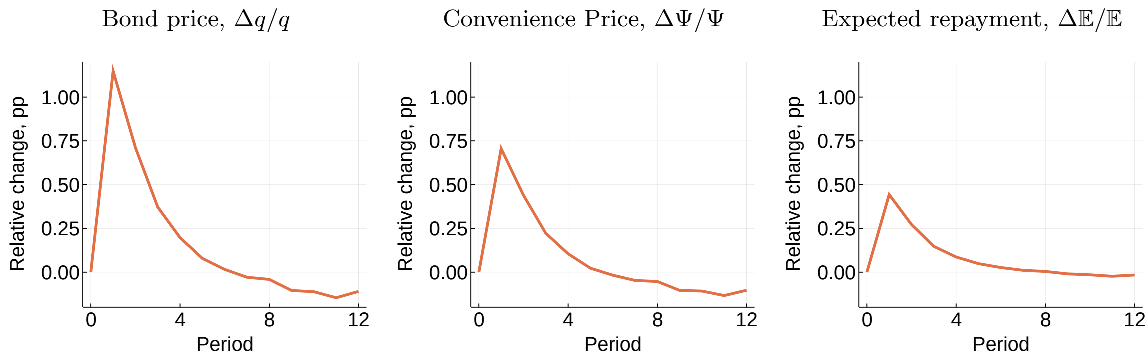
prices and expected repayment. For a 5% increase in the passive demand (as a share of the total stock of debt), bond prices increase by almost 1.5% and about 40% of that increase is explained by an increase in the bonds' expected repayment. Panel (c) shows the change in one-period ahead default risk. For a 5% increase in the passive demand, default risk decreases about 15%. As the persistence of the τ process decreases, the implied changes on bond prices, expected repayment, and default risk decrease. For the "lower persistence" case, for instance, default risk almost does not change, even for large shifts in the passive demand.

Panel (d) shows that the government reacts to the τ' shock (one period after the shock). In particular, the government finds it optimal to increase its stock of debt in response to an increase in the passive demand. The response, however, is rather small: for every 1% increase

Appendix Figure C2
Impulse response to an increase in the passive demand

(a) Effects on debt and bond prices

(b) Decomposition: Counterfactual with fixed debt



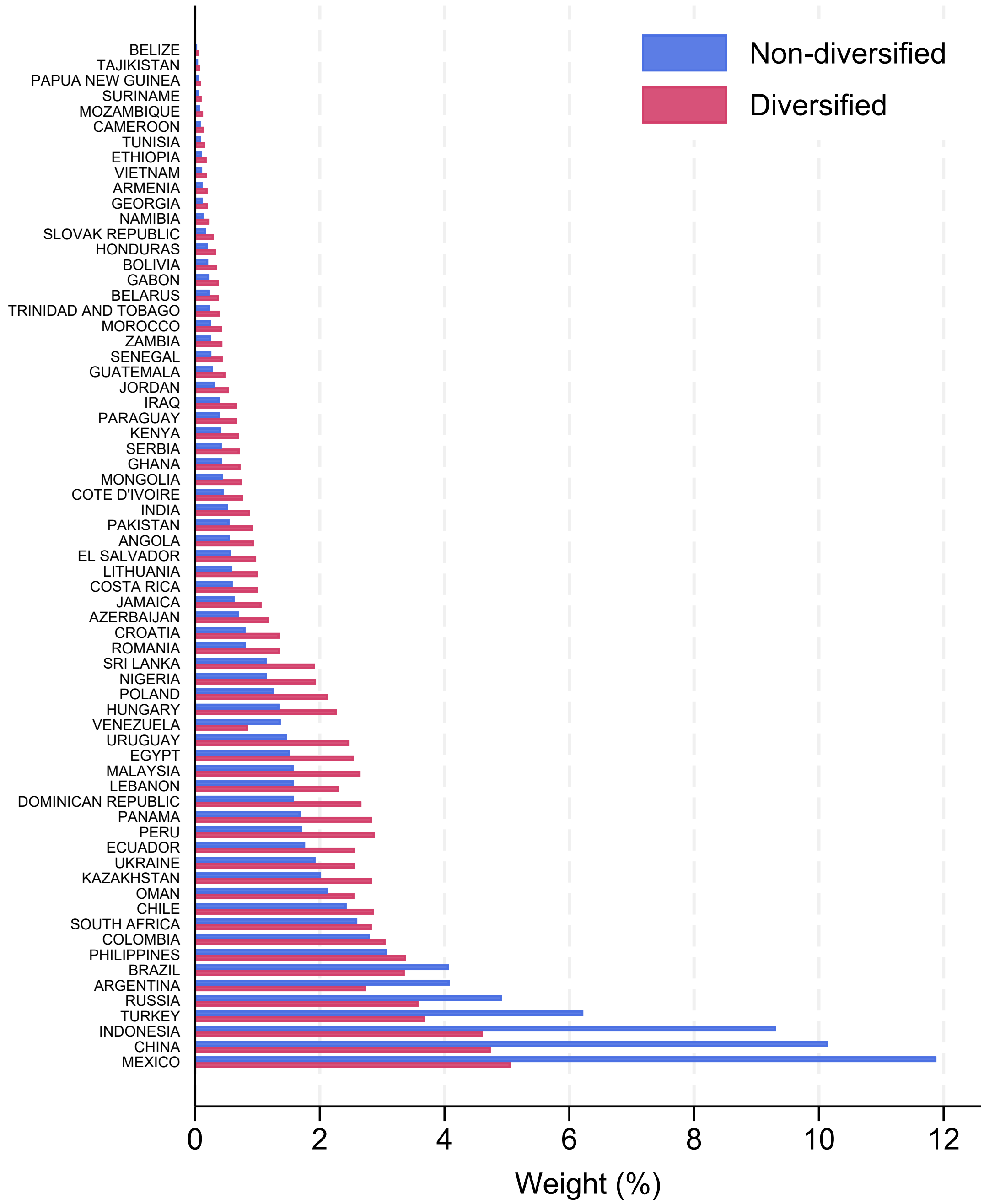
Note: The top panel shows impulse responses to an increase in the passive demand. The bottom panel shows a decomposition for bond price changes across time, in a counterfactual in which the stock of debt remains fixed.

