When Safe Assets Stop Looking Safe: Global Forces in Sovereign Bond Yields

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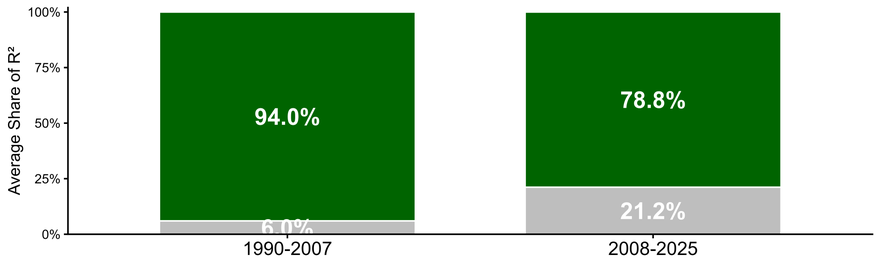
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Andrea Ricciardi

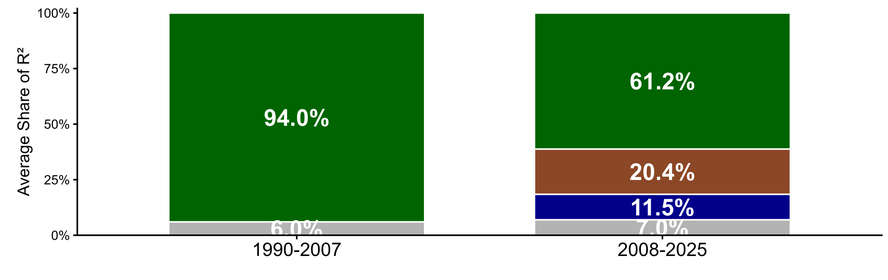
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The Big Picture

A decomposition using **Risk-free** *forces* misses an important part of sovereign pricing. I argue that the missing **Global** pieces are **Credit** and **Convenience**.



Global Risk-free and Country Component



Global Risk-free, Credit, Convenience and Country Component

Shapley R^2 Yields decomposition: **Global** and **Country** components.

The Theoretical Framework

Government Bond Prices in country (k) and maturity (n): $\Rightarrow$

$$P_{k,t}^{(n)} = \mathbb{E}_t \underbrace{\left[M_{k,t,t+n} \prod_{j=1}^{n} (1 - \chi_{k,t+j})\, e^{\left(-\sum_{j=1}^{n} w_{k,t+j-1}^{n-j+1}\right)} \right]}_{Risk-free \;+\; Default \;+\; Convenience}$$

Government Bond Yields in country (k) and maturity (n):

A. Risk-free model: only Risk-free factors $\Rightarrow$

$$y_{k,t}^{(n)} = -\frac{1}{n}\log\left[P_{k,t}^{(n)}\right] = \underbrace{r_{k,t}^{(n)}}_{Risk-free} = A_k^{(n)} + B_k^{(n)}\mathbf{X}_{k,t}$$

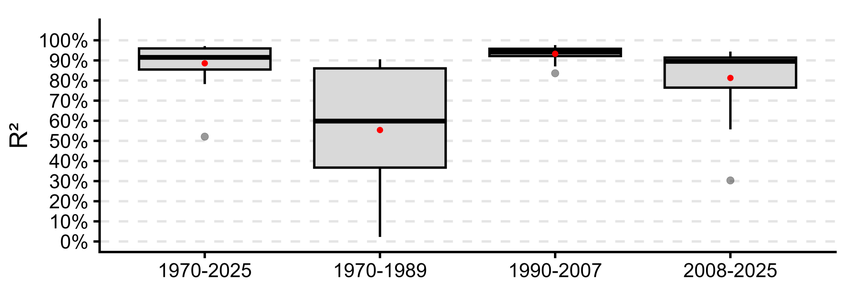
B. The Extended Framework: adding Default and Convenience $\Rightarrow$

$$y_{k,t}^{(n)} = -\frac{1}{n}\log\left[P_{k,t}^{(n)}\right] = \underbrace{r_{k,t}^{(n)}}_{Risk-free} + \underbrace{\delta_{k,t}^{(n)}}_{Default} + \underbrace{\lambda_{k,t}^{(n)}}_{Convenience} = \hat{A}_k^{(n)} + \hat{B}_k^{(n)}\mathbf{X}_{k,t}$$

A. Risk-free model: Reduced Form Evidence

We can decompose the Yields in:

$$y_{k,t}^{(10)} = \underbrace{A_k^{(n)} + B_k^{(n)}[\theta_k X_{G,t}]}_{Global} + \underbrace{B_k^{(n)}[x_{k,t}]}_{Country} = \underbrace{\alpha_k + \beta_k^L Level_t + \beta_k^S Slope_t}_{Global} + \underbrace{\varepsilon_{k,t}}_{Country} \quad (1)$$



Drop in R^2 for different sub-samples. *Country Macro Trends* ($i_{k,t}^*$, Long-run Interest Rates), can explain heterogeneity in the first, but not last sub-sample. What are the missing **Global Factors** after GFC?

- **Global Uncertainty** (EPU, VIX, EMV, GARCH, ...): $\times$
- **Global Credit Factors** $(CDS_{level},\ CDS_{slope})$: ✓

The Global Credit Risk Factor

(Panel Regressions): What explain CDS movements?

$$\Delta CDS_{k,t}^{(5)} = \alpha_k + \beta^\top \Delta L_{k,t} + \gamma^\top \Delta G_t + \varepsilon_{k,t} \quad (2)$$

where $L_{k,t}$ denotes domestic factors and G_t refers to the global factors.

Among Developed Economies there is a strong global credit-risk factor structure, not strictly related to US premium (as, instead, for Emerging countries)

	(1) $\Delta CDS_{k,t}^{(5)}$	(2) $\Delta CDS_{k,t}^{(5)}$	(3) $\Delta CDS_{k,t}^{(5)}$	(4) $\Delta CDS_{k,t}^{(5)}$	(5) $\Delta CDS_{k,t}^{(5)}$
Local Ret	-1.36***	-1.30***	-1.12***	-0.29***	-0.69***
	(-5.90)	(-5.17)	(-6.28)	(-2.53)	(-4.69)
Δ Local Vol	-2.62	3.88	-0.66	-0.67	3.85*
	(-1.08)	(1.55)	(-0.35)	(-0.63)	(1.92)
Local FX	1.12***	1.02***	0.99***	0.09	0.16
	(3.54)	(3.25)	(3.41)	(0.57)	(0.96)
USA Ret		-2.01***			1.56***
		(-2.77)			(3.35)
Δ USA Vol		-8.48***			-5.12***
		(-3.08)			(-2.88)
Δ USA Gov 5y		-0.88			-0.37
		(-0.31)			(-0.28)
USA Term Premia		0.71			0.32
		(1.27)			(1.34)
Δ USA Bond Spread		2.51			-0.64
		(1.58)			(-1.12)
Δ USA CAPE		7.89***			-3.55*
		(3.55)			(-2.80)
$\Delta CDS_{USA,t}^{(5)}$			0.53***	-0.01	0.08
			(3.11)	(-0.28)	(1.41)
$\Delta CDS_{lev,t}$ w/o USA				1.40***	1.45***
				(12.87)	(12.82)
$\Delta CDS_{slo,t}$ w/o USA				13.89***	14.15***
				(2.86)	(3.23)
Observations	3279	3279	3279	3279	3279
R^2	0.13	0.15	0.14	0.29	0.30

Countries: AUS, DNK, GBR, JPN, NOR, SWE, EUR: [AUT, BEL, DEU, ESP, FIN, FRA, IRL, ITA, NLD, PRT]

B. The Extended Framework: Reduced Form Evidence

The Decomposition:

$$y_{k,t}^{(n)} = \underbrace{\left[\beta_{r,k}^{(n)} r_{G,t} + \beta_{\delta,k}^{(n)} \delta_{G,t} + \beta_{\lambda,k}^{(n)} \lambda_{G,t}\right]}_{Global\ Component} + \underbrace{\left[\tilde{r}_{k,t}^{(n)} + \tilde{\delta}_{k,t}^{(n)} + \tilde{\lambda}_{k,t}^{(n)}\right]}_{Country\ Component}$$

Risk-free rate component $r_{k,t}^{(n)}$: $\rightarrow$ *Highly Synchronized*

- **Overnight Index Swap (OIS)**: Country Term-Structure of OIS

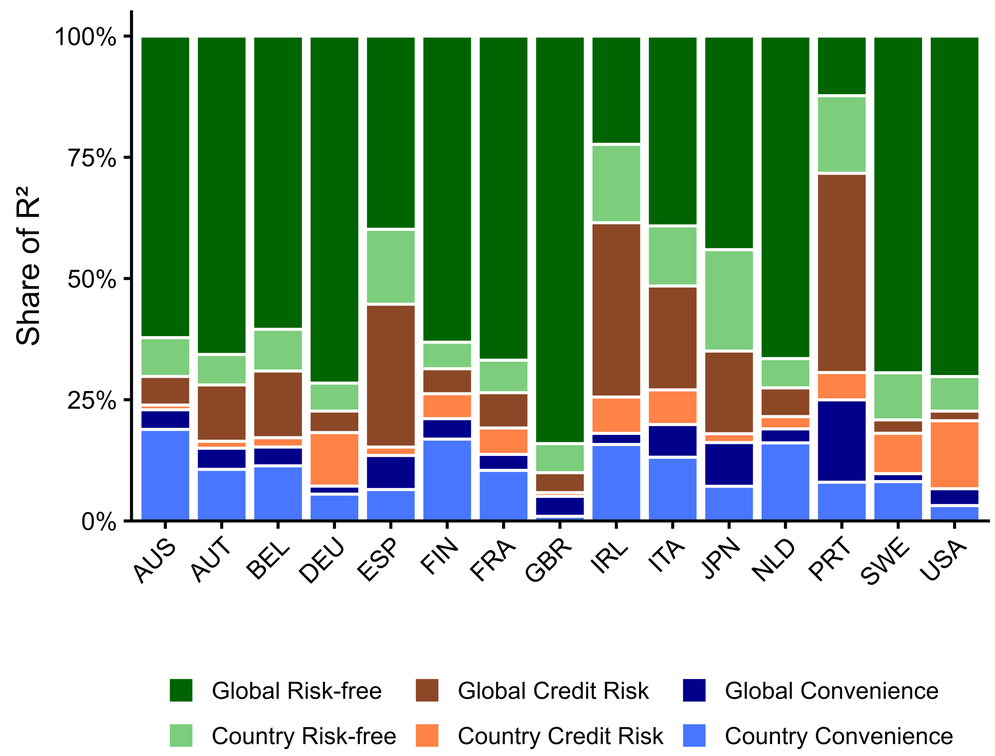
Default spread component $\delta_{k,t}^{(n)}$: $\rightarrow$ *Highly Synchronized*

- **Country Term-Structure of Credit Default Swaps (CDS)**: $CDS_{k,t}^{(n)}$

Convenience yield component $\lambda_{k,t}^{(n)}$: $\rightarrow$ *Highly Heterogeneous*

- $\lambda_{k,t}^{(n)} = Y_{k,t}^{(n)} - r_{k,t}^{(n)} - \delta_{k,t}^{(n)}$

The Shapley R^2 Yields decomposition shows the role of **Global** and **Country** components:



Policy Implications and Next Steps (Work in progress)

- **Policy Implications:**
  - International "Sovereign-bank doom-loop"
  - Global Fiscal-Monetary interaction and spillovers
  - "Who moves Convenience Yields around the World?"
- **Next Steps:**
  - Develop and estimate a no-arbitrage model consistent with the empirical evidence
  - Connect Global Credit Risk Factor with Fiscal Policy dynamics
  - Test the drivers of the Heterogeneous Convenience and its decline over time

When Safe Assets Stop Looking Safe: Global Forces in Sovereign Bond Yields

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[*Preliminary draft (Not published online yet) – Please do not circulate*]

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Abstract

Using historical and high-frequency data for 20 advanced economies, I show that global risk-free rate models capture the secular rise in sovereign yield comovement over the postwar era, but their explanatory power breaks down at long maturities after the Global Financial Crisis. I address this challenge by decomposing sovereign yields into risk-free rates, default spreads, and convenience yields, each with global and local components. The risk-free component remains the dominant global force, while global credit risk emerges as the missing factor behind post-crisis long-rate comovement. Its role is strongest for stressed sovereigns, yet it is only weakly linked to broad U.S. financial indicators, suggesting that global sovereign credit conditions are not simply a reflection of U.S. factors. Convenience yields are also important determinants of yield variation at the country level, but not comovement across countries. Finally, I document a striking erosion in safety premia across the maturity spectrum: convenience yields fall first in the United States and then more broadly across countries after 2024.

