Benchmark Index Inclusion and Sovereign Risk

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March 3, 2025

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Abstract

Rising global capital flows intermediated by investment funds that replicate benchmark indices—the returns of a basket of eligible assets—have raised financial stability concerns. I exploit variation in benchmarks used by investors holding bonds from the same issuer to estimate the causal effect of adding a country's debt to benchmark indices on bond price volatility. Using micro-level data on government debt from emerging economies, I show that index inclusion insulates bond prices from changes in fundamental risk, *reducing* volatility. On the borrower side, benchmark inclusion encourages borrowing as the level of demand for a country's bonds rises. However, the dampening effect of inclusion on the elasticity of demand for the bond has a countervailing impact. I develop and estimate a structural model with benchmark-driven demand and endogenous asset supply. The level effect on demand dominates, indicating that an increased supply of index-eligible assets contributes to volatility.

* The previous version of this paper originally circulated under the title "Benchmarking and Sovereign Risk". I acknowledge Paul Bergin, Nicolas Caramp, James Cloyne, Xian Jiang, Òscar Jordà, Emile Marin, Katheryn Russ and Ina Simonovska for spending time discussing the paper with me. The opinions expressed in this paper are solely those of the author and do not necessarily reflect the viewpoints of any other organization. The analysis makes use of data that are proprietary to Morningstar and/or its content providers. Neither Morningstar nor its content providers are responsible for any of the views expressed in this article. Any errors in the content are the author's responsibility.

1 Introduction

Investment funds, particularly open-end mutual funds and ETFs, manage one-sixth of global assets on behalf of households and institutions (Pascual et al., 2021). Managers of funds receive performance-based pay and select a subset of market indices—the returns of a basket of eligible assets—to benchmark performance. This compensation structure, along with increasingly passive strategies that replicate the constituents of benchmark indices, is known for creating herding and financial contagion. Investment funds are often blamed for amplifying financial market stress during crises. Despite financial stability concerns regarding investment funds, the effect of adding assets to existing indices used by funds as benchmarks, the so-called index inclusion, on asset price volatility is little studied. This paper fills this gap.

Identifying the effect of index inclusion on the volatility of bond prices is challenging[1] because global financial services firms do not add assets to index baskets at random. I focus on the asset class of emerging-market (EM) sovereign bonds denominated in local currencies (LC). Countries generally issue these bonds in domestic markets, unlike dollar-denominated bonds, which are issued in global financial centers. The large capital flows to EM domestic markets by global investment funds and numerous inclusion events of EM LC bonds into global indices make this asset class particularly appealing to study. To estimate the causal effect of adding a country's LC bonds to existing bond benchmark indices, I exploit cross-sectional variation in benchmark indices used by investors holding bonds from the same issuing country. To accommodate inclusion and exclusion events in hundreds of indices with EM LC bonds, I create a novel measure of exposure to index inclusion: the share of holders of a particular sovereign bond who benchmark to indices with EM assets. Using the VIX as a proxy for fundamental risk, I show that when a bond is more exposed to inclusion in this way, the bond price exhibits less volatility from fundamental risk. I further show that the identified effect from this exposure allows one to estimate what the volatility of bond prices would be if a country were excluded from every bond index.

Crucial to my empirical design is the use of country-time fixed effects, and hence the estimates do not capture how an endogenous asset supply responds to index inclusion or how inclusion affects volatility in equilibrium. Even if a country's index inclusion were random, the direction of changes in the supply of an asset upon inclusion is ambiguous in theory. My empirical results are consistent with a channel where compensating managers based on performance relative to benchmark indices creates incentives to hold assets included in their benchmarks. This channel directly implies that the level of demand for benchmark-inclusive assets rises upon index inclusion. Since managers are

[1] In the context of local-currency bonds issued by emerging economies, countries may tailor their policy for index inclusion and hence inclusion is endogenous. For example, the Egyptian finance minister, in response to Egyptian bonds entering the JP Morgan GBI-EM index in 2022, stated that the efforts to "fulfill the requirements of index inclusion" had paid off (Ministry of Finance Arab Republic of Egypt, 2022).

risk-averse, this channel also implies that the demand becomes less sensitive to prices—a reduction in demand elasticity. The rigidity of the weight applied to the share of the bond in the index's asset basket acts as a "cap" on demand. The manager will purchase fewer bonds as the price falls to respect the weight assigned to the bond within the index. While an increase in the level of demand raises prices for any given quantity and encourages a country to borrow more, less-elastic demand incentivizes countries to borrow less. Guided by conditional moments from Colombia's index inclusion, I estimate a structural model and show that countries borrow more upon index inclusion as the level effect of demand dominates in equilibrium.

To begin with, I provide a new stylized fact on the heterogeneity of investors' benchmarks: investors benchmarked to indices that include only dollar-denominated assets often hold EM LC bonds. I refer to these investors as *Dollar funds*, and I refer to investors whose benchmark indices have ever included EM LC bonds as *EM funds*. Using cross-sectional holdings data from the universe of U.S.-domiciled funds, I document that investors holding EM LC bonds often use benchmarks entirely unrelated to EM LC bonds. This fact challenges the view that investment funds act as preferred-habitat investors within the asset class underlying their benchmark indices. Comparing the outcomes of countries with and without index inclusion status is confounded by selection bias. More importantly, the fact I uncover makes it possible to identify the effect of inclusion through the following comparison.

Consider two sovereign bonds with similar characteristics issued by the same country and traded in segmented financial markets. Suppose that the issuing country experiences an inclusion episode, and these two bonds, which were already traded in secondary markets, are added to global bond indices. If one bond is held only by Dollar funds, index status of the issuing country does not affect the price volatility of this bond because the return on this bond does not directly affect the benchmark of Dollar funds. By contrast, if another bond is held only by EM funds, then its price should reflect the effects of index inclusion when fundamental risk changes. When the issuer is already included in global indices, comparing the outcomes of these two bonds reveals the effects of index inclusion. The identification requires that 1) the identity of investors does not affect bond price volatility if the issuing country is excluded by any index and that 2) the assignment of investors to bonds is effectively random. I call the first assumption the "parallel trend" assumption because Dollar funds is used to approximate the counterfactual world where EM funds hold index-exclusive assets. I call the second assumption the "exogenous holdings" assumption as estimates are biased when unobserved factors affecting portfolio decisions and volatility are present.

I provide support for the "parallel trend" assumption through a partial equilibrium model and robustness checks. In particular, the model shows that unobserved trading strategies across different funds approximated by different degrees of risk aversion do not invalidate this assumption. In the model, investors derive utility from both the absolute return and the return relative to LC bond index, whose weights are determined by an exogenous function. This functional form is motivated by the micro-foundation of using benchmark indices in asset management by Kashyap et al. (2020). The model features two types of investors who differ in their risk aversion and their choices of benchmark indices. The model introduces a measure of the degree of index inclusion using the share of bonds held by EM funds. The model predicts that greater exposure leads to bond prices being less sensitive to changes in fundamental risk. Moreover, if indices did not impact portfolio allocations, this exposure measure should not influence bond price volatility. I test these predictions.

I conduct a placebo test using Colombia's index inclusion event in 2014 to provide further support for this assumption. The set of funds whose benchmark indices included Colombian peso-denominated bonds after 2014 should not have reduced the bond price volatility prior to index inclusion. Empirical estimates indeed validate the prediction. This falsification test shows that the heterogeneity along other dimensions between EM and Dollar funds does not invalidate this "parallel trend" assumption. Therefore, Dollar funds can be used as a counterfactual for EM funds during periods when assets are excluded from benchmark indices of EM funds.

Identifying index inclusion effects also requires exogenous variation in holdings. I use country-time and bond fixed effects to address unobserved factors. Moreover, I provide support for the idiosyncratic selection of bonds to replicate the desired country portfolio weight among global investors. In other words, investors may choose different varieties of bonds from the same issuer to replicate their desired country weights since fundamental risk at the issuer level drives prices. I use the VIX to approximate fundamental risk. Estimates show that greater exposure to index inclusion reduces the impact of the VIX on bond yields. The reduction peaks at 0.11 percent in the fourth quarter following a one-percent increase in the VIX.

Empirical results so far are silent on the effect of index inclusion when borrowers endogenously alter the supply of assets in response to index inclusion. I address this issue by integrating lenders benchmarked to indices into a quantitative model of sovereign debt. The model features one-period LC bonds and exogenous processes for output and exchange rates, which can be interpreted as fundamental risk. The model has two key ingredients. A departure from many sovereign default models is the introduction of a secondary market: a period when the price of outstanding bonds changes due to exogenous shocks and the announcement of an index inclusion takes place. This feature generates model moments comparable to a real index inclusion event, as the empirical analysis uses bonds traded in secondary markets. Another key model ingredient accounts for a two-sided sorting into global indices between the issuing country and financial services firms, which decide the constituents of the basket of assets in indices. The country makes an optimal decision on index inclusion or exclusion. A country's index status switches to inclusion when it voluntarily opts for inclusion and receives an approval from index providers, which arrives with an exogenous probability.

In the model, index inclusion affects borrowing through two mechanisms. First, the behavior of tracking index weights increases the demand for sovereign bonds included in the index and hence increases the price given the existing supply of bonds. Since this mechanism deals with the demand while fixing the supply, it is interpreted as inclusion raising the level of demand. Second, inclusion reduces demand elasticity. Managers are less inclined to purchase more of a bond when its price falls because the optimal portfolio weight of this bond reflects its index weight. The weight, constructed according to certain rules, is often updated sluggishly in response to changes in bond prices. Therefore, managers' responses to changes in bond prices are "capped" by the benchmark weight, making demand for assets less sensitive to prices, a reduction in demand elasticity.

In principle, index inclusion could improve a country's welfare. An equilibrium effect of reduced default risk emerges when the welfare-improving effects of index inclusion exist for certain states. The set of states in which a country chooses to default becomes smaller in a world with index inclusion than in one without it. This equilibrium effect implies higher prices when creditors are risk-neutral. When creditors are risk-averse, a higher expected return due to lower default risk is offset by increased volatility of returns. This equilibrium effect offers a nuanced explanation of repaying debt: index inclusion is a reward for repaying debt because it overcomes frictions in developed markets.

I calibrate the model to match the macro moments of the Colombian economy as well as the reduction in yields upon Colombia's index inclusion. The estimated quantitative model confirms the rise in bond prices under a country index-inclusion status. In the quantitative exercise, I analyze the transmission of exchange rate and output shocks. I decompose the transmission of these two shocks by considering two counterfactual cases: one where the country, compared to the baseline under index inclusion, has a zero index weight, and another where no index includes EM LC bonds. These two cases differ in the amount of debt a country borrows, as the quantity of outstanding debt affects the propagation of shocks. Quantitatively, if countries had been excluded from indices, the observed external LC debt-to-output ratio would be 4% lower. Including assets in benchmark indices is more potent at insulating against output shocks, while it has limited, though positive, effect on insulating exchange rate shocks. The reason behind this divergence is that global shocks to the exchange rate directly reduce the country's index weight as the index weight often follows market value. Output shocks have no direct effect on the index weight.

Contributions This paper contributes to the debate on how passive, index-driven investment and, more broadly, capital flows from mutual funds affect financial market volatility. The existing literature establishes that benchmarking increases market volatility. For equities, Appendix D in Kashyap et al. (2020) provides a theoretical argument, and Ben-david et al. (2018) presents empirical evidence on ETFs. Studies examining capital flows from ETFs and index funds report similar findings (Chari et al., 2022; Converse et al., 2020). The insulation role of benchmarks in this study contrasts with existing results mainly in equity markets and contributes to the debate on the financial stability implications of index-driven investors (Anadu et al., 2020).

As Anadu et al. (2020) note, compared to equities, there is relatively little research on how benchmarking affects valuations in bond markets. Existing studies of bond index inclusion do not address bond valuations beyond a short window of a few days, leaving longer-term pricing effects understudied. This paper examines the valuation of risky bonds both in secondary markets with fixed supply and in primary markets where issuers internalize the equilibrium effects of benchmarking. While the mechanism of perfectly inelastic demand driven by benchmarks is not new, this study explores how such demand propagates shocks, a question that remains underexamined in the literature.

Moreover, this paper builds on an extensive finance literature and recent macroeconomic studies on benchmarking and mutual fund capital flows, particularly those that use changes in benchmark weights for identifications (Broner et al., 2021; He and Beltran, 2022; Pandolfi and Williams, 2019; Moretti et al., 2024). Rather than focusing on index rebalancing or inclusion events, I investigate how indices affect sovereign risk.

My empirical approach extends research analyzing mutual fund credit supplies and asset prices, including studies on funding shocks across different types of funds (Calomiris et al., 2022), capital allocations (Chari et al., 2022; Chari, 2023; Raddatz et al., 2017), and the transmission of funding shocks to asset prices (Jotikasthira et al., 2012; Zhou, 2023). Unlike most of these works with the exception of Zhou (2023), I conduct a bond-level analysis with a particular focus on EM LC markets.

The model employs a reduced-form approach where asset managers derive utility from both absolute returns and returns relative to a benchmark, following studies that provide micro-foundations for benchmarking behavior (Kashyap et al., 2018, 2020; Duffie et al., 2014). I extend results from microfinance research on benchmarks to local-currency debt markets, which have been extensively studied regarding sovereign risk (Du et al., 2017; Ottonello and Perez, 2019; Engel and Park, 2022; Lee, 2022). Previous studies have not analyzed the impact of benchmark indices on EM LC risk. My creditor-centered analysis is related to studies on banks and sovereign risk (Bocola, 2016; Morelli et al., 2022; Perez, 2015). In contrast to these studies that focus on amplification mechanisms, I find that benchmarking acts as a stabilizing mechanism in the context of EM LC bonds.

Structure of the paper In Section 2, I introduce a new classification of mutual funds and present a new stylized fact on capital flows to EM bond markets using this classification. Section 3 presents a conceptual framework to identify the effect of index inclusion on volatility and a model featuring lenders benchmarked to indices. I derive testable predictions from this model. In Section 4, I empirically estimate the effects of index inclusion. Section 5 discusses issues related to identification and presents an instrument for the measure of exposure to index inclusion. Section 6 checks the robustness of the empirical results against alternative explanations. Section 7 quantifies the effects of index inclusion on sovereign borrowing. Section 8 concludes. The appendix contains further evidence of EMs' index-related policies and analytical derivations.

2 Background and Data

2.1 A brief background of bond indices

Institutional investors, such as sovereign wealth funds, pension funds, and mutual funds, ubiquitously use market indices as references for their performance. Market indices measure the return of a basket of eligible assets. Selective market indices are used as benchmarks to measure the performance of institutional investors. These indices are commonly referred to as *benchmark indices*. This paper focuses on the asset class of emerging market local-currency sovereign bonds—sovereign bonds denominated in emerging markets' local currencies and generally issued in their domestic bond markets. This is a unique asset class in which major investors are mutual funds instead of other types of private investors, such as deposit-taking commercial banks, insurance firms, and hedge funds[2]. Although the impact of index inclusion on volatility may not be unique for this asset class, I take advantage of the importance of mutual funds for EM LC bonds and the accessibility of their holdings data from Moringstar, a commercial data provider.

Global financial services firms, such as J.P. Morgan and Bloomberg, construct benchamrk indices by setting specific rules for constituents and portfolio weights. Moreover, index providers set country- and bond-specific eligibility criteria. The most commonly used indices that include EM LC bonds are the FTSE Global Bond Index, the Bloomberg Global Aggregate Index, the JP Morgan Government Bond Index-Emerging Market Global Diversified (GBI-EM), along with their variants. The first two are global indices because they include developed-market sovereign bonds and corporate bonds. The JP Morgan GBI-EM Index only includes EM LC sovereign bonds. Variants of these indices arise from tightening or loosening certain eligibility criteria so that the index becomes broader for gauging overall market performance or narrower for replication by investors.

Income levels and market access hurdles, such as capital controls and liquidity, are two important criteria for country eligibility. A country may experience index inclusion or exclusion when its income level changes. For example, the JP Morgan GBI-EM Broad Diversified included the

[2]See Appendix B for a comparison of EM LC bond holdings by mutual funds and other types of creditors using the European Central Bank and the U.S. TIC data.

Czech Republic in February 2017 after JP Morgan reclassified it as an emerging market country based on GNI per capita (Broner et al., 2021). Index providers require certain degree of market liquidity. This condition differentiates all-inclusive broad market indices from narrowly defined indices for replication.

Moreover, indices set bond-level criteria related to maturity, issuance size, and coupon types[3]. For example, to qualify for the JP Morgan GBI-EM Broad Diversified Index, a bond must have a size greater than \$1 billion for domestic issuance and \$500 million for global issuance, a residual maturity of more than two and a half years, and a coupon type restricted to fixed-rate non-inflation-indexed coupons. Once index providers select a set of bonds, they often use market values to determine portfolio weights. Providers may fulfill a diversification objective by capping a country's index weight[4].

2.2 Constructing a representative sample of global investors

This section describes the procedure for constructing a representative sample of global investors using commercial data from Morningstar. Without access to the universe of holdings data in Morningstar, identifying the holdings of EM LC bonds by specific mutual funds, particularly those that have already been liquidated, is challenging. The key to this procedure is the use of a variable called *Morningstar Category*. Morningstar categorizes funds into over 200 detailed categories, called Morningstar Category, based on their portfolios and locations. The Morningstar Category reflects the "de facto" holdings, while benchmarks or investment strategies reflect the "de jure" holdings. Therefore, this "de facto" classification is suitable for creating a sample of global mutual funds that hold EM LC bonds. I identify categories likely to contain funds exposed to EM LC bonds and extract the positions from all the funds within these categories. I compile a list of fixed-income funds domiciled in developed markets, including Canada, developed European countries[5], Hong Kong, Japan, Singapore, and the United States. I proceed the selection of funds in two steps.

First, I use portfolio data from mutual funds' mandatory filings between 2019 and 2022 in Form N-PORT-P to validate my approach of selecting funds based on Morningstar Category. I show that a few categories provide good coverage of mutual funds holding EM LC bonds. Form N-PORT-P is used by investment companies domiciled in the U.S. to disclose their portfolios to the U.S. Securities and Exchange Commission.[6] The data is accessible and free to the public. I describe this dataset in Appendix A.2. Using Form N-PORT-P filing data, which covers the universe of U.S.

[3] Interested readers may refer to Arslanalp et al. (2020) for more details of these rules.

[4] For more on exploiting this feature to construct capital flow shocks that may be exogenous to a country's fundamentals, I refer interested readers to Pandolfi and Williams (2019), He and Beltran (2022), and Moretti et al. (2024).

[5] Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

[6] See Sikorskaya (2023) for another application of the data from Form N-PORT-P.

funds, I identify Morningstar Categories containing funds exposed to EM LC bonds. As Appendix Table A.3 shows, the first eight categories of funds coverages over 90% of the holdings. I focus on fixed-income funds due to the presence of small positions in allocation funds, which invest in both stocks and bonds, as observed in public filings. I then identify the corresponding categories for EU funds. I exclude seven U.S. categories with the least exposure— representing 3.7% of the total U.S. fund exposure in Q4 2019—and their corresponding non-U.S. fund categories.

Second, Morningstar calculates the percentage of fixed-income holdings in different currencies over time for each fund. This calculation provides good coverage for surviving funds. I compile a list of all fixed-income funds domiciled in Luxembourg and Ireland and calculate the share of bonds denominated in EM currencies in their portfolios. After identifying funds with exposure to EM currencies, I obtain a list of the Morningstar Categories to which they belong. I then find the corresponding categories for funds domiciled in Canada, Singapore, Hong Kong, Japan, and other EU countries.

These two steps result in 61 Morningstar categories, 6200 funds, and 160,000 quarterly portfolios. I download portfolios from Morningstar Direct and add bond characteristics and yields to maturity from Bloomberg.

From the variables "Primary Prospectus Benchmark" and "Secondary Prospectus Benchmark" in Morningstar, I retrieve information on benchmark indices. The primary and secondary benchmarks of funds that have ever been exposed to EM LC bonds yield approximately 1,000 unique indices. Using publicly available documentation from index providers, I identify countries along with the exact timing of inclusion and exclusion events and asset classes—EM LC sovereign bonds, EM hard currency denominated sovereign bonds, EM corporate bonds, and developed-market bonds. Appendix A.1 details the procedure for identifying unique bonds. Appendix A.4 outlines the steps taken to clean holdings data.

Table 1 lists historical country inclusion and exclusion events in major indices. It shows that countries are frequently added to or deleted from benchmark indices.

Given that investors use hundreds of different benchmark indices, a natural question is: are investors in EM LC bonds mainly those benchmarked to EM LC bonds? To answer this, I focus on data from Form N-PORT-P, which covers the universe of investment funds domiciled in the US. I classify funds based on whether or not their benchmark indices include any EM LC bonds. Table 2 lists the EM local-currency bonds held by US fixed-income mutual funds in Q4 2019[7]. The key insight from the table is that over 40% of credit supplied to EM LC bond markets is unrelated to the asset type underlying mutual fund performance benchmarks. Moreover, index funds, whether they are ETFs or not, pursue active strategies in the U.S. and have discretion over country weights

[7] Appendix Table A.2 summarizes non-benchmark driven holdings across different categories of mutual funds, such as allocation, alternative, and equity funds. Allocation funds held EM LC bonds with a market value $2 billion.

Table 1: Benchmark index inclusion and exclusion events after index inceptions

Currency	Bloomberg EM LC	Bloomberg Global Aggregate	Bloomberg Pan-European Aggregate	FTSE International ILSI	FTSE WBIG	FTSE World ILSI	JPM GBI-EM	JPM GBI-EM Broad	JPM GBI-EM Global	Morningstar Global Treasury
COP		09/2020 in					03/2014 in†	03/2014 in†	03/2014 in†	
CZK			01/2005 in					02/2017 in	02/2017 in	
HUF		11/2013 ex 04/2017 in	11/2013 ex 04/2017 in							
IDR		06/2018 in								
ILS		01/2012 in			05/2020 in	05/2020 in				10/2022 in
MXN				12/2013 in	10/2010 in	12/2013 in				10/2022 in
MYR		01/2006 in			07/2007 in					10/2022 in
PEN		09/2020 in								
PLN				12/2013 in 02/2014 ex		12/2013 in 07/2021 ex				10/2022 in
RON	04/2013 in	09/2020 in	09/2020 in					01/2013 in	01/2013 in	
RUB	03/2022 ex	04/2014 in 03/2022 ex	04/2014 in 03/2022 ex							
THB		03/2007 ex 07/2008 in								
TRY		04/2014 in 10/2016 ex								
ZAR		05/2018 ex		12/2013 in	10/2012 in 05/2020 ex	12/2013 in 05/2020 ex				

Notes: This table outlines the inclusion and exclusion events of countries following index inception. The event dates are sourced from publicly available index methodologies provided by index providers. Brazil has intermittently imposed explicit capital controls. According to He and Beltran (2022), Brazil experienced a brief period of exclusion from the JP Morgan GBI-EM Global Index. However, to the best of my knowledge, without a paid subscription to index providers, public news sources have no details on Brazil's index exclusions. The symbol † denotes COP bonds (Colombian TES) issued in Colombian local markets.

and the degree of benchmark index tracking errors. This explains why index funds are exposed to $160 million in EM LC bonds issued by countries which are absent from widely used benchmark indices.

Table 2: Characters of US bond funds holding (USD bn) EM LC sovereign debts reported between 12/2019 and 02/2020

Fund benchmarks	Total	Common EM countries		Other developing countries	
		Non-index fund	Index fund	Non-index fund	Index fund
Include EM LC bonds	46.95	29.40	12.67	4.72	0.16
Exclude EM LC bonds	33.67	27.77	0.01	5.89	0

Notes: This table summarizes the distribution of local-currency sovereign bond holdings across the universe of U.S. fixed-income funds. Common EM countries are those that have ever been included in EM LC bond indices. They are Argentina, Brazil, Chile, China, Colombia, Czechia, Dominican Republic, Egypt, Hungary, Indonesia, Malaysia, Mexico, Peru, Philippines, Poland, Romania, Russian, South Africa, Thailand, and Turkey. Other countries are Costa Rica, India, Kazakhstan, Sri Lanka, Pakistan, Uruguay, Ukraine, and Venezuela.

To provide further context on the heterogeneity of investors' benchmarks, existing studies almost exclusively focus on investors benchmarked to indices of asset classes examined. For the asset class of EM LC bonds, studies such as He and Beltran (2022) and Pandolfi and Williams (2019) that examine the effect of changing country weights on benchmarks have focused only on funds whose benchmarks are the JP Morgan GBI-EM Index. An exception is Calomiris et al. (2022), which analyzes EM corporate bond holdings by funds which mainly invest in bonds issued by developed markets. Another exception is Arslanalp et al. (2020). It mentions benchmark-driven funds versus those tracking global bond indices, termed unconstrained funds due to small portfolio weight in EM countries.

Although Table 1 shows a time-varying country index status, I do not often observe holdings of bonds over a period long enough to cover the switch in the issuing country's index status. In this paper, I adopt a research design that compares outcomes among bonds held by investors benchmarked and not benchmarked to these bonds.

3 Index inclusion and bond price volatility in a framework of international lending with benchmarking investors

I first illustrate the ideal identification of the effect of index inclusion on bond price volatility within a conceptual framework. I then discuss how to implement this ideal research design. A crucial aspect of the implementation is accommodating hundreds of different indices that include EM LC bonds and creating a measure of exposure to index inclusion—the share of bonds held by investors whose benchmark indices include the issuing country of the bond. I present a framework of international lending that includes benchmark indices and investors who are heterogeneous in their benchmark indices and in their risk aversion. I derive testable predictions from this framework and illustrate how to use this exposure term to assess bond price volatility if the country were excluded from every benchmark index.

3.1 Identification in a conceptual framework

I consider a scenario in which risky EM LC bonds denoted by i with identical characteristics from one issuing country are auctioned in segmented financial markets. These bonds are purchased and permanently held by one of two types of foreign investors. Performance benchmarks are used to evaluate the return of their portfolios. Both types choose a portfolio of EM LC bonds and risk-free dollar assets. Dollar assets are in their benchmarks, but one of types are treated by adding the emerging market country to the benchmark index. For convenience, I refer to investors subject to index inclusion as *EM funds* and the other type as *Dollar funds*. The fundamental risk z_t, such as US monetary policy, global commodity price, a country's output, drives the yield-to-maturity y_{it} of the bond. Let the treatment of adding a country to the benchmark index of EM funds be D_t. The effect of index inclusion on the price volatility from its fundamental risk can be estimated via a difference-in-differences strategy.

$$\Delta y_{it} = \alpha + \lambda \Delta z_t + \beta \Delta z_t \times \text{EMfund}_i + \gamma \Delta z_t \times \text{EMfund}_i \times D_t + \epsilon_{it}$$

where the indicator for the type of investors EMfund_i switches on when the bond i is held by a EM fund.