in the passive demand (as a share of the stock of debt), the government increases its debt by 0.10%.

To shed further light on the dynamics of debt and default, Figure C2b shows the impulse response to an increase in the passive demand. The top panel shows the responses for debt and bond prices. Even though the government increase its debt, bond prices still increase as the result of the larger demand. The orange line shows a counterfactual in which we keep the bond policy fixed. In this case, the bond price increases about 40% more on impact. The bottom panel decomposes the change in bond prices for the counterfactual in which debt is fixed.

D Appendix: Additional Figures and Tables

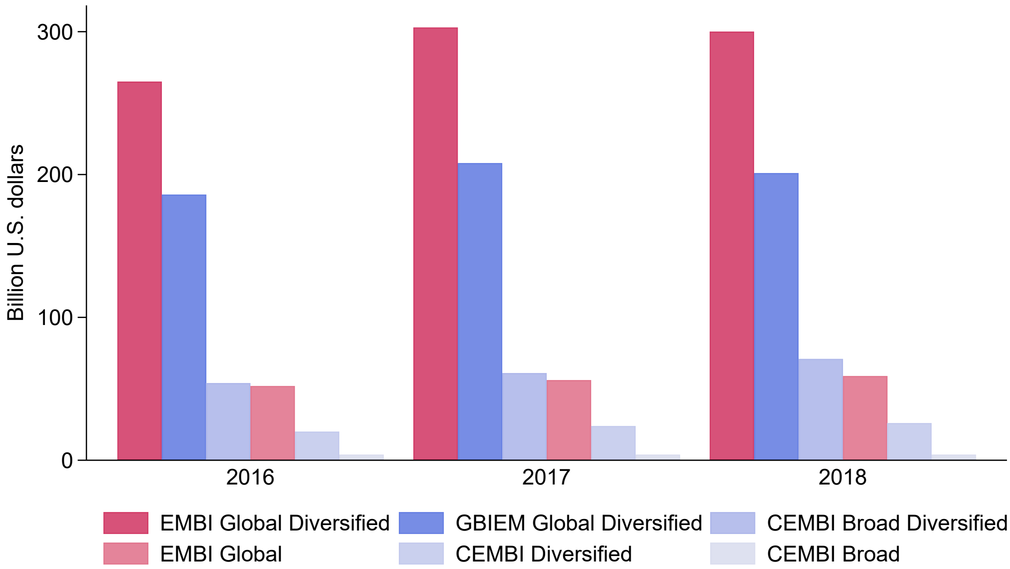
Appendix Figure D1
EMBI Global country-level weights in December 2018