JEL Classification: E43, E44, F36, G12, G15, H63

Keywords: Sovereign Bond Yields, Global Factors, Risk-Free Rates, Credit Risk, Convenience Yields, Safe Assets, Term Structure, International Bond Markets

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1. Introduction

Government bond markets are central to macro-finance. They anchor benchmark discount rates, shape the pricing of financial assets and play a central role in monetary transmission, public debt management and global financial stability. Moreover, they have returned to the forefront of economic and policy debates. The IMF warns that high public debt remains a key downside risk to global growth and financial stability IMF (2026). Recent articles point to a "new era of fiscal dominance", in which heavy sovereign issuance, rising debt-service burdens and pressure on central banks may keep long-term yields elevated and weaken the traditional safe-asset status of government debt (Financial Times (2025a); Financial Times (2026a)). At the same time, recent discussions of Treasury markets, that extend at the international level, suggest that sovereign yields increasingly reflect not only *risk-free forces*, but also sovereign *credit conditions* and changes in *convenience yields* associated with safety, liquidity and scarcity (Financial Times (2025b); The Two Cents (2026); Financial Times (2026b)). These developments make it especially important to understand which global forces drive government bond yields.

Addressing this question entails two key challenges. First, sovereign yields combine several economically distinct components: they reflect not only *risk-free rates*, but also *default risk* and *convenience yields*, so reduced-form global factor models can easily confound distinct economic forces. Furthermore, none of the underlying components is directly observed in a clean cross-country setting, making measurement itself a central challenge. Second, the importance of these forces varies across maturities and over time. In particular, "standard *risk-free rate* models"[1] perform well in periods of strong international synchronization and low default risk, but become less informative for long-maturity yields after the Global Financial Crisis (GFC), precisely when sovereign debt becomes most relevant for macroeconomic stabilization and fiscal sustainability. This paper addresses these challenges by bringing together historical (low-frequency) and modern (high-frequency) international evidence, market-based proxies for *risk-free rates* and sovereign *default risk*, and a decomposition of bond yields into *risk-free*, *default risk* and *convenience-yield* components, each with global and local drivers.

I first show that for 20 advanced economies, in "standard *risk-free rate* models" global factors account for a large share of sovereign yield variation, especially in the postwar period and during the Great Moderation, when short- and long-term rates became tightly synchro-

[1] In what follows, I use the term "standard *risk-free rate* models" to refer to the baseline specification: conventional *default- and convenience-free* models, in which sovereign yield dynamics are driven exclusively by risk-free forces linked to inflation and real activity.

nized across countries. This extends the findings on the central role of global macro and yield-based factors emphasized by recent work of Bauer and Rudebusch (2020), for US, and Davis et al. (2024), for 10 developed economies. Yet this interpretation becomes less persuasive precisely when it matters most. After the GFC, the explanatory power of standard global yield factors weakens at long maturities, even though sovereign yields remain highly correlated across countries. A decomposition based only on global and local forces implied by *macro-trend* or *risk-free rate* dynamics alone therefore misses an important part of sovereign pricing.

I argue that the missing pieces are *credit risk* and *convenience yields*. Extending the framework of Jiang et al. (2025) from the euro area to an international setting, I show that once sovereign yields are decomposed into *risk-free*, *default*, and *convenience* components, the international evidence changes sharply. The *risk-free* component remains the most global part of the yield curve, but *credit risk* also exhibits a strong global dimension, especially at long maturities and during periods of sovereign stress. At the same time, the *credit-risk* evidence reveals an important asymmetry: developed-country sovereign CDS dynamics are tightly linked to global credit factors not primarily driven by the U.S., whereas emerging-market sovereign risk remains much more exposed to the U.S. financial conditions. *Convenience yields*, by contrast, are substantially more heterogeneous and remain more strongly shaped by local forces. I also document a decline in short- and long-maturity *convenience yields* in the United States in recent years, followed by a broader erosion in convenience values across countries after 2024. This new evidence suggests that the scarcity and safety services embedded in government debt are neither stable nor uniform, even among advanced economies.

These distinctions matter for both theory and policy. Models that abstract from *default risk* misclassify global credit conditions as country-specific yield variation. Models that ignore *convenience yields* miss an important source of persistent cross-country heterogeneity in sovereign bond pricing and may fail to detect changes in the safe-asset status of government debt. More broadly, identifying the right drivers of sovereign yields is essential for interpreting safe-asset scarcity, sovereign risk transmission, unconventional monetary policy, and the fiscal consequences of shifts in global demand for government debt. The paper's central implication is straightforward: sovereign bond markets are not governed entirely by risk-free factors, they are shaped by the interaction of *global risk-free* forces, *global credit* conditions, and time-varying *convenience* values. Since the Global Financial Crisis, the balance among these forces has changed, making it increasingly important for policymakers and investors to account jointly for all three components when interpreting sovereign bond markets and making decisions.

1.1. Unpacking the Analysis

Figure 1 previews the logic of the paper. In Panel A of Figure 1, I estimate a "standard *risk-free rate* model" in which each country's 10-year sovereign yield loads on the global yield-curve level and slope. I use a Shapley R^2 decomposition[2] to split the average explanatory power across countries into a global component and a residual country component. The global factors explains most long-yield variation before 2008, but its power declines sharply after the GFC, leaving a much larger residual share even though cross-country comovement remains strong. In Panel B of Figure 1, I use the same approach, but replace the benchmark global factors with a richer set of *global risk-free*, *credit-risk*, and *convenience-yield* factors.[3] The comparison across panels shows that what appears as idiosyncratic residual variation in the benchmark model is, to an important extent, reclassified as global credit and convenience forces after 2008.

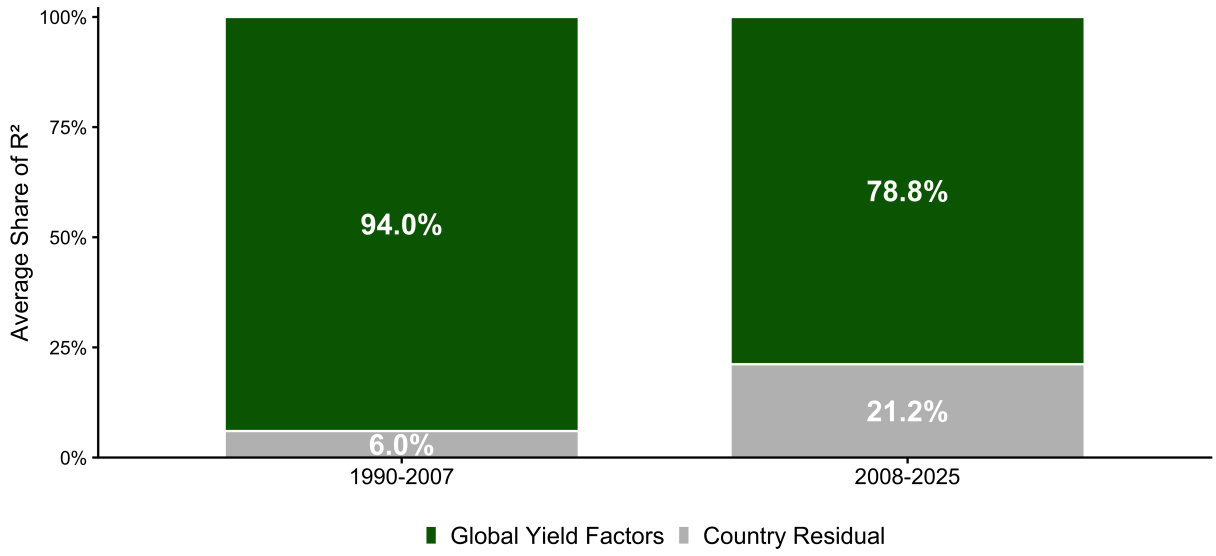
In the main analysis, I use daily yield data for 20 advanced economies from 1970 to 2025 and extract global level and slope factors from the international yield curve. I show that these global forces explain a substantial share of domestic yield fluctuations, especially during the Great Moderation, when long-term rates across countries become tightly synchronized. Moreover, using historical annual data (1850-2025), I show that the sharp increase in the importance of global forces is a meaningful historical development that begins after World War II. At the same time, the modern sample reveals the paper's central puzzle: after the GFC, explanatory power of the global factor model weakens at long maturities even though sovereign yields remain highly correlated across countries.

Having established this puzzle, I use the model to map the yields into a decomposition with four components: a global macro trend, a global cycle, a country macro trend and a country cycle. I show that global macro trend remains the dominant force in long-maturity yields, but also that the global cycle and the two country-specific components become much more uneven after 2008. This result suggests that the post-crisis weakening of standard global factor models is not primarily due to a breakdown in global macro-trend synchronization. Rather, it points to an omitted component in sovereign pricing that becomes especially important at long maturities.

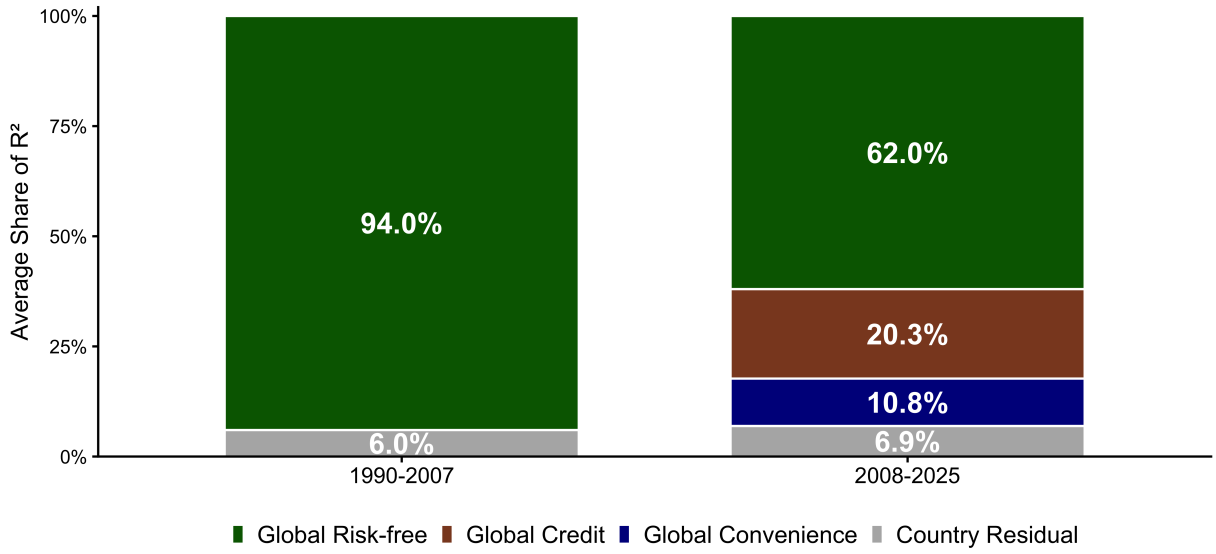
I then test this interpretation directly. I augment the benchmark global-factor speci-

[2]The Shapley R^2 decomposition allocates a regression's total explanatory power among its regressors using the Shapley value from cooperative game theory Shapley (1951). Recent applications in economics and finance include Shorrocks (1982), Israeli (2007) and Couts, S. Gonçalves and Loudis (2023).

[3]Because directly observed OIS-based global risk-free factors are only available in the post-GFC sample, I map OIS level and slope to the global yield level and slope over 2008–2025, and then use the implied fitted values to back out a projected global risk-free component for 1990–2007; after 2008, I use the observed global OIS, CDS, and convenience factors directly.



(a) "Standard *risk-free* rate model" decomposition (10 years)



(b) *Risk-free*, *credit-risk*, and *convenience-yield* decomposition (10 years)

Figure 1: Unpacking the global and country components of sovereign bond yields

Panel A reports the Shapley R^2 decomposition of 10-year sovereign yields in the (1990-2007) and (2008-2025) samples using the benchmark global *risk-free* rate model from Section 2. Panel B reports the corresponding decomposition from Section 3, when yields are split into a richer set of global risk-free, credit-risk, and convenience-yield factors. Section 2 provides details on the model estimation and empirical analysis for Panel A. Section 3 provides details on the model estimation and empirical analysis for Panel B. Appendix A provides details on the construction of the series and the estimation procedure.

Notes: Section 2 presents the analysis for the full 20-country sample. For the *credit risk* and *convenience yields* decomposition in Section 3, however, the required data are available for only 15 countries. For a direct comparison, this figure reports the decompositions for the common 15-countries for which both are available.

fication with a range of global uncertainty and volatility proxies and show that they add little explanatory power. By contrast, global CDS level and slope factors add much more explanatory power and compress its cross-country dispersion. Furthermore, I use Augustin (2018) approach to study sovereign CDS dynamics through panel regressions that combine domestic controls, global CDS factors and U.S. financial variables. These regressions show that global *credit* factors are the common drivers of sovereign CDS spreads. They also reveal an important asymmetry: advanced-economy CDS spreads are linked mainly to a broad global *credit* cycle, whereas emerging-market CDS spreads are much more sensitive to U.S. financial conditions. At the same time, U.S. sovereign *credit risk* itself appears less tightly connected to the global credit factors than the *credit risk* of many other advanced economies.

Having identified *credit risk* as the missing global force, I then move to a richer structural decomposition of sovereign yields. Building on Jiang et al. (2025), I decompose each sovereign yield into a *risk-free* rate, a *default spread*, and a *convenience yield*, and then split each of these components into global and country-specific parts. I proxy the *risk-free* rate with OIS curves, the *default* spread with sovereign CDS curves, and the *convenience yield* as the residual wedge between bond yields and the sum of *risk-free* and *default* components. I then construct global level and slope factors separately for each block and evaluate how much of the cross-country variation they explain across maturities. Three central results emerge. First, the global *risk-free* component remains the most global part of sovereign yields. Second, the global *credit-risk* component also has a strong global dimension and accounts for an important share of long-maturity comovement, especially in countries more exposed to sovereign stress. Third, global *convenience yield* is negligible, while country-specific *convenience yields* account for much of the remaining cross-country variation. I also document new evidence of a decline in *convenience yields* in the United States, followed by a broader erosion in *convenience* values across countries and maturities after 2024, suggesting that the safety and scarcity services embedded in government debt are time-varying rather than fixed.