The effect of index inclusion on the price sensitivity to fundamental risk is γ. Being less sensitive to fundamental risk is interpreted as index inclusion reducing price volatility driven by fundamental risk. The causal interpretation requires the assumption that index inclusion D_t is exogenous. Setting aside the question of whether index inclusion, as seen above, is exogenous, the research design explores within-bond variation in index status for given investors. In reality, only holdings from Colombia and Romania allow for the exploitation of this source of variation at the bond level. Considering Dollar funds as a counterfactual for EM funds under an index-inclusion state naturally creates an alternative research design: when a country is included in an index, the empirical strategy compares the outcomes of bonds held by investors who are and are not benchmarked to this country.

$$\Delta y_{it} = \alpha + \lambda \Delta z_t + \beta \Delta z_t \times \text{EMfund}_i + \epsilon_{it}$$

This research design explores the cross-sectional variation in the type of creditors. Since index inclusion alters the incentives of creditors, whether bonds are treated with index inclusion or not should not matter for bonds invested by Dollar funds: their benchmark indices do not include any EM LC bonds anyway. This cross-sectional comparison can be interpreted as the index inclusion effect if fundamental risk affects asset price volatility regardless the type of investors under *index exclusion*. More precisely, the assumptions can be summarized as follows.

1. There is no unobserved factor affecting price volatility that also affects whether a bond held by an EM fund versus a Dollar fund;

2. Unobserved factors affecting why some funds choose an index potentially include EM LC bonds do not affect the sensitivity of asset prices to fundamental risk.

This paper focuses on this cross-sectional variation. The research design in the following sections provides evidence to support these assumptions. The major concern is that EM and Dollar funds are fundamentally different in their trading strategies even when they choose a portfolio of assets outside their benchmark. This unobserved factor may invalidate the second assumption. I present a model of international lending with investors who are heterogeneous in their trading strategies, represented by their risk aversion. This framework serves two purposes. It shows that heterogeneity in risk aversion is not a concern. Moreover, in reality, both EM and Dollar funds invest in EM LC bonds, and I use the framework to illustrate that, instead of a binary treatment, a new measure based on the share of a bond invested by EM funds can be used to quantify the degree of index inclusion and to identify the effect of index inclusion on volatility.

3.2 A framework of international lending with benchmarking investors

3.2.1 Global asset managers

Two types of asset managers of a unit mass domicile in the developed economy and are managing mutual funds. Mutual funds publish the indices used as performance benchmarks. The binary classification of benchmark indices divides funds into EM and Dollar funds. Throughout this paper, I use the $j \in \{\text{EM fund}, \text{Dollar fund}\}$ to denote the type of manager or fund. Each type of manager receives funding D_0. The mass of managers managing EM funds is $\mathcal{M}_{\text{EM fund}} = 1 - \mu$. The risk-bearing ability of managers $\gamma_j \in \{\gamma_L, \gamma_H\}$ with $\gamma_L < \gamma_H$ characterizes their investment strategies. I assume that managers of EM and Dollar funds have risk aversions of γ_L and γ_H, respectively.

A market index prescribes a portfolio whose weights follow a specific rule. EM funds use an index that includes EM LC bonds, while Dollar funds use an index that excludes them. I summarize the weight of EM LC bonds w_j^b in the benchmark index for a fund of type j below.

$$w_{j,t}^b = \begin{cases} > 0 & \text{if } j = \text{EM Fund} \\ 0 & \text{if } j = \text{Dollar Fund} \end{cases} \tag{1}$$

Index providers construct indices for EM funds according to a rule summarized by the function $\Omega(.)$. One possible rule is that time-varying weights depend on the *current* market value of EM bonds, denoted as $s_t^{-1} q_t B_{t+1}$. q_t is the price of the bond denominated in local currency. B_{t+1} is the principal value of a one-period EM LC bond issued at time t and maturing at time $t+1$. s_t is the real exchange rate . A rising s_t means depreciation.

The manager of type j chooses a portfolio consisting of claims $b_{j,t+1}^{DM}$ on developed market risk-free bonds and local-currency bonds $b_{j,t+1}$. Managers have a mean-variance utility based on a weighted sum of the absolute return, $W_{j,t+1}$, and the return relative to the portfolio prescribed by their benchmark index, $W_{j,t+1} - W_{j,t+1}^b$. The weight assigned to the absolute return is $\alpha \in (0,1)$. The portfolio problem for the manager of type j is:

$$\begin{aligned} \max_{b_{j,t+1}^{DM}, b_{j,t+1}} \; & \mathbb{E}_t(\alpha W_{j,t+1} + (1-\alpha)(W_{j,t+1} - W_{j,t+1}^b)) - \frac{\gamma_k}{2} \mathrm{Var}_t(\alpha W_{j,t+1} + (1-\alpha)(W_{j,t+1} - W_{j,t+1}^b)) \\ \text{s.t. } & D_0 = q_t^{DM} b_{j,t+1}^{DM} + s_t^{-1} q_t b_{j,t+1} \\ & W_{j,t+1} = b_{j,t+1}^{DM} + s_{t+1}^{-1}(1 - d_{t+1}) b_{j,t+1} \end{aligned} \tag{2}$$

where q_t^{DM} is the price of risk-free developed market bonds b_{t+1}^{DM}, and q_t is the local-currency price of EM bonds. $1 - d_{t+1}$ is the fraction of the principal value in local-currency terms recovered when the bond matures. $d_{t+1} = 1$ means default, and $0 < d_{t+1} < 1$ means partial default.

3.2.2 Discussion of managers' utility function

The main assumption regarding asset managers is that the relative returns influence their decisions. This functional form is directly from Kashyap et al. (2020), which derives the optimal benchmark compensation contract between investment firms and asset managers of mutual funds. A higher

$1 - \alpha$ implies more frictions in the asset management industry. Investment firms, on behalf of savers, use compensation contracts to overcome two frictions. One is managers' private portfolio-management costs for risky assets, which are borne by asset managers and not shared with other agents. The other friction is unobserved portfolios. As a result, investors cannot directly instruct managers to hold an optimal portfolio, as would be the case in a frictionless world.

The main difference between this paper and Kashyap et al. (2020) is the introduction of heterogeneous asset managers and the assumption that they have different benchmarks. Kashyap et al. (2020) considers the contract for only one representative asset manager and leaves aside the question of why manager's benchmarks differ from one another in practice.

In Appendix D, I address this question by extending Kashyap et al. (2020) with two additional assumptions. I assume that the private cost of management depends on the type of asset under management. Moreover, investment firms cannot punish managers based on positive returns relative to benchmarks: an asset manager's salaries cannot be deducted if his performance is better than any benchmarks.

A final note on the utility function is that benchmarking under a CRRA preference implies benchmarking alters the risk aversion of managers. α affects risk aversion so that the risk tolerance becomes γ_k/α. I formalize this point in Appendix C.

3.2.3 Market equilibrium

To align this stylized model of one-period bonds with the empirical analysis using secondary market prices, I introduce two sub-periods between the issuance and maturity of bonds, occurring between time t and $t+1$. Instead of specifying specific fundamental risk, I assume that fundamental risk is correlated with a risk factor z_t. Changes in fundamental risk drives the expected return through affecting the current and expected exchange rates as well as the expected probability of default. These changes correspond to changes the risk factor from z_0 to z_1 during two sub-periods. Throughout this section, I use the yield to maturity, y. The timeline in the secondary market is:

1. Given the outstanding local-currency debt B, the exchange rate s_0, the expected value of repayment per unit of bond at time $t+1$, $\mathbb{E}(\psi_0) \equiv \mathbb{E}(s_{t+1}^{-1}(1-d_{t+1})|z_0)$, the yield corresponding to the secondary market clearing price is y_0. The index weight is $w_0^b = w_0^b(s_0^{-1}y_0^{-1}B)$. It is useful to define a new variable θ_0 to measure exposure to index inclusion:

$$\theta_0 \equiv \frac{\text{Market value of bonds held by EM Fund}}{\text{Total market value}} \tag{3}$$

2. In the second sub-period, fundamental risk changes. The exchange rate unexpectedly changes to s_1 and the expected value of repayment is $\mathbb{E}(\psi_1) \equiv \mathbb{E}(s_{t+1}^{-1}(1 - d_{t+1})|z_1)$. Creditors adjust

their portfolios, and the bond yield y_1 clears the market.

The market demand B^d_ν for local-currency bonds in two sub periods $\nu = 1, 2$ from mutual funds satisfy the asset demand equation:

$$D_0 \sum_{j\in J} \mathcal{M}_j w_j(s_\nu, B, z_\nu) = s_\nu^{-1} q(s_\nu, B^d_\nu, z_\nu) B^d_\nu, \quad \nu = 0, 1 \tag{4}$$

Given an exogenous bond supply B, an exogenous process of risk factor z_ν, the asset market clearing condition is

$$B^d_\nu = B, \quad \nu = 0, 1 \tag{5}$$

The equilibrium in the secondary market consists of exogenous processes, prices, and portfolio weights derived from the first-order conditions of portfolio optimization problems, ensuring that the asset market clears.

To understand how benchmarks affect prices, I derive the portfolio of EM funds prior to the shock.

$$w_{\text{EM Fund},0} = \frac{\frac{\mathbb{E}(\mathcal{E}')}{q_0(1+r^f)} - 1}{\gamma_L(1+r^f) D_0 \operatorname{Var}(\frac{\mathcal{E}'}{q_0(1+r^f)})} + (1-\alpha) w^b_{\text{EM Fund}} \left(s_0^{-1} q_0 B\right) \tag{6}$$

where the expected value of repayment prior to the risk factor shock is

$$\mathcal{E}' = \frac{s_0}{s_{t+1}} \times (1 - d_{t+1}) \equiv s_0 \psi_0 \tag{7}$$

Throughout the analytical derivations, I use the approximation $\operatorname{Var}(\frac{\mathcal{E}'}{q_0(1+r^f)}) \approx \operatorname{Var}(s_0\psi_0)$. This approximation omits the second-order effect of prices when the difference between the EM bond yield and risk-free rate is small. The portfolio weight for Dollar funds has a similar expression. Imposing the market clearing condition, $B^d_\nu = B, \nu = 0, 1$, the price of bonds in local currency is

$$q_0 = \frac{\mathbb{E}(s_0\psi_0)/(1+r^f)}{\underbrace{E_\gamma^{-1}}_{(1)} \operatorname{Var}(s_0\psi_0)(1+r^f) D_0 \underbrace{\left(\frac{s_0^{-1} q_0 B}{D_0} - (1-\mu)(1-\alpha) w^b_0\right)}_{(2)} + 1} \tag{8}$$

where the term for average risk aversion is $E_\gamma = \frac{1-\mu}{\gamma_L} + \frac{\mu}{\gamma_H}$. The price depends on two components: (1) the average risk aversion of creditors; and (2) the bond supply in excess of benchmark weights.

An observation from the above pricing equation—Eq. 8—is that the price under a positive index weight is always higher than that with a zero weight. Appendix C.1 shows the proof. This observation is consistent with the large literature on the short-run valuation effect of index inclusion (Broner et al., 2021; Shleifer, 1986). It is useful to analyze how index inclusion affects the slope of the demand curve. When there is an exogenous increase in the benchmark weight, a rising index weight increases the sensitivity of demand to a rising price, $\frac{\partial^2 B^d}{\partial q \partial w^b} > 0$. This result holds regardless of how the weighting function is specified. In other words, the inactive components of demand imply that demand becomes more *inelastic*.

3.2.4 Exposure to index inclusion and bond price volatility

I analyze the impact of changes in fundamental risk that leads to an unexpected currency devaluation, represented by a rise in s_0, and a lower expected repayment value, represented by a decline in $\mathbb{E}(\psi_0)$. I perform a first-order approximation of the market clearing condition. I use $\wedge$ to denote the log deviation from the initial value in the secondary market. To simplify notation, I define the following variables: $V_0 \equiv (1+r^f)D_0 \operatorname{Var}(\frac{s_0(1-d_1)}{s_1})$, $R_0 \equiv \mathbb{E}(\frac{s_0(1-d_1)}{s_1})$, $w_0 \equiv \frac{s_0^{-1}B}{y_0 D_0}$, and $\epsilon^b \equiv \frac{\partial w^b}{\partial(s_0^{-1}B/y_0)} \cdot \frac{s_0^{-1}B}{y_0}$.

The impact consists of supply-side effects through the devaluation of the dollar value of the debt, both directly due to the impact of changes in fundamental risk on the exchange rate and indirectly through the response of bond prices, as shown in (1) in equation 9. This effect includes changes in the value of outstanding bonds (a) and the benchmark weight (b).

$$
\begin{aligned}
\Big[1+\frac{(1+r^f)V_0}{R_0 y_0 E_\gamma}\overbrace{\Big(\underbrace{w_0}_{(a)}-\underbrace{\epsilon^b(1-\mu)(1-\alpha)}_{(b)}\Big)}^{(1)}\Big]\hat{y}_0 = \underbrace{-\Phi_R}_{(2)}\,\hat{z}_0 + \\
\Phi_v \hat{z}_0 \frac{(1+r^f)V_0}{R_0 y_0 E_\gamma}\underbrace{\big(w_0-(1-\mu)(1-\alpha)w_0^b\big)}_{(3)} + \\
\Phi_s \hat{z}_0 \frac{(1+r^f)V_0}{R_0 y_0 E_\gamma}\big(\big(-w_0+\epsilon^b(1-\mu)(1-\alpha)\big)
\end{aligned}
\tag{9}
$$

On the demand side, changes in fundamental risk affect bonds through direct impacts on the expected value in part (2) and indirect effects on risk premium of active portfolios (3). Changes in fundamental risk have direct impacts on the risk premium, as in $\Phi_v \equiv \frac{z_0}{V_0}\frac{\partial V_0}{\partial z_0}$, the expected return, as in $\Phi_R \equiv \frac{z_0}{R_0}\frac{\partial R_0}{\partial z_0}$, and the exchange rate, as in $\Phi_s \equiv \frac{z_0}{s_0}\frac{\partial s_0}{\partial z_0}$. The key effect of creditor composition works in part (3): a higher θ_0 implies a higher w_0^b, and hence the risk factor shock affects less outstanding debt. Rewriting the above expression by substituting w_0^b with θ_0 yields the following result.

Proposition 1 *The following relationship holds in the secondary market*

If $w^b > 0$, *then*

$$\hat{y}_0 = \big(-\Phi_s + \Phi_1\left(-\Phi_R + \Phi_s + \Phi_v\Phi_2\right)\big)\,\hat{z}_0$$

where $\Phi_1 = \left(1 + \frac{w_0 - \epsilon^b(1-\mu)(1-\alpha)}{\phi + \frac{E\gamma}{(1+r^f)V_0}}\right)^{-1}$, $\Phi_2 = \frac{\phi}{\phi + \frac{E\gamma}{(1+r^f)V_0}}$, *and* $\phi \equiv (1-\theta_0)w_0(1 + \frac{(1-\mu)\gamma_H}{\mu\gamma_L})$. *The term* Φ_1 *and* Φ_2 *are decreasing in* θ_0 *when* $w_0 > \epsilon^b(1-\mu)(1-\alpha)$.

If $w^b = 0$, *then* $\phi = w_0$ *and* θ_0 *does not enter into the term* $\Phi_1\left(-\Phi_R + \Phi_s + \Phi_v\Phi_2\right)$.

Appendix C.2 shows the proof.

If a rising z_0 represents a negative shock that depreciates the currency, lowers the expected repayment, and raises the yield, then

$$\frac{\partial \hat{y}_0}{\partial \hat{z}_0} = -\Phi_s + \Phi_1\left(-\Phi_R + \Phi_s + \Phi_v\Phi_2\right) > 0$$

Currency devaluation implies that $\frac{\partial s}{\partial z} > 0$ and $-\Phi_s < 0$. Given that $\Phi_1 > 0$ under the assumption $w_0 > \epsilon^b(1-\mu)(1-\alpha)$. The term $\left(-\Phi_R + \Phi_s + \Phi_v\Phi_2\right)$ must be greater than zero for the yield to rise.

The above proposition implies the following

$$\frac{\partial^2 \hat{y}_0}{\partial \hat{z}_0 \partial \theta_0} \begin{cases} \frac{\partial \Phi_1}{\partial \theta_0}\left(-\Phi_R + \Phi_s + \Phi_v\Phi_2\right) + \Phi_1\Phi_v\frac{\partial \Phi_2}{\partial \theta_0} < 0, & \text{if } w^b > 0, \Phi_v > 0, \text{ and } w_0 > \epsilon^b(1-\mu)(1-\alpha) \\ = 0, & \text{if } w^b = 0 \end{cases} \tag{10}$$

A prediction of the current model with benchmarks is that the higher θ_0 is, the smaller the changes in bond yields. Other than the requirement of the weighting function, the prediction only requires that the shock to fundamental risk increases the volatility of the expected return, which depends on changes in the exchange rate s_0 and the expected value of repayment ψ_0. This condition is likely to be met when the shock generates a large currency deviation.

When the valuation effect on index weights is small ($w_0 - \epsilon^b(1-\mu)(1-\alpha) > 0$), as θ_0 increases, the coefficients Φ_1 and Φ_2 decrease[8]. Therefore, changes in fundamental risk have a smaller impact on bond yields when θ_0 is high. Another feature is the term w_0 enters the expression $\Phi_1\left(-\Phi_R + \Phi_s + \Phi_v\Phi_2\right)$. This suggests constructing the empirical counterpart of w_0 when testing the model's prediction. The second part of the proposition says that θ_0 would not affect the sensitivity of changes in fundamental risk to bond yields if benchmarks were irrelevant to portfolio decisions. This is intuitive because θ_0 reflects the current unexpected changes in risk that drives expected returns and should not predict future changes in risk, which in turn determines changes in yields.

[8] ϵ^b is generally small. See footnote 20 for additional information.

Index inclusion and bond price volatility Does index inclusion make asset prices less or more volatile to the global risk factor? The answer to this question depends on

$$\frac{\partial \hat{y}_0}{\partial \hat{z}_0}|_{\text{exclusion}} - \frac{\partial \hat{y}_0}{\partial \hat{z}_0}|_{\text{inclusion}}$$

and ultimately on how index inclusion changes the value of $\Phi_1(-\Phi_R + \Phi_s + \Phi_v \Phi_2)$. As Φ_2 decreases upon index inclusion, the volatility depends on Φ_1, whose value decreases if $w^b - \epsilon^b - \frac{E_\gamma}{(1+r^f)V_0}\frac{\epsilon^b}{w^b} > 0$. A sufficient condition for reduced volatility is that the benchmark weight is insensitive to changes in current bond prices ($\epsilon^b = 0$). In practice, benchmark weights are infrequently updated, and accordingly $\epsilon^b = 0$, implying that the Φ_1 term decreases and index inclusion reduces volatility from the global risk factor. The following proposition summarizes the result.

Proposition 2 (Equivalence) *When index weights are infrequently updated, there is no response of the weight to changes in current prices. This weighting rule is a sufficient condition for reduced bond price volatility to changes in fundamental risk. The impact of index inclusion*

$$\frac{\partial \hat{y}_0}{\partial \hat{z}_0}|_{exclusion} - \frac{\partial \hat{y}_0}{\partial \hat{z}_0}|_{inclusion} \tag{11}$$

to the first order is $-\gamma$, which can be estimated from

$$\hat{y}_0 = \alpha \hat{z}_0 + \beta \hat{z}_0 \times w_0 + \gamma \hat{z}_0 \times w_0 \times \theta_0$$

Appendix C.3 shows the proof. This proposition also states that, to the first order, the effect of index inclusion on the transmission of global shocks to bond prices is identical to the coefficient on the EM fund share (i.e. the measure of exposure to index inclusion) in an OLS regression.

"Index inclusion" refers to adding a country to existing benchmark indices. Identifying the causal effect of a binary treatment like this often employs methods such as difference-in-difference or event studies. This proposition suggests an alternative approach by leveraging the extend to which a bond is held by investors whose benchmark index includes this bond, which is summarized in θ_0. The counterfactual for index exclusion is equivalent to θ_0 being zero.

4 Empirical results: exposure to index inclusion and the pass-through of fundamental risk to bond yields

This section describes the research design based on the framework in the previous section. I first define an empirical measure of exposure to index inclusion, which is analogous to the variable θ_0 defined in Eq. 3 previously. For the bond i issued by country $c(i)$, θ_{it} measures the proportion of a bond's market value held by mutual funds benchmarked to indices that include the issuer, relative to the market value held by all global funds in the sample.

$$\theta_{it} = \frac{\sum_f H_{ift} \times \mathbb{1}(c(i) \in \mathcal{B}_{ft})}{\sum_f H_{ift}}$$

where H_{ift} is the market value in dollars of a bond held by mutual fund f. The indicator $\mathbb{1}(c(i) \in \mathcal{B}_{ft})$ switches on when the issuing country $c(i)$ of bond i is included in the benchmark index $\mathcal{B}_{ft}$ used by the mutual fund f.

In addition to this term, I discuss the regularity of data that the research design needs to accommodate. The first one is the choice of a proxy for fundamental risk. The previous framework shows that the nature of fundamental risk, whether it originates from global output shocks or US monetary policy shocks, does not matter as along as the fundamental risk affects the expected returns of EM LC bonds. For example, in the case of output shocks, this fundamental risk affects a countries' incentives to impose capital controls—that is, to "default" on debt payments—and hence the expected return. Throughout this paper, I focus on a proxy based on the VIX, which is correlated with the global risk factor. Although the VIX is commonly used in studies of the global finance cycle, it is desirable because the VIX or the global risk factor is likely to affect the volatility of the expected return of EM LC bonds. As shown in the previous framework, changes in variance are a sufficient condition for a reduction in bond price volatility under index inclusion.

The second regularity I address is the unobserved investors, those domiciled in either in EM domestic markets or foreign countries investing EM LC bonds but without known positions. As shown in the summary statistics in Appendix Table E.5, the coverage, defined as the average market value relative to the amount issued, ranges from 5% to 10%. I address the presence of unobserved positions by controlling for the extent to which a bond's position is observed in my sample. My preferred measure is

$$I_{\text{fund},it} = \frac{\sum_f H_{ift}}{\sum_f \text{Total Asset}_{f(i)t}} \tag{12}$$

This measure is the market value of a bond held by investors in the dataset divided by the total market value of assets invested by these funds. $I_{\text{fund},it}$ measures the proportion of the market value of a bond held by global funds relative to the total net assets of the funds holding it. This measure is a direct analog of $w_t = s_t^{-1} q_t B_t / D_0$, the market value relative to the funding D_0, as defined in the previous section. I also check for robustness by using face values to construct $I_{fund,it}$ and θ_{it}. $I_{fund,t}$ represents the proportion of the face value in local-currency units of a bond held by funds relative to the total issuance in local-currency units.

$$I_{\text{fund},it} = \frac{\sum_f H_{ift}^{face}}{\text{Amount Issued}_i}$$

where the face values of holdings H_{ift}^{face} and the amount of a bond issued Amount Issued_i are both in local-currency units.

The previous conceptual framework estimates the causal effect of index inclusion at the bond level and assumes that bonds with identical characteristics issued by the same country are traded in segmented financial markets. If bonds are not traded in segmented financial markets, investors should arbitrage among bonds with the same issuer. This introduces many complications. For example, arbitrage implies that the demand for a bond depends on the benchmark weight of this bond and on all other bonds issued by the same country. An omitted variable bias arises when the benchmark weights are not controlled for. In Appendix Table E.7, I show that there can be differences of up to 20bp in the yield-to-maturity of bonds with similar characteristics. This persistent difference indicates that bonds are likely to be traded in segmented financial markets and supports a bond-level empirical design without controlling for the demand of all other bonds from the same issuer.

Another limitation of the data is that, at the bond level, my classification does not distinguish whether an index includes a specific bond. I address this issue by selecting sovereign bonds eligible for the JP Morgan GBI-EM Index, which has the most stringent eligibility criteria. These bonds are likely to be included in other bond indices with less stringent criteria.

After accounting for the above data-related regularities, the following empirical specification is adapted from the previous conceptual framework by comparing outcomes for bonds with different exposure to index inclusion.

$$\begin{aligned}\log(1+y_{it+h}) - \log(1+y_{it-1}) = {} & \beta^h \Delta\log(\text{VIX}_t) \times I_{\text{fund},it-1} + \gamma^h \Delta\log(\text{VIX}_t) \times I_{\text{fund},it-1} \times \theta_{it-1} \\ & + \alpha_i^h + \alpha_{c(i)t}^h + \Gamma^h \mathbf{X}_{it} + \epsilon_{it}, \quad h = 0, 1, ..., 8\end{aligned} \tag{13}$$

The focus is on the coefficient γ— the effect of index inclusion on the pass-through of the VIX to yields. The vector $\mathbf{X}_{it}$ includes $I_{\text{fund},it-1}$, θ_{it-1}, and bonds' residual maturities.

The identification of the effect of index inclusion on volatility requires the following assumptions.

1. Exogenous holdings: $\mathbb{E}(\Delta\log(\text{VIX}_t) I_{\text{fund},it-1}\theta_{it-1}\epsilon_{it}|\mathcal{F}_{it}) = 0$, where $\mathcal{F}_{it}$ includes all the controls.

2. "Parallel trend": $\Delta log(\text{VIX}_t)$ affects the yields of bonds regardless of the identity of investors when the issuing country of these bonds is excluded from any benchmark index used by investors.