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 D2

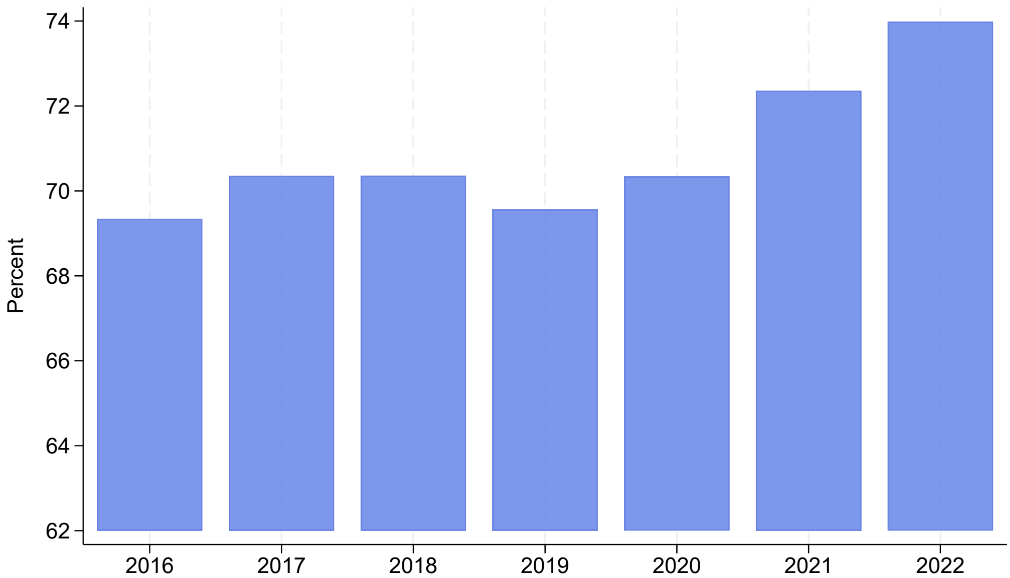
Assets under management benchmarked to emerging economies bond indexes