To conclude, a global *risk-free*-rate model largely identifies the role of common macro forces, but it does not fully explain sovereign pricing after the Global Financial Crisis. Once sovereign yields are unpacked into *risk-free*, *default*, and *convenience-yield* components, the missing structure becomes clear. Yield comovement remains largely global, but it is not purely *risk-free*: common *credit* conditions are central, the U.S. does not strongly load on those global *credit* forces in the same way as other advanced economies, and *convenience yields* are key to understanding why substantial heterogeneity persists even in highly integrated bond markets. The recent erosion of *convenience yields* has direct implications for fiscal and monetary policy, two central objects in current economic debates.

1.2. Literature Review

This paper connects three strands of the macro-finance literature. The starting point is the no-arbitrage term-structure literature, in which bond yields are affine functions of a state vector x.[4] The central empirical question is whether the yield curve spans the information relevant for forecasting rates and returns, or whether economically important forces remain weakly represented in yields themselves.[5] Over the last two decades, this literature has increasingly moved away from the strong view that all relevant macro information is fully spanned by the yield curve. Papers such as Duffee (2006), Duffee (2011), and Joslin, Priebsch and Singleton (2014) formalize the idea of unspanned or weakly spanned factors, while Cieslak and Povala (2015) and Bauer and Rudebusch (2020) show that slow-moving inflation and real-rate trends are central to understanding long-run bond dynamics. In an international setting, comovement across national bond markets is unlikely to be driven solely by correlated local shocks; it should also reflect common exposure to global forces. For example, Diebold, Li and Yue (2008), show that a small number of global yield-curve factors account for a large share of national term-structure movements, and Abbritti et al. (2013) show that the importance of global shocks rises with maturity and horizon. Related work by Dahlquist and Hasseltoft (2013), Zhao, Zhou and Zhu (2021), and Davis et al. (2024) connects global bond factors to expected returns, macro-spanning failures, and common international macro trends.[6] This paper builds on that literature by developing a dynamic term structure framework with global factors and unspanned macro risks, and by showing that global *risk-free* rate models explain a substantial share of sovereign yield comovement over both long historical samples and modern high-frequency data. At the same time, I show that one of the main limitations of these models, namely the lack of credit and convenience components, has become critical after the Global Financial Crisis.

A second strand studies the pricing of sovereign default risk, with post-GFC crisis evidence that makes clear that sovereign yields can embed nontrivial credit-risk premia even in developed markets.[7] On the pricing side, the modern literature models sovereign credit with reduced-form and affine structures that connect bond spreads and CDS curves to default

[4]The literature on bond pricing starting with Vasicek (1977) and Cox, Ingersoll and Ross (1985), therefore has focused on closed-form solutions, with a more general characterization of models with affine bond yields provided by Duffee (2002). A broad review of the literature has been discussed in Duffie (2001), Singleton (2006), Piazzesi (2010), Gürkaynak and Wright (2012), Duffee (2013a), Duffee (2013b), Veronesi, ed (2016) and Campbell (2018)

[5]See, for example, Fama and Bliss (1987); Campbell and Shiller (1991); Cochrane and Piazzesi (2005); Joslin, Singleton and Zhu (2011); Adrian, Crump and Moench (2013); Bauer and Rudebusch (2017); Abrahams et al. (2016).

[6]For an historical international prospective on the global macro trends and interest rate dynamics, see Del Negro et al. (2019), Jordà et al. (2019) and Rogoff, Rossi and Schmelzing (2024)

[7]See Manzo and Veronesi (2016) for a recent survey of the literature.

intensities, recovery, and risk premia.[8] On the empirical side, a parallel literature shows that sovereign credit spreads are driven not only by domestic fundamentals but also by powerful common factors. Longstaff et al. (2011) is especially important in this respect: the paper shows that sovereign CDS spreads are strongly connected to global market conditions and investor risk appetite, often more so than to local macro variables. Ang and Longstaff (2013), Augustin and Tédongap (2016), Augustin (2018), and Klingler and Lando (2018) deepen this view by showing that sovereign CDS curves load on common global forces and that the term structure of CDS contains economically meaningful information about how credit risk is priced across horizons and regimes.[9] The innovative use of sovereign credit default swaps (CDS) enables quantifying the interplay between a country's probability of default and the credit-risk premia.[10] This paper contributes to this literature by showing that the performance of standard global yield models deteriorates post-GFC, with global credit risk representing the key missing factor underlying this pattern. Incorporating exposure to a *global default risk* materially improves the fit of long-maturity sovereign yields. Furthermore, while most studies report results for developed and emerging countries together (or are limited to emerging countries), I show that advanced-economy sovereign credit is linked mainly to a broad global credit cycle, whereas, in line with previous findings, emerging-market remains more sensitive to U.S. financial conditions.

The third strand of the literature studies the convenience yield on government bonds. The basic idea is that sovereign debt is valued not only for promised cash flows, but also for the services it provides: liquidity, collateral value, regulatory usefulness, balance-sheet relief and safety. These services generate a wedge between observed sovereign yields and the benchmark risk-free rate that would prevail in a frictionless asset-pricing environment.[11] A closely related macro literature interprets this wedge as the equilibrium value of scarce safe assets and links it to intermediary balance-sheet capacity, safety transformation and the aggregate demand for public liabilities.[12] More recent empirical work has moved beyond broad liquidity premia toward more explicit measures of convenience yields, although most of this literature

[8] See, among others, Duffie and Singleton (1999); Duffie, Pedersen and Singleton (2003); Pan and Singleton (2008); Doshi, Jacobs and Zurita (2017); Monfort et al. (2021).

[9] For evidence on the role of global factor and determinants of credit risk in emerging markets, see Borri and Verdelhan (2011); Du and Schreger (2016); Borri and Shakhnov (2021); Horn, Reinhart and Trebesch (2022); Gopinath et al. (2025)

[10] Chernov, Schmid and Schneider (2020) show that the US CDS premiums reflect the endogenous risk-adjusted probabilities of fiscal default. Augustin et al. (2021) demonstrates that US benchmark rates are themselves affected when the sovereign is risky. Costain, Nuño and Thomas (2025) emphasizes that movements in Euro Area sovereign spreads can be understood largely through time variation in credit-risk premia

[11] See, among others, Amihud and Mendelson (1991); Duffie (1996); Longstaff (2004); Krishnamurthy and Vissing-Jorgensen (2012, 2015); Nagel (2016).

[12] See, among others, Caballero, Farhi and Gourinchas (2008, 2016); Caballero and Farhi (2017); He, Krishnamurthy and Milbradt (2016, 2019); Diamond (2020); Brunnermeier, Merkel and Sannikov (2024).

estimates convenience yields while abstracting from default risk. For the United States, Fleckenstein, Longstaff and Lustig (2014), Van Binsbergen, Diamond and Grotteria (2022), and Fleckenstein and Longstaff (2024) show that Treasuries trade at valuations that are difficult to reconcile with cash-flow fundamentals alone. In international settings, Diamond and Van Tassel (2021) documents cross-country differences in convenience premia, while Du, Im and Schreger (2018), Valchev (2020), Jiang, Krishnamurthy and Lustig (2021), and Jiang, Krishnamurthy and Lustig (2024a) connect convenience yields to exchange rates, reserve demand, and the global role of safe sovereign debt.[13] Most closely related to this paper, Jiang et al. (2025) show that once default risk is properly separated, convenience-yield differentials explain an important share of euro-area sovereign-yield dispersion. This paper extends that logic along two dimensions. First, I bring the decomposition to a broader international panel and to multiple maturities. Second, I show that *risk-free rates* are strongly global, *credit spreads* also contain a sizable global component, especially at medium and long maturities, and *convenience yields* are precisely the component of sovereign yields that is least globally synchronized. This pattern is economically intuitive: convenience depends on local market structure, collateral demand, institutional segmentation, reserve status and the perceived safety of a particular sovereign instrument. These features do not necessarily move together across countries, even when macro trends and credit conditions do. I also document a new fact that, to my knowledge, has not been emphasized in the literature: U.S. *convenience yields* begin to decline in the late 2010s and a broader erosion appears across countries after 2024. This modern evidence complements the long-run historical findings in Chen et al. (2025), where they find that hegemonic issuers earn safe-asset rents ("exorbitant privilege"), but those rents are contingent and can erode with fiscal/geopolitical deterioration.

The rest of the paper is organized as follows. Section 2 develops a no-arbitrage dynamic term structure framework and uses both historical and high-frequency data to show that global forces account for a substantial share of sovereign yield comovement. It also documents the model weakness after the GFC and that global *credit risk* helps explain the missing comovement. Section 3 then decomposes sovereign yields into *risk-free* rates, *default* spreads, and *convenience* yields. It shows how these building blocks reshape the interpretation of sovereign bond markets. Section 4 provides a policy discussion. Section 5 concludes. The appendices provide details on the data, additional empirical results and model derivations.

[13] More recently, Coppola, Krishnamurthy and Xu (2023) extends the mechanism to liquidity, debt denomination, and currency dominance, while Du, Keerati and Schreger (2025) shows that dollar privilege and Treasury privilege can decouple, refining identification of currency versus sovereign convenience channels

2. The Challenges of a No-Arbitrage Model with Global Factors

In this section, I outline a standard (*default- and convenience-free*) dynamic term structure framework in which sovereign yields are driven by both global and country-specific forces related to inflation, real rates, and cyclical components. Then, I use reduced-form evidence to quantify their relative importance across advanced economies. The model decomposes yield factors into a common global component and a local one. The aim is to quantify how much of sovereign-yield comovement can be explained by a model that abstracts from default risk and convenience yields. The empirical evidence delivers three main results. First, global factors account for a substantial share of sovereign yield variation, with the importance of global forces rising over time. Second, the post-2008 period marks a partial breakdown of this global-factor structure at long maturities. Although global trend forces remain the dominant driver of sovereign yields, their explanatory power weakens for long rates after the Global Financial Crisis, and cross-country heterogeneity re-emerges. Third, global proxies for uncertainty and volatility do little to resolve the post-crisis decline in explanatory power. By contrast, global CDS factors materially improve the fit of the model and reduce cross-country dispersion in residual yield variation, suggesting that the missing common component in sovereign yields after 2008 is closely related to global credit risk. Taken together, the results show that sovereign bond yields are shaped by a powerful global component, but that its nature changes over time: secular macro forces dominate in moderate periods, whereas global credit conditions become relevant in the post-GFC era.

2.1. A Dynamic Term Structure Model with Global Factors

I present a standard Dynamic Term Structure Model (DTSM) with Global Factors and Unspanned Macro Risks. The model follows the standard assumptions in the literature and builds on the general version presented in Joslin, Priebsch and Singleton (2014), accounting for the link between macro-trends and interest rate trends in the spirit of Bauer and Rudebusch (2020).[14] For each country, the state variables are N linear combinations of yields in the vector $X_{k,t}$, that can be decomposed in their global and country-specific components:

$$\mathbf{X}_{k,t} = \theta_k \mathbf{X}_{G,t} + x_{k,t} \tag{1}$$

[14]For a similar approach using global factors in DTSM see Wright (2011), Abbritti et al. (2013) and Zhao, Zhou and Zhu (2021) among others. They assume that only local factors can span the yields (global are unspanned). This paper approach is more similar to Diebold, Li and Yue (2008), assuming that both global and local factors affect yields dynamics, while I formally describe the system in a DTSM

where $\mathbf{X}_{G,t}$ is the global and $x_{k,t}$ the country-specific components of the state variables. Countries have a heterogeneous exposure (θ_k) to the global component ($\mathbf{X}_{G,t}$). I specify the common trend dynamic system in a global version of Bauer and Rudebusch (2020):

$$\mathbf{X}_{G,t} = \overline{\mathbf{X}} + \gamma\tau_t + \tilde{\mathbf{X}}_t, \quad \tau_t = \tau_{t-1} + \eta_t, \quad \tilde{\mathbf{X}}_t = \mathbf{\Phi}\tilde{\mathbf{X}}_{t-1} + \tilde{\mathbf{u}}_t \tag{2}$$

$$x_{k,t} = \overline{x}_k + \gamma_k\tau_{k,t} + \tilde{x}_{k,t}, \quad \tau_{k,t} = \rho\tau_{k,t-1} + \eta_{k,t}, \quad \tilde{x}_{k,t} = \Phi_k\tilde{x}_{k,t-1} + \tilde{u}_{k,t} \tag{3}$$

where γ and γ_k are N-vector with the loadings on the macro-trends, $\eta = [\eta_t \ \eta_{k,t}]$ are i.i.d. normal with covariance matrix Σ_η, $\tilde{\mathbf{X}}_t$ and $\tilde{x}_{k,t}$ are the N cycle components that have i.i.d. normal innovations $u = [\tilde{\mathbf{u}}_t \ \tilde{u}_{k,t}]$ with covariance matrix $\tilde{\Omega}$, and $\mathbf{\Phi}$ and Φ_k are mean-reversion matrices that have eigenvalues with modulus less than 1, so $\tilde{\mathbf{X}}_t$ and $x_{k,t}$ are stationary. I assume global macro trend (τ_t) follows a Random Walk, while the country deviation from the global macro trend ($\tau_{k,t}$) are assumed to be stationary ($\rho \leq |1|$). Accordingly, the global state variables $\mathbf{Z}_t = (\tau_t, \mathbf{X}_{G,t})'$ are trivially cointegrated.[15] It follows that, the country short-term interest rate is taken to be an affine function of $\mathbf{X}_{k,t}$:

$$i_{k,t} = Y^{(1)}_{k,t} = \delta_{k,0} + \delta'_{1,k}\mathbf{X}_{k,t} \tag{4}$$