Given the definitions of θ_{it} and $I_{\text{fund},it-1}$, the first assumption can be rewritten as

$$\mathbb{E}(H_{ift-1} \times \mathbb{1}(c(i) \in \mathcal{B}_{ft-1}) \times \epsilon_{it} | \Delta \log(\text{VIX}_t), \mathcal{F}_{it}) = 0 \quad \forall f \tag{14}$$

The main challenge in testing the model is the sorting of countries into indices and the selection of investors into holding a country's assets based on factors, often unobserved, other than the expected return and the benchmark weights.[9]

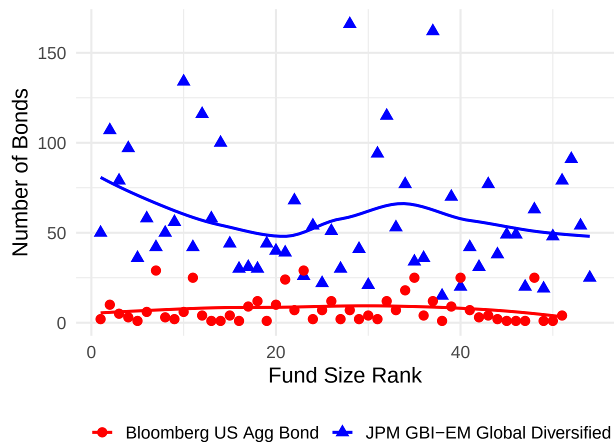
I address the endogeneity of index status $\mathbb{1}(c(i) \in \mathcal{B}_{ft-1})$ by using country × time fixed effects. These fixed effects also absorb any country-level macroeconomic policy that influences the demand H_{ift-1}. Another concern is that H_{ift-1} is still correlated with unobserved time-varying bond-level factors. I address this by showing that investors often achieve their targeted country weights in their portfolios and that the choice of the exact bonds used to replicate the desired country weights exhibits randomness. In other words, investors have idiosyncratic preferences for bonds with similar characteristics from the same issuers. I provide support for this in Figure 1. I show that among investors tracking two popular indices, there are variations in the number of EM LC bonds in their portfolios. Investors benchmarked to the JP Morgan GBI-EM Global Diversified Index hold, on average, 50 different bonds out of 290 bonds with similar characteristics (other than their currency of denomination) observed in the sample in Q4 2019. The number of varieties is uncorrelated with the size of the investor (i.e. assets under management). Moreover, investors benchmarked to the Bloomberg U.S. Aggregate Bond Index, which excludes EM LC bonds, generally hold fewer than ten varieties of EM LC bonds. This case study of two indices indicates that investors have idiosyncratic preferences for varieties. This idiosyncrasy suggests that the relative market value of holdings H_{ift-1} among bonds from the same issuer is likely to be random after using country×time fixed effects.

Table 3 presents the summary statistics of key variables: bond-level funding, $I_{\text{fund},it}$, and exposure to index inclusion, θ_{it}, and their residual values after controlling for the covariates of residual maturity, bond and country×time fixed effects. On average, θ_{it} is 59.85%, with a standard deviation of 20.35%. These values align with the notion that mutual funds often invest in assets outside their performance benchmarks' underlying asset class. The last column in Table 3 shows considerable variation in exposure to inclusion even after controlling for country × time fixed effects.

In Figure 2, Panels 2a) and 2b) show that a one percent increase in the VIX raises bond yields, with the peak effect of 0.09 percent occurring three quarters after the impact. Greater exposure to

[9]Similar reasons introduce bias in difference-in-differences strategies. Countries excluded from an index may seek to join one and implement policies to reduce financial market volatility. This, in turn, makes investing in these countries more profitable, leading global financial service providers to add assets from these countries to their indices. Given the institutional feature in which financial service providers survey asset managers about their opinions on the assets in the index they are using, the assumption of no anticipatory effect is violated. Investors may find EM countries profitable for investment and, hence, lobby index providers to add these assets.

Figure 1: Idiosyncrasy of bond holdings



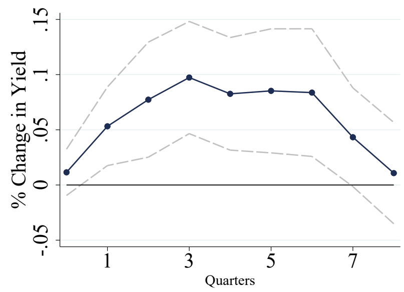
Notes: This figure shows the number of bonds held by investors using the "JP Morgan GBI-EM Global Diversified (Total Return in Dollars)" (in *blue triangles*) and "Bloomberg US Aggregate Bond (Total Return in Dollars)" (in *red circles*) as primary benchmarks in Q4, 2019. The total number of unique bonds every held by investors in the sample are about 290 bonds issued from fifteen emerging market countries (BR, CO, CL, CZ, HU, ID, IL, MY, MX, PE, PH, PL, RO, RU, TH, TR, ZA). These bonds are all issued in domestic markets in these emerging market countries. They all have residual maturities greater than one year, issuance amount greater than one billion dollars, and non-zero fixed coupon payments. Investors are ranked by the asset under management in Q4, 2019 among investors of the same primary benchmarks. LOESS lines are plotted.

index inclusion reduces the impact of the VIX on bond yields, with the reduction peaking at 0.11 percent four quarters after the impact. Both estimates are significant at the 90% confidence level under robust standard errors.

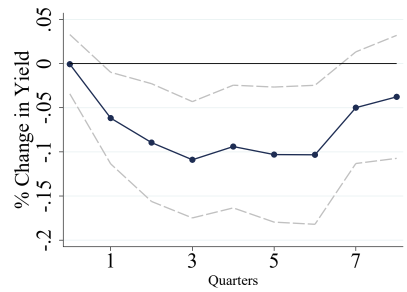
In Figure 2, Panels 2c) and 2d) confirm the previous results under specifications using face values to construct $I_{\text{fund},it}$. Moreover, within this specification, I divide bonds based on whether they are issued in the global or domestic market. Panels F.6a) and F.6b) in Figure F.6 in the appendix show that the response of global bonds is much more pronounced.

I also check for robustness by interacting $\Delta\log(\text{VIX}_t)$ with two additional time-varying controls: $\bar{I}_{fund,c(-i)t-1}$ and $\bar{I}_{fund,c(-i)t-1} \times \bar{\theta}_{c(-i)t-1}$. $\bar{I}_{fund,c(-i)t}$ averages the fund credit supply across all bonds issued by country c, excluding bond i at time t. The same method is applied to construct a leave-one-out average of exposure to index inclusion, $\bar{\theta}_{c(-i)t}$. These two controls capture the influence of all other bonds issued by the same country. In Appendix Figure F.6, Panels F.6c) and F.6d) show that the effect of index inclusion becomes slightly more negative, with a peak reduction of 0.14 percent.

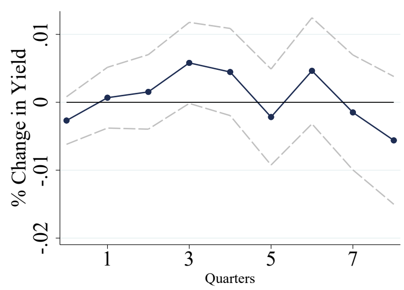
Figure 2: Effects of index inclusion



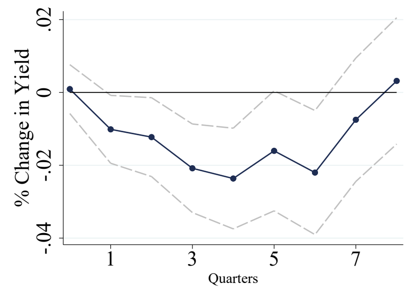
(a) VIX, fund holding effect (market value measures)



(b) VIX, index inclusion effect (market value measures)



(c) VIX, fund holding effect (face value measures)



(d) VIX, index inclusion effect (face value measures)

Notes: These figures show the responses of bond yields to changes in the VIX. The "fund holding effect" refers to the effect of the interaction term $\Delta ln(VIX_t) \times I_{\text{fund},it-1}$. $I_{\text{fund},it-1}$ controls the share of bonds held by mutual funds observed in the sample. It is the total market value of bonds observed in the sample divided by the net assets of mutual funds holding these bonds. The "index inclusion" effect refers to the effect of the interaction term $\Delta ln(VIX_t) \times I_{\text{fund},it-1} \times \theta_{it-1}$. θ_{it-1} measures exposure to index inclusion. It is the share of investors who benchmark to indices with the issuing country of bond i. The sample of bonds is restricted to bonds with issuance greater than one billion dollars and residual maturities greater than two years. Dotted lines plot the 90% robust standard error bands.

Table 3: Bond-level summary statistics

	Funding	EM fund share	Funding residualized	EM fund share residualized
Mean	0.78	59.85	0.00	0.00
Median	0.70	62.35	-0.04	1.17
Std Dev	0.43	20.35	0.40	18.27

Note: This table summarizes the measures of funding, $I_{\text{fund},it}$, and EM fund share, θ_{it}, and the residual values of them after controlling covariates in eq (13), (residual maturity and country × time and bond fixed effects). Statistics are computed at the bond level, then averaged across bonds. The sample includes 650 bonds with an issuance amount exceeding one billion dollars and a residual maturity of more than two years, denominated in the following currencies: BRL, CLP, COP, CZK, HUF, IDR, ILS, MXN, MYR, PEN, PLN, RON, THB, TRY, and ZAR.

5 An instrument variable approach based on random purchases prior to index inclusion

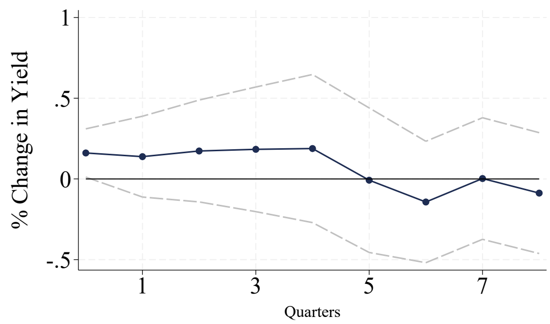
There are still concerns that the portfolios of EM funds are correlated with unobserved bond-level, time-varying factors. One possible source of this correlation comes from time-varying bond weights. As index providers update bond weights on a monthly or quarterly basis, investors may anticipate rising index weights and increase their holdings. I address the concern by examining the holdings of bonds by EM funds for a country prior to that country's index inclusion. I use the portfolio share prior to index inclusion to predict the future portfolio share upon inclusion because bond-level index weights do not influence portfolios before index inclusion occurs.

I use a subsample of holdings to construct the instrument for θ_{it}. I select holdings from Dollar funds and a subsample of investors whose benchmark indices experience at least one episode of an EM country's inclusion. Only bonds from Colombia and Romania experience changes in index status, conditional on the same investor holding the bond.

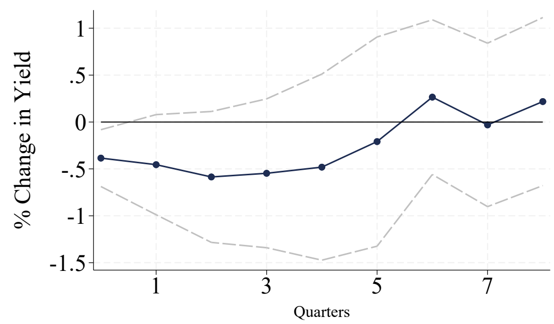
To construct the instrument, I rewrite the exposure term θ_{it} as the sum of the product of the portfolio weight of the bond i, w_{ift}, an indicator for index status, $\mathbb{1}(c(i)_t \in \mathcal{B}_{ft})$, net assets, D_{ft}, and a bond-level term κ_{it}.

$$\theta_{it} \equiv \sum_{f \in \mathcal{J}} \underbrace{\frac{1}{\sum_{f \in \mathcal{J}} H_{ift}}}_{\kappa_{it}} H_{ift} \mathbb{1}(c(i)_t t \in \mathcal{B}_{ft}) = \sum_{f \in \mathcal{J}} w_{imt} \mathbb{1}(c(i)_t \in \mathcal{B}_{ft}) D_{ft} \kappa_{it}$$

Figure 3: Effects of index inclusion using an IV approach



(a) VIX, fund holding effect



(b) VIX, index inclusion effect

Notes: These figures show the responses of bond yields to changes in the VIX. The "fund holding effect" refers to the effect of the interaction term $\Delta ln(VIX_t) \times I_{\text{fund},it-1}$. $I_{\text{fund},it-1}$ controls the share of bonds held by mutual funds observed in the sample. It is the total market value of bonds observed in the sample divided by the net assets of mutual funds holding these bonds. The "index inclusion" effect refers to the effect of the interaction term $\Delta ln(VIX_t) \times I_{\text{fund},it-1} \times \theta_{it-1}$. θ_{it-1} measures exposure to index inclusion. It is the share of investors who benchmark to indices with the issuing country of bond i. The sample of bonds is restricted to bonds with issuance greater than one billion dollars and residual maturities greater than two years. Currencies are COP and RON. Mutual funds are restricted to funds benchmarked to indices that do not include bonds denominated in COP and RON and to indices that have experienced inclusion events. I use the portfolio weight prior to index inclusion in the measure of exposure to index inclusion and use this measure as an instrument to θ_{it}. Dotted lines plot the 90% robust standard error bands.

The identification requires:

$$\mathbb{E}\left(w_{ift-1}\mathbb{1}(c(i) \in \mathcal{B}_{ft})D_{ft-1}\epsilon_{it}|\Delta ln(VIX_t), \kappa_{it-1}, \mathcal{F}_{it}\right) = 0 \forall f$$

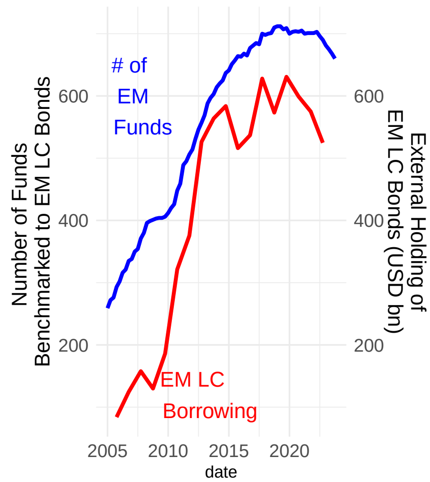
I use the portfolio weight prior to index inclusion to predict the actual portfolio weight w_{ift-1} and construct an instrument $\hat{\theta}_{it-1}$ for θ_{it-1}. I exploit the fact that the relative portfolio weights of bonds with almost identical characteristics from the same issuers are likely to be exogenous when the issuing country is excluded from any index.

$$\hat{\theta}_{it-1} = \sum_{f \mathcal{J}_1} \hat{w}_{ift-1} \times D_{ft-1} \times \kappa_{it-1}$$

where $\hat{w}_{ift-1}$ is the portfolio weight in the quarter just prior to index inclusion.

Figure 3 shows the response of yields to changes in the VIX using the instrument for the exposure term θ_{it}. Index inclusion reduces the response by 0.5 percent to every one percent increase in the VIX. The magnitude is about four times larger than that estimated from the main specification. Despite this difference, the result still points to reducing asset price volatility upon inclusion.

Figure 4: Benchmark usages and EM LC borrowing



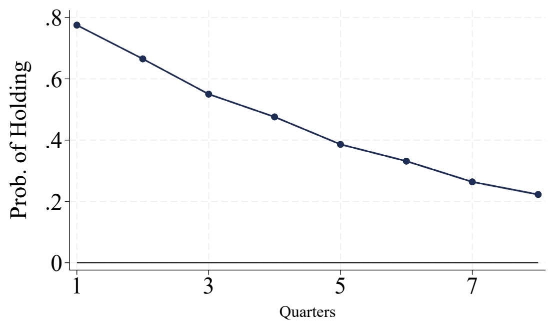
Notes: To measure the number of EM funds over time, I obtain a list of EM funds based on the binary classification of their benchmark indices. Given that each fund has multiple share classes, I use the earliest inception date and the latest obsolescence date among share classes as a fund's survival period. The total EM LC borrowing is calculated by summing the total externally held debt from EM countries (BR, CO, CL, CZ, HU, ID, IL, MY, MX, PE, PH, PL, RO, RU, TH, TR, ZA) using data from Onen et al. (2022). In the borrowing data, the valuation is in the face value of debt in dollars whenever the data is available.

6 Robustness

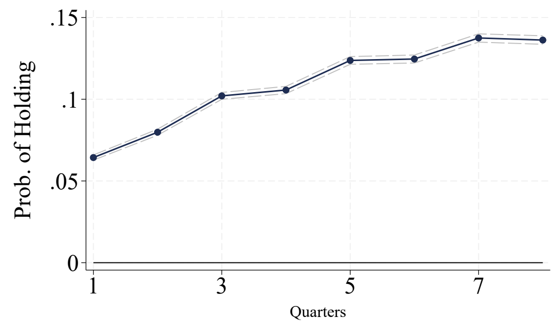
The identification in the main empirical specification of exposure to index inclusion assumes that the effect of the VIX on bond prices is uncorrelated with the identity of the investor when the issuer of the bonds is excluded from every index. Through a stylized model of international lending, the previous section shows that the inherent heterogeneity in trading strategies, approximated by differences in risk aversion, is not a concern. However, EM funds have experienced rapid entry in the past decades, and they generally have "stickier" portfolios when holding EM LC bonds. I elaborate on this point below.

Figure 4 compares the number of EM funds to the total face value of externally held EM LC bonds over the past two decades. The two statistics show a correlation: the stagnation in fund entries around the 2008 financial crisis corresponded with a decline in borrowing, and both the number of EM funds and borrowing plateaued in 2018 before subsequently declining. Given that the net assets of each EM fund have remained stable over time, this correlation suggests that the sorting of funds as EM funds contributes to the fluctuations in the holdings of EM LC bonds by EM funds. To further examine the "stickiness" of portfolio holdings, I use the current bond ownership status to predict its future status within two years. Specifically, I estimate this at the bond level,

Figure 5: Extensive margin of fund holdings



(a) Extensive margin, fund holding effect



(b) Extensive margin, index inclusion effect

Notes: For a bond currently in a fund's portfolio, these two graphs show the hazard rate that a fund continues holding this bond for two years conditional on the date being one year before a fund's liquidation. The estimation controls bond and country-time fixed effects. The first graph shows the hazard rate of dollar funds, and the second shows the difference in hazard rates between dollar and EM funds.

both with and without conditioning on a fund's survival. I estimate

$$D_{if,t+h} = \alpha_i + \alpha_{c(i)t} + \beta D_{if,t} + \gamma D_{if,t} \times \mathbf{1}\{i(c) \in \mathcal{B}_{ft}\} + \epsilon_{ift}$$

where the indicator of holdings $D_{if,t}$ switches on if fund f holds bond i. The indicator $\mathbf{1}\{i(c) \in \mathcal{B}_{ft}\}$ is equal to 1 if an EM fund holds bond i. β indicates the persistence of asset ownership, while γ indicates the difference in ownership between EM and Dollar funds. $D_{if,t+h}$ for $1 \le h \le 8$ may switch from 1 to 0 when a fund sells a bond or when a fund is liquidated. To examine the contribution of liquidation to observed positions, I estimate the model conditional on the fund not being liquidated during the entire period from t to $t + h$. Appendix Figure F.5 shows estimates that are unconditional on fund liquidation. After two years, the probability of holding a bond is only 20% for Dollar funds, whereas EM funds have a slightly higher probability of holding the same bond. Fund liquidation plays a minimal role in this observed pattern.

This section provides additional support showing that persistent differences between EM and Dollar funds are not a concern for identification. I first show preliminary results using another proxy for changes in fundamental risk. I then use Colombia as a case study to show that the identity of investors is indeed irrelevant prior to a country's index inclusion. Finally, I directly estimate the demand elasticity of investors benchmarked to EM LC bonds and connect the elasticity estimates to the existing literature.

6.1 Alternative proxy of fundamental risk

The VIX correlates with a global risk factor and common components of EM exchange rates. However, the fundament risk driving changes in the VIX is not well identified. A major concern arises from omitted variable bias, where the VIX may be more correlated with changes in assets under management of investors who do not benchmark to EM LC bonds. During the global downturn, investors using indices without EM assets may experience a larger drop in funding and be forced to liquidate their holdings. I address this concern by presenting results using a proxy for fundamental risk that originates from individual emerging market countries and is uncorrelated with global conditions. I achieve this by constructing short-term LC interest rate shocks originating from monetary policy shocks in individual countries.

Changes in the short-term interest rate pass through to the yields of long-term bonds. A shock reducing the short-term interest rate is considered a shock that reduces the expected return of long-term bonds. Index inclusion would reduce the degree of pass-through. However, the shock originating from EM countries is less likely to be correlated with changes in the funding of mutual funds, as individual countries account for a small portfolio weight among global investors in the sample. I use monetary policy shocks identified in six EM countries as proxies for short-term interest rate shocks. The results in this section are the weakest in the paper, and future tasks should extend the sample of countries and provide a more thorough analysis.

These shocks are identified using changes in forward premia around monetary policy announcements. I collect the dates of EM monetary policy press releases from central banks and measure changes in the one-year forward premium within a four-day window around each release, specifically calculating the difference between the two-day average before and after the release. Short-term LC interest rates y_t^{LC} depend on the CIP wedge λ_t, the U.S. short-term rate $y_{US,t}^{\$}$, and the forward premium $fp_{c,t,t+1} = \frac{F_{lc/\$,t,t+1}}{E_{lc/\$,t}}$, as shown below. The identifying assumption is that the unexpected component of the monetary policy announcement does not affect the CIP wedge or U.S. interest rates. Witheridge (2024) empirically assesses this assumption and demonstrates that this high-frequency approach identifies EM monetary policy shocks.

$$y_t^{LC} \times \lambda_t = y_{US,t}^{\$} \frac{F_{lc/\$,t,t+1}}{E_{lc/\$,t}} \tag{15}$$

Let $\Delta \tilde{y}_t^{LC}$ denote the monetary policy shock. I calculate changes in bond yields $\Delta \log(1 + y_{ict})$ as the difference between the 7-day average yields before and after the monetary policy press release. I then estimate how short-term borrowing rates pass through to the actual borrowing costs of long-term bonds y_{it} across different bonds using the baseline specification, which includes country-time and bond fixed effects.

The estimates in Table 4 show that bond ownership by EM funds reduces the pass-through of short-term interest rate shocks to long-term bond yields. The overall point estimate of the interaction term with exposure to index inclusion is negative.

Table 4: Pass through of EM short-term interest rate shocks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\Delta \log(1 + y_{ict})$	All	Brazil	Colombia	Mexico	Peru	Philippines	Turkey
$\Delta\tilde{y}^{lc}_{c,t} \times I_{\text{fund},it-1}$	2.185*	0.598	-1.904	3.631**	1.407	1.334	3.321
	(0.949)	(1.699)	(1.050)	(1.110)	(1.681)	(0.778)	(5.777)
$\Delta\tilde{y}^{lc}_{c,t} \times I_{\text{fund},it-1} \times \theta_{i,t-1}$	-1.852	2.953	10.23	-3.293*	5.519	-1.274	-5.036
	(1.213)	(4.465)	(17.01)	(1.561)	(3.563)	(0.939)	(8.713)
Obs	8261	371	961	1439	1052	2917	1521

Notes: All specifications include country-time and bond fixed effects. Time-varying controls are residual maturities, the amount held by global funds, and the share held by EM funds. * $p < 0.1$,** $p < 0.05$ *** $p < 0.01$

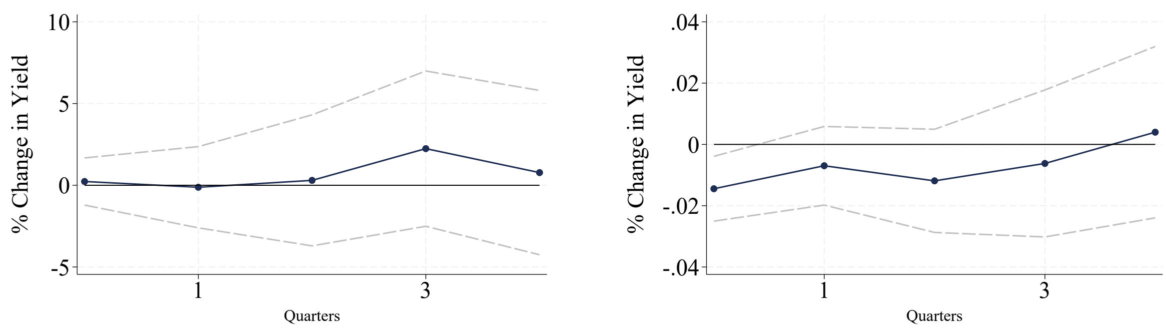
6.2 Falsification test

Another explanation for the existing results is that investors who do not use benchmarks with EM LC bonds face tighter financial constraints than those who use benchmarks that include EM LC bonds. Possible financial frictions include the costs of raising funds from households and value-at-risk constraints in risk management. These frictions suggest that investors benchmarked to EM assets are likely to maintain a sticky portfolio of EM LC bonds, thereby dampening the transmission of shocks through their bond ownership.

If this explanation holds true, then these investors would reduce the impact from fundamental risk even before a country's index inclusion. I use Colombia's inclusion in the JP Morgan GBI-EM Index to test this prediction. Specifically, investors benchmarked the JP Morgan GBI-EM Index should not affect price sensitivity to the VIX before Colombia's index inclusion in 2014, whereas the same investors should reduce sensitivity after index inclusion.

Colombia serves as an ideal case study due to its significant post-inclusion index weights and consistent domestic current account policies over the past two decades. Despite having foreign capital gains withholding taxes, Colombia did not impose explicit capital flow controls. The proportion of LC bonds held externally by global funds exceeded 20% even before 2014. The next big index inclusion event for Colombia was its inclusion in the Bloomberg Global Aggregate Index in September 2020. Therefore, I focus on global funds benchmarked to JP Morgan GBI-EM indices and analyze the period between 2009 and 2019 to avoid the impact of two global crises and the second major index inclusion event.

Figure 6: Falsification test using pre-inclusion periods



(a) Pre-inclusion effect (2009 to 2013)

(b) Post-inclusion effect (2014 to 2019)

Notes: This graph come from estimating the baseline specification for Colombia. To construct creditor composition measure, I use a subsample of EM funds whose benchmarks include JPM GBI-EM family indices. The graph presents a 90% confidence band from robust standard errors.

Like the baseline, I include bond fixed effects and time fixed effects. I use the face value of holdings to construct $I_{fund,it}$ and θ_{it}, as in Figure 2 panels e) and f). Colombia saw the index inclusion into the JP Morgan GBI-EM index family. Figure 6 graphs the cumulative impact of the VIX on yields over a year during the pre-inclusion period 2009q1 $\leq \{t+h|h,t\} <$ 2014q1 and the post-inclusion period 2014q1 $\leq \{t+h|h,t\} <$ 2020q1. θ_{it-1} is the measure of exposure to investors benchmarked to the JP Morgan GBI-EM Index family. The point estimates change from zero to negative between the two periods. Existing theories based on financial frictions cannot explain why the same types of funds would not affect the pass through of the VIX to bond prices before Colombia's index inclusion but dampen the shock thereafter.

6.3 Further empirical supports from demand elasticity estimated using flow-induced demand shocks

I perform an additional exercise to connect this paper with the existing evidence on the demand elasticity of global mutual funds. I construct bond-level demand shocks by exploiting idiosyncratic funding outflow shocks. Capital outflows from mutual funds reduce the size of these funds and their demand for EM sovereign bonds. This part follows Zhou (2023), which uses funding flows to construct an instrument for bond prices. Similarly, Sander (2019) uses changes in mutual funds' funding to construct an instrument for capital flows to emerging economies. The demand shock

Z_{it} to bond i due to the funding outflows by global mutual funds depends on a share term share_{ift} and a shifter term $\tilde{g}_{ft}$. share_{ift} is the lagged value of a bond in fund f's portfolio relative to the total market value of this bond held by global mutual funds.