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

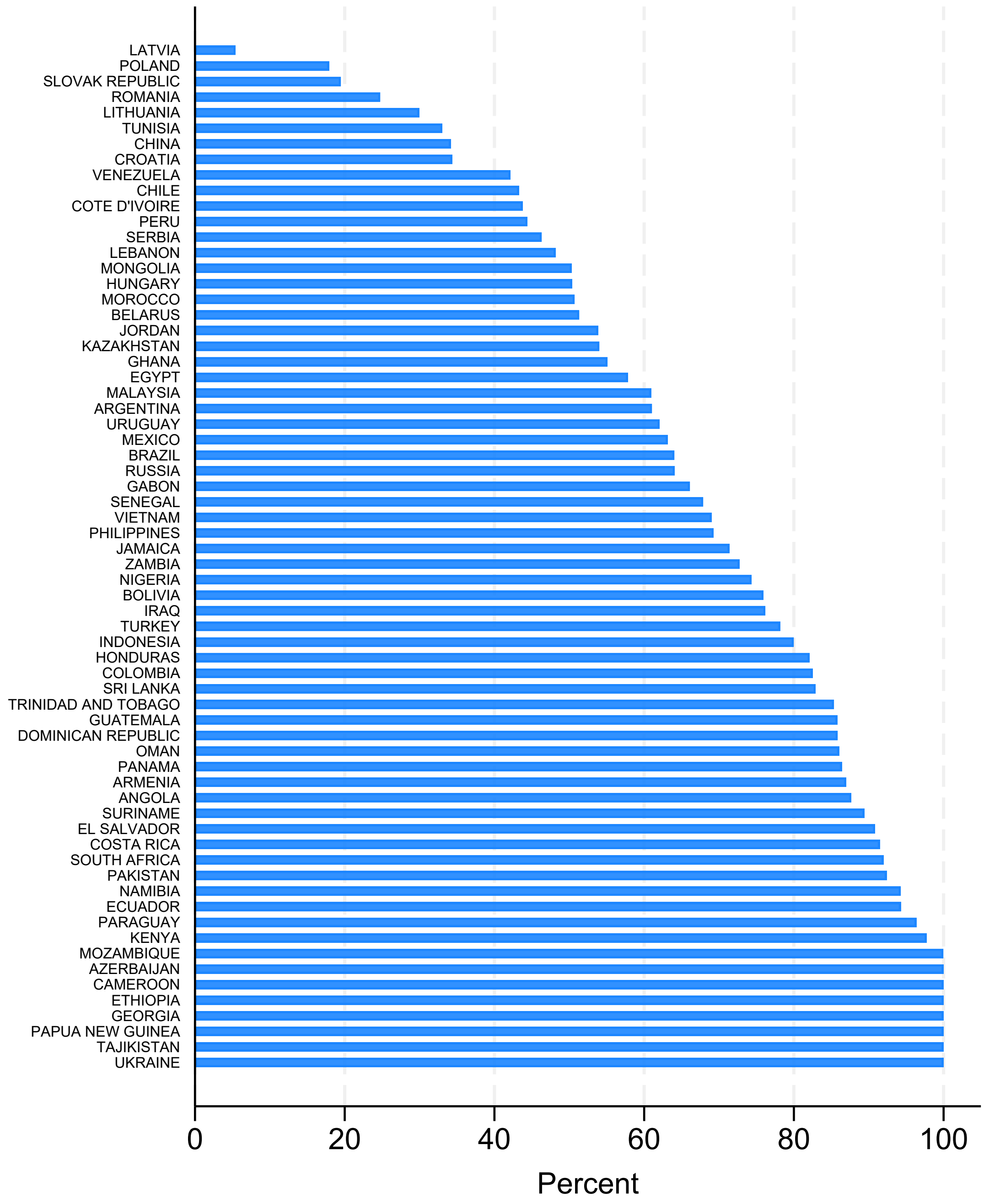
Appendix Figure D3

Share of U.S. dollar-denominated emerging economies sovereign debt



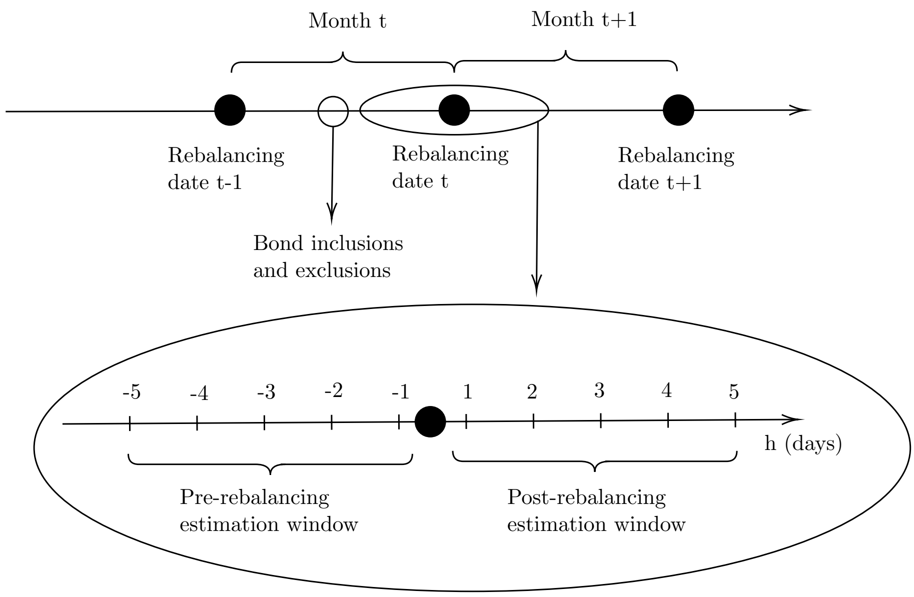
Note: The bars show the U.S. dollar-denominated sovereign debt in the EMBI Global index as a percentage of each country's general government debt securities issued in international markets. Averages are derived by calculating this percentage for each country and year, and then averaging these values annually across countries. Each country's percentage is weighted by its debt amount outstanding included in the EMBI Global indexes. Sources: BIS, J.P. Morgan Markets, and authors' calculations.

Appendix Figure D4
Share of U.S. dollar-denominated emerging economies sovereign debt