As in Bauer and Rudebusch (2020), I assume absence of arbitrage opportunities so that there exists a "risk-neutral" probability measure, denoted by $\mathcal{Q}$, which prices all financial assets. Implicit in this $\mathcal{Q}$ measure is the assumption of no default and no convenience yields. In section 3, I provide a general framework, where these assumptions can be relaxed to incorporate *convenience* and *default* dynamics. The risk-neutral dynamics are specified as:

$$\mathbf{X}_{k,t} = \boldsymbol{\mu}^{\mathcal{Q}}_k + \mathbf{\Phi}^{\mathcal{Q}}_k\mathbf{X}_{k,t-1} + \mathbf{u}^{\mathcal{Q}}_{k,t} \tag{5}$$

following the assumption in Bauer and Rudebusch (2020).[16] Equations 4 and 5 imply that yields are affine functions of the vector $X_{k,t}$, that can be decomposed in their global and country-specific components:

$$\mathbf{Y}^{(n)}_{k,t} = \mathbf{A}^{(n)}_k + \mathbf{B}^{(n)}_k\mathbf{X}_{k,t} = \mathbf{A}^{(n)}_k + \underbrace{\mathbf{B}^{(n)}_k[\theta_k\mathbf{X}_{G,t}]}_{Global\ Component} + \underbrace{\mathbf{B}^{(n)}_k[x_{k,t}]}_{Country\ Component} \tag{6}$$

[15] As in Bauer and Rudebusch (2020), I assume that innovations to trend and cycle are orthogonal, $E(\eta\ u) = \mathbf{0}$, as is commonly done with unobserved components models. For further details, see references therein.

[16] The innovations $\mathbf{u}^{\mathcal{Q}}_{k,t}$ are i.i.d. normal (under $\mathcal{Q}$) with covariance matrix Ω. I assume that $\mathbf{X}_{k,t}$ is stationary under $\mathcal{Q}$ by imposing that $\Phi^{\mathcal{Q}}_k$ has eigenvalues less than 1 in absolute value, thus forward rates, yields, and bond convexity remain finite in the limit as maturity increases

The loadings in $\mathbf{A}_k^{(n)}$ and $\mathbf{B}_k^{(n)}$ are determined by the risk-neutral parameters. An important aspect of this model is that the long-run trend is unspanned by the yield curve, that is, the cross section of interest rates at time t is not deterministically related to τ_t and $\tau_{k,t}$.[17] The full derivation of the model follows the same steps as in Bauer and Rudebusch (2020), with the usual exponentially affine SDF, prices and yields of zero-coupon bonds that are exponentially affine, and forward rates and excess bond returns that are affected by the macro-trends and the cyclical components of $\mathbf{X}_{k,t}$. The full model estimation is beyond the scope of this analysis.

In what follows, I investigate empirically the role of the global and country factors in shaping yields dynamics over time. For that, I estimate a reduced-form version of the model, where the time series of country yields is a linear function of a vector of latent state variables, as in equation (6). As mentioned in Abbritti et al. (2013), since the estimation of the prices of risk is not crucial for the results in this section, I can consistently estimate the factor loadings $\mathbf{A}_k^{(n)}$ and $\mathbf{B}_k^{(n)}$ by simple OLS and thus to avoid the computational burden of estimating a fully specified affine term structure model.[18]

2.2. The Role of Global Factors in Spanning the Yields

Following the recent international macro-finance literature, I show that both short- and long-term interest rates contain a substantial global component, evident in both secular trends and high-frequency comovement. In this section, I study the role of global forces in shaping yield dynamics across 20 advanced economies. The sample includes Australia, Canada, Switzerland, Denmark, the United Kingdom, Japan, Norway, New Zealand, Sweden, and the United States, together with ten euro-area countries: Austria, Belgium, Germany, Spain, Finland, France, Ireland, Italy, the Netherlands, and Portugal. I construct global factors as GDP-weighted averages of local yields, following the spirit of Dahlquist and Hasseltoft (2013), who build a global Cochrane and Piazzesi (2005) factor using country-level information.[19] I use daily government bond yield data for 1970-2025 to study how the importance

[17] Asset pricing models generally imply spanning, since in the absence of knife-edge restrictions the state variables can be backed out from the yield curve. For an extensive discussion on this topic see Duffee (2013b), Duffee (2011) and Joslin, Priebsch and Singleton (2014). In this model, such inference is not possible because the trend does not directly affect yields: conditional on $\mathbf{X}_{k,t}$, yields do not load on $\tau_t, \tau_{k,t}$. For empirical evidence in support of this hypothesis and the rationale for an unspanned trend see the discussion in Bauer and Rudebusch (2020)

[18] As mentioned in Abbritti et al. (2013) and in the references therein, in the absence of restrictions in the price of risk, the OLS and no-arbitrage estimates of $\mathbf{A}_k^{(n)}$ and $\mathbf{B}_k^{(n)}$ are extremely close and, in consequence, there is no gain from using a term structure model. The pricing accuracy of a fully specified affine term structure model is only slightly inferior to the one of the reduced-form model.

[19] An alternative would be to construct equal-weighted measures or latent factors, as in Diebold, Li and Yue (2008), using the covariance matrix of local CP factors. Such approaches may capture a larger share

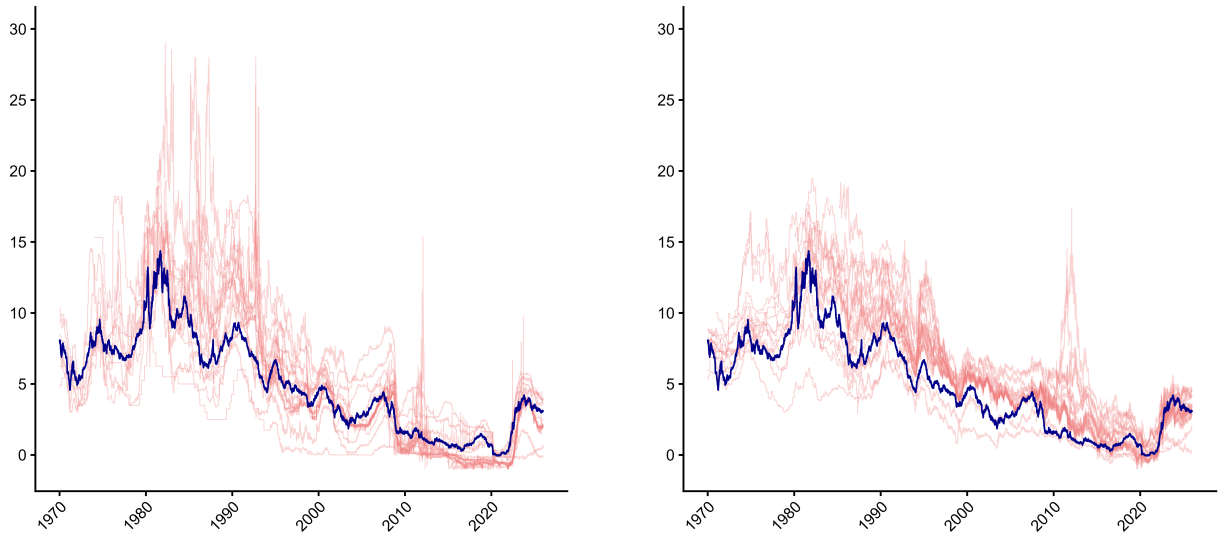
of global forces varies across maturities in the modern era. In Appendix B.1, I complement this evidence with annual data on short- and long-term interest rates spanning 1850 to 2025 and show that the pattern reflects a broader post–World War II rise in the share of yield variation accounted for by the global factor. Furthermore, I find that for short maturities, the contribution of the global factor rises monotonically in more recent subsamples. For long maturities, by contrast, the relation is non-monotonic: the share of variance explained by global forces declines after the Global Financial Crisis, while cross-country dispersion increases.

2.2.1. Modern High-frequency Decomposition

I collect daily data on the term structure of government bond yields over 1970-2025. To extract the global factors, I first construct proxy series for global government bond yields at different maturities. For each maturity, I define the global yield as the GDP-weighted cross-sectional average of local yields. For a discussion of alternative proxies, see Appendix A.1. Following Piazzesi (2010), I then apply principal component analysis to the global yield curve to estimate its level, slope, and curvature components. In the main analysis, I focus on the level and slope factors, which together explain 99% of high-frequency variation. In the remainder of this section, I refer to the Global Level and Global Slope as the *Global Factors*, denoted by $\mathbf{X}_{G,t}$. A full description of the data and factor construction is provided in Appendix A. Figure 2 plots the resulting Global Level Factor together with country-level short-term (3-month) and long-term (10-year) government bond yields. Figure 2 highlights pronounced common movements in yields alongside meaningful country-specific deviations. The Global Level Factor rises sharply during the 1970s, peaks near 15%, and then declines secularly from the early 1980s onward, eventually approaching the effective lower bound in the later part of the sample. Country-level yields tend to co-move closely with the global series, yet large and persistent departures remain visible in the early part of the sample and during the European sovereign debt crisis (2010-2015), particularly at long maturities. Short-term yields also display substantial cross-sectional dispersion early in the sample and turn negative for some countries after the global financial crisis, remaining so until the end of the Covid period. To quantify the importance of global forces in domestic yield fluctuations, I estimate, for each country k and each maturity n, the regression:

$$Y_{k,t}^{(n)} = \alpha_k + \boldsymbol{\beta}_k' \mathbf{X}_{G,t} + \varepsilon_{k,t} = \alpha_k + \beta_k^L Level_t + \beta_k^S Slope_t + \varepsilon_{k,t} \tag{7}$$

of common variation, but at the cost of a less transparent economic interpretation. I therefore use GDP-weighted aggregates, which allow the contribution of each country to vary naturally with its economic size.



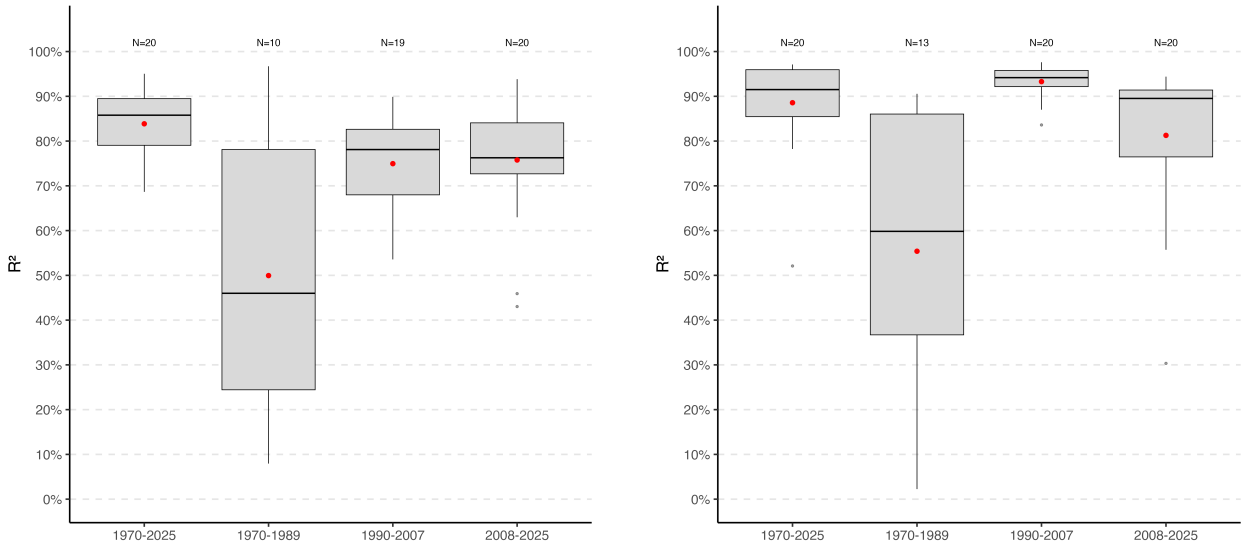
(a) Short-term bond yields (3 months)

(b) Long-term bond yields (10 years)

Figure 2: Global short- and long-term government bond yields.

The figure plots short-term (3-month) and long-term (10-year) government bond yields for the 20 advanced economies. Country yields are shown in red, while the Global Level Factor is shown in blue. Section 2.2.1 and Appendix A provide measurement details and sources.