The shifter term attempts to capture funding outflows (i.e. a mutual fund's assets under management) due to fund-specific conditions unrelated to broad macroeconomic conditions. Denote g_{ft} as the reduction in funding, normalized by the size of the mutual fund in the previous period, $g_{ft} \equiv -\frac{D_{f,t}-D_{f,t-1}}{D_{f,t-1}}$, where $D_{f,t}$ is assets under management.

$$Z_{i,t} = \sum_{f\in\mathcal{J}(i)_t} \text{share}_{ift} \times \widehat{\tilde{g}}_{ft} = \sum_{f\in\mathcal{J}(i)_t} \left(\frac{w_{if,t-1}D_{f,t-1}}{\sum_f w_{if,t-1}D_{f,t-1}} \right) \times \widehat{\tilde{g}}_{ft}$$

Since mutual fund returns directly affect outflows, I extract outflows unrelated to a fund's return. $\widehat{\tilde{g}}_{ft}$ is the residual of funding flows obtained by estimating

$$g_{ft} = \alpha_t + \sum_{l=-1}^{L=2} \beta_l r_{f,t-l} + \tilde{g}_{ft} \tag{16}$$

The construction of the demand shock is similar to a shift-share instrument. The assumption is that the funding shock $\widehat{\tilde{g}}_{ft}$ is as good as randomly assigned to each fund, such that each mutual fund is expected to face identical funding shocks regardless of the unobservable factors affecting a fund's choice of bond i in its portfolio (Borusyak et al., 2022). Moreover, the credibility of these demand shocks depends on the exogeneity of the lagged value of the portfolio weight. I focus on using funding outflows from investor that use indices without any EM LC bonds to construct the demand shocks. The reason is that the portfolio weights of these investors are more likely to exhibit idiosyncratic variation uncorrelated with bond returns. Whenever bonds are included in an investor's benchmark, a reserve causality concern arises because a bond with a higher expected return is likely to have a higher index weight and thus create an incentive for investors to hold more of it. In other words, I use Dollar funds to construct demand shocks to estimate the demand elasticity of EM funds.

I estimate demand elasticity by regressing changes in bond prices on changes in the face value of bond holdings. Bond prices are instrumented with demand shocks Z_{it}.

$$\Delta ln(H_{it}) = \alpha_{c(i)} + \alpha_t + \beta \Delta ln(y_{it}) + \Gamma \mathbf{X}_{it} + \epsilon_{it} \tag{17}$$

β is interpreted as the demand elasticity for EM funds. I include country fixed effects and time fixed effects. The estimated demand elasticity β is 7.34, which means that whenever the bond price experience an increase of one percent, the holdings of the bond by investors benchmarked to

Table 5: Demand Elasticity for investors benchmarked to EM LC bonds: the response of holdings to prices

	OLS	OLS	IV	IV
$\Delta ln(H_{it})$	(1)	(2)	(3)	(4)
$\Delta ln(\text{price}_{it})$	-0.267*	-0.293*	-0.446	-7.341**
	(0.148)	(0.170)	(1.308)	(3.651)
Observations	11,619	11,619	10,517	10,517
1st stage F			58.220	12.158
Fixed Effects	Currency	Currency,Time	Currency	Currency,Time

Notes: The table presents the estimates from a regression of changes in prices on changes in the face value of holdings, after controlling for country fixed effects, time fixed effects, and time-varying characteristics (GDP and residual maturity) ($\Delta ln(H_{it}) = \alpha_{c(i)} + \alpha_t + \Delta ln(\text{price}_{it}) + \Gamma X_{it} + \epsilon_{it}$) for investors whose benchmarks have at some point included EM LC bonds. $\Delta ln(\text{price}_{it})$ is instrumented using the outflow-induced funding shock from Dollar funds—investors who use indices that exclude emerging market countries. The estimate -7.341 is interpreted as demand elasticity. *,**,*** indicate significance at the 10%, 5%, 1% level, respectively.

indices including these bonds decrease by 7.34 percent. This implies an inverse demand elasticity of 0.136, which is within the range inverse demand elasticities summarized by Moretti et al. (2024). However, Moretti et al. (2024) described the inverse demand elasticity as being around 1 based on estimates using demand shocks derived from index rebalancing.

7 A sovereign debt model with benchmark index inclusion

I use a model-based approach to address two questions difficult to answer empirically. Previous results show that index inclusion reduces the impact of the global risk factor, approximated by VIX, on local bond markets. Changes in the VIX imply a combination of shocks. I examine the stabilizing role of index inclusion under different shocks. Moreover, the supply-demand framework of sovereign bonds implies that the quantity of bonds outstanding in the secondary market affects the volatility of bond prices. I endogenize the quantity of bonds in the secondary market by introducing a primary bond market in an Eaton-Gersovitz style model of sovereign default. The counterfactual experiment allows me to disentangle the direct effect due to index inclusion from the equilibrium effect of changing the quantity of debt carried into the secondary market.

In a preliminary calibration, I demonstrate that the model can generate moments consistent with the observed reduction in yields following a country's index inclusion. However, the current model includes only a single bond issued by a small open economy. Consequently, replicating the empirical evidence using simulated data and employing micro-level empirical moments to calibrate the model's parameters are tasks reserved for future extensions. Specifically, the extended model will incorporate multiple local-currency bonds.

7.1 Model environment

7.1.1 Primary bond market

The emerging market is modeled as a single representative country. Identical households with the following preference populate the country.

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta_{EM}^t u(c_t) \tag{18}$$

where $u(.)$ is increasing and concave, c_t denotes consumption of the representative EM household in period t, and $\beta_{EM} \in (0,1)$ is the subjective discount factor of EM households.

Each period, EM households receive an endowment of tradable goods Y_t. After the realization of exchange rate s_t and the current index status h_t, households choose whether to repay their debt or to default, where default is indicated by $d_t = 1$. Bonds are interpreted as local-currency bonds auctioned in the domestic market.

Upon default, households are unable to raise additional funds from private foreign investors, and consumption becomes $c_t = Y_t - \mathcal{L}(Y_t)$, where $\mathcal{L}(.)$ represents losses associated with default. I assume an exogenous capital account policy such that, following a default, foreign capital re-enters with a probability of ϕ_{market}.

If the country chooses not to default, it borrows local-currency index eligible bonds, denoted B_{t+1} which are due in the next period $t+1$.

Once the country has an open capital account, it chooses whether to join global bond indices ($k_t = 1$) or to refrain from satisfying index inclusion criteria by choosing the policy $k_t = 0$. At the end of the period, the index provider has a probability ϕ_{index} of including a country committed to inclusion ($k_t = 1$) when its initial index status is $h_t = 0$. Similarly, the index provider excludes this country from the index if $k_t = 0$, even if the initial index status is $h_t = 1$.

7.1.2 Secondary market

Denote $\mathbf{S}_t = (Y_t, s_t)$ as the tuple representing the current state of output and exchange rates. A secondary market consisting of three stages opens for outstanding bonds before the next period. Stage 0 inherits the states $(\mathbf{S}_t, B_{t+1})$ and has outcomes identical to the primary market. In Stage 1, new endowment and exchange rate are observed. Asset managers adjust their portfolios based on the default probability revealed by the new state. The price $q_{smt,1}$ clears the market. At this point, if

Table 6: Timing of events

Current period				Next period
Primary market	Secondary market			Primary market
	Stage 0	Stage 1	Stage 2 (if $h = 0$,$k = 1$)	
−Observe states $(\mathbf{S}, h)$ −Inherit state B −Decide to default or not −If not, decide k and borrow B' − Market clearing at q	− Identical to the primary market	−Observe state S_{sm} −Inherit states B' −Market clearing at q_{sm1}	−Announce h' $Pr(h' = 1) = \phi_{\text{index}}$ −Market clearing at q_{sm2}	−Observe states $(\mathbf{S}', h')$ −Inherit state B'

a country has exclusion status and opts for index inclusion, then Stage 2 begins. The index provider announces the country's inclusion with probability ϕ_{index} and updates h_{t+1} to 1. Otherwise, h_{t+1} remains at 0. After Stage 2, the secondary market ends, and agents observe a new state in the next period. Table 6 summarizes the sequence of events.

Global asset managers enter EM local bond markets and can purchase any bonds issued or traded there. Their problem is identical to that described in Section 3.2.1.

7.2 Discussion of assumptions

"Defaulting" domestically issued local-currency bonds Unlike outright default on hard-currency denominated bonds, countries can suspend, delay, or defer coupon or principal payments on domestically issued bonds held by foreign creditors. Sovereigns may implement these policies through capital outflow or currency exchange controls. In this context, "defaulting" refers to any of these actions, which can be potentially costly for mutual funds[10]. For example, in 2014, JP Morgan justified Nigeria's exclusion from the index due to its currency exchange controls and reduced liquidity in its currency markets (Mu'azu, 2015). Iceland forced foreign investors to reinvest capital gains in local bonds instead of allowing the funds to leave the country (Bianchi and Lorenzoni, 2021; Central Bank of Iceland, 2021).

Moreover, accumulating interest and principal arrears or deferring coupon payments on local-currency denominated bonds was common during the COVID-19 pandemic. U.S. mutual funds report whether or not a bond is in default in their Form N-PORT-P filings[11]. Appendix Table E.6 summarizes reported cases of defaults or deferred interest/principal payments, most of which have an average market value of about \$1 million. Overall, empirical evidence supports modeling LC

[10] Beers et al. (2023) reports that domestic LC debt in arrears accounted for 2.5% of the total arrears in 2022.

[11] The form asks, "Currently in default?" and "Are there any interest payments in arrears or have any coupon payments been legally deferred by the issuer?"

defaults similarly to defaults on hard-currency denominated debt.

Optimal policies related to index presence I argue that sovereigns have policy instruments to influence a country's eligibility for index inclusion and the degree of its presence. Capital controls influence a country's eligibility, and the characteristics of bonds influence a country's index weights. Appendix Section B.2 provides narrative and quantitative evidence of issuing index-eligible bonds to support this argument.

Omitting domestic index ineligible bonds, foreign-currency bonds, and long-term bonds If the EM country chooses the optimal portfolio of index-eligible and ineligible bonds, then index-eligible and ineligible bonds issued by a country included in the index should have an identical price. However, these two bonds are still imperfect substitutes because they face different supply elasticities[12]. Therefore, depending on the index weight, the channel in the model gives rise to endogenous portfolios of bonds with different index status. In fact, I show in Appendix Section B.2.3 that for countries persistently in the index, the issuance of index-eligible bonds relative to the total domestic debt is procyclical: countries tilt away from index-eligible bonds during global downturns. Depending on benchmark weights, the model could generate this result qualitatively.

Existing studies have extensively analyzed dollar-denominated bonds underwritten in developed markets and long-term bonds. Given that these studies focus on the trade-off between defaulting and repaying, they do not directly interact with the operative mechanism of sovereign benchmarks explored here. Nonetheless, long-term bonds could introduce new mechanisms with bond benchmarks: countries may swap index ineligible bonds with index eligible ones when the index status changes. Analyzing long-term bonds is left for future research.

Further discussion The model is designed to examine the transmission of shocks in the secondary market. However, it is silent on how realized shocks and capital inflows thereafter in the secondary market affect future debt policies. Given the nature of forward-looking prices, anticipated changes in future debt policies would be reflected in prices. The answer to the question in this paper may be different when considering changes in future debt policies.

Broner et al. (2021) suggest capital flows related to index inclusion and alternating weights affect exchange rates and could have distributional effects across sectors. Although the aggregate effect remains an open question, the model in this paper shuts off any feedback channels.

[12]The coexistence of two bonds with identical prices in a standard Eaton-Gersovitz class of model requires adding bond-specific default costs. Dellas and Niepelt (2016) analyzes a country's portfolio of private and official loans, which have identical prices because a country cannot selectively default on one type of creditor. They argue that additional default costs of official creditors explain the coexistence of both debts.

How secondary market prices affect *future* debt policies and borrowing cost in the primary market[13] is still an open research agenda. The consensus view is that prices in primary and secondary markets are linked. The detailed transmission channel across these two markets remains elusive. Zhou (2023) analyzes how prices in primary and secondary markets are linked for 41 cases where new issues have identical characteristics between the two markets in the appendix of his paper. In fact, he shows the price in the primary market is lower than in the secondary market. The most widely recognized and analyzed linkage is through liquidity in the secondary market (Chaumont, 2020).

7.3 Recursive equilibrium

I characterize a Markov perfect equilibrium. The state space is summarized by the tuple $(\mathbf{S}, h, B)$. $\mathbf{S}$ is the tuple of current exogenous states (Y, s), where Y is the endowment and s is the exogenous exchange rate. h is the country's index inclusion status, taking values 1 or 0. B is the bond issued in the previous period and due in the current period.

If the government has an open capital account, it chooses the policy d, deciding whether to default ($d = 1$) or not ($d = 0$).

$$V(\mathbf{S}, h, B) = \max_{d \in \{0,1\}} \left\{ V^r(\mathbf{S}, h, B), V^d(\mathbf{S}) \right\} \tag{19}$$

When the government repays, it chooses the optimal level of debt B' and consumption. If the country is currently in the index ($h = 1$), then it can choose to be excluded $k = 0$. The state of the index status in the primary market and in stages 0 and 1 depend on $h \times k$. It means that the index status is inclusion when index providers approve (i.e. inheriting an index status $h = 1$) and the actual optimal policy is inclusion ($k = 1$).

$$\begin{aligned} V^r(\mathbf{S}, h, B) &= \max_{c, B', k} u(c) + \mathbb{E}_{\mathbf{S}_{sm}|\mathbf{S}} V^{sm}(\mathbf{S}_{sm}, h \times k, B', k) \\ &\text{s.t. } c = Y + q(\mathbf{S}, h \times k, B', k)B' - B \end{aligned} \tag{20}$$

During the secondary market, the value function and the index status are updated according to

[13] Analyzing primary market is not a common theme in the sovereign debt literature. Some papers examining the frictions in the primary markets are Cole et al. (2022) and Cole et al. (2024). An alternative view of the secondary market is that the functioning of the secondary market determine nature of the default. Broner and Ventura (2016) argue that creditors do not expect the country to default when foreign creditors are able to trade with domestic creditors in the secondary market.

exogenous processes and the updating rule:

$$
\begin{aligned}
V^{sm}(\mathbf{S}_{sm}, h \times k, B', k) =& \beta_{EM} \mathbb{E}_{\mathbf{S}'|\mathbf{S}_{sm}} (V(\mathbf{S}', h', B')) \\
&\text{s.t. } h' = \begin{cases} 0, & \text{if } h = 0, k = 0 \\ 1, & \text{if } h = 1, k = 1 \\ 0, & \text{if } h = 1, k = 0 \end{cases} \\
&\Pr(h' = 1) = \phi_{\text{index}}, \text{ if } h = 0, k = 1
\end{aligned}
\tag{21}
$$

If the country is currently excluded from the index ($h = 0$), then it remains excluded by choosing the optimal policy $k = 0$. If the government defaults, then

$$
\begin{aligned}
V^{d}(\mathbf{S}, 0, 0) =& u\big(Y - \mathcal{L}(Y)\big) \\
&+ \beta_{EM} \mathbb{E}_{\mathbf{S}'|\mathbf{S}} \big(\phi_{market} V(\mathbf{S}', 0, 0) + (1 - \phi_{market}) V^{d}(\mathbf{S}', 0)\big)
\end{aligned}
\tag{22}
$$

The first order condition of the portfolio choice problem of asset manager type j during the primary market is

$$
\begin{aligned}
w_j(\mathbf{S}, h \times k, B', k) =& (1 - \alpha) w_j^b(\mathbf{S}, h \times k, B', q) \\
&+ \frac{\mathbb{E}_{\mathbf{S}',h'|\mathbf{S},h,k}(\Delta R')}{(1 + r^f) D_0 \gamma_j \operatorname{Var}_{\mathbf{S}',h'|\mathbf{S},h,k}(\Delta R')}, \quad j = \{\text{EM fund}, \text{Dollar fund}\}
\end{aligned}
\tag{23}
$$

where the expressions of depreciation adjusted for default and the excess return are:

$$
\mathcal{E}' = \frac{s}{s'} \times (1 - d'(\mathbf{S}', h', B')), \quad \Delta R' = \frac{\mathcal{E}'}{q(\mathbf{S}, h \times k, B', k)(1 + r^f)} - 1
$$

The weighting function accounting for a country's index status is:

$$
w_j^b = \begin{cases} \Omega(s^{-1} q B') & \text{if } j = \text{EM Fund}, h \times k = 1 \\ 0 & \text{if } j = \text{Dollar Fund, or } j = \text{EM Fund}, h \times k = 0 \end{cases}
$$

The secondary market starts with Stage 0, where the clearing price is identical to that in the previous primary market. In Stage 1, once asset managers observe the new state $\mathbf{S}_{sm} = (Y_{sm}, s_{sm})$, the portfolio choice is

$$
\begin{aligned}
w_{j,sm1}(\mathbf{S}_{sm}, h \times k, B', k) =& (1 - \alpha) w_{j,sm1}^b(S_{sm}, h \times k, B', q_{sm1}) \\
&+ \frac{\mathbb{E}_{S',h'|S_{sm},h,k}(\Delta R'_{sm})}{(1 + r^f) D_0 \gamma_j \operatorname{Var}_{S',h'|S_{sm},h,k}(\Delta R'_{sm})}, \quad j = \{\text{EM fund}, \text{Dollar fund}\}
\end{aligned}
\tag{24}
$$

where the expressions of depreciation adjusted for default in the secondary market and the excess return in the secondary market are

$$\mathcal{E}'_{sm} = \frac{s_{sm}}{s'} \times (1 - d'(\mathbf{S}', h', B')), \quad \Delta R'_{sm} = \frac{\mathcal{E}'_{sm}}{q(\mathbf{S}_{sm}, h \times k, B', k)(1 + r^f)} - 1$$

When an index inclusion announcement occurs in the Stage 2 in the secondary market, the portfolio choice is

$$\begin{aligned} w_{j,sm2}(\mathbf{S}_{sm}, 1, B') = &(1-\alpha) w^b_{j,sm2}(\mathbf{S}_{sm}, 1, B', q_{sm2}) \\ &+ \frac{\mathbb{E}_{\mathbf{S}'|\mathbf{S}_{sm}}\left(\frac{\frac{s_{sm}}{s'} \times (1-d'(\mathbf{S}',1,B'))}{q_{sm2}(\mathbf{S}_{sm},1,B')(1+r^f)} - 1\right)}{(1+r^f) D_0 \gamma_j \operatorname{Var}_{\mathbf{S}'|\mathbf{S}_{sm}}\left(\frac{\frac{s_{sm}}{s'} \times (1-d'(\mathbf{S}',1,B'))}{q_{sm2}(\mathbf{S}_{sm},1,B')(1+r^f)} - 1\right)}, \quad j = \{\text{EM fund}, \text{Dollar fund}\} \end{aligned} \tag{25}$$

The asset market clearing in the primary market is

$$D_0 \sum_{j \in J} \mathcal{M}_j w_j(\mathbf{S}, h \times k, B', k) = s^{-1} q(\mathbf{S}, h \times k, B', k) B' \tag{26}$$

When the new state $\mathbf{S}_{sm}$ is realized, the market clearing condition for Stage 1 is

$$D_0 \sum_{j \in J} \mathcal{M}_j w_{j,sm1}(\mathbf{S}_{sm}, h \times k, B', k) = s_{sm}^{-1} q_{sm1}(\mathbf{S}_{sm}, h \times k, B', k) B', \tag{27}$$

If the announcement of index inclusion occurs in the secondary market, then the market clearing condition for Stage 2 is

$$D_0 \sum_{j \in J} \mathcal{M}_j w_{j,sm2}(\mathbf{S}_{sm}, 1, B') = s_{sm}^{-1} q_{sm2}(\mathbf{S}_{sm}, 1, B') B', \tag{28}$$

A Recursive Markov Equilibrium consists of exogenous states $\{\mathbf{S}(Y, s), \mathbf{S}_{sm}(Y_{sm}, s_{sm}), h\}$, value functions $\{V(.), V^r(.), V^{sm}(.), V^d(.)\}$, policy functions $\{d(.), B'(.), k(.), \{w_j(.)\}_{j=\{\text{EM fund,Dollar fund}\}}\}$ in the primary market and bond pricing function $q(.)$ in the primary market such that:

1. Taking as given the bond price function $q(.)$, the government's policy functions $B'(.)$ and $k(.)$, and choices of default $d(.)$ solve the optimization problem in equations (19), (20), and (22). $V(.), V^r(.)$, and $V^d(.)$ are the associated value functions. Value functions $V^{sm}(.)$ and $V(.)$ are consistent with equation (21).

2. Given $d(.)$ and $B'(.)$, the bond price $q(.)$, portfolio choices in the primary market $\{w_j(.)\}$ solve equation (23).

3. The primary market clears as in equation (26).

Additional policy functions of the portfolio choices are denoted $\{w_{j,sm\nu}(.)\}_{,j=\{\text{EM fund,Dollar fund}\},\nu=\{1,2\}}$ in the secondary market, and prices $\{q_{sm\nu}\}_{\nu=\{1,2\}}$ in the secondary market such that given $d(.)$ and exogenous states, the secondary market clears as in equations (27) and (28).

7.4 Calibration

I calibrate the model at a quarterly frequency in two steps. First, I fix a subset of parameters to standard values from the literature or based on the business cycle statistics of Colombia. I estimate the remaining parameters using macro moments, changes in the yields during Colombia's index inclusion.

I assume that EM households' utility function is $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$. I set the inter-temporal elasticity of substitution σ at 2, as is standard in the literature. I set the quarterly risk-free rate at $r^f = 0.01$, which is consistent with the average real risk-free rate observed in the U.S. For the risk aversion parameter of dollar fund managers, I fix $\gamma_H = 21$, following the value used by Kekre and Lenel (2024) for the risk-bearing capacity of U.S. households. I pick the risk averse $\gamma_L = 14$ for managers of EM funds. I choose the initial wealth of mutual funds $D_0 = 1.5$ which is aligning with the existing sovereign debt literature using risk averse creditors (Lee, 2022; Aguiar et al., 2016).[14]

There is no evidence so far on the average duration of exclusion from the domestic market. Therefore, I conservatively set this duration at 4 years, based on empirical studies (Richmond and Dias, 2009; Gaston Gelos et al., 2004) focused on dollar debts. This corresponds to a re-entry probability of 0.0613. I also assume a conservative value for the exclusion from the index. According to Fick (2015), a country is not eligible for reentry into JP Morgan indices for one year after its exclusion. In practice, Egypt has faced an exclusion spell of 8 years, and Nigeria has been excluded since 2015. I set the index inclusion probability equal to the market re-entry probability.

I assume a multivariate AR(1) process for output and the (real) exchange rate of Colombia[15]. I log-linearly detrend quarterly real GDP and exchange rate values from Q1 2000 to Q3 2023. I assume that exogenous states follow the same processes in the primary and secondary markets. The transition from the secondary market at $t-1$ to the primary market at t and the transition from primary market to the secondary market at t are:

$$\begin{bmatrix} ln(Y_t) \\ ln(s_t) \end{bmatrix} = A \begin{bmatrix} ln(Y_{t-1,sm}) \\ ln(s_{t-1,sm}) \end{bmatrix} + \epsilon_t, \text{ and } \begin{bmatrix} ln(Y_{t,sm}) \\ ln(s_{t,sm}) \end{bmatrix} = A \begin{bmatrix} ln(Y_t) \\ ln(s_t) \end{bmatrix} + \epsilon_{t,sm}, \text{ where } \Sigma_{\epsilon_t} = \Sigma_{\epsilon_{t,sm}} \equiv \Sigma \tag{29}$$

[14] Lee (2022)'s model implicitly implies $D_0 = 1$. In Table 10, Aguiar et al. (2016) set the wealth of investors to be 2.5-2.7 times the average endowment.

[15] Colombia's quarterly real GDP is from its central bank. I obtain the nominal exchange rate from FRED and adjust it by CPI inflation from IFS.

The shock to the primary and secondary market both follow the same variance-covariance matrix Σ.

I adjust the variance-covariance matrix to ensure that it is consistent with the primary and the secondary markets each occupying half of a period. I first estimate a multivariate AR(1) using quarterly data from Colombia to obtain an estimate of the transition matrix A and a variance-covariance matrix $\hat{\Omega}$.

$$\hat{A} = \begin{bmatrix} 0.704, -0.047 \\ \\ 0, 0.986 \end{bmatrix}, \text{and } \hat{\Omega} = 10^{-4} \times \begin{bmatrix} 5.33, -2.53 \\ \\ -2.35, 27.13 \end{bmatrix}$$

I estimate the variance-covariance matrix Σ to ensure that:

$$\text{Var}\left(\begin{bmatrix} ln(Y_{t+1}) \\ \\ ln(s_{t+1}) \end{bmatrix} | \begin{bmatrix} ln(Y_t) \\ \\ ln(s_t) \end{bmatrix} \right) = \hat{A}\Sigma\hat{A}^T + \Sigma = \hat{\Omega} \Rightarrow \hat{\Sigma} \approx 10^{-4} \begin{bmatrix} 3.5, -1.0 \\ \\ -1.0, 13.8 \end{bmatrix}$$

Output costs take the the form $L(y_{EM}) = \max\{0, a_1 y_{EM} + a_2 y_{EM}^2\}$ as in Chatterjee and Eyigungor (2012).

For the mass of EM funds, I use the full sample of funds downloaded from Morningstar. I identify the EM funds using my classification methodology. I estimate the proportion of their net assets relative to the net assets of all the funds in my sample. Specifically, I approximate each fund's net assets by dividing the market value of its holdings by the portfolio share. Next, I sum over two groups of funds each quarter. This approach is consistent with the procedure in Section 4, where I estimate the funding from global funds. I then take the average across time. The value $\mu = 0.63$ reflects the dollars funds, on average, have 63% funding in the mutual fund industry in the data. 35% of the managers' compensation comes from performance-based pay, corresponding to $\alpha = 1 - 0.35 = 0.65$. This value falls within the typical range of 20% to 40% for bonus pay in the asset management industry. Using micro-level data to discipline the value of α is left as a task in an extended model with multiple bonds.

I choose the following functional form for the benchmark weighting function $\Omega(d) = \frac{d}{d+\kappa}$. This functional form is motivated by the real-world practice of benchmark indices including multiple countries, where κ represents the outside assets in indices.

I select the remaining four parameters $\{\beta_{EM}, a_1, a_2, \kappa\}$ to match four moments, with three macro moments and one moment from the secondary market.