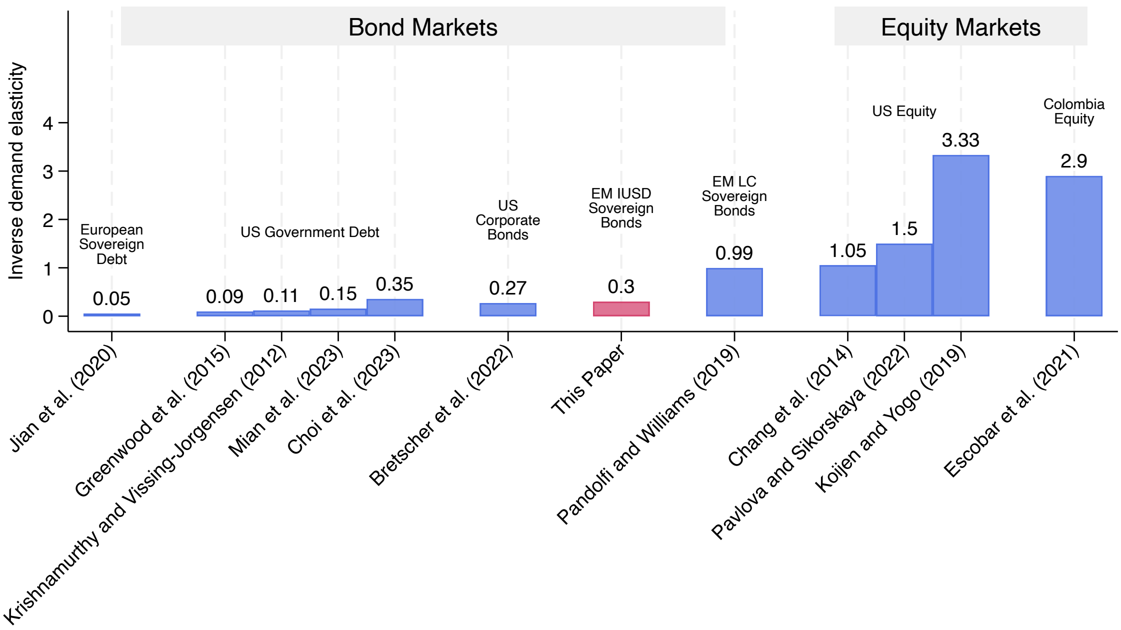


Note: The bars show the U.S. dollar-denominated sovereign debt in the EMBI Global index as a percentage of each country's general government debt securities issued in international markets. The averages are derived by calculating this percentage for each country and year, and then averaging these values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

Appendix Figure D5
Timeline



Appendix Figure D6
Estimated inverse demand elasticities for financial markets



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. The elasticities in Jiang et al. (2021a), 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. (2022), we take the midpoint elasticity from the IV estimates, while for our paper, we compute the midpoint in elasticity from Table 5. 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 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.

Appendix Table D1

Log price and FIR: varying the share of passive funds

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: This table presents 2SLS estimates of log bond prices on the FIR measure (defined in Equation (2)), instrumented by Z (defined in Equation (4)), around rebalancing dates. The first- and second-stage equations are described in Equation (5). 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). Each different column indicates the share of passive funds used to construct the FIR face amount measure. 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.

Appendix Table D2
Log price and FIR: different 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: This table presents 2SLS estimates of bond log prices on the FIR measure, with each column reporting estimates for different h-day symmetric windows before and after a rebalancing event. The sample period, the construction of $h-$day windows, and the 2SLS procedure are identical to those described in Table 5. Standard errors are clustered at the country-month level. *, **, and *** denote statistically significant at the 10%, 5%, and 1% level, respectively.

Appendix Table D3
Log price and FIR: dropping quasi-sovereign bonds

Dependent Variable: Log Price				
FIR	1.078			
	(0.924)			
FIR X Post	0.249**	0.249**	0.249**	0.175*
	(0.107)	(0.108)	(0.107)	(0.103)
Post	0.000	0.000	0.000	
	(0.000)	(0.000)	(0.000)	
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: This table presents 2SLS estimates of log bond prices on the FIR measure (Equation (2)), instrumented by Z (Equation (4)), around rebalancing dates. The first- and second-stage equations are described in Equation (5). 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 (0 otherwise), and bond characteristics are fixed effects that interact maturity and ratings fixed effects. Maturity fixed effects 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). Ratings from each bond are from Moody's. Bond controls indicate whether the estimation includes the log face amount and log stripped spread of the bond. 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.

Appendix Table D4

Log price and FIR: spread heterogeneity (3 groups)

Dependent Variable: Log Price						
	High Spread		Median Spread		Low Spread	
FIR	2.179		0.140		0.391	
	(1.810)		(0.508)		(0.361)	
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)
Post	0.001*	0.001*	0.001**	0.001**	-0.000	-0.000
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
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

Note: This table presents 2SLS estimates of log bond prices on the FIR measure (Equation (2)), instrumented by Z (Equation (4)), around rebalancing dates. The first- and second-stage equations are described in Equation (5). The estimations use a symmetric four-trading-day window excluding $h = -1$ and $h = +5$, with *Post* as an indicator variable (equal to 1 for the five trading days after rebalancing, and 0 otherwise). The sample is divided into bonds with high spreads (Columns 1 and 2), median spreads (Columns 3 and 4), and low spread (Columns 5 and 6), with spreads divided according to their 33.3 and 66.6 percentile into the three different buckets. 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.