Here, $Y_{k,t}^{(n)}$ denotes the country-specific yield at maturity n, and $\mathbf{X}_{G,t}$ is the vector containing the global level and slope factors. The coefficients β_k^L and β_k^S measure each country's exposure to the global factors, while the R^2 summarizes the share of domestic yield variation accounted for by those factors. Table B.3 in Appendix B.2 reports the country-level R^2, while Figure 3 summarizes their cross-sectional distribution (mean, median, and interquartile range) in the full sample and in the 1970-1989, 1990-2007, and 2008-2025 subsamples. The global component is economically large in the modern sample, especially for long-term yields. Over 1970–2025, global factors explain on average 83.9% of the variation in 3-month yields and 88.6% of the variation in 10-year yields across countries. Comovement is much weaker in 1970–1989, rises sharply in 1990–2007, and remains strong after 2008, although long-rate comovement declines somewhat and becomes more heterogeneous. This pattern shows greater cross-country dispersion in long yields during the era of unconventional monetary policy and, for some countries, it suggests heightened sovereign risk and/or market segmentation. In Appendix B.1, I complement this evidence with annual data on short- and long-term interest rates spanning 1850 to 2025 and show that the pattern reflects a broader post–World War II rise in the share of yield variation accounted for by the global factor. Historical low-frequency evidence shows that global forces explain a substantial and rising share of cross-country interest rate fluctuations, especially in the postwar period. This



(a) Short-term bond yields (3 months)

(b) Long-term bond yields (10 years)

Figure 3: Cross-sectional distribution of variance explained by global factors.

The figure plots the cross-sectional distribution - mean (red dot), median (black horizontal line), and interquartile range - of the R^2 from equation (7) in the full sample and in the 1970-1989, 1990-2007, and 2008-2025 subsamples. Section 2.2.1 and Appendix A provide details on the construction of the series and the estimation procedure.

pattern is consistent with the post-World War II expansion in financial integration documented by Stulz (2005) and with the stronger international comovement in macroeconomic trends emphasized by Davis et al. (2024), together suggesting that government bond yields have become increasingly driven by global rather than purely domestic forces. Furthermore, the decline in explanatory power in the final subsample becomes larger at longer maturities and remains even when including the Global Curvature Factor, suggesting that adding further factors extracted from the global yield curve contributes little additional explanatory power.[20] Overall, the evidence supports the view that global forces account for a substantial share of daily interest-rate fluctuations across advanced economies, although the importance of the global component suggested by this decomposition does not increase monotonically over time for long maturities.

[20] Appendix B.2 reports the corresponding results for additional maturities (1, 3, 5, and 7 years). The qualitative pattern is similar across maturities, although the decline in explanatory power in the final subsample becomes larger at longer maturities. I also report, in Appendix B.2, results for short-term (3-month) and long-term (10-year) yields that include the Global Curvature Factor. The results remain quantitatively and qualitatively very similar, suggesting that adding further factors extracted from the global yield curve contributes little additional explanatory power.

2.3. The modern subsample failures of the global factor

The model in Section 2.1 implies that, for each country, the state vector can be decomposed into a global component and a country-specific deviation:

$$\begin{aligned}\mathbf{X}_{k,t} &= \underbrace{\theta_k \mathbf{X}_{G,t}}_{\text{Global exposure}} + \underbrace{x_{k,t}}_{\text{Country deviation}} \\ &= \theta_k(\overline{\mathbf{X}} + \gamma\tau_t + \tilde{\mathbf{X}}_t) + (\overline{x}_k + \gamma_k\tau_{k,t} + \tilde{x}_{k,t}) \\ &= \underbrace{[\theta_k\overline{\mathbf{X}} + \overline{x}_k]}_{\text{Constant}} + \underbrace{[\theta_k\gamma\tau_t + \gamma_k\tau_{k,t}]}_{\text{Macro trends}} + \underbrace{[\theta_k\tilde{\mathbf{X}}_t + \tilde{x}_{k,t}]}_{\text{Cyclical component}}\end{aligned}$$

The second line follows from substituting equations (2) and (3) into equation (1). The third line simply groups the constant, trend, and cyclical terms into their global and country-specific parts. The yield at maturity n can therefore be written as:

$$\begin{aligned}Y_{k,t}^{(n)} &= \mathbf{A}_k^{(n)} + \mathbf{B}_k^{(n)}\mathbf{X}_{k,t} \\ &= \mathbf{A}_k^{(n)} + \mathbf{B}_k^{(n)}\left\{[\theta_k\overline{\mathbf{X}} + \overline{x}_k] + [\theta_k\gamma\tau_t + \gamma_k\tau_{k,t}] + [\theta_k\tilde{\mathbf{X}}_t + \tilde{x}_{k,t}]\right\} \\ &= \overline{\mathbf{A}}_k^{(n)} + \mathbf{B}_k^{(n)}\left\{\underbrace{[\theta_k\gamma\tau_t]}_{\text{Global trend}} + \underbrace{[\theta_k\tilde{\mathbf{X}}_t]}_{\text{Global cycle}} + \underbrace{[\gamma_k\tau_{k,t}]}_{\text{Country trend}} + \underbrace{[\tilde{x}_{k,t}]}_{\text{Country cycle}}\right\}\end{aligned}$$

where the constant is $\overline{\mathbf{A}}_k^{(n)} = \mathbf{A}_k^{(n)} + \mathbf{B}_k^{(n)}[\theta_k\overline{\mathbf{X}} + \overline{x}_k]$. This representation separates the contribution of global and country-specific trend and cycle components to sovereign yields.

I follow Bauer and Rudebusch (2020) and use the equilibrium nominal short rate ($i^*_{k,t}$) as a proxy for the macro-trend component and extend the series at the international level, as in Davis et al. (2024). As in Bauer and Rudebusch (2020) and Davis et al. (2024), I proxy long-run country inflation, $\pi^*_{k,t}$, using the measure in Cieslak and Povala (2015). For the real natural rate, $r^*_{k,t}$, the literature offers several alternatives; see Kiley (2020) for a review. Following one of the approaches proposed by Bauer and Rudebusch (2020), I use a model-free estimate that is available at high frequency for all countries in the sample and interpret it as the equilibrium real interest rate consistent with economic activity equal to its long-run potential level, absent of convenience and credit risk. I construct the equilibrium nominal short rate as $i^*_{k,t} = \pi^*_{k,t} + r^*_{k,t}$. I define the global equilibrium global nominal short rate as $i^*_{G,t} = \pi^*_{G,t} + r^*_{G,t}$.[21] A detailed description on the series estimation is provided in Appendix A.3, A.4 and A.5.

[21] For the global series, I first compute GDP-weighted averages of country inflation ($\pi^*_{G,t}$) and real-rate ($r^*_{G,t}$) series and then construct the equilibrium global nominal short rate as: $i^*_{G,t} = \pi^*_{G,t} + r^*_{G,t}$

I use the equilibrium nominal short rates and define the trend components as follows:

- Global Macro trend: $\tau_t = i^*_{G,t}$.
- Country Macro trend: $\tau_{k,t} = i^*_{k,t} - \alpha_k - \beta_k i^*_{G,t}$.

Figure 4 plots the resulting global ($i^*_{G,t}$) and country-specific ($i^*_{k,t}$) equilibrium nominal rates. Two patterns stand out. First, cross-country dispersion is substantial in the early part of the sample. Second, this dispersion narrows markedly over time as equilibrium nominal rates decline secularly from the 1980s onward. These patterns extend the evidence in Davis et al. (2024) and point to stronger synchronization in macro-trend components across the 20 advanced economies in the later part of the sample. This result is important for the interpretation of long-maturity yields: if cross-country dispersion in trend components falls over time, the post-2008 divergence in long yields is unlikely to be driven primarily by macro-trend differences.

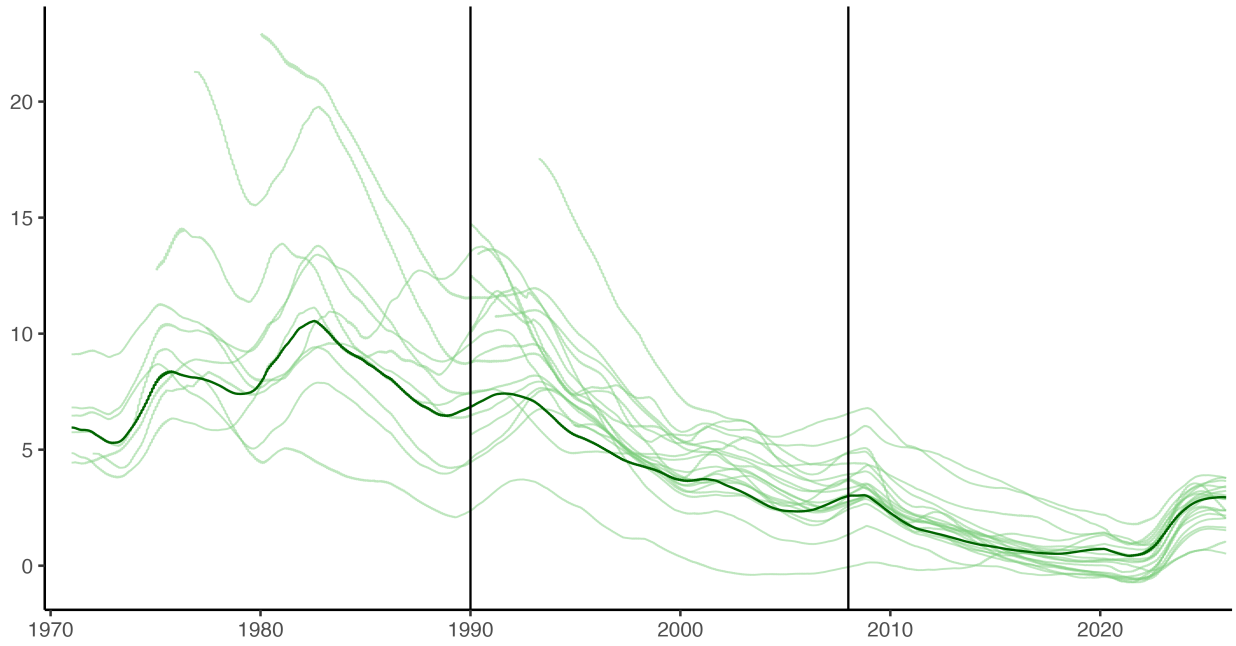


Figure 4: Global and country-specific equilibrium nominal rates over time

The figure plots the global and country-specific equilibrium nominal rates for the 20 developed economies. Country rates are shown in light green, while the global rate is shown in dark green. Section 2.3 and Appendix A provide measurement details and sources.

Given the trend proxies, I recover the cyclical components as residuals implied by the model. The global cycle is the residual from projecting the global level and slope factors on the global trend:

$$\tilde{\mathbf{X}}_t = \mathbf{X}_{G,t} - \overline{\mathbf{X}} - \gamma \tau_t$$

The country cycle for country k at maturity n is then the residual component of the yield once the global trend, country trend, and global cycle have been removed:

$$\tilde{x}_{k,t}^{(n)} = Y_{k,t}^{(n)}/\mathbf{B}_k^{(n)} - \mathbf{A}_k^{(n)}/\mathbf{B}_k^{(n)} - [\theta_k \gamma \tau_t] - [\theta_k \tilde{\mathbf{X}}_t] - [\gamma_k \tau_{k,t}]$$

Appendix A.7 provides further details on the construction and dynamics of these series. To assess the quantitative importance of each component in explaining yield variation, I compute a Shapley R^2 decomposition of equation (8):[22]

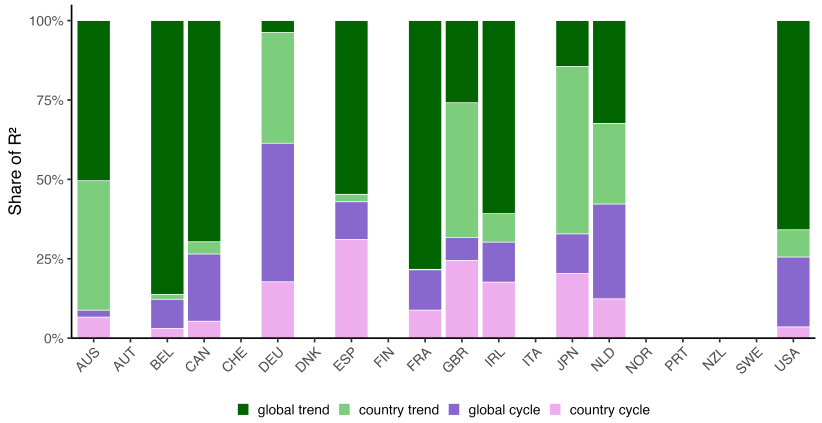
$$Y_{k,t}^{(n)} = \overline{\mathbf{A}}_k^{(n)} + \mathbf{B}_k^{(n)} \left\{ \underbrace{[\theta_k \gamma \tau_t]}_{\text{Global trend}} + \underbrace{[\theta_k \tilde{\mathbf{X}}_t]}_{\text{Global cycle}} + \underbrace{[\gamma_k \tau_{k,t}]}_{\text{Country trend}} + \underbrace{[\tilde{x}_{k,t}]}_{\text{Country cycle}} \right\} \tag{8}$$

Figure 5 shows that the sources of long-term yield variation change markedly across subsamples. In 1970-1989, the decomposition is relatively heterogeneous: both global and country-specific components contribute meaningfully across countries, indicating that long-term yields reflect a combination of common and domestic forces.[23] In 1990-2007, by contrast, the global macro trend becomes overwhelmingly dominant in almost all economies, while the contributions of country-specific and cyclical components shrink substantially. This pattern points to a pronounced synchronization of long-term bond markets during the Great Moderation. After 2008, the global macro trend remains the leading driver of long yields, but the decomposition becomes more dispersed again. In particular, the global cycle gains importance in several countries, and the country macro trend also regains explanatory power for a subset of economies, indicating a partial re-emergence of cross-country heterogeneity. The country cycle generally remains modest, although it is not negligible in some markets. Figure B.15 in Appendix B.3 shows a similar pattern for 3-month sovereign yields.[24] Overall, the evidence suggests that the secular global macro trend is the central driver of sovereign yields. Its dominance is strongest during the Great Moderation and somewhat less absolute both before 1990 and after the Global Financial Crisis.