I use Colombia's index inclusion event (see Appendix B.2.2 for a discussion of the event and Colombian debt policies). I calculate the average changes in the yields of index-eligible bonds in

Table 7: Parameter values of the baseline calibration

Panel A: Fixed Parameters			Panel B: Calibrated Parameters		
Param.	Description	Value	Param.	Description	Value
σ	Risk aversion—EM households	2.00	β_{EM}	Discount rate of EMs	0.73
ϕ_{market}	Market re-entry probability	0.0613	a_1	Default cost—level	-0.30
ϕ_{index}	Index re-entry probability	0.0613	a_2	Default cost—curvature	0.325
D_0	Funding	1.5	κ	Weighting rules— other assets	5.0
r^f	Risk-free interest rate	0.01			
γ_H	Risk aversion—Dollar funds	21			
γ_L	Risk aversion— EM funds	14			
α	Compensation-absolute return	0.65			
μ	Mass of dollar funds	0.63			

a two-week window around the announcement of Colombia's bonds in the JP Morgan GBI-EM index. I define an elasticity term η as follows[16]:

$$\eta = \frac{\Delta y}{\Delta debt/GDP} \times \frac{1}{y} = \frac{-0.51\%}{\text{COL\$}\,86.75 \times 10^{12}/\,\text{COL\$}\,191 \times 10^{12}}\frac{1}{6.95\%} = -0.16 \tag{30}$$

I identify outstanding bonds qualified for inclusion Δdebt into the JP Morgan GBI-EM index. I choose parameters so that the simulation features index inclusion events and the model-implied elasticity aligns with Colombia's case. Colombia is not the only country with index inclusion events, and Appendix G.1 discusses why Colombia's case is better than other inclusion event used for calibrating the model.

I use macro data from Q1 2005 to Q1 2021 from Colombia to construct three moments. Two of these moments are the mean and volatility of the LC bond spreads. For the spread, I use the five-year LC interest and US interest rate complied by Du and Schreger (2016). I use external LC debt data from Onen et al. (2022) to calculate the average of externally held LC debt to GDP for Colombia. These three moments are commonly used in the literature to calibrate the subjective discount factor and the cost of default (Uribe and Schmitt-Grohé, 2017).

I approximate the equilibrium dynamics through value-function iteration over a discretized state space. For the exogenous states of output and exchange rate, I discretize using 10 points for log output and 10 points for log exchange rate, covering ±3 times the unconditional standard

[16] I do not multiply the term debt/GDP in the expression as in the usual definitions of elasticity, since the model does not include index-ineligible bonds during a country's inclusion period. $\Delta debt$ presents the sum of principal values in COP and GDP is the annualized nominal GDP in COP for Q4 2014

deviation of their estimated process. To construct the transition probability matrix, I apply the iterative procedure proposed by Schmitt-Grohe and Uribe (2009)[17]. Finally, the stock of external debt is discretized on a grid of 25 equally spaced points, starting at 0 and ending at 0.8.

Discussion Table 7 lists all the fixed and calibrated parameters. The discount factor of the emerging market country $\beta_{EM} = 0.73$, which is very low but not uncommon in the sovereign debt literature. Table 8 compares five empirical moments used for calibration and their counterparts from simulation. The model matches data well except for the volatility of spread. Existing literature tweaks the emerging market discount factor and two parameters governing the cost of default to adjust the first and the second moments of spreads. The goal of endogenously generating episodes of index inclusion poses addition challenges. For example, raising β_{EM} reduces the volatility of spread and lowers the probability of default, as agents assign higher values to future consumption and avoid costly defaults. Given fixed parameters and the functional form of weight, index inclusion is always beneficial. As a result, a country does not choose to be excluded from the index. Generating index inclusion episodes relies on episodes of default followed by the index thereafter in the simulation. A lower probability of default under a higher β_{EM} results in no observed default and index inclusion. Since the elasticity η is informative on the deep parameters κ related to benchmarking, the current calibration chooses to sacrifice the match of the volatility of the spread in favor of the index inclusion elasticity.

Moreover, I show the evidence that EM funds reduce the transmission of shocks. I create a time series of secondary market prices and bond ownership between EM and dollar funds. Let $\Delta \log(s_{sm,t})$ be defined as $log(s_{sm_1,t}) - log(s_{sm_0,t})$ and $\Delta \log(y_{sm,t})$ as $log(y_{sm_1,t}) - log(y_{sm_0,t})$. Using model-simulated EM fund share θ, I estimate the reduced-form equation:

$$\Delta \log(y_{sm,t}) = \alpha + \beta \Delta \log(s_{sm,t}) + \gamma \Delta \log(s_{sm,t}) \times \theta_{sm0,t-1} + \Gamma X_t + \epsilon_t \tag{31}$$

where the controls X_t include $\theta_{sm0,t}$ and the change in output, $log(Y_{sm1,t}) - log(Y_{sm0,t})$, in the secondary market. Under above calibrations, the sign of $\hat{\beta} = -42.6$ is positive and the sign of $\hat{\gamma} = 22.3$ is negative. While this regression does not replicate the panel regression with fixed effects presented in the empirical section, the finding that EM funds reduce the sensitivity of asset prices to shocks is consistent with the empirical results.

7.5 Mechanisms and their quantitative importance

Under the supply-demand framework in the model, the quantity of bonds affects the transmission of shocks in the secondary market. To see this, I extend the analysis of the impact of the risk factor

[17] https://www.columbia.edu/~mu2166/tpm/tpm.pdf

Table 8: Moments

Target	Description	Data	Model
$\mathbb{E}[SP]$	EM LC bond spreads— average	5.1%	5.2%
$\sigma(SP)$	EM LC bond spreads— volatility	2.0%	7.9%
$\mathbb{E}[B/Y]$	External LC debt to output	18.7%	18.4%
η	Index inclusion yield elasticity	-0.16	-0.27

Notes: The spread (SP) is the difference between annualized yields of Colombian and US Treasury bonds at a 5-year tenor. The data is from Du and Schreger (2016). η is defined in equation 30.

z_0 on yield y_0 in Section 3.2.4 to the outstanding bond B:

$$\frac{\partial^2 \hat{y}_0}{\partial \hat{z}_0 \partial B} \propto \phi + (w_0 - (1-\mu)(1-\alpha)\epsilon^b)(1 - \frac{1}{(1+r^f)V_0})$$

where $w_0 - (1-\mu)(1-\alpha)\epsilon^b$, ϕ and V_0, as defined in Section 3.2.4, are positive. The quantity of bonds has ambiguous effects on the transmission, but when the exchange rate is very volatile (larger V_0), the relationship is likely to be positive. Benchmarking could affect the outstanding debt in the secondary market in equilibrium, and this motivates me to analyze mechanisms during the primary market.

I omit the secondary market and analyze model mechanisms in a two-period model, followed by their quantitative relevance based on previous calibration. At $t = 1$, the government inherits a legacy debt B_{01} and observes the state $\mathbf{S}_1$ and the index status h. It decides to repay the legacy debt or not. If it repays, it can borrow using a one-period bond B due at $t = 2$. After observing the new state $\mathbf{S}_2$ at $t = 2$, the government decides to repay or default. The value functions are $V_t(\mathbf{S}_t, h)$. I assume a log utility function $u(c) = ln(c)$.

7.5.1 Index inclusion changes prices and demand elasticity

I analyze when a country benefits from index inclusion. I conduct a hypothetical experiment. Suppose that a country with an open capital account is under index exclusion ($h = 0$). The direct effect of index inclusion is raising the price, that is $q(\mathbf{S}_1, h = 1) - q(\mathbf{S}_1, h = 0) > 0$[18]. Let B^* and q^* be the optimal borrowing and the bond price for a given state $\mathbf{S}_1$ under index exclusion. Welfare

[18] See equation 32 in Appendix C.1 for the derivation. Section 3.2.3 also discusses this effect.

improvement requires the inequality below when prices and their derivatives are evaluated at B^*:

$$
\begin{aligned}
&(Y_1 - B_{01})(q(\mathbf{S}_1, h=1) - q(\mathbf{S}_1, h=0)) \\
&+ (Y_1 - B_{01})B\left(\frac{\partial q(\mathbf{S}_1, h=1)}{\partial B}\Big|_{q(\mathbf{S}_1,h=1)} - \frac{\partial q(\mathbf{S}_1, h=0)}{\partial B}\Big|_{q(\mathbf{S}_1,h=0)}\right) \\
&+ B^2\left(q(\mathbf{S}_1, h=0)\frac{\partial q(\mathbf{S}_1, h=1)}{\partial B} - q(\mathbf{S}_1, h=1)\frac{\partial q(\mathbf{S}_1, h=0)}{\partial B}\right) > 0
\end{aligned}
$$

Given that $q(\mathbf{S}_1, h=1) - q(\mathbf{S}_1, h=0) > 0$, the second line in the above inequality being greater than zero is a sufficient condition for a welfare improvement under index inclusion. The proposition below summarizes this.

Proposition 3 *A sufficient condition exists to ensure the following holds:*

$$V_1(\mathbf{S}_1, h=1) \geq V_1(\mathbf{S}_1, h=0), \textit{ and } B(\mathbf{S}_1, h=1) > B(\mathbf{S}_1, h=0)$$

Appendix C.4 shows the proof.

Under the assumption that rising debt levels depress bond prices, a country improves its welfare by joining the index because bond prices become less sensitive to increases in supply. The deeper reason is that benchmarking overcomes the private cost of asset managers. Underinvestment in risky assets occurs when managers are compensated only by their absolute returns. Awarding performance relative to benchmark returns reduces underinvestment and potentially improves the welfare of EM countries[19].

To further characterize this sufficient condition, I denote the index weight upon inclusion, if the government continues to borrow at the previous optimal B^* but the equilibrium price $q(\mathbf{S}_1, h=1)$ under index inclusion, as $w^b \equiv w^b(s_1^{-1}q(\mathbf{S}_1, h=1)B^*)$. The sufficient conditions are

$$
\begin{aligned}
&1 > \frac{\partial w^b}{\partial(s_1^{-1}qB)}\frac{s_1^{-1}q(\mathbf{S}_1, h=1)B^*}{w^b} \\
&\frac{\partial \mathbb{E}_1(\frac{s_1(1-d_2)}{s_2})}{\partial B}\operatorname{Var}(\frac{s_1(1-d_2)}{s_2}) - \frac{\partial \operatorname{Var}(\frac{s_1(1-d_2)}{s_2})}{\partial B}\mathbb{E}_1(\frac{s_1(1-d_2)}{s_2}) > 0 \\
&\frac{s_1^{-1}q(\mathbf{S}_1, h=1)B^*}{D_0} - (1-\mu)(1-\alpha)w^b > \frac{s_1^{-1}q(\mathbf{S}_1, h=0)B^*}{D_0}
\end{aligned}
$$

where $\tilde{\epsilon}(q, B) \equiv \frac{\partial w^b}{\partial(s_1^{-1}qB^*)} \times \frac{s_1^{-1}q(\mathbf{S}_1,h=1)B}{w^b}$ is the sensitivity of the index weight to changes in bond market values. One real world interpretation of the index weight is that it is a weighted average of the country's weight across all existing indices that include this country. I want to remind readers

[19]Credit ratings, another bond market institution, also operate through price-based disciplines (Yang, 2023). Unlike bond benchmarks, which support more borrowing, price-based disciplines often imply that a country borrows less.

that $0 \le \tilde{\varepsilon} < 1$ as long as indices use market-value weighting rules[20]. However, many indices deviate from simple market-value weighting. For example, the JP Morgan GBI-EM index imposes a ceiling on country weights to ensure diversification. A country's index inclusion may also come at the expense of lowering the weight of other countries.

In the second condition, borrowing increases the probability of default, so $\frac{\partial \mathbb{E}_1(\frac{s_1(1-d_2)}{s_2})}{\partial B} < 0$. Higher default probability implies that there are fewer states of the world where the country repays, and the variance of the exchange rate depreciation is also reduced, $\frac{\partial \operatorname{Var}(\frac{s_1(1-d_2)}{s_2})}{\partial B} < 0$. Therefore, the second condition says that changes of the variance of the exchange rate depreciation is more sensitive to changes of the expected value. In the third condition, $\frac{s_1^{-1}q(\mathbf{S}_1,h=1)B^*}{D_0} - (1-\mu)(1-\alpha)w^b$ can be interpreted as the "active portfolio". This condition says that the active portfolio weight rises under index inclusion.

Quantitative relevance. Figure 7 plots the difference in prices between index inclusion and exclusion for a "good" state (high y and low s). Higher prices under index inclusion align with the analytical results, but the difference is small. However, this difference increases as borrowing levels rise.

7.5.2 Index inclusion changes the probability of default

Let the set of states $\mathbb{S}$ be the combination of output and the exchange rate such that the country is indifferent between repaying and defaulting under index exclusion:

$$\mathbb{S} = \{\mathbf{S} : V_1(\mathbf{S}, B_{01}, h = 0) = V_1^d(\mathbf{S}, h = 0)\}$$

If the Proposition 3 holds for at least one element in the set $\mathbb{S}$, meaning that a country improves its welfare through index inclusion, then

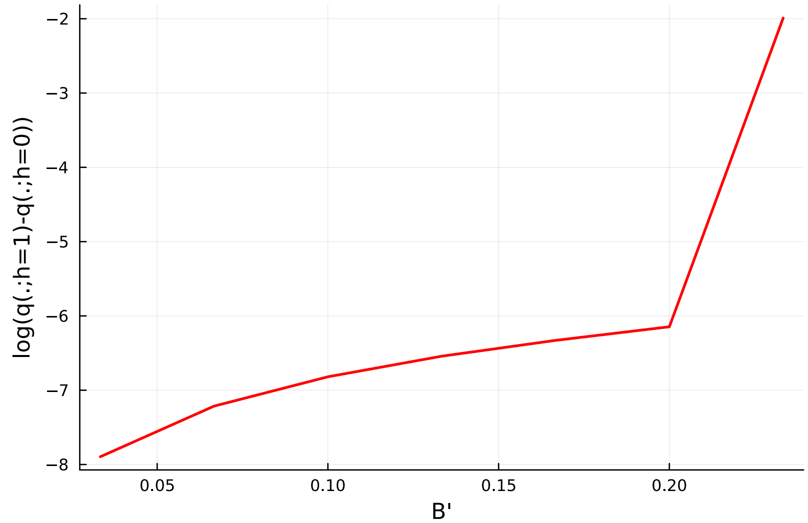
$$\exists \mathbf{S} \in \mathbb{S} \text{ s.t. } V_1(\mathbf{S}, B_{01}, h = 1) > V_1^d(\mathbf{S}, h = 1)$$

[20]The proof is straightforward. The set of indices that include a country's LC sovereign bonds consists of N indices. Each index includes other assets, such as LC bonds from other EM countries, sovereign bonds from developed markets, or corporate bonds. b_{EM} denotes the market value of LC bonds from country c and $b_{o/t,n}$ denotes the market value of other assets in the index n. $w^b \equiv \sum a_n \frac{b_{EM}}{b_{EM}+b_{o/t,n}}$, where arbitrary weights a_n satisfy $\sum_{n=1}^N a_n = 1$. Then $\tilde{\epsilon} = (\sum a_n \frac{b_{o/t,n}}{(s^{-1}q^*B^*+b_{o/t,n})^2}) \times \frac{s^{-1}q^*B^*}{w^b}$. Given that real-world values $s^{-1}q^*B^* + b_{o/t,n} > 2\ \forall n$, the following inequalities hold

$$\tilde{\epsilon} < (\sum a_n \cdot \frac{b_{o/t}^{max}}{(s^{-1}q^*B^* + b_{o/t}^{max})^2}) \times \frac{s^{-1}q^*B^*}{s^{-1}q^*B^*/(s^{-1}q^*B^* + b_{o/t}^{max})} < \frac{b_{o/t}^{max}}{s^{-1}q^*B^* + b_{o/t}^{max}} < 1$$

where $b_{o/t}^{max} \equiv \max\{b_{o/t,n} : n = 1...N\}$.

Figure 7: Difference in prices ($log(q(.,h=1)-q(.,h=0))$ under a "good" state



Notes: This graph plots the log difference in the pricing function with respect to future borrowing when the country has an output above average and an exchange rate below average (i.e., a "good" state for the country).

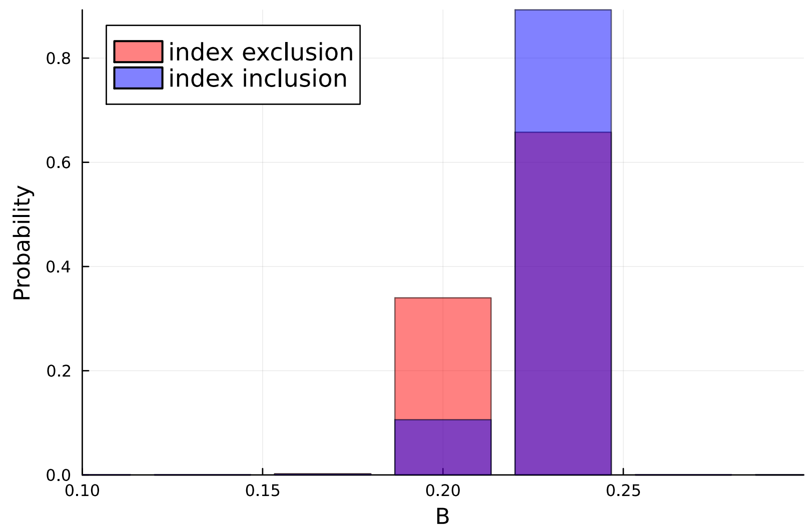
In other words, the country does not default under index inclusion for states that would otherwise lead to default under index exclusion. Benchmarking reduces the set of states in which the country chooses to default.

I provide a concrete example here. Suppose that value function under any index status is monotone decreasing in output for a given exchange rate $\tilde{s}_1$. Then, there is a unique cutoff output level $Y_1^{\min}$, below which the country defaults at $t = 1$ under index exclusion. When a country benefits from index inclusion under the state $(Y_1^{\min}, \tilde{s}_1)$, according to the proposition above, $V_1(Y_1^{\min}, \tilde{s}_1, B_{01}, h = 1) > V_1(Y_1, \tilde{s}_1, B_{01}, h = 0)$. The monotone relationship between the output and the value function implies that the cutoff output for default under $h = 1$ must be smaller than $Y_1^{\min}$. This relationship means that prior to the realization of Y_1, the country is expected to be less likely to default and could withstand a worse output shock.

Shrinking the set of states a country chooses to default increases the prices when creditors are risk-neutral. However, the higher expected return is offset by higher volatility of the return for risk-averse creditors here. As a result, the overall effect of lowered probability of default on prices is ambiguous.

The model of benchmarking offers a nuanced explanation for why countries are able to borrow despite their limited commitment to repaying: repaying debt is rewarded with potentially beneficial index inclusion, and the net cost of defaulting increases when this beneficial index inclusion is present.

Figure 8: Distribution of default probability



Notes: Conditional on a country choosing to default in the current period, this plot shows the distribution of the probability of default across three different levels of debt the country defaults on under two cases: the country is under index inclusion or exclusion status in the current period. To construct the plot, I simulate the economy over 10 million periods and calculate the distribution of debt for periods when the country chooses to default under different index statuses.

Quantitative relevance. Conditional on a country choosing to default, Figure 8 shows the distribution of default probability across different levels of current debt for the country under index inclusion or exclusion. When the economy is under index inclusion, defaults are pushed to higher debt levels. In the current calibration, conditional on repayment, the value of index inclusion is higher in all possible states. Since the value when choosing to default is identical regardless of index status, the net cost of default is higher under index inclusion. Therefore, the country is more likely to choose to repay its existing debt.

7.6 Decomposing the transmission of shocks under index inclusion

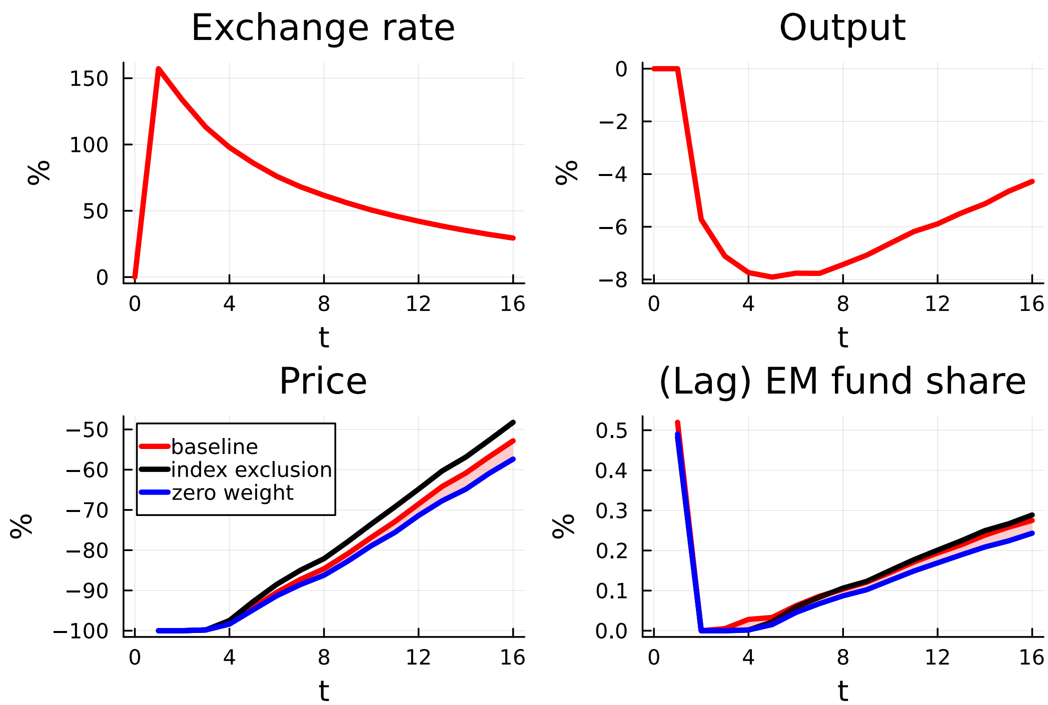
I use the calibrated model to decompose the propagation of shocks into direct and equilibrium effects. Figures 9 and 10 plot the impulse response functions to one-standard-deviation shocks to the exchange rate and output. *Zero weight* refers to a counterfactual scenario where the country has a zero index weight while all else remains identical to the baseline case under index inclusion. The difference between this and the baseline case is the direct effect of benchmarking. *Index exclusion* refers to a counterfactual world where this country is excluded from the index. It is a counterfactual world without benchmarking for only one period in the primary market and the following secondary market, where the counterfactual experiment takes place. This case captures the equilibrium effect. It differs from *zero weight* by allowing the outstanding bonds in the secondary market to be optimally determined. When the outstanding bonds are identical under *index exclusion* and *zero weight*, the propagation of shocks is identical because they share the same pricing function.

Across all experiments, prices are lower under *zero weight*. This confirms the central message that benchmarking reduces the transmission of shocks to prices. However, benchmarking is more effective in insulating against output than exchange rate shocks, as exchange rate shocks directly reduce the benchmark weight. After 16 quarters, the price is about half of what it is prior to the shocks in the baseline, and benchmarking contributes to 8% of the total effect as the decline is 5 percentage points larger under *zero weight*. Figure 10 shows that benchmarking is effective at insulating against output shocks, as the price is 7.5% lower under the baseline compared with 15% under *zero weight*. Compared to exchange rate shocks, output shocks do not directly affect the index weight, and the stabilizing effect is preserved.

The experiment also reveals that the shock has a slightly smaller impact on prices from the second period onward in a world without benchmarking (*index exclusion*) relative to the baseline. The reason is that under *index exclusion*, the country reduces the amount of debt carried to the secondary market. The debt-to-output ratio is 18.7% in the baseline, whereas it is 4% lower under *index exclusion*.

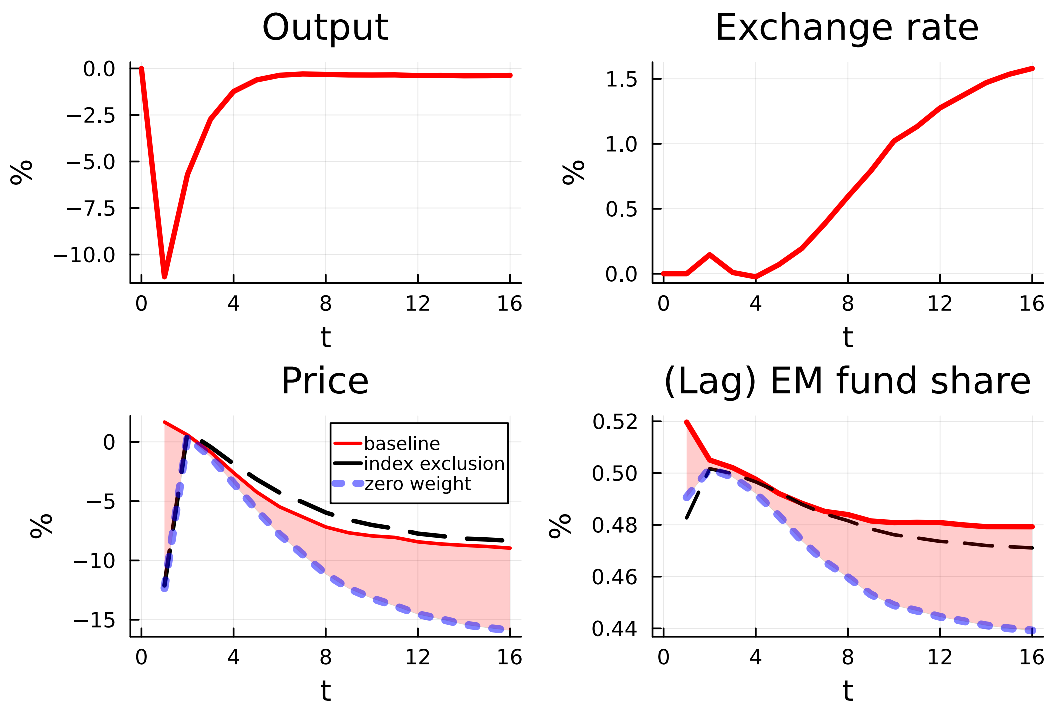
Benchmarking provides the most stabilizing on the impact of shocks. For a large exchange rate shock, the secondary market of sovereign bonds unravels: the price approaches zero. At this point, the difference in price between the baseline and the two counterfactual scenarios is indistinguishable. For a output shock, benchmarking almost completely insulates the shock in the baseline, while the price falls by 12.5% in two counterfactual cases.