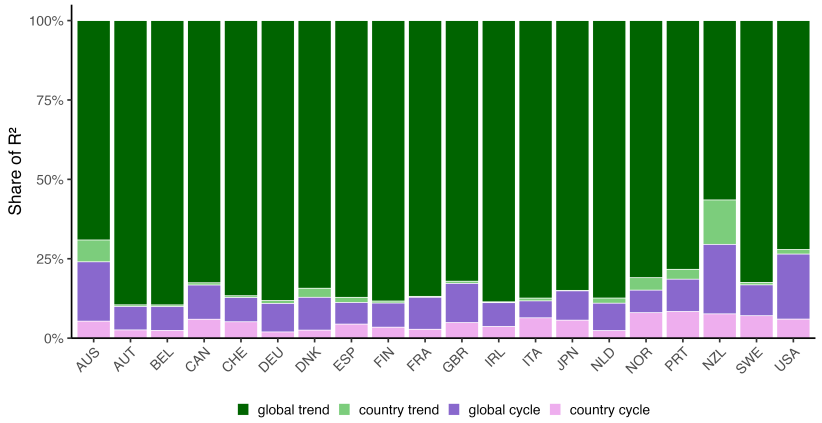
[22] By construction, the yield components sum to the yield itself, implying that the variance shares attributed to the individual components sum to 100%.

[23] Although the global trend already plays an important role in several economies, its contribution is far from uniform, and domestic forces remain quantitatively important in a number of cases. This pattern is consistent with incomplete integration: a common long-run force is present, but it does not yet dominate long-term yields everywhere.

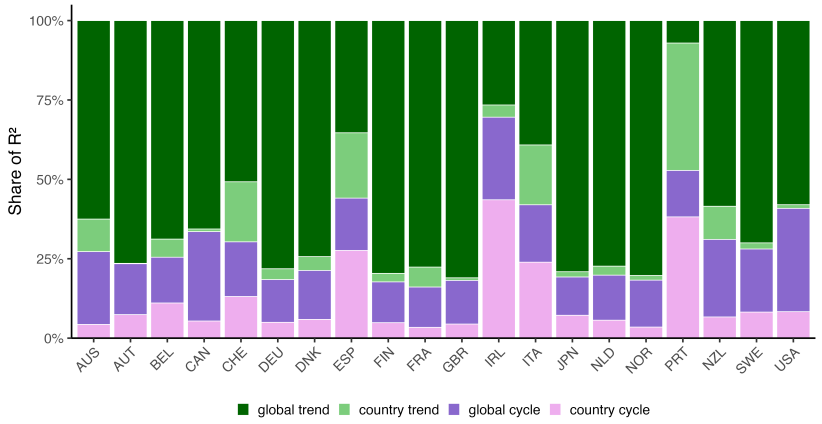
[24] Results on the short-rate decompositions also display substantial heterogeneity in the first subsample. In the later subsamples, the global trend becomes dominant across most countries, indicating a high degree of synchronization in short-rate dynamics, with only a modest re-emergence of the global cycle and, for some countries, the country-specific trend after the Global Financial Crisis.



(a) Long-term bond yields (10 years), 1970-1989



(b) Long-term bond yields (10 years), 1990-2007



(c) Long-term bond yields (10 years), 2008-2025

Figure 5: Shapley R^2 decomposition of long-term bond yields (10 years)

The figure reports the Shapley R^2 decomposition of equation (8) for the 1970-1989, 1990-2007, and 2008-2025 subsamples. Section 2.3 and Appendix A provide details on the construction of the series and the estimation procedure.

2.4. The missing global component: credit risk

The model in Section 2.1 has two natural limitations: it does not incorporate heteroskedasticity or credit risk. This section therefore examines the role of both in a reduced-form setting. I collect a range of global proxies for uncertainty and volatility, including daily measures (EPU, G20 market GARCH, and G20 market 30-day volatility), a monthly measure (EMV), and quarterly measures of inflation and consumption volatility based on GARCH estimates. To proxy for credit risk, I also collect the country term structure of credit default swaps, ($CDS_k^{(n)}$), at maturities of 6 months and 1, 3, 5, 7, and 10 years. I then construct the corresponding global CDS term structure, ($CDS_G^{(n)}$), as the GDP-weighted average of country CDS series at the daily frequency. From this global CDS curve, I extract the CDS level and slope factors, denoted CDS_{level} and CDS_{slope}. Appendix A provides further details on the data and estimation procedures.

I assess the incremental role of global uncertainty, volatility, and credit risk in domestic yield fluctuations after the Global Financial Crisis. For each country k and each maturity n, I first estimate the country component as:

$$Y_{k,t}^{(n)} = \alpha_k^{(n)} + \beta_k^{(n)} \mathbf{X}_{G,t} + v_{k,t}^{(n)} \tag{9}$$

Then, I investigate the role global uncertainty, volatility, or credit risk in explaining the country residuals:

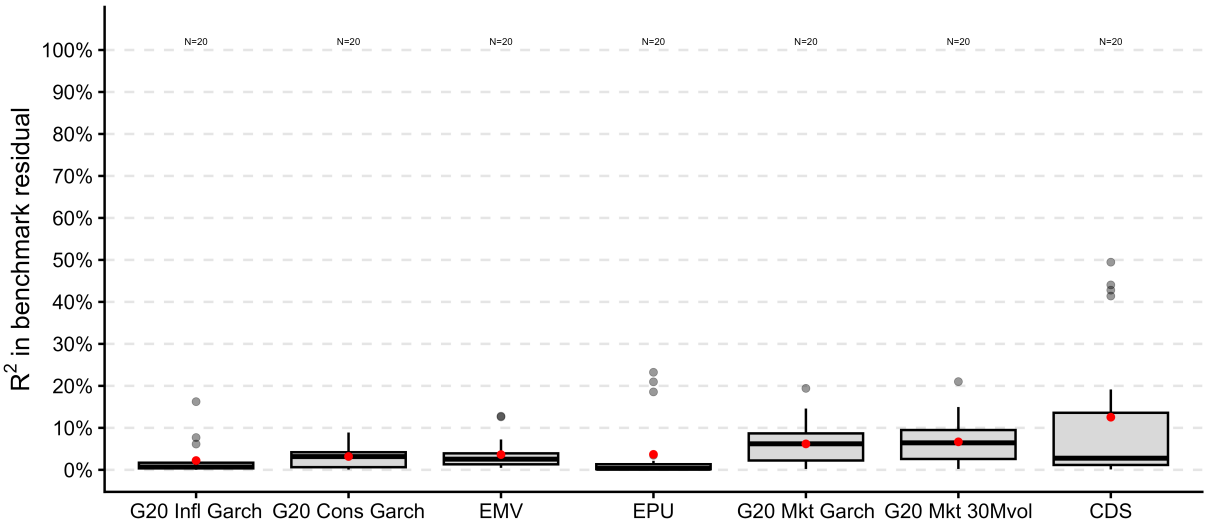
$$v_{k,t}^{(n)} = \delta_k^{(n)} + \gamma_k^{(n)} \mathbf{\Gamma_{G,t}} + \varepsilon_{k,t}^{(n)} \tag{10}$$

where $Y_{k,t}^{(n)}$ denotes the country-specific yield at maturity n, $\mathbf{X}_{G,t}$ is the vector of global level and slope factors, and $\mathbf{\Gamma_{G,t}}$ contains, in turn, one proxy for global uncertainty, volatility, or credit risk. The R^2 summarizes the share of country residuals variation explained by the global uncertainty, volatility, and credit risk proxies: $[\delta_k^{(n)} + \gamma_k^{(n)} \mathbf{\Gamma_{G,t}}]$. Figure 6 reports the cross-sectional distribution of R^2 (mean, median, and interquartile range) for the 2008-2025 subsample, adding each proxy separately.[25]

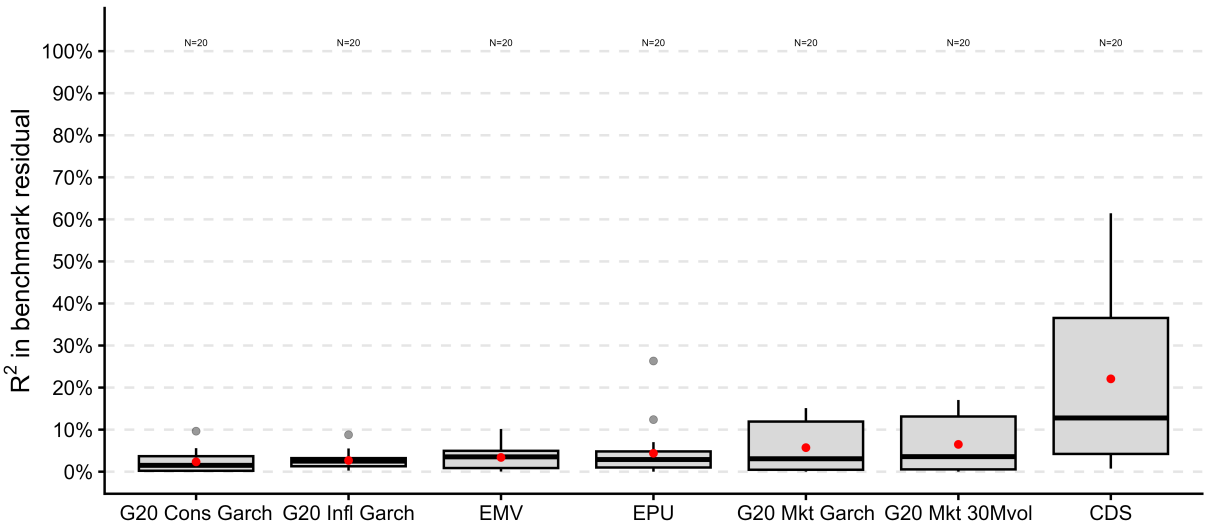
The results are stark. Standard proxies for uncertainty and volatility do not explain a huge part of the variation in the country residuals at the 1-year and 10-year maturity, leaving the cross-sectional distribution of R^2 largely unchanged. By contrast, global CDS_{level} and CDS_{slope} factors shifts the distribution upward, with especially pronounced gains and lower role for the country component at the long end. This evidence suggests that, in the post-2008 period, an important share of sovereign yield comovement reflects a global credit-risk

[25] Appendix B.4 reports results for the 2010-2025 subsample, showing that the findings are not solely driven by the 2008-2009 crisis period.

component that is not fully spanned by broader measures of uncertainty or volatility.



(a) Short-term rates (1 year)



(b) Long-term rates (10 years)

Figure 6: Cross-sectional distribution of variance explained by global factors

The figure plots the cross-sectional distribution (mean, median, and interquartile range) of the R^2 from equation (10) in the 2008-2025 subsample for 1-year and 10-year yields. Each bar adds, one at a time, the corresponding proxy for uncertainty, volatility, or credit risk in equation (10). Section 2.4 and Appendix A provide details on the construction of the series and the estimation procedure.

3. Credit Risk and Convenience Yields around the World

This section decomposes sovereign bond yields into three economically distinct components: the *risk-free rate*, the *default spread*, and the *convenience yield*. Due to limited data for CDS and Overnight Index Swaps (OIS), in this section, I study the role of global forces in shaping yield dynamics across 15 advanced economies. The sample includes Australia, the United Kingdom, Japan, Sweden and the United States, together with ten euro-area countries: Austria, Belgium, Germany, Spain, Finland, France, Ireland, Italy, the Netherlands, and Portugal. I study the extent to which each yield is driven by global rather than country-specific forces. The central objective is to use reduced-form evidence on global yield comovement to identify which underlying blocks account for the common variation in sovereign yields across countries. I show that the risk-free component is the most tightly linked to global factors, consistent with the strong international synchronization of macro trends and safe rates. Credit risk also contains a meaningful global dimension, especially at longer maturities and in countries more exposed to sovereign stress, while convenience yields are substantially more heterogeneous and remain more strongly shaped by local market conditions. Taken together, the evidence shows that global sovereign yield comovement is driven primarily by common risk-free and credit risk forces, with cross-country divergence arising through default spread and, even more so, through convenience yields.

3.1. A Dynamic Term Structure Model with Credit Risk and Convenience Yields

Building on a general version of the Jiang et al. (2025) model, sovereign bond yields can be decomposed into a *risk-free rate*, a *default spread*, and a *convenience yield* component. I present the main features and economic intuition here. Appendix C develops the connection to the model in Section 2.1 and provides the full derivation of the components.

Government Bond Pricing. I define the nominal pricing kernel $M_{k,t,t+n}$ for country k at horizon n. I introduce the possibility of sovereign default for country k, denoting by $\chi_{k,t+1} = L_k \mathcal{H}_{k,t+1}$ the event of government default at time $t+1$ in country k. Furthermore, sovereign bonds carry a country- and tenor-specific Euler equation wedge, $w_{k,t}^{(n)}$, which represents how much risk-adjusted return investors are willing to forgo to hold the bonds of country k. Following Jiang et al. (2025), sovereign bonds contain a *risk-free*, *default* and

convenience component. I generalize the Euler equations for bonds with maturity n as:

$$P_{k,t}^{(n)} = \mathbb{E}_t \left[M_{k,t,t+n} \prod_{j=1}^{n} (1 - \chi_{k,t+j})\, e^{\left(-\sum_{j=1}^{n} w_{k,t+j-1}^{n-j+1}\right)} \right] \tag{11}$$

Government Bond Yields Decomposition. I decompose the sovereign bond yields in country k into their *risk-free rate* $r_{k,t}^{(n)}$, *default spread* $\delta_{k,t}^{(n)}$, and *convenience yield* $\lambda_{k,t}^{(n)}$ components:

$$\boxed{y_{k,t}^{(n)} = -\frac{1}{n} \log \left[P_{k,t}^{(n)} \right] = r_{k,t}^{(n)} + \delta_{k,t}^{(n)} + \lambda_{k,t}^{(n)}} \tag{12}$$

where, assuming that each component has a global (G) and country ($\sim$) part:

- The *risk-free rate*:

$$r_{k,t}^{(n)} = -\frac{1}{n} \log \mathbb{E}_t \left[M_{k,t,t+n} \right] = \beta_{r,k}^{(n)} r_{G,t} + \tilde{r}_{k,t}^{(n)} \tag{13}$$

- The *default spread*:

$$\delta_{k,t}^{(n)} = -\frac{1}{n} \log \mathbb{E}_t \left[M_{k,t,t+n} \prod_{j=1}^{n} (1 - \chi_{k,t+j}) \right] + \frac{1}{n} \log \mathbb{E}_t \left[M_{k,t,t+n} \right] = \beta_{\delta,k}^{(n)} \delta_{G,t} + \tilde{\delta}_{k,t}^{(n)} \tag{14}$$

- The *convenience yields*:

$$\lambda_{k,t}^{(n)} = -\frac{1}{n} \log \mathbb{E}_t \left[M_{k,t,t+n} \prod_{j=1}^{n} (1 - \chi_{k,t+j}) e^{\left(-\sum_{j=1}^{n} w_{k,t+j-1}^{n-j+1}\right)} \right] + \frac{1}{n} \log \mathbb{E}_t \left[M_{k,t,t+n} \prod_{j=1}^{n} (1 - \chi_{k,t+j}) \right] = \beta_{\lambda,k}^{(n)} \lambda_{G,t} + \tilde{\lambda}_{k,t}^{(n)} \tag{15}$$

For each country, I can disentangle the impact of the *risk-free rate*, the *default spread*, and the *convenience yield* and decompose their global and country components:

$$\begin{aligned}
y_{k,t}^{(n)} &= \underbrace{r_{k,t}^{(n)}}_{Risk-free} + \underbrace{\delta_{k,t}^{(n)}}_{Default} + \underbrace{\lambda_{k,t}^{(n)}}_{Convenience} \\
&= [\underbrace{\beta_{r,k}^{(n)} r_{G,t}}_{Global\ r} + \underbrace{\tilde{r}_{k,t}^{(n)}}_{Country\ r}] + [\underbrace{\beta_{\delta,k}^{(n)} \delta_{G,t}}_{Global\ \delta} + \underbrace{\tilde{\delta}_{k,t}^{(n)}}_{Country\ \delta}] + [\underbrace{\beta_{\lambda,k}^{(n)} \lambda_{G,t}}_{Global\ \lambda} + \underbrace{\tilde{\lambda}_{k,t}^{(n)}}_{Country\ \lambda}] \\
&= \underbrace{\left[\beta_{r,k}^{(n)} r_{G,t} + \beta_{\delta,k}^{(n)} \delta_{G,t} + \beta_{\lambda,k}^{(n)} \lambda_{G,t}\right]}_{Global\ Component} + \underbrace{\left[\tilde{r}_{k,t}^{(n)} + \tilde{\delta}_{k,t}^{(n)} + \tilde{\lambda}_{k,t}^{(n)}\right]}_{Country\ Component}
\end{aligned}$$

where the second line is obtained by substituting equations (13), (14) and (15) into equation (12), while the third line is obtained by separating the global and country components. Using

this reduced form decomposition, I can disentangle the empirical contribution of the global and country *risk-free rate*, *default spread*, and *convenience yield* for each country.

3.2. Global risk-free rates

Following Jiang et al. (2025), I proxy the nominal *risk-free* rate with overnight index swap (OIS) rates, under the assumption that the OIS zero rate, $OIS_{k,t}^{(n)}$, provides a good measure of the benchmark nominal *risk-free* rate for country k and does not embed a convenience yield. I collect the term structure of OIS rates at maturities of 6 months and 1, 3, 5, 7, and 10 years. For euro-area countries, I follow Jiang et al. (2025) and use a common EUR OIS curve.[26] I then construct the corresponding global OIS term structure, $OIS_{G,t}^{(n)}$, as the GDP-weighted average of country OIS series at the daily frequency. From this global OIS curve, I extract the level and slope factors, denoted $OIS_{lev,t}$ and $OIS_{slo,t}$. Appendix A provides details on the construction of these series. I decompose the risk-free rate for country k and maturity n as:

$$r_{k,t}^{(n)} = \beta_{r,k}^{(n)} r_{G,t} + \tilde{r}_{k,t}^{(n)} \tag{16}$$

where $r_{k,t}^{(n)}$ denotes the country-specific OIS yield at maturity n, ($OIS_{k,t}^{(n)}$), and the global risk-free block is given by a constant and the global OIS level and slope factors ($r_{G,t} = [1 \; OIS_{lev,t} \; OIS_{slo,t}]$). Figure 7 reports the heatmap of R^2 values from equation (16).

The fit is high across most countries and maturities, indicating that global OIS level and slope factors explain a large share of the variation in domestic risk-free rates. The explanatory power is especially strong for the euro area, the United Kingdom, and the United States. For the euro area, the R^2 ranges from about 89% at 6 months to 93% at 7 years, remaining above 90% at almost all maturities. The United Kingdom exhibits an even tighter fit, with values around 94-96% across the curve, while the United States records R^2 values between 89% and 96%. For these large financial markets, the global risk-free component captures nearly all of the relevant variation in domestic OIS rates. The fit is somewhat lower, though still substantial, for Australia and Sweden, and distinctly weaker for Japan, especially at short maturities. In Australia, the R^2 rises from 71% at 6 months to 84% at maturities between 3 and 5 years, before easing slightly to 81% at 10 years. Sweden displays a similar pattern, with the fit increasing from 74% at 6 months to 88% at 10 years. Japan stands out as the main exception: the R^2 is only 47% at 6 months and 52% at 1 year, although it rises gradually to 78% at 10 years. This suggests that Japanese short-term OIS rates are less synchronized with the global risk-free component, while longer maturities remain more

[26] The underlying assumption is that, even if risk sharing across euro-area countries is incomplete, investors agree on the price of *risk-free* bonds denominated in euros.

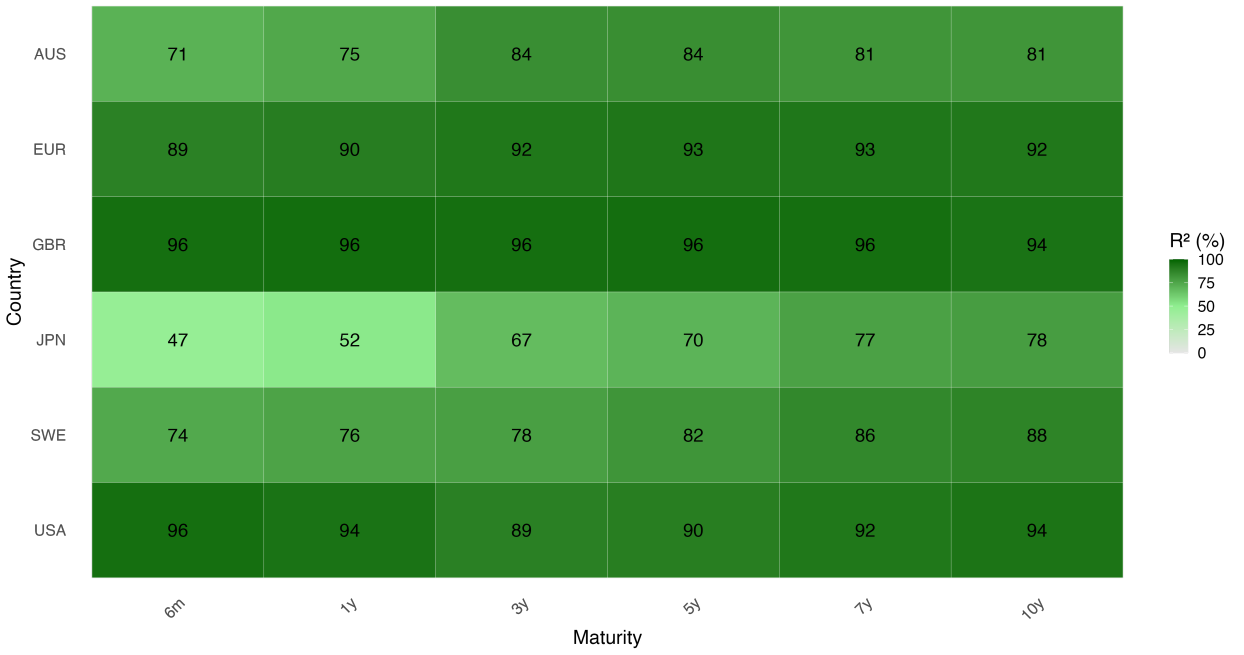


Figure 7: Risk-free rate: global and country decomposition

The figure reports a heatmap of the R^2 values obtained from equation (16). Country-specific rates, $OIS_{k,t}^{(n)}$, are regressed on a constant and the global OIS level and slope factors, $r_{G,t} = [1 \; OIS_{lev,t} \; OIS_{slo,t}]$, across maturities from 6 months to 10 years. Darker cells indicate greater explanatory power of the global factors. Section 3.2 and Appendix A provide details on the construction of the series and the estimation procedure.

tightly linked to it. In several countries, the fit increases with maturity, consistent with stronger long-run convergence to global risk-free forces. I relate the *risk-free* component to macro-trend measures in Appendix B.5. This connects naturally the decomposition in Section 2 with this model, in which slow-moving macro trends and their cyclical counterparts should primarily be reflected in the *risk-free* part of sovereign yields rather than in *default* or *convenience-yield* wedges. The evidence shows that global macro trends explain most of the variation in country-specific OIS yields, particularly at longer maturities and especially for the euro area, the United Kingdom, and Japan. Adding country-specific trend components improves the fit only modestly, and mainly at the short end of the curve. Japan again stands out, displaying a weaker connection between its risk-free rate and the corresponding country macro-trend. Overall, the results indicate that risk-free rate dynamics are predominantly global and largely driven by changes in global macro trends, even in the post-GFC period.

3.3. Credit Risk as a Global Factor

Following Jiang et al. (2025), I proxy credit risk using the term structure of credit default swap (CDS) spreads. Specifically, I collect country-level CDS rates in USD and EUR,

$CDS^{(n)}_{k,t}$, at maturities of 6 months and 1, 3, 5, 7, and 10 years. I then construct the corresponding global CDS term structure, $CDS^{(n)}_{G,t}$, as the GDP-weighted average of country CDS series at the daily frequency. From this global curve, I extract the level and slope factors, denoted $CDS_{lev,t}$ and $CDS_{slo,t}$. Appendix A provides details on the construction of these series. For this analysis, I use the USD CDS, but I repeat the analysis using EUR CDS in Appendix B.6. I decompose the default spread for country k and maturity n as:

$$\delta^{(n)}_{k,t} = \beta^{(n)}_{\delta,k}\delta_{G,t} + \tilde{\delta}^{(n)}_{k,t} \tag{17}$$

where $\delta^{(n)}_{k,t}$ denotes the country-specific CDS at maturity n, that is, $CDS^{(n)}_{k,t}$, and the global credit-risk block is given by a constant and the global CDS level and slope factors ($\delta_{G,t} = [1\ CDS_{lev,t}\ CDS_{slo,t}]$). Figure 8 reports the heatmap of R^2 values from equation (17).