Figure 9: Decomposing of the transmission of exchange rate shocks



Notes: Impulse response functions to a one-standard-deviation real exchange rate shock in the secondary market for the economy under index inclusion, the baseline case, and two counterfactual cases. The unconditional standard deviation is 0.226. Before the shock, the stochastic real exchange rate and output follow their underlying Markov processes. Upon the EM country's entry into the secondary market, the exchange rate shock occurs while output remains constant. For the following 15 periods in the same secondary market, both the exchange rate and output follow their Markov processes. The response functions of the exchange rate, output, and the price of bonds in local currency are the deviations from the levels prior to the shock. The lagged EM fund share refers to the share of sovereign bonds' market value held by EM funds in the previous period. The graph plots the response of the bond price and the EM fund share starting from $t = 1$. The response functions consider two alternative scenarios. *Zero weight* refers to the case where the EM country has a zero index weight, while the debt level in the secondary market is identical to the baseline case. *Index exclusion* refers to a counterfactual case where the country has an index exclusion status throughout the primary and secondary markets. This scenario differs from *zero weight* by allowing the outstanding bonds to be optimally determined prior to the shock. Responses are the average of 10,000 simulations.

Figure 10: Decomposing of the transmission of output shocks



Notes: Impulse response functions to a one-standard-deviation output shock in the secondary market for the economy under index inclusion, the baseline case, and two counterfactual cases. The unconditional standard deviation is 0.0436. Before the shock, the stochastic real exchange rate and output follow their underlying Markov processes. When the EM country enters into the secondary market, the output shock occurs while the real exchange rate remains constant. For the next 15 periods in the same secondary market, both the exchange rate and output follow their Markov processes. See the notes in Figure 9 for other details.

8 Conclusion

Benchmark indices are market indices used to measure the performance of investors. Many developing countries, such as China, Egypt, and India, tailor their financial market reforms to achieve inclusion in bond benchmark indices. Yet, our understanding of the effect of index inclusion on the volatility of bond prices is limited.

This paper shows that the index inclusion of emerging market local-currency bonds in global bond indices reduces the impact of changes in fundamental risk on bond prices and reduces volatility. Using a micro-level holdings data from global mutual funds, I document that investors hold local-currency bonds even when their benchmark indices are unrelated to these bonds. I create a measure of exposure to index inclusion—the share of investors who benchmark to indices with EM assets. When a bond is more exposed to inclusion, the bond price exhibits less volatility from the global risk factor, approximated by the VIX.

More significantly, if the creditors' heterogeneity in benchmarks directly affects asset prices, the determinants of benchmarks upon the entry of investment funds over the global financial cycle affect capital flows. Emerging economies may need to facilitate the entry of investors benchmarked to their assets or the creation of market indices that include their assets to further globalize their capital markets. Policies that influence the footprint in global indices become alternative forms of capital controls. For example, countries included in global bond indices have direct controls over the characteristics of bonds and hence the degree of presence in global indices, which ultimately influences capital account openness. In principle, the framework of benchmarking in this paper is qualitatively consistent with the pro-cyclical borrowing in bonds with characteristics that make them index eligible[21]. Future research could examine the imperfect substitution of two types of local-currency bonds—one with and one without index status—despite identical credit and currency risk.

More broadly, this paper examines the macroeconomic implications of financial frictions in asset management and their remedies through performance-based compensation using benchmarks. On the one hand, while models often invoke collateral constraints, as He and Krishnamurthy (2008) note, the micro-foundation of collateral constraints assumes the absence of benchmarks. Without this assumption, only a few works, such as Krishnamurthy (2003) and Di Tella (2017), explain financial amplification. On the other hand, benchmark compensation contracts—the micro-foundation behind the relative return in the utility function in this paper—are common in asset management. Assuming benchmark contracts does not preclude financial amplification due to the heterogeneity of benchmarks and deviations in investing in benchmark-related asset classes. The

[21] Appendix Section B.2 documents policies related to the degree of index presence. It also shows that countries are less likely to issue index eligible bonds during global downturns.

financial frictions in asset management may differ from those in other types of financial intermediaries, such as banks and hedge funds (He and Krishnamurthy, 2013), and may have broader macroeconomic implications for future exploration.

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Appendix
Benchmark Index Inclusion and Sovereign Risk

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October 24, 2025

Table of Contents

A Data appendix

A.1 Bloomberg data

Identifying duplicate bonds. Commonly used bond identifiers, such as CUSIP and ISIN, do not uniquely identify bonds in Bloomberg bond data. I describe a procedure to identify duplicate bonds by considering STRIPS (Separate Trading of Registered Interest and Principal of Securities), global offerings under Regulation S or 144A, and GDN (Global Depository Notes). Bloomberg Terminal offers a built-in function to consolidate duplicate bonds resulting from STRIP or Regulation S/144A. I download two lists of sovereign bonds, restricting the variable "BCLASS II" to "Treasury" or "Sovereign", with and without consolidating duplicated bonds. The union of these two lists covers all CUSIP and ISIN identifiers that might be reported by mutual funds. Bloomberg also reports the status of bonds being "STRIP", "Reg S/144A", and "GDN". I retrieve a list of these types of bonds and include the variable "DES Notes", which provides additional descriptive information about a bond. From these notes, I obtain parent bond identifiers. I use ISIN to identify bonds whenever available, and use CUSIP when the corresponding ISIN cannot be found. Additionally, I refer to the GDN list from Citi Bank[22].

Bond yields. I download bond bid yield to maturity data from the Bloomberg Terminal. I select BVAL as the pricing source whenever available[23]. The pricing source is mainly BGN for bond yields before 2010.

A.2 Form N-PORT-P data

I create a dataset of U.S. mutual fund and ETF holdings of EM LC bonds using Form N-PORT-P from the U.S. Security Exchange Commission (SEC). The advantage of this dataset is that it is supposed to contain the universe of mutual funds in the U.S. Investment firms in the U.S. disclose fund-level portfolios to the SEC. SEC only releases filings to the public in the third month of the filers' fiscal quarters. The disadvantage of this dataset is that the sample only covers 12 quarters, from Q2 2019 to Q2 2022.

To create this data, I compile a list of share class IDs of U.S. mutual funds from Morningstar and identify corresponding ones in the SEC Investment Firm directory. Then, I link CIKs between the SEC Investment Firm directory and SEC Filing Index, which allows me to identify the ID numbers of filings to download. Appendix Table A.1 shows the identifiers in each dataset.

[22] See https://depositaryreceipts.citi.com/adr/guides/uig.aspx?pageId=8&subpageid=34. I also cross-check the GDN cases from Deutsche Bank (https://www.adr.db.com/drwebrebrand/dr-universe/dr_universe_type_e.html)

[23] See https://data.bloomberglp.com/professional/sites/10/Fixed-Income-Cash-Pricing-Sources.pdf for details of different pricing sources.

Table A.1: Identifiers in Morningstar and SEC data

Source	Morningstar	SEC Investment Firms	SEC Filing Index	Form N-PORT-P
Usage	Identify tickers of relevant funds and managing firms	Using tickers to get CIKs	Getting directory of Form N-PORT	Getting holdings
Parent Firm ID (CIK)		✓	✓	✓
SEC Fund Series ID		✓		✓
Share Class ID (Ticker)	✓	✓		

Note: SEC filing index: https://www.sec.gov/Archives/edgar/full-index/; SEC Investment firms: https://www.sec.gov/open/datasets-investment_company. A sample of filing is https://www.sec.gov/Archives/edgar/data/741350/000175272422215831/xslFormNPORT-P_X01/primary_doc.xml

I validate the Form N-PORT-P data against official data. The credit supply of $43.97 billion to EM local currency bond markets in Q2 2022 in the N-PORT-P data is comparable to $40 billion reported by mutual funds in the U.S. Portfolio Holdings of Foreign Securities as of December 2022[24]. Similarly, the credit supply of $65.66 billion in Q4 2020 and $65.95 billion in Q4 2021 from the Form N-PORT-P data is comparable to $69 billion in December 2020 and $67 billion in December 2021 from the official data.

A.3 Colombian sovereign bond issuance

I search for Colombian Peso denominated sovereign bonds from Bloomberg Terminal. The search criteria include asset classes categorized as "Government" (with consolidated duplicate bonds), BCLASS classification as "Treasury" and "Sovereign," maturity dates after January 1, 2005, and issuance dates prior to December 31, 2023. After removing duplicate bonds, such as those from Global Depository Notes (as described in Appendix Section A.1), and excluding bonds without information on the amount issued, my search yields 309 individual bonds. The earliest bond in the sample was issued in 1997, and the latest maturity is in 2050. There is no coupon information available for floating-rate bonds, so their coupon payments are excluded from the analysis.

The discount rate used is the average annual short-term rate in Colombia from 2005 to 2023,

[24] See https://ticdata.treasury.gov/resource-center/data-chart-center/tic/Documents/shca2022_report.pdf

Table A.2: EM LC credit supplies (USD bn) in Q4, 2019 by US fund categories

Fund Category	Benchmarks Include EM LC bonds	Benchmarks Exclude EM LC bonds
Allocation	1.14	0.77
Alternative	0.01	0.26
Taxable Bond	46.95	33.67
Commodities		0.05
International Equity		0.62
Miscellaneous		0.01
Nontraditional Equity		0.00
Sector Equity		0.00
U.S. Equity		0.01

Notes: This table presents the market value (in USD billion) of EM local-currency bonds held by different categories of U.S. mutual funds, as reported in portfolios from Form N-PORT-P between December 2019 and February 2020. Fund categories are provided by Morningstar. The identification of EM local-currency sovereign bonds is based on reported currency denominations, issuer sectors (i.e., corporate versus treasury), and issuer countries. Benchmark information from Morningstar is also used. A fund is considered to include EM local-currency bonds if either its primary or secondary benchmark includes EM LC bonds.

sourced from the FRED series COLIR3TCD01STQ. For inflation-linked bonds, of which there are 57 in my sample, I use the Colombia Peso to UVR exchange rate published by the central bank[25]. I use the exchange rate on the last day of each year from 2005 to 2023 to calculate an average rate of exchange rate depreciation, and then use this rate to interpolate the level of exchange rates from 1997 up to 2050 to adjust the principal payment of inflation-linked bonds.

A.4 Morningstar data

A.4.1 Sample selection based on Morningstar Category

Funds in the Form N-PORT-P filings fall into the following categories in Appendix Table A.3 [26]. The following seven categories with the smallest shares are omitted during the selection: US Fund Short-Term Bond, US Fund Long-Term Bond, US Fund Ultrashort Bond, US Fund Intermediate

[25] https://www.banrep.gov.co/es/estadisticas/unidad-valor-real-uvr

[26] See https://awgmain.morningstar.com/webhelp/glossary_definitions/mutual_fund/glossary_mf_ce_Morningstar_Category.html for a description of Morningstar Categories.

Table A.3: Morningstar Category

Morningstar Category	Share (%)
US Fund Global Bond	25.4
US Fund Emerging-Markets Local-Currency Bond	16.6
US Fund Nontraditional Bond	16.3
US Fund Global Bond-USD Hedged	14.8
US Fund Multisector Bond	8.0
US Fund Intermediate Core-Plus Bond	7.7
US Fund Emerging Markets Bond	6.2
US Fund High Yield Bond	1.4
US Fund Short-Term Bond	0.9
US Fund Long-Term Bond	0.9
US Fund Ultrashort Bond	0.8
US Fund Intermediate Core Bond	0.4
US Fund Corporate Bond	0.4
US Fund Inflation-Protected Bond	0.2
US Fund Intermediate Government	0.0

Note: This table shows the relative market value of holdings of EM LC bonds from mutual funds domiciled in the U.S. across different Morningstar Categories. The holdings are based on the mandatory portfolio disclosure in Form N-PORT-P filed between December 2019 and February 2020.

Core Bond, US Fund Corporate Bond, US Fund Inflation-Protected Bond, and US Fund Intermediate Government. I identify the corresponding Morningstar Categories for non-US funds and omit them.[27]

[27] For example, the corresponding omitted EM categories are: EAA Fund EUR Inflation-Linked Bond, EAA Fund USD Ultra Short - Term Bond, EAA Fund Global Inflation-Linked Bond - USD Hedged, EAA Fund Global Inflation-Linked Bond - GBP Hedged, EAA Fund Global Inflation-Linked Bond - EUR Hedged, EAA Fund EUR Government Bond, EAA Fund USD Government Bond, EAA Fund EUR Corporate Bond - Short Term, EAA Fund USD Corporate Bond, EAA Fund USD Corporate Bond - Short Term, EAA Fund EUR Corporate Bond, EAA Fund GBP Government Bond, EAA Fund SEK Corporate Bond, EAA Fund GBP Corporate Bond, EAA Fund EUR Ultra Short-Term Bond, EAA Fund USD Diversified Bond - Short Term, EAA Fund GBP Diversified Bond - Short Term, EAA Fund EUR Diversified Bond - Short Term, EAA Fund SEK Bond - Short Term, EAA Fund EUR Bond - Long Term, and EAA Fund Global Inflation-Linked Bond.

A.4.2 Holding data

Once I have a list of funds through the two-step procedure described in Section 2.2, I then download their portfolio reporting dates from Morningstar Direct. At this stage, I further restrict the sample to funds with consistent portfolio reporting. I then use the API from Morningstar Direct to directly download holdings.

A large number of holdings lack CUSIP or ISIN identifiers. For the purposes of this study, I extract issuer names, bond coupons, and bond maturities from the security description field in the holding data. These three pieces of information are the minimum required for matching a bond identifier. However, out of millions of positions I have downloaded, approximately 10,000 do not have reported bond identifiers but contain enough information in the bond description to assign an identifier using an external database. Since this small number is unlikely to affect the results, I delete these positions without bond identifiers.

I then clean the fund holding data. First, I sum the weights of the bonds in each portfolio. I delete funds whose total reported weight in any quarter exceeds 100%. There is inconsistency and a lack of uniformity in how funds report the quantity of bonds in the "shares" field. Ideally, they should report the face value or the number of bonds in multiples of the par amount—the minimum face value of bonds auctioned in the primary market. I retrieve the exchange rates and calculate the implied market price of the bonds. Based on this price, I determine whether the quantity of the bond is reported in multiples of tens.

I illustrate the solution for cleaning reported face values using the SPDR Bloomberg Emerging Markets Local Bond UCITS ETF. I retrieve its portfolio on July 4th, 2024 from Morningstar Direct and validated using its public disclosure. It held the Brazilian bond—LETRA TESOURO NACIONAL 0 07/01/2026 (BRSTNCLTN848)— with reported shares of 89,300, a bond price of 0.8057, and a market value of $13,096,800.92. Here, the fund reported the share in units of 1,000. The adjusted share should be 89,300,000. I account for this possibility in the reported shares in the data.

Using the variable Portfolio Currency, I identify the currency denomination in the reported market values of holdings and convert the market value to dollars.

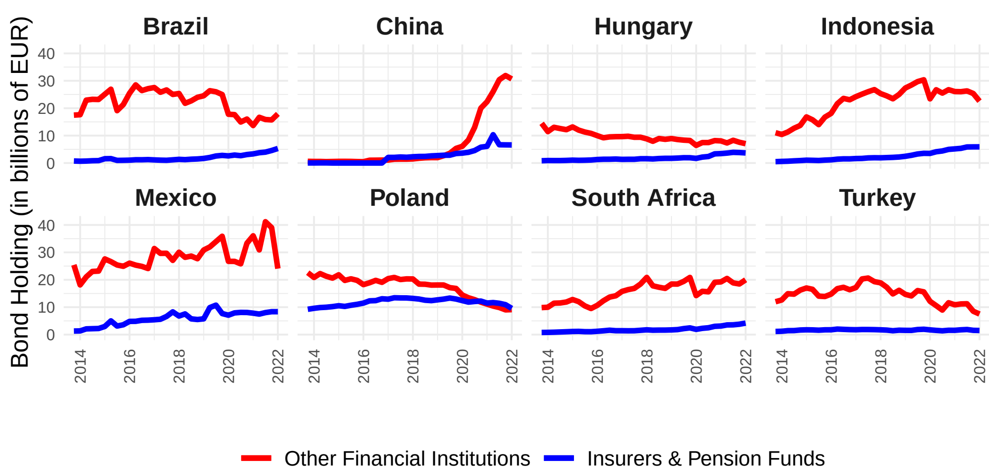
B Empirical result appendix

B.1 Investment funds and EM LC globalization

Many developing countries have globalized their domestic sovereign bond markets over the past two decades. Unlike hard-currency denominated debts, investment funds hold more local-currency denominated sovereign bonds than other types of non-official creditors who are crucial for their hard-currency borrowing, such as commercial banks, insurance companies, and pension funds.

To gauge the size of credit from investment funds, I use credit supply data by investor sectors from the ECB. I select non-developed countries which experienced local currency market development. As Figure B.1 shows, the investor sector "other financial institutions" which include European investment funds generally supply more credit than insurance and pension funds. Depository banks, extensively analyzed, supplied little credit to these countries. The visual inspection also reveals that the credit from "other financial institutions" are volatile. This fact is consistent with the discussion of flighty credit from investment funds.

Figure B.1: Credit supplied to emerging markets by investor sectors



Notes: Data comes from the European Security Holding Database. "Other financial intuitions" include mutual funds. It is referred to "Financial corporations other than money-issuing institutions, insurance corporations and pension funds" (sector code S12P) in the ECB data.

ECB data does not reveal details on finer divisions by currency and creditor types such as the credit supplied by hedge funds. For hedge funds, U.S. Treasury International Capital (TIC) System data indicates that the holdings by other financial firms which include hedge funds are \$8 billion, \$7 billion and \$16 billion in 2020, 2021 and 2022 respectively, comparing to an average of \$59 billion by mutual funds in these years.

B.2 Additional evidence on borrowers' policy decisions on benchmark index presence

I present the following facts:

1. Countries have policy tools to influence their index presence;
2. Countries without explicit capital controls and that are persistently included in global indices tilt their LC borrowing away from index-eligible bonds during global downturns.

The model in the main text assumes the country only issues index eligible bonds. That model is consistent with these facts qualitatively, and the quantitative importance depends on the specific weighting function.

B.2.1 Narrative evidence

China relaxed its capital controls specific to mutual funds in 2016 and subsequently gained index inclusion in the JP Morgan GBI-EM index (Clayton et al., 2022). Like China, India imposed discriminatory capital control policies across different types of creditors (Patnaik et al., 2013). Policies that removed capital controls and developed clearing technologies promoted India's inclusion in the JP Morgan GBI-EM index in 2023. Argentina and Nigeria are two cases where countries prioritized managing exchange rates and controlling capital flows. Facing economic downturns, these two countries restricted currency exchanges to stabilize the value of their currencies. Global index providers deemed this policy as reducing market liquidity and currency convertibility despite potential benefits. As a result, JP Morgan issued warnings but both countries responded by heightening currency exchange controls. Consequently, JP Morgan excluded Nigeria in 2013 and Argentina in 2019, just two years after the inclusion in 2017, from the GBI-EM Broad index.

Egypt is another recent example. It is a country with no explicit capital control to foreign investors. However, it imposes policies to borrow in index eligible bonds and fulfill index requirement to gain inclusion in JP Morgan's indices (Ministry of Finance Arab Republic of Egypt, 2022). Shortly after its 2022 inclusion, Egypt suffered an economic crisis in 2023, devalued its currency, and depleted its dollar reserves. JP Morgan excluded Egyptian domestic bonds in 2024. What complicates the Egyptian case are the divided views on index inclusion and exclusion from the perspective of emerging markets. Despite the expected small index weights, the finance minister tailored reforms to appeal to index providers and seek inclusion. The opposing view emerged when the exclusion occurs— arguing that Egypt's index weights are too small for any significant negative consequence from the exclusion (Abdel-Razek, 2024).

B.2.2 A case study of Colombia

I further use Colombia to illustrate how the characteristics of bonds may influence index presence. Colombian global LC bonds were already in the index prior to the full inclusion, representing about 0.3% in the JP Morgan GBI-EM Global Diversified index, JP Morgan rationalized the inclusion in domestically issued bonds as the "result of improved transparency and accessibility for international investors in the local TES market" (Broner et al., 2021). Colombia did not have any significant bond market or capital account policy changes prior to inclusion, but borrowing in index-eligible bonds may have been a precursor.

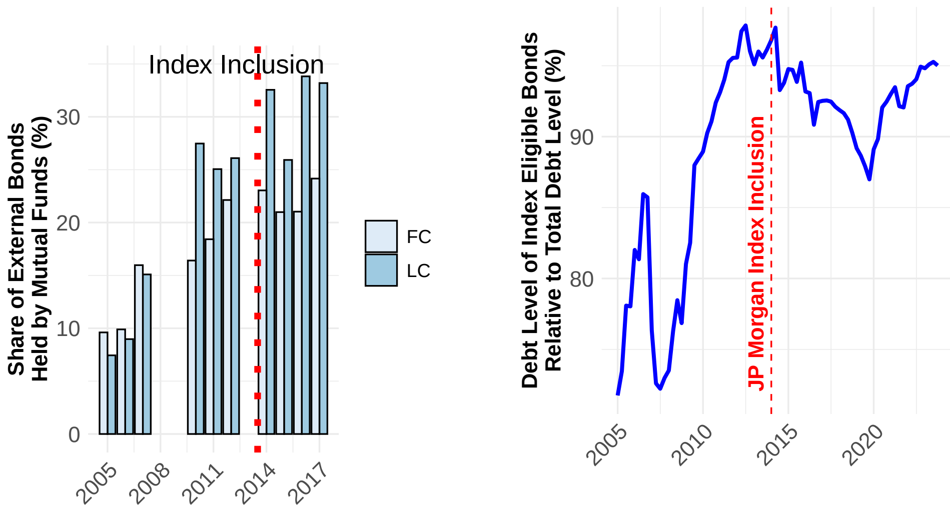
For each unique COP-denominated bond issued by the Colombian Treasury, I classify them as index-eligible or ineligible according to the criteria outlined in JP Morgan documentation. Given the different characteristics of bonds and varying maturities, I calculate the present value of expected interest and principal payments in Colombian Peso. This represents the debt level of the Colombian government. Historical coupon payment data is not available from commercial sources, so the estimates of the debt level omit interest payments for floating-rate and variable-rate bonds. The Colombian government experienced a significant increase in the debt level of eligible bonds prior to index inclusion. However, after inclusion, the government shifted away from issuing eligible bonds. I also decompose the debt level by other bond characteristics, such as coupon types, maturity, and issuance size, in Appendix A.3. Following the inclusion, the government borrowed more through short-term bonds.

Furthermore, I directly estimate the share of external local-currency bonds held by mutual funds using their aggregate positions up to 2017 from the Global Capital Allocation Project (Maggiori et al., 2027; Coppola et al., 2021). I construct the share of external local- and hard-currency sovereign bonds held by mutual funds. Figure B.2 shows that mutual fund shares reached 35% for local-currency denominated debt in 2017. More importantly, mutual fund shares of local-currency debt are consistently higher than those of dollar-denominated debt. Colombia was able to attract capital from global funds even with minimal index presence. This fact is consistent with the model.

B.2.3 Issuing index eligible bonds over the global financial cycle

The case study of Colombia shows that it borrows in both index-eligible and ineligible bonds and that the debt level of index-eligible bonds exhibits cyclical patterns. I further explore the cyclicality of issuing index-eligible bonds. I collect data from Bloomberg on local-currency sovereign bonds issued by common emerging market countries from 2005 to 2023. Similar to the case study, I use the bond eligibility criteria of the JP Morgan GBI-EM Diversified index to identify index

Figure B.2: A case study of Colombia's index inclusion: creditor and debt instrument compositions



(a) Colombian external debts held by mutual funds

(b) Colombian debt level of index eligible bonds

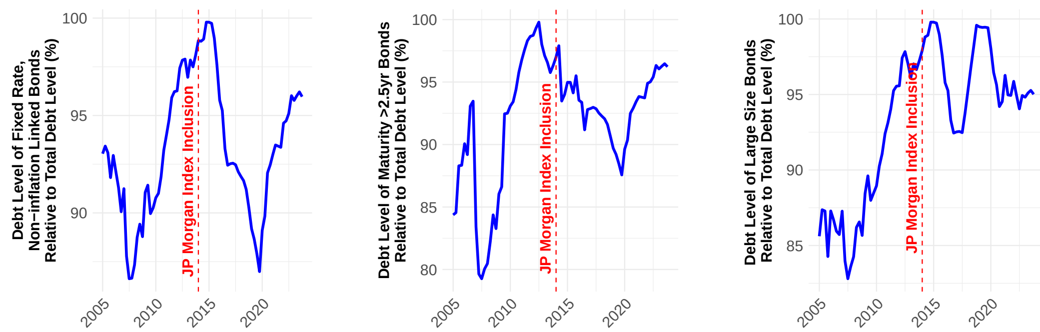
Notes: Aggregate positions of mutual funds domiciled in Ireland, Luxembourg, and the U.S. are from: www.globalcapitalallocation.com, based on the work of Maggiori et al. (2027) and Coppola et al. (2021). Foreign creditor holdings of domestic debts by currency are from Onen et al. (2022). Data for years 2008, 2009, and 2013 are missing because Colombian represented less than 1% of the total sovereign fixed income portfolios for Ireland, Luxembourg, and the US. As a result, the data omits Colombia. I estimate the present value of debt service payments. The discount rate is the average of Colombian short-term interest rate from 2005 and 2023. I retrieve the end-of-year Colombian Peso to UVR (the real value unit for inflation index bonds) exchange rate from the central bank. I use the average growth between 2005 and 2023 to interpolate for other years. When coupon payments are not available, the principal payment is used. See Appendix A.3 for more details on the construction.

eligible bonds[28]. After extracting the cyclical components of the VIX and the share of issuing index-eligible debt relative to total LC bonds at the annual frequency, I calculate their correlations.

Table B.4 Panel A presents the cyclical pattern of these currencies, while currencies that experienced inclusion/exclusion events are shown in Panel B. Countries persistently included in GBI-EM index tend to issue fewer index- eligible bonds when the VIX is high during global downturns. This negative correlation between the VIX and the issuance share of index-eligible bonds is present in nine countries, excluding Thailand and Poland.

[28]Note that JP Morgan has discretion to decide which bonds are eligible. As mentioned above, liquidity could be a concern. To the best of my knowledge, these isn't any study of JP Morgan GBI-EM that analyzes exactly which bonds are eligible. All existing approaches focus on the country weight in the GBI-EM index. Using a snapshot of the publicly available index weights of individual bonds from the GBI-EM website, I verified using eligibility criteria and identified all but a few bonds in July 2023. The bond-level index weights can be assessed here: https://www.jpmorgan.com/insights/global-research/index-research/composition. However, historical index weights are not publicly available without a paid subscription.

Figure B.3: Colombian debt level



(a) Debt level of Fixed-rate non-indexed bonds

(b) Debt level of bond with maturities ≥ 2.5yr

(c) Debt level of large size bonds

Even though two bonds differ in their index status, they face identical credit risk. The supply of index-eligible $B^{e\prime}$ and ineligible $B^{o\prime}$ bonds issued by the same country included the index should have identical prices. Let the $B_d^{e\prime}$ and $B_d^{o\prime}$ be the bond demand by global mutual funds, and the demand depends on

$$q = \frac{\mathbb{E}\left(\frac{s(1-d')}{s'}\right)/(1+r^f)}{(1+r^f)D_0\left(\frac{1-\mu}{\gamma_L}+\frac{\mu}{\gamma_H}\right)\mathrm{Var}\left(\frac{s(1-d')}{s'}\right)\left(\frac{s^{-1}q\times(B_d^{e\prime}+B_d^{o\prime})}{D_0}-(1-\mu)(1-\alpha)w^b(s^{-1}qB^{e\prime})\right)+1}$$

Index-eligible and ineligible bonds have an identical demand elasticity because $\frac{\partial q}{\partial B_d^{e\prime}} = \frac{\partial q}{\partial B_d^{o\prime}}$ whenever the demand for index-eligible and index-ineligible bonds $B_d^{e\prime} = B_d^{o\prime}$. However, their supply elasticities are different. Imposing the market clearing conditions, $B_d^{e\prime} = B^{e\prime}$ and $B_d^{o\prime} = B^{o\prime}$, yields

$$q = \frac{\mathbb{E}\left(\frac{s(1-d')}{s'}\right)/(1+r^f)}{(1+r^f)D_0\left(\frac{1-\mu}{\gamma_L}+\frac{\mu}{\gamma_H}\right)\mathrm{Var}\left(\frac{s(1-d')}{s'}\right)\left(\frac{s^{-1}q\times(B^{e\prime}+B^{o\prime})}{D_0}-(1-\mu)(1-\alpha)w^b(s^{-1}qB^{e\prime})\right)+1}$$

For any identical supplies $B^{e\prime} = B^{o\prime}$, the supply elasticities are different because the country internalizes the additional effect of issuing index-eligible bonds in the benchmark weight. If larger borrowing depresses bond prices in equilibrium, as in standard sovereign default models, then $\frac{\partial q}{\partial B^{e\prime}} < 0$. Using the Implicit Function Theorem, I obtain:

$$\frac{\partial q}{\partial B^{e\prime}} - \frac{\partial q}{\partial B^{o\prime}}\bigg|_{B^{e\prime}=B^{o\prime}} \propto \frac{\partial w^b}{\partial(s^{-1}qB^{e\prime})}s^{-1}q \geq 0$$

Therefore, the price is less responsive to the supply of index-eligible bonds. Above patterns of issuing fewer index eligible bonds in global downturns are qualitatively consistent with a model where the supply elasticities of index-eligible and ineligible bonds are different.

Table B.4: Summary of the cyclical pattern of the debt issuance by currencies eligible for the JP Morgan GBI-EM index

Currency HP filter detrended	Avg. index eligible share (%) Y	Corr. with VIX (%) Y	Corr. with VIX (%) N
Panel a: Currencies included since the index inception			
BRL	7.22	-31.30	-24.04
CLP	4.11	-2.60	-10.85
HUF	16.08	-8.71	-18.66
IDR	29.79	-18.99	-18.72
MXN	12.98	-4.31	5.09
MYR	47.43	-13.25	-22.70
PEN	23.64	-20.72	-15.24
PLN	44.01	3.03	-2.30
THB	8.71	14.67	12.50
TRY	29.09	-11.20	-18.57
ZAR	15.68	-46.22	-38.53
Average	21.70	-12.69	-13.82
Median	16.08	-11.20	-18.57
Std.Dev	14.54	16.62	14.34
Panel B: Currencies with inclusion/exclusion events			
ARS	0.23	5.62	-1.09
CNY	54.52	-36.91	-27.79
COP	53.40	48.85	53.52
CZK	10.19	10.96	10.29
DOP	2.16	21.33	16.21
EGP	9.17	14.11	11.39
ILS	22.31	-4.37	-6.31
INR	27.87	10.25	14.05
PHP	35.98	-41.96	-38.04
RON	55.65	7.30	-15.04
RUB	18.58	32.22	27.27
Average	26.37	6.13	4.04
Median	22.31	10.25	10.29
Std.Dev	20.93	26.68	25.71

Notes: The index-eligible share refers to the proportion of index eligible bonds relative to the total LC bonds issued annually. The correlation between the VIX and the index eligible LC bond share refers to the relationship between the cyclical components of both the VIX and the share after 2005. The currencies in Panel A represent countries that have been included in the GBI-EM index since its inception and have not experienced any inclusion or exclusion events.

C Analytical appendix

C.1 Deriving portfolios

The portfolio weight w_{jt} for $j = \{\text{EM fund}, \text{Dollar fund}\}$ is

$$w_{jt} = \frac{\frac{1}{q_t}\mathbb{E}_t\left(\frac{s_t(1-d_{t+1})}{s_{t+1}(1+r^f)}\right) - 1}{(1+r^f)D_0\gamma_j \operatorname{Var}\left(\frac{s_t(1-d_{t+1})(1+r_t)}{s_{t+1}(1+r^f)} - 1\right)} + (1-\alpha)w^b_{jt} \approx \frac{\frac{1}{q_t}\mathbb{E}_t\left(\frac{s_t(1-d_{t+1})}{s_{t+1}(1+r^f)}\right) - 1}{(1+r^f)D_0\gamma_j \operatorname{Var}\left(\frac{s_t(1-d_{t+1})}{s_{t+1}}\right)} + (1-\alpha)w^b_{jt}$$

where the approximation is under a state without any currency and credit risk, that is $1/q_t = 1 + r_t \approx 1 + r^f$. The asset demand B^d_{t+1} by global mutual funds is

$$(1-\mu)D_0 \cdot w_{\text{EM Fund},t} + \mu \cdot D_0 \cdot w_{\text{Dollar Fund},t} = s_t^{-1} q_t B^d_{t+1}$$

Using the expressions of portfolio weights, the asset demand is

$$q_t = \frac{\mathbb{E}_t\left(\frac{s_t(1-d_{t+1})}{s_{t+1}(1+r^f)}\right)}{(1+r^f)D_0\left(\frac{1-\mu}{\gamma_L} + \frac{\mu}{\gamma_H}\right)^{-1} \cdot \operatorname{Var}\left(\frac{s_t(1-d_{t+1})}{s_{t+1}}\right) \cdot \left(\frac{s_t^{-1}q_t B^d_{t+1}}{D_0} - (1-\mu)(1-\alpha)w^b_t(s_t^{-1}q_t B_{t+1})\right) + 1}$$

where the supply of local currency bond B_{t+1} instead of the demand B^d_{t+1} determines the benchmark weight. I omit the time subscript and express the asset demand for B^d as

$$K(q, B^d) = q - \frac{a_0}{a_1(\frac{s^{-1}B^d}{D_0}q - a_2 w^b_t(s^{-1}qB)) + 1} = 0$$

where $a_0 = \mathbb{E}(\frac{s(1-d')}{s'(1+r^f)})$, $a_1 = (1+r^f)D_0(\frac{1-\mu}{\gamma_L} + \frac{\mu}{\gamma_H})^{-1} \cdot \operatorname{Var}(\frac{s(1-d')}{s'})$, and $a_2 = (1-\mu)(1-\alpha)$. Using the Implicit Function Theorem,

$$\frac{\partial q}{\partial w^b}\Big|_{w^b=0} = -\frac{\partial K/\partial w^b}{\partial K/\partial q} = \frac{a_0 a_1 a_2}{(a_1\frac{s^{-1}B^d}{D_0}q + 1)^2 + a_0 a_1 \frac{s^{-1}B^d}{D_0}} > 0 \tag{32}$$

which implies that index inclusion raises the price.

The slope of the demand curve

$$\frac{\partial B^d}{\partial q} = -\frac{\partial K/\partial q}{\partial K/\partial B^d} = -\frac{(a_1(\frac{s^{-1}B^d}{D_0}q - a_2 w^b) + 1)^2 + a_0 a_1(\frac{s^{-1}B^d}{D_0} - a_2 q^{-1}\epsilon^b)}{a_0 a_1 \frac{s^{-1}q}{D_0}} \tag{33}$$

where the partial elasticity of benchmark weights with respect to the market value of assets $\epsilon^b =$

$\frac{\partial w^b}{\partial(s^{-1}qB)}(s^{-1}Bq)$. Moreover,

$$\frac{\partial^2 B^d}{\partial q \partial w^b} > 0 \tag{34}$$

which means that a rising benchmark weight makes demand more inelastic.

Relationship to CRRA preference. The manager's problem under a CRRA preference is

$$\begin{aligned} \max_{b^{DM}_{j,t+1}, b_{j,t+1}} \mathbb{E}_t & \frac{(\alpha W_{j,t+1} + (1-\alpha)(W_{j,t+1} - W^b_{j,t+1}))^{1-\gamma_k}}{1-\gamma_k} \\ \text{s.t. } D_0 &= q^{DM}_t b^{DM}_{j,t+1} + s_t^{-1} q_t b_{j,t+1} \\ W_{j,t+1} &= b^{DM}_{j,t+1} + s^{-1}_{t+1}(1-d_{t+1}) b_{j,t+1} \end{aligned} \tag{35}$$

The first order condition of the portfolio choice for type j fund is:

$$\mathbb{E}_t \left[\left(\frac{s_t(1-d_{t+1})(1+r_t)}{s_{t+1}(1+r^f)} - 1 \right) \left(\alpha + \left(\frac{s_t^{-1} q_t B_{t+1}}{D_0} - (1-\alpha) w^b_t \right) \left(\frac{s_t(1-d_{t+1})(1+r_t)}{s_{t+1}(1+r^f)} - 1 \right) \right)^{-\gamma_j} \right] = 0$$

To derive the portfolio share, I expand $\frac{s_t(1-d_{t+1})(1+r_t)}{s_{t+1}}$ around the risk-free rate $1 + r^f$ up to the second order. In other words, I solve the portfolio problem using the Taylor expansion around a state without any risk. The result for EM funds is below, and the expression of a similar form applies for dollar funds.

$$\mathbb{E}_t \left(\frac{s_t(1-d_{t+1})(1+r_t)}{s_{t+1}(1+r^f)} - 1 \right) - \frac{\gamma_L}{\alpha} \left(\frac{s_t^{-1} q_t B_{t+1}}{D_0} - (1-\alpha) w^b_t \right) \mathbb{E}_t \left(\frac{s_t(1-d_{t+1})(1+r_t)}{s_{t+1}(1+r^f)} - 1 \right)^2 = 0$$

The portfolio weight w_{jt} for $j = \{\text{EM fund}, \text{Dollar fund}\}$ is

$$w_{jt} = \frac{\frac{1}{q_t} \mathbb{E}_t \left(\frac{s_t(1-d_{t+1})}{s_{t+1}(1+r^f)} \right) - 1}{\frac{\gamma_L}{\alpha} \operatorname{Var} \left(\frac{s_t(1-d_{t+1})}{s_{t+1}} \right)} + (1-\alpha) w^b_{jt}$$

The asset market clearing condition is

$$(1-\mu) D_0 \cdot w_{\text{EM Fund},t} + \mu \cdot D_0 \cdot w_{\text{Dollar Fund},t} = s_t^{-1} q_t B_{t+1}$$

The expression of bond price q_t is

$$q_t = \frac{\mathbb{E}_t \left(\frac{s_t(1-d_{t+1})}{s_{t+1}(1+r^f)} \right)}{\frac{\left(\frac{1-\mu}{\gamma_L} + \frac{\mu}{\gamma_H} \right)^{-1}}{\alpha} \cdot \operatorname{Var} \left(\frac{s_t(1-d_{t+1})}{s_{t+1}} \right) \cdot \left(\frac{s_t^{-1} q_t B_{t+1}}{D_0} - (1-\mu)(1-\alpha) w^b_t \right) + 1}$$

I explain why bond prices do not enter in $\mathrm{Var}(.)$, as $\mathbb{E}_t\left(\frac{s_t(1-d_{t+1})(1+r_t)}{s_{t+1}(1+r^f)}-1\right)^2 \approx \mathrm{Var}\left(\frac{s_t(1-d_{t+1})}{s_{t+1}}\right)$. Define $\frac{1+r^f+r_{t+1}-r^f}{1+r^f}=1+\frac{r_{t+1}-r^f}{1+r^f}\equiv 1+\Delta_t$ and $\frac{s_t(1-d_{t+1})}{s_{t+1}}\equiv x_{t+1}$. The original term can be written as

$$\begin{aligned}\mathbb{E}((1+\Delta_t)x_{t+1}-1)^2 &= \mathbb{E}(1+\Delta_t)^2x_{t+1}^2+1-2\mathbb{E}(x_{t+1})(1+\Delta_t)\\ &= \mathrm{Var}(x_{t+1})+\left(\Delta_t^2+2\Delta_t\right)\mathbb{E}\left(x_{t+1}^2\right)+\mathbb{E}^2(x_{t+1})+1-2\mathbb{E}(x_{t+1})(1+\Delta_t)\end{aligned}$$

When $\Delta_t\to 0$, $\mathbb{E}((1+\Delta_t)x_{t+1}-1)^2=\mathrm{Var}(x_{t+1})+\mathbb{E}^2(x_{t+1})+1-2\mathbb{E}(x_{t+1})$. When $\mathbb{E}_t(d_{t+1})\to 0$ (i.e. the default probability is approaching zero) and the exchange rate is not expected to depreciate (i.e. $\mathbb{E}\left(\frac{s_t}{s_{t+1}}\right)\to 1$), the above expression becomes $\mathbb{E}((1+\Delta_t)x_{t+1}-1)^2=\mathrm{Var}(x_{t+1})+1+1-2=\mathrm{Var}(x_{t+1})$

C.2 Proof of Proposition 1.

From the market clearing condition:

$$y_0=(1+r^f)\left(\mathbb{E}(\frac{s_0(1-d_{t+1})}{s_{t+1}})\right)^{-1}\left(\frac{(1+r^f)D_0\,\mathrm{Var}(\frac{s_0(1-d_{t+1})}{s_{t+1}})}{E_\gamma}(\frac{s_0^{-1}B}{y_0D_0}-(1-\mu)(1-\alpha)w^b(\frac{s_0^{-1}B}{y_0}))+1\right)$$

Denote $R_0\equiv\mathbb{E}_0\left(\frac{s_0(1-d_1)}{s_1}\right)$, $w_0\equiv\frac{s_0^{-1}B}{y_0D_0}$, $\varepsilon^b\equiv\frac{\partial w^b}{\partial(s^{-1}B/y_0)}\frac{s_0^{-1}B}{y_0}$, $V_0\equiv(1+r^f)D_0\,\mathrm{Var}(\frac{s_0(1-d_1)}{s_1})$. I rewrite the market clearing condition as

$$y_0=(1+r^f)R_0^{-1}\left(\frac{V_0}{E_\gamma}\left(w_0-(1-\mu)(1-\alpha)w^b\right)+1\right)$$

I perform the first-order Taylor expansion of y_0, R_0, V_0 and s_0. $\wedge$ denotes the log-deviation from the initial value.

$$\begin{aligned}(1+\frac{(1+r^f)V_0}{R_0y_0E_\gamma}(w_0-(1-\mu)(1-\alpha)\epsilon^b)\hat{y}_0=-\hat{R}_0+&\\ \hat{s}_0\frac{(1+r^f)V_0}{R_0y_0E_\gamma}(-w_0+(1-\mu)(1-\alpha)\epsilon^b)+&\\ \hat{V_0}\frac{(1+r^f)V_0}{R_0y_0E_\gamma}(w_0-(1\mu)(1-\alpha)w^b)&\end{aligned}\tag{36}$$

Define the creditor composition θ_0 as the market value of the bond held by EM funds relative to the market value of the bond held among global mutual funds.

$$\theta_0=\frac{\left[\left(\frac{y_0R_0}{1+r^f}-1\right)\frac{1-\mu}{\gamma_LV_0}+(1-\mu)(1-\alpha)w^b\right]D_0}{\frac{s_0^{-1}B}{y_0}}\Rightarrow(1-\mu)(1-\alpha)w^b=\theta_0b_0-\left(\frac{y_0R_0}{1+r^f}-1\right)\frac{1-\mu}{\gamma_LV_0}$$

Using the definition of dollar fund ownership,

$$1-\theta_0=\frac{\left(\frac{y_0R_0}{1+r^f}-1\right)\frac{\mu}{\gamma_HV_0}D_0}{\frac{s_0^{-1}B}{y_0}}\Rightarrow\frac{y_0R_0}{1+r^f}-1=(1-\theta_0)\frac{s_0^{-1}B}{y_0D_0}\cdot\left(\frac{\mu}{\gamma_HV_0}\right)^{-1}$$

Using the above expressions, I rewrite terms with w^b.

$$w_0-(1-\mu)(1-\alpha)w^b=(1-\theta_0)w_0(1+\frac{1-\mu}{\mu}\frac{\gamma_H}{\gamma_L})$$

Define the following

$$\begin{aligned}\hat{R}_0&=\frac{\partial R_0}{\partial z_0}\frac{z_0}{R_0}\hat{z}_0\equiv\Phi_R\hat{z}_0\\ \hat{s}_0&=\frac{\partial s_0}{\partial z_0}\frac{z_0}{s_0}\hat{z}_0\equiv\Phi_s\hat{z}_0\\ \hat{V}_0&=\frac{\partial V_0}{\partial z_0}\frac{z_0}{V_0}\hat{z}_0\equiv\Phi_v\hat{z}_0\end{aligned}$$

Finally, using above results, I rewrite equation 36.

$$\begin{aligned}\hat{y}_0&=-\Phi_R\hat{z}_0+\Phi_1\left(-\Phi_R+\Phi_s+\Phi_v\Phi_2\right)\hat{z}_0,\\ \text{where }\Phi_1&=\left(1+\frac{w_0-\epsilon^b(1-\mu)(1-\alpha)}{(1-\theta_0)w_0(1+\frac{(1-\mu)\gamma_H}{\mu\gamma_L})+\frac{E_\gamma}{(1+r^f)V_0}}\right)^{-1},\\ \Phi_2&=\frac{(1-\theta_0)w_0(1+\frac{(1-\mu)\gamma_H}{\mu\gamma_L})}{(1-\theta_0)w_0(1+\frac{(1-\mu)\gamma_H}{\mu\gamma_L})+\frac{E_\gamma}{(1+r^f)V_0}}\end{aligned}$$

QED.

C.3 Proof of Proposition 2.

To show Proposition 2, when the asset is under index exclusion, $w^b=0$ and by definition $\theta_0=0$. When the index status changes from inclusion to exclusion, according to the above definition, Φ_1 and Φ_2 become larger. Therefore, $\frac{\partial\hat{y}_0}{\partial\hat{z}_0}|_{\text{exclusion}}-\frac{\partial\hat{y}_0}{\partial\hat{z}_0}|_{\text{inclusion}}>0$. Moreover, to the first order approximation around $w_0=\bar{w}$ and $\theta_0=0$,

$$\frac{\partial\hat{y}_0}{\partial\hat{z}_0}|_{\text{exclusion}}-\frac{\partial\hat{y}_0}{\partial\hat{z}_0}|_{\text{inclusion}}=-\left[(-\Phi_R+\Phi_s)\frac{\partial\Phi_1}{\partial(w_0\theta_0)}|_{\bar{w},0}w_0\theta_0+\Phi_v\frac{\partial(\Phi_1\Phi_2)}{\partial(w_0\theta_0)}|_{\bar{w},0}w_0\theta_0\right]$$

The first order approximation of $\hat{y}_0 = -\Phi_R \hat{z}_0 + \Phi_1 \left(-\Phi_R + \Phi_s + \Phi_v \Phi_2\right) \hat{z}_0$ is

$$\hat{y}_0 = \alpha \hat{z}_0 + \beta \hat{z} \times w_0 + \gamma \hat{z}_0 \times w_0 \times \theta_0$$

where $\gamma = (-\Phi_R + \Phi_s) \frac{\partial \Phi_1}{\partial (w_0 \theta_0)}|_{\bar{w},0} w_0 \theta_0 + \Phi_v \frac{\partial (\Phi_1 \Phi_2)}{\partial (w_0 \theta_0)}|_{\bar{w},0} w_0 \theta_0$.

QED.

C.4 Proof of Proposition 3.

To show Proposition 3, I first use the first-order condition at $t = 1$ when $h = 0$. The optimal choice of bonds $B^* > 0$ satisfies the following.

$$\frac{1}{Y_1 + q(h=0, B^*)B^* - B_{01}} \left(\frac{\partial q\,(h=0)}{\partial B} \cdot B^* + q\,(h=0) \right) + \beta_{EM} \frac{\partial E_1(V_2(S_2, B))}{\partial B} = 0$$

I first show when $V_1\,(h=1, B^*) > V_1\,(h=0, B^*)$ could happen. I analyze if the first order condition becomes positive when the index status switches to inclusion, $h = 1$, when the amount of borrowing remains the same at B^*. Given that the value function is concave in B, the first order condition being positive at B^* is a necessary condition for a higher debt level and a higher value of the value function under index inclusion. Let $q^0 \equiv q(h=0, B^*)$ and $q^1 \equiv q\,(h=1, B^*)$. Given that the price is higher under index inclusion, a sufficient condition is:

$$\left.\frac{\partial q^1}{\partial B}\right|_{B=B^*, q^1} - \left.\frac{\partial q^0}{\partial B}\right|_{B=B^*, q^0} > 0 \quad \text{and} \quad \left.\frac{\partial q^1}{\partial B}\right|_{B=B^*, q^1} \cdot q^0 - \left.\frac{\partial q^0}{\partial B}\right|_{B=B^*, q^0} \cdot q^1 > 0$$

I assume that above partial derivatives are negative. Quantitative sovereign default models typically imply this negative relationship because rising debt increases the default risk and depresses the price. With this assumption, a sufficient condition for more debt under index inclusion is $\left.\frac{\partial q^1}{\partial B}\right|_{B=B^*, q^1} - \left.\frac{\partial q^0}{\partial B}\right|_{B=B^*, q^0} > 0$. I characterize conditions under which this inequality holds. Let $a_0(B) \equiv \mathbb{E}_1(\frac{s_1(1-d_2)}{s_2})$, $a_1(B) = (1+r^f) D_0 \operatorname{Var}(\frac{s_1(1-d_2)}{s_2}) \frac{1}{E_\gamma}$, $a_2 = (1-\mu)(1-\alpha)$, $w_0 = \frac{s_0^{-1} q^0 B^*}{D_0}$, $w_1 = \frac{s_0^{-1} q^1 B^*}{D_0}$, $\phi_0 = \frac{\partial a_0(B)}{\partial B}$, $\phi_1 = \frac{\partial a_0(B)}{\partial B} a_1 - \frac{\partial a_1(B)}{\partial B} a_0$, and $\epsilon^b = \frac{\partial w^b}{\partial (s_1^{-1} q B)} (s_1^{-1} q^1 B^*)$.

$$\left.\frac{\partial q^1}{\partial B}\right|_{B^*, q^1} - \left.\frac{\partial q^0}{\partial B}\right|_{B^*, q^0} > 0 \Leftrightarrow \begin{array}{l} (\phi_0 + \phi_1(w_1 - a_2 w^b) + a_1(w_1 - a_2 \epsilon^b) B^{-1})((w_0 a_1 + 1)^2 + a_0 a_1 w_0 \dfrac{1}{q^0}) \\ - (\phi_0 + \phi_1 w_0 + a_1 w_0 B^{-1})(((w_1 - a_2 w^b) a_1 + 1)^2 + a_0 a_1 (w_1 - a_2 \epsilon^b) \dfrac{1}{q^1}) > 0 \end{array}$$

Under the above assumption of a lower price under higher debt, $(\phi_0 + \phi_1(w_1 - a_2 w^b) + a_1(w_1 - a_2 \epsilon^b) B^{-1}) < 0$ and $(\phi_0 + \phi_1 w_0 + a_1 w_0 B^{-1}) < 0$. A sufficient condition to ensure the above inequality is that inequalities below hold at the same time

$$(\phi_0 + \phi_1(w_1 - a_2 w^b) + a_1(w_1 - a_2\epsilon^b)B^{-1}) - (\phi_0 + \phi_1 w_0 + a_1 w_0 B^{-1}) > 0$$

$$(((w_1 - a_2 w^b)a_1 + 1)^2 + a_0 a_1 (w_1 - a_2\epsilon^b)\frac{1}{q^1}) - ((w_0 a_1 + 1)^2 + a_0 a_1 w_0 \frac{1}{q^0}) > 0$$

Relationships below are sufficient conditions.

$$1 > \frac{\partial w^b}{\partial(s_1^{-1} q B)} \frac{s_1^{-1} q^1 B}{w^b}$$
$$\frac{\partial \mathbb{E}_1(\frac{s_1(1-d_2)}{s_2})}{\partial B} \operatorname{Var}(\frac{s_1(1-d_2)}{s_2}) - \frac{\partial \operatorname{Var}(\frac{s_1(1-d_2)}{s_2})}{\partial B} \mathbb{E}_1(\frac{s_1(1-d_2)}{s_2}) > 0$$
$$\frac{s_1^{-1} q^1 B^*}{D_0} - (1-\mu)(1-\alpha)w^b > \frac{s_1^{-1} q^0 B^*}{D_0}$$

QED.

C.4.1 Bond supply elasticity and benchmark weight

How does the change of benchmark weight affect the bond supply elasticity in equilibrium? Let $a_0(B) = \mathbb{E}_1(\mathcal{E}_2)$, $a_1(B) = (1+r^f)D_0 \operatorname{Var}(\mathcal{E}_2)\frac{1}{E_\gamma}$, $a_2 = (1-\mu)(1-\alpha)$, $f^1(q(h=1,B),B) = \frac{s_1^{-1}qB}{D_0} - a_2 w^b$, and $f^0(q(h=0,B),B) = \frac{s_1^{-1}qB}{D_0}$.

$$\frac{\partial q}{\partial B} = \frac{\frac{\partial a_0(B)}{\partial B} + (\frac{\partial a_0(B)}{\partial B}a_1 - \frac{\partial a_1(B)}{\partial B}a_0)(\frac{s^{-1}Bq^1}{D_0} - a_2 w^b) + a_1(\frac{s^{-1}B}{D_0} - a_2 B^{-1}\epsilon^b)}{(a_1(\frac{s^{-1}Bq^1}{D_0} - a_2 w^b) + 1)^2 + a_0 a_1(\frac{s^{-1}B}{D_0} - a_2 q^{-1}\epsilon^b)} \tag{37}$$

The supply elasticity depends on the expected default probability and the variance of the expected repayment. If $\frac{\partial a_0(B)}{\partial B}a_1 - \frac{\partial a_1(B)}{\partial B}a_0 < 0$, then $\frac{\partial^2 q}{\partial B \partial w^b} < 0$, implying a rising benchmark weight makes the equilibrium price more sensitive to changes in bond supply. If it is greater than zero, the sign is ambiguous. The implication of this result is consistent with Moretti et al. (2024) (p.25), which argues that the inelastic demand is a disciplinary mechanism that limits government debt.

D The relationship to the literature of benchmark contracts

This section outlines the micro-foundation of the reduced-form utility function, in which asset managers invest in an asset class that is entirely different from the asset class specified in the performance benchmark. I extend the model in Kashyap et al. (2020) by introducing heterogeneity in asset managers' private costs. Furthermore, I also account for the (non-pecuniary) cost that investors derive from holding specific assets.[29]

I consider a two-period CARA-normal model with two risky assets. The risky asset pays $\tilde{D}_i \sim N(\mu_i, \sigma_i^2)$ per unit at date 1 for $i = 1, 2$. The exogenous gross interest rate of a risk free asset is normalized to 0. The aggregate supply of the risky asset is $\bar{x}_i$. I assume the pay-off depends on a common and an idiosyncratic component, that is $\tilde{D}_i = \nu + \tilde{D}_{\epsilon,i}$ where the common shock $\nu \sim N(0, \sigma_A^2)$ and specific shocks $\tilde{D}_{\epsilon,i} \sim N(0, \sigma_{\epsilon,i}^2)$. This implies a covariance $cov(\tilde{D}_1, \tilde{D}_2) = \sigma_A^2$.

There is a unit mass of two types of agents: asset managers (indicated by M) and asset management firms (indicated by F). Both agents have an identical CARA preference over their wealth at date 1. I denote the risk tolerance by γ. The objective of the agents is to maximize the expected utility $\mathbb{E}(-exp(-\gamma W_j))$ for $j = F, M$.

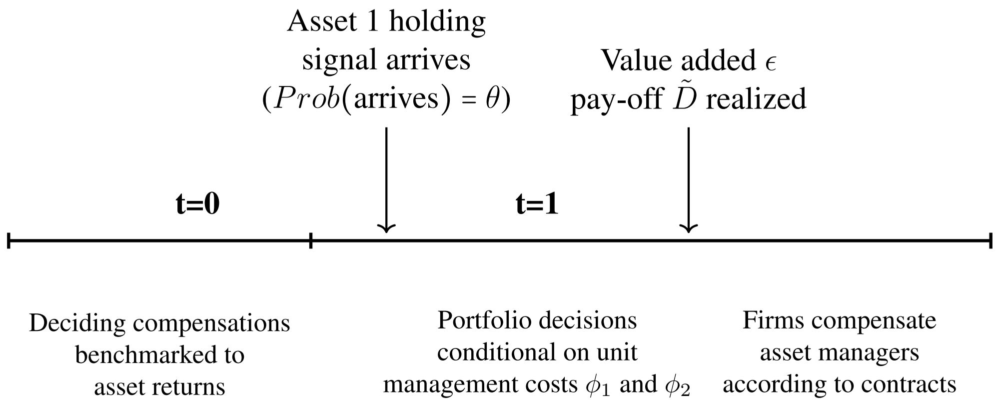
Asset management firms assign the asset manager the task of managing a risky asset 2. This is reflected by a wealth loss ϕ_p of the firm per unit of asset 1 the manager invests. The manager has an lump-sum value added $\epsilon \sim N(0, \sigma_\epsilon)$. Managing assets incurs a private management cost (or negative values can be thought of as private benefits) ϕ_i per unit for $i = 1, 2$. The manager may not commit to the task and may decide to invest in risky asset 1.

I divide the timeline into three stages and summarize it below. Figure D.4 also describes the timeline graphically. In the first stage, the asset management firm and the manager sign a compensation contract. The firm evaluates the manager's absolute return, and the return relative to assets 1 and 2. The contract (a, b, c) maximizes the welfare between the firm and the manager. Their expected utilities are U^F and U^M. Compensations depend on a fund's absolute return r_x and the return relative to benchmark indices with weights (a_0, a_1, a_2), that is $w = a_0 r_x + a_1(r_x - r_1) + a_c(r_x - r_2)$. Alternatively, the compensation can be written as $w = ar_x - br_1 - cr_2$. In the second stage, the signal of the manager investing in asset 1 arrives with a probability of θ. The manager only invest in risky asset 1 when the signal arrives. Conditional on the arrival of the signal, the manager decides to hold x_1 shares of asset 1 and x_2 shares of asset 2. Asset prices clear the market. In the last stage, values added to the management ϵ are realized. The pay-offs of assets are realized.

I solve the optimal compensation scheme when there aren't any asset 2 specific shocks (i.e. $\sigma_{\epsilon 2}^2 = 0$). I focus on parameters satisfying $1 > a^* > 0$. I summarize key insights below. Moreover,

[29] Kashyap et al. (2024) also examines the optimal benchmark contract with asset-specific costs faced by investors.

Figure D.4: Model Timeline



following Kashyap et al. (2020), the compensation should be benchmarked to the indices if the optimal benchmark contract contains $b > 0$ or $c > 0$.

The first result from the extension of the benchmark contract literature is that the optimal compensation may involve $b^* < 0$ and $c^* > 0$. $b^* < 0$ means that the manager is penalized even if he generates positive returns relative to the index of risk asset 1. If this penalty is not allowed in a compensation contract, then b^* should be 0. In other words, the practice of benchmarking to dollar indices despite of their actions of investing EM LC bonds may be optimal.

Moreover, I analyze how private costs affect the transmission of shocks. In this environment, I conduct an experiment on the how rising volatility affects the equilibrium price.

Proposition 4 *Let $\rho_1 = \gamma(b^*\sigma_{\epsilon 1}^2 + c^*\sigma_A^2) + \theta(\phi_p + \phi_1)$ denote the price of risk of asset 1. $\mathbb{E}_0(r_1) = \gamma\theta(1-a^*)(\sigma_{\epsilon 1}^2 + 2\sigma_A^2)\bar{x}_1 + \rho_1$, where the first term represents the quantity of risk. The following holds.*

1. $\frac{\partial \rho}{\partial \sigma_{\epsilon 1}^2} > 0$.
2. $\frac{\partial \rho}{\partial \sigma_A^2} > 0$ *or* < 0. *Specifically, when* $\frac{1-\theta}{\gamma a^*}(\frac{1}{a^*} - 1)\phi_1 > \phi_p + (3+\theta)\sigma_{\epsilon 1}^2(2 - \frac{1}{a^*})\bar{x}_1$, $\frac{\partial \rho}{\partial \sigma_A^2} < 0$.
3. *If* $\frac{\partial \rho}{\partial \sigma_A^2} < 0$ *for any* $(\tilde{\phi}_1, \tilde{\phi}_2, \tilde{\phi}_p)$, *then* $\frac{\partial \rho}{\partial \sigma_A^2} < 0 \forall \phi_2 > \tilde{\phi}_2$.

This proposition summarizes how specific volatility ($\sigma_{\epsilon 1}^2$) and common shocks (σ_A^2) affect the price of risk. Amplification through balance sheet channels implies that financial frictions increase the risk premia regardless of whether the shocks are aggregate or idiosyncratic. The first result describes an amplification mechanism, showing that the price of risk increases when asset 1 specific volatility rises. The second result reflects a key departure from the traditional channels: there is an ambiguous effect on the price of risk when common volatility of common shocks.

Surprisingly, common shocks may reduce the price of risk. To induce the manager to commit to investing in asset 2, the firm would share the risk of asset 2 and reduce the incentives of investing asset 1. When a common shock drives asset returns, this compensation scheme effectively reduces the impact of common shocks on the asset manager's wealth.

The third result highlights how stabilization could happen. These conditions occur when the private cost of investing asset 1, ϕ_1, is small or even negative (i.e. there may be a private benefit.). Moreover, increasing the value of ϕ_2 may also produce this result.

Summary. 1) What dollar funds do in practice—investing in an out-of-benchmark asset type—may be optimal, given that the structure of private costs cannot be internalized in the compensation contract. 2) Benchmarking changes the composition of risk when it is micro-founded. Benchmarking increases the impact of idiosyncratic volatility on expected returns, but it may mitigate the impact of common shocks. For the above result to hold, the manager must have different private benefits/costs when investing in different assets.

Proof of Proposition 4.

I solve the optimal compensation scheme (a^*, b^*, c^*) when $\sigma_{\epsilon 2}^2 = 0$. a^* satisfies

$$\gamma a^{*2}(2a^* - 1)\sigma_{\epsilon 1}^2 = \frac{1}{\sigma_A^2}(\frac{1}{a^*} - 1)\phi_1\phi_2 + \frac{1}{\sigma_{\epsilon 1}^2}\theta(\phi_1 - \phi_2)\Big(\frac{\phi_p}{a^{*2}} + (\frac{1}{a^*} - 1)(\phi_1 + \phi_p)\Big) \tag{38}$$

The expected return of asset 1 is

$$E_0(r_1) = \gamma\theta(1 - a^{*2})(\sigma_{\epsilon 1}^2 + 2\sigma_A^2)\bar{x}_1 + \gamma(b^*\sigma_{\epsilon 1}^2 + c^*\sigma_A^2) + \theta(\phi_p + \phi_1) \tag{39}$$

The term $\gamma(b^*\sigma_{\epsilon 1}^2 + c^*\sigma_A^2) + \theta(\phi_p + \phi_1)$ can be thought as the price of risk. It depends on the returns relative to the benchmarks of asset 1 and 2 given the weights b^* and c^*. Under this special parameter case, the volatility of the common shock does not affect the value of a^*. Furthermore, the price of the risk is

$$\theta(\phi_p + \phi_1) + \theta a^*\gamma\frac{\sigma_{\epsilon 1}^2}{2\sigma_{\epsilon 1}^2 + (1-\theta)\sigma_A^2}\left(\bar{x}_1(2 - \frac{1}{a^*})(\sigma_{\epsilon 1}^2 + 2\sigma_A^2) + \frac{1}{\gamma a^*}\big(\phi_1(\frac{1}{a} - 1) - \phi_p\big)\right) \tag{40}$$

I can derive the Proposition 4 using equations 38 and 40.

QED.

E Additional tables

Table E.5: Summary statistics by currency

Currency	Number of Bonds	Amount Issued ($B)	Coverage (%)	YTM(%)	Residual Maturity (yr)
BRL	18	27.39	3.78	10.95	7.06
CLP	14	4.42	8.36	4.82	13.32
COP	29	7.58	8.95	7.52	8.21
CZK	48	4.55	2.53	2.54	10.97
HUF	50	4.29	6.12	4.92	7.06
IDR	99	4.80	7.09	7.68	11.62
ILS	37	5.52	1.47	2.27	8.71
MXN	36	15.81	7.63	7.05	11.65
MYR	133	3.83	3.97	3.75	9.17
PEN	8	4.45	6.19	6.03	15.75
PLN	38	10.23	5.17	3.56	7.02
RON	56	2.90	3.46	4.91	5.86
THB	67	4.54	2.65	2.89	13.58
TRY	64	7.25	3.43	12.73	5.18
ZAR	16	20.99	3.38	9.27	16.42

Notes: This table summarizes the characteristics of bonds used in the main empirical section. The empirical analysis omits bonds from the Philippines and Russia and further restricts the residual maturity to more than two years and the issuance size to more than one billion dollars. "Coverage" refers to the share of the market value of bonds held by investors in the sample relative to the amount issued.

Table E.6: Summary of reported defaulted local-currency bonds by country (06/2019-12/2021)

country	# of defaulted bonds	# of funds reported	average market value (USD M)
AR	7	16	0.19
BR	2	3	29.83†
CL	1	1	2.48
CN	1	1	1.41
CO	1	1	0.58
DO	1	1	1.17
TH	1	3	1.65
UY	2	3	1.36
ZA	2	2	1.85

Notes: This table tabulates the statistics of defaulted bonds reported by US mutual funds from Form N-PORT-P filings.†:The extreme value comes from filings of two funds managed by Carillon Reams. For example, Carillon Reams Unconstrained Bond Fund reported that a Brazilian sovereign bond in BRL was in default in 04/2021.

Table E.7: Average ranges (bp) of yields for bonds with similar characteristics

Residual Maturity (yr)	BRL	CLP	COP	CZK	HUF	IDR	ILS	MXN	MYR	PEN	PLN	RON	THB	TRY	ZAR
2-4	23	28	47	26	43	58	26	35	29		23	38	24	68	39
4-6	15	3	39	32	28	50	19	18	22		19	21	18	72	21
6-8		5	23	13	24	43	21	13	20		12	15	13	13	30
8-10		21	13	11	12	21	19	9	13	8	10	10	10	32	20
10-12		8	13	22	13	38	14	8	26	19	11	13	13		22
12-14			2	9	16	24			11	7	3	4	8		9
14-16				5		25			16	2	4		14		13
16-18						16			9				13		10
18-20						16			11				13		6
20-22						28			7				6		6
22-24						16			3				8		9
24-26						14			6				8		11
26-28						137			6				0		
28-30						13			11				8		
30-32													3		
32-34													3		
34-36													2		
36-38													7		
Average	19	13	23	17	23	36	20	17	14	9	12	17	46	16	19

Notes: For each group of residual maturity and each currency, I first calculate the range of yields for each date to construct the table. Then, I ignore dates with zero ranges and average the ranges over time for each group of residual maturity (in years). All bonds are issued in domestic markets of emerging economies. They all have non-zero fixed coupon rates. None of these bonds are indexed to inflation. If bonds from the same issuer and with similar characteristics are traded in segmented markets, their yields to maturity will differ. The larger the value in the table, the more segmented the bond market is for a specific residual maturity.

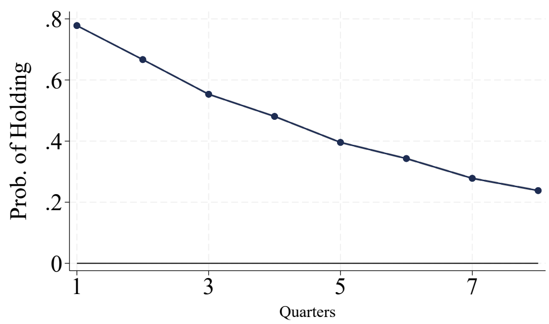
Table E.8: The response of holdings to yields

Investor Type	Dollar Fund	EM Fund
Variable	$\Delta ln(H_{it})$	$\Delta ln(H_{it})$
Δy_{it}	0.653	0.373**
	(0.846)	(0.169)
Observations	10,961	10,517
1st stage F	2.706	7.471
Currency and Time Fixed Effects	Yes	Yes

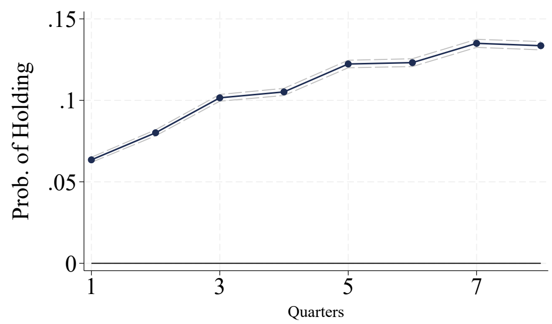
Notes: The table presents the estimates from a regression of changes in yields (pp) on changes in the face value of holdings, after controlling for country fixed effects, time fixed effects, and time-varying characteristics (GDP and residual maturity) ($\Delta ln(H_{it}) = \alpha_{c(i)} + \alpha_t + \Delta y_{it} + \Gamma X_{it} + \epsilon_{it}$) for dollar and EM funds. In the estimations for two types of mutual funds. In these estimations, the two types of mutual funds are defined as follows: Dollar funds refer to investors who use indices that exclude emerging market countries, while EM funds include all other investors whose benchmarks have ever included EM LC bonds. In the regression of dollar funds (EM funds), Δy_{it} is instrumented using the outflow-induced funding shock from EM funds (dollar funds). The estimate 0.37 is interpreted as meaning that the demand for LC bonds, measured by face value, increases by 37% for a one-percentage-point increase in bond yields. *,**,*** indicate significance at the 10%, 5%, 1% level, respectively.

F Additional figures

Figure F.5: Extensive margin of fund holding



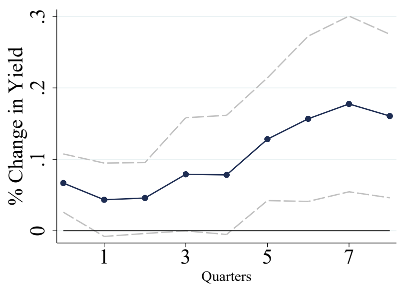
(a) Extensive margin, fund holding effect



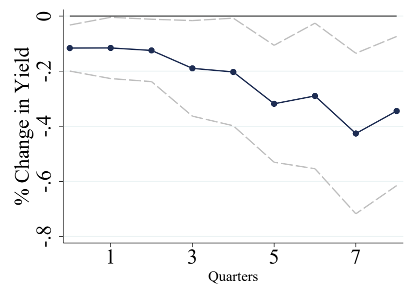
(b) Extensive margin, index inclusion effect

Notes: For a bond currently in a funds' portfolio, this two graphs show the hazard rate that a fund continues holding this bond in two years. A fund stops holding a bond may due to a fund doesn't report a bond in its holding or due to a fund's liquidation. The estimation controls bond and country-time fixed effects. The two types of mutual funds are defined as follows: Dollar funds refer to investors who use indices that exclude emerging market countries, while EM funds include all other investors whose benchmarks have ever included EM LC bonds. The first graphs shows the hazard rate of dollar funds, and the second shows the difference in hazard rates between dollar and EM funds.

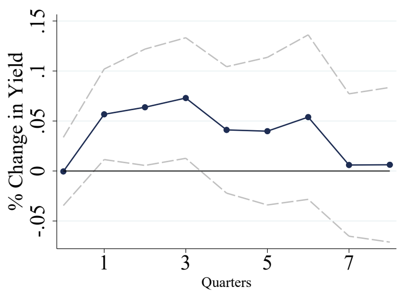
Figure F.6: Effects of index inclusion under alternative specifications



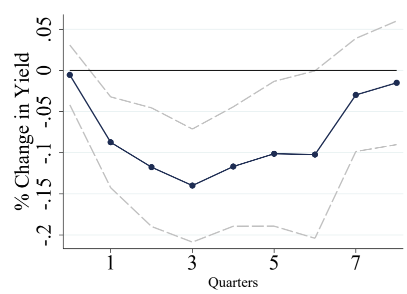
(a) VIX, fund holding effect (global LC bonds)



(b) VIX, index inclusion effect (global LC bonds)



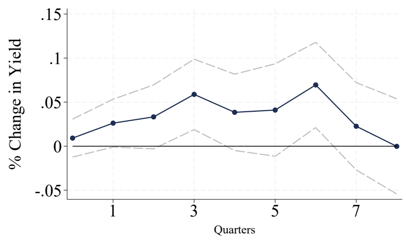
(c) VIX, fund holding effect (additional controls)



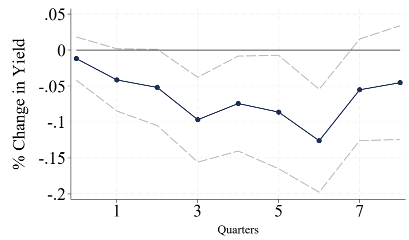
(d) VIX, bechmarking effect (additional controls)

Notes: These figures show the responses of bond yields to changes in the VIX. The "fund holding effect" refers to the effect of the interaction term $\Delta ln(VIX_t) \times I_{\text{fund},it-1}$. $I_{\text{fund},it-1}$ controls the share of bonds held by mutual funds observed in the sample. It is the total market value of bonds observed in the sample divided by the net assets of mutual funds holding these bonds. The "index inclusion" effect refers to the effect of the interaction term $\Delta ln(VIX_t) \times I_{\text{fund},it-1} \times \theta_{it-1}$. θ_{it-1} measures exposure to index inclusion. It is the share of investors who benchmark to indices with the issuing country of bond i. The sample of bonds is restricted to bonds with issuance greater than one billion dollars and residual maturities greater than two years. Currencies are BRL, CLP, COP, CZK, HUF, IDR, ILS, MXN, MYR, PEN, PLN, RON, THB, TRY, ZAR. In additional to these restrictions, panels (a) and (b) use a subsample of bonds issued in global markets. Panels (c) and (d) include time-varying controls for other bonds from the same issuer. Dotted lines plot the 90% robust standard error bands.

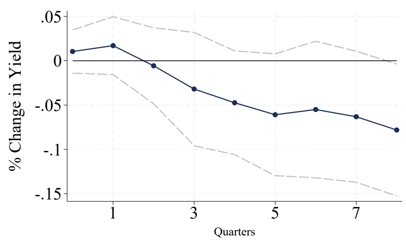
Figure F.7: Effects of index inclusion using alternative lagged variables



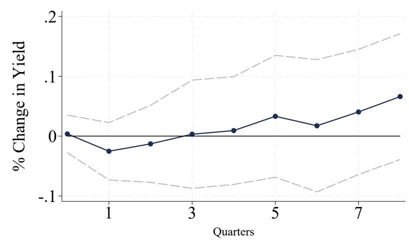
(a) VIX, fund holding effect (2 lags)



(b) VIX, index inclusion effect (2 lags)



(c) VIX, fund holding effect (4 lags)



(d) VIX, index inclusion effect (4 lags)

Notes: These figures show the responses of bond yields to changes in the VIX. In panels (a) and (b), the "fund holding effect" refers to the effect of the interaction term $\Delta ln(VIX_t) \times I_{\text{fund},it-2}$. $I_{\text{fund},it-2}$ controls the share of bonds held by mutual funds observed in the sample. It is the total market value of bonds observed in the sample divided by the net assets of mutual funds holding these bonds. The "index inclusion" effect refers to the effect of the interaction term $\Delta ln(VIX_t) \times I_{\text{fund},it-2} \times \theta_{it-2}$. θ_{it-2} measures exposure to index inclusion. It is the share of investors who benchmark to indices with the issuing country of bond i. Panels (c) and (d) use $I_{\text{fund},it-4}$ and θ_{it-4}. The sample of bonds is restricted to bonds with issuance greater than one billion dollars and residual maturities greater than two years. Currencies are BRL, CLP, COP, CZK, HUF, IDR, ILS, MXN, MYR, PEN, PLN, RON, THB, TRY, ZAR. Dotted lines plot the 90% robust standard error bands.

G Quantitative model appendix

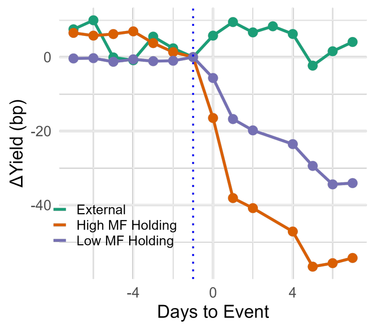
G.1 Index inclusion events

I provide further evidence on how a country's benchmark inclusion affects bond prices. I focus on EM's inclusion in JP Morgan's GBI-EM Index and Citi's WBI local currency bond index. Broner et al. (2021) analyzed these index inclusion events.

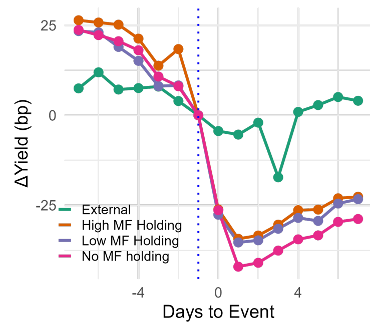
Using Asset Ownership Database in Bloomberg Terminal, I count the number of investment companies domiciled outside these countries reported holding in the quarter prior to the announcement. I classify local currency bonds into three categories based on how many different investment companies hold a bond. Low mutual fund holdings mean that fewer than five global investment companies report holdings. External bonds are dollar-denominated bonds issued in the global markets.

Figure G.8 shows that index inclusion has an impact on bonds already held by mutual funds. It is surprising that for bonds not held by global mutual funds in Romania and South Africa, they experienced larger changes in yields than sovereign bonds directly affected by the index inclusion shock. I have to note that standard theories cannot generate an overreaction if the inclusion shock only affects the quantity of bonds in the market. The co-movement of prices across bonds with different degrees of mutual fund ownership indicates a high substitution across bonds. The direct effect of index inclusion in the index-eligible bonds is attenuated. For this reason, examining the inclusion episode of Romania may underestimate the direct effect of inclusion.

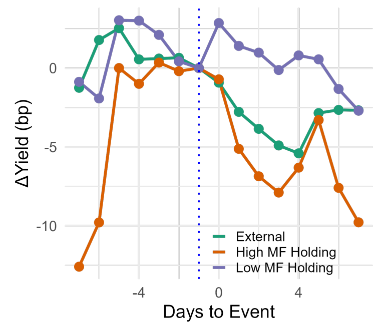
Figure G.8: Effects of index inclusion on sovereign bond yields



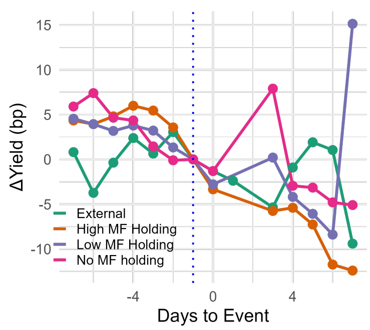
(a) Colombia



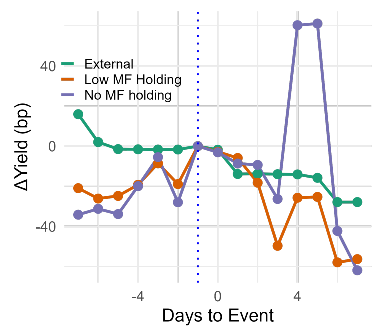
(b) Romania



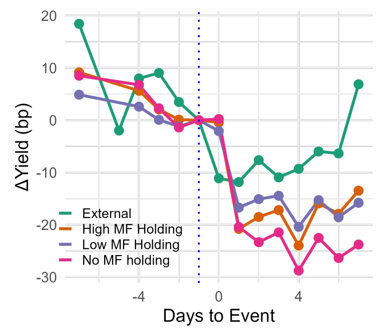
(c) Czech Republic



(d) Mexico



(e) Nigeria



(f) South Africa

Notes: This set of figures aims to replicate the analysis of the index inclusion events in Broner et al. (2021). I extend their study by including dollar-denominated bonds. Moreover, I use an alternative approach to measure the influence of the announcement of inclusion: index-eligible bonds are often widely held by global mutual funds even prior to the index inclusion events. The Security Ownership on Bloomberg Terminal, a database comparable to Morningstar's mutual fund database, directly reports for each bond the number of global investment firms, the ultimate owners of mutual funds, holding. "Low MF Holding" refers to bonds invested by fewer than five investment firms domiciled outside of respective countries in the quarter prior to the announcement.