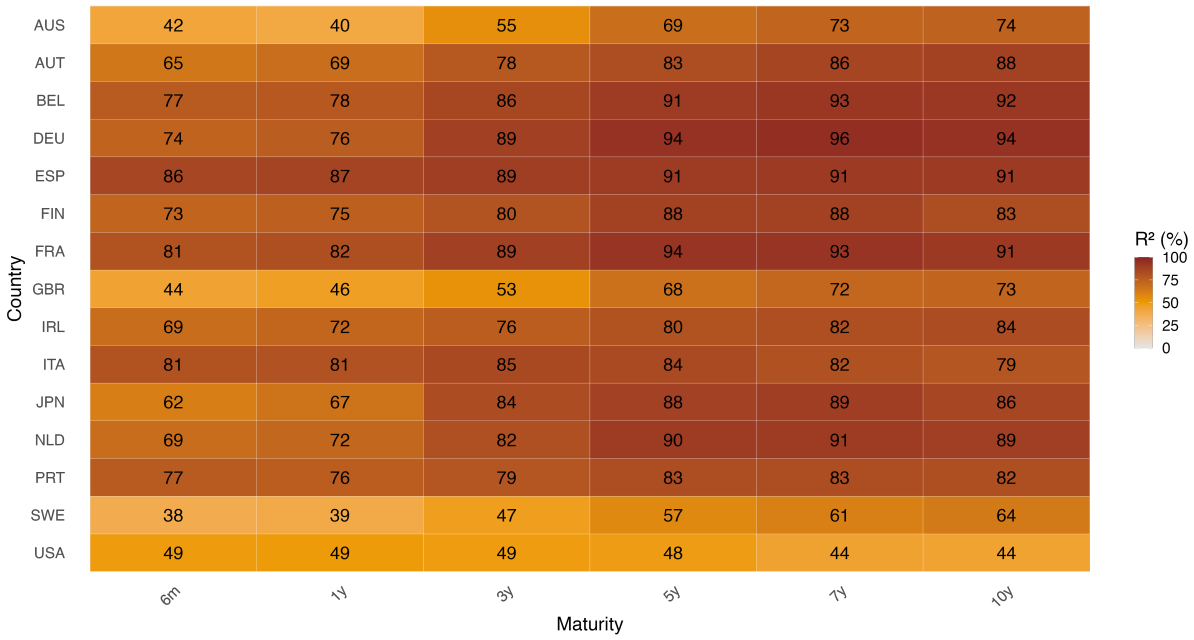


Figure 8: Credit risk: global and country decomposition

The figure reports a heatmap of the R^2 values obtained from equation (17). Country-specific CDS, $CDS^{(n)}_{k,t}$, are regressed on a constant and the global CDS level and CDS slope factors, $\delta_{G,t} = [1\ CDS_{lev,t}\ CDS_{slo,t}]$, across maturities from 6 months to 10 years. Darker cells indicate greater explanatory power of the global factors. CDS data are denominated in U.S. dollars. Section 3.3 and Appendix A provide details on the series and estimation procedure.

The results show that global CDS factors explain a substantial share of national CDS variation, and that their explanatory power generally rises with maturity. At short maturities (6 months to 1 year), the fit is often moderate, whereas at longer maturities (5 to 10 years) it becomes high in most countries. This pattern suggests that global credit forces are par-

ticularly important for the long end of sovereign default-risk curves. The strongest global comovement appears in Europe, where countries such as Germany, Belgium, France, and Spain display very high R^2 values at longer maturities. By contrast, the linkage is weaker in the United States and Sweden, indicating a larger role for persistent country-specific credit-risk components in those markets. The analysis using EUR CDS, reported in Appendix B.6, delivers qualitatively similar results and, for the United States, an even stronger connection to the global component. This is consistent with quanto-CDS theory.[27] Overall, the evidence points to a sizable global component in sovereign credit risk, especially at medium and long maturities.

3.3.1. Credit Risk Determinants

The determinants of sovereign CDS premia have been studied extensively, with the literature emphasizing both global and domestic drivers; see for example Pan and Singleton (2008), Longstaff et al. (2011), Ang and Longstaff (2013) and Klingler and Lando (2018). Following Augustin (2018), I estimate panel regressions to evaluate the relative role of domestic and global factors in explaining sovereign CDS dynamics. For each country k, changes in the monthly 5-year CDS spread, $\Delta CDS^{(5)}_{k,t}$, are projected on domestic and global risk factors:

$$\Delta CDS^{(5)}_{k,t} = \alpha_k + \beta^\top \Delta L_{k,t} + \gamma^\top \Delta G_t + \varepsilon_{k,t} \tag{18}$$

where $L_{k,t}$ is a vector of domestic variables and G_t is a vector of global variables. The domestic factors are the local stock-market return in domestic currency, the exchange-rate change vis-à-vis the U.S. dollar, and local market volatility. I consider three alternative sets of global controls. The first includes the estimated global CDS factors: $CDS_{lev,t}$ and $CDS_{slo,t}$. The second includes U.S. financial variables as in Augustin (2018): the excess U.S. stock-market return, changes in the 5-year Treasury yield, the U.S. term premium (5-year minus 3-month Treasury yield), changes in U.S. corporate bond spreads, and changes in the earnings-price ratio of the S&P 500.[28] The third uses the U.S. 5-year sovereign CDS together with global CDS factors constructed excluding the United States. Data sources and variable definitions are reported in the Appendix A.

Augustin (2018) report results for developed and emerging countries together. To investigate any possible difference between the two groups, tables 1 and 2 report the results

[27] As Augustin et al. (2020) show, the wedge between CDS contracts in different currencies prices the interaction between sovereign default risk and exchange-rate depreciation conditional on default. For U.S. sovereign CDS, denomination in euros adds exposure to EUR/USD risk and thus increases sensitivity to the joint pricing of U.S. default and dollar-depreciation risk.

[28] For further details on the series construction and their role as good proxy for the U.S. risk appetite, see the discussion in Augustin (2018)

separately for advanced and emerging economies.[29]

Two findings stand out. First, the role of U.S. financial factors differs sharply across the two groups. In advanced economies, domestic variables explain only a modest share of monthly CDS changes ($R^2 = 0.13$), and adding U.S. financial variables raises explanatory power only slightly ($R^2 = 0.15$). By contrast, global CDS factors are much more informative ($R^2 = 0.25$), already well above the specification based only on domestic variables. Once local variables are combined with global CDS factors the fit rises ($R^2 = 0.27$) in column (4), with only a small increase adding U.S. financial indicators ($R^2 = 0.29$). The same message emerges in columns (6)-(8): the U.S. 5-year CDS alone explains some variation ($R^2 = 0.15$ in column (6)), but global CDS factors constructed excluding the United States have substantially greater explanatory power ($R^2 = 0.29$ in column (7)), and the combined model reaches $R^2 = 0.31$ in column (8), the highest value in the table. The coefficient estimates point in the same direction. Local equity returns enter negatively and local exchange-rate depreciations positively, but the global CDS level and slope are highly significant and economically large across all relevant specifications, whereas most U.S. financial variables are either insignificant or unstable. For advanced economies, sovereign CDS dynamics are therefore primarily linked to a common global credit-risk component rather than to broad U.S. financial conditions.

Second, emerging-market CDS spreads are much more sensitive to U.S. financial conditions, but global CDS factors still remain central. Domestic variables alone already explain a nontrivial share of the variation ($R^2 = 0.39$), and adding U.S. financial variables increases the fit markedly to $R^2 = 0.49$. The coefficients on U.S. equity returns, the 5-year Treasury yield, and the earnings-price ratio are large and statistically significant, indicating that emerging-market CDS spreads are tightly connected to shifts in U.S. risk appetite and global financing conditions. At the same time, the global CDS factors also matter strongly: the fit rises from 0.30 with global CDS factors alone to 0.50 when domestic variables are added and to 0.53 when both domestic and U.S. financial variables are included. In columns (6)-(8), the U.S. sovereign CDS is also strongly significant, and global CDS factors excluding the United States retain substantial explanatory power.

A broader conclusion emerges: the most robust common drivers of sovereign CDS dynamics are the global CDS level and slope factors. These factors remain highly significant across both advanced and emerging economies, and models that combine them with domestic variables consistently deliver the strongest fit. By contrast, U.S. financial variables add little for advanced economies but matter materially for emerging markets. This contrast is

[29] Due to data availability, I use 16 out of the 20 developed economies: AUS, AUT, BEL, DEU, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, PRT, and SWE. For the same reason, for emerging countries, I use data for BGR, BRA, CHL, CHN, COL, CZE, EST, HRV, HUN, IDN, ISL, ISR, KOR, MAR, MEX, MYS, PAN, PHL, POL, QAT, ROU, SGP, SVK, TUR, ZAF.

economically intuitive: sovereign credit risk in advanced economies appears to load mainly on a broad global credit cycle, while in emerging markets it is more tightly interlinked with shifts in U.S. financial conditions and global dollar funding risk. Dollar-denominated debt remains central to the macro-finance of emerging-market sovereigns, even if its role is less mechanical than in the classic "original sin" era.[30]

At the same time, these reduced-form regressions have limits. Without a full structural model, it is not possible to cleanly distinguish variation in expected default losses from variation in credit risk premia, nor to identify the deeper macro-financial mechanisms underlying the global CDS factors. A full model-based decomposition, together with richer proxies for underlying risk processes, would be needed to separate these channels more precisely.

[30] Eichengreen, Hausmann and Panizza (2003) show why reliance on dollar debt historically made sovereign balance sheets highly vulnerable to exchange-rate movements, while Du and Schreger (2016) show that, even as local-currency sovereign debt markets have deepened, sovereign risk in emerging markets remains tightly linked to currency risk and global dollar conditions. Gopinath et al. (2020) dominant currency paradigm provides the broader mechanism: when trade, invoicing, and financing are organized around the dollar, U.S. financial conditions propagate globally even without explicit dollar borrowing. Then, emerging-market spreads remain more exposed to U.S. financial conditions, consistently with the view that dollar matters, nowadays less through the currency denomination of debt per se than through the pricing of sovereign risk and external funding conditions.

Table 1: Panel regressions for daily changes in 5-year sovereign CDS spreads: advanced economies

	(1) $\Delta CDS^{(5)}_{k,t}$	(2) $\Delta CDS^{(5)}_{k,t}$	(3) $\Delta CDS^{(5)}_{k,t}$	(4) $\Delta CDS^{(5)}_{k,t}$	(5) $\Delta CDS^{(5)}_{k,t}$	(6) $\Delta CDS^{(5)}_{k,t}$	(7) $\Delta CDS^{(5)}_{k,t}$	(8) $\Delta CDS^{(5)}_{k,t}$
Local *Ret*	-1.32***	-1.31***		-0.30***	-0.77***	-1.15***	-0.29***	-0.68***
	(-6.28)	(-5.22)		(-2.99)	(-5.31)	(-6.51)	(-2.75)	(-4.72)
Δ Local *Vol*	-3.11	2.55		0.14	4.73**	-1.03	-0.93	3.50*
	(-1.32)	(1.02)		(0.11)	(2.42)	(-0.54)	(-0.86)	(1.80)
Local FX	1.07***	0.99***		0.26*	0.44**	1.04***	0.12	0.21
	(3.94)	(3.36)		(1.78)	(2.60)	(3.76)	(0.79)	(1.22)
USA *Ret*		-1.12			1.11**			1.21***
		(-1.43)			(2.32)			(2.61)
Δ USA *Vol*		-7.69***			-4.70***			-5.65***
		(-3.03)			(-2.76)			(-3.02)
Δ USA Gov 5y		-2.12			-1.36			-0.33
		(-0.74)			(-0.98)			(-0.26)
USA Term Premia		0.46			0.65*			0.40
		(0.84)			(1.82)			(1.63)
Δ USA Bond Spread		1.48			-0.34			0.10
		(1.04)			(-0.64)			(0.14)
Δ USA CAPE		4.83**			-1.30			-2.40*
		(2.07)			(-1.11)			(-1.81)
$\Delta CDS_{lev,t}$			1.70***	1.65***	1.76***			
			(12.70)	(9.64)	(9.57)			
$\Delta CDS_{slo,t}$			15.88***	15.67***	16.15***			
			(9.85)	(7.77)	(7.85)			
$\Delta CDS^{(5)}_{USA,t}$						0.53***	-0.02	0.06
						(3.13)	(-0.33)	(1.20)
$\Delta CDS_{lev,t}$ w/o USA							1.40***	1.43***
							(12.96)	(12.31)
$\Delta CDS_{slo,t}$ w/o USA							14.02***	13.98***
							(2.90)	(3.17)
Observations	3402	3402	3832	3402	3402	3294	3294	3294
R^2	0.13	0.15	0.25	0.27	0.29	0.15	0.29	0.31

This table reports panel regressions of monthly changes in 5-year sovereign CDS spreads for advanced economies (AUS, AUT, BEL, DEU, DNK, ESP, FIN, FRA, GBR, IRL, ITA, JPN, NLD, NOR, PRT, and SWE). Columns (1) and (6) include only domestic controls or U.S. sovereign CDS, columns (2) and (8) add U.S. financial variables, columns (3) and (7) use global CDS level and slope factors, and columns (4)-(5) combine domestic variables with global CDS factors, with column (5) also adding U.S. financial controls. All specifications include country fixed effects. Local controls are the domestic equity return, local market volatility, and the exchange-rate change against the U.S. dollar. U.S. financial variables include the U.S. excess equity return, changes in U.S. equity-market volatility, the 5-year Treasury yield, the term premium, corporate bond spreads, and the earnings-price ratio. Global CDS factors are constructed as GDP-weighted aggregates of country CDS curves. Section 3.3 and Appendix A provide details on the CDS series and estimation procedure. For the details on the local and U.S. variables see Augustin (2018). T-statistics, reported in parentheses, are based on Driscoll and Kraay (1998), with lag selection following Newey and West (1994). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: Panel regressions for daily changes in 5-year sovereign CDS spreads: emerging economies

	(1) $\Delta CDS^{(5)}_{k,t}$	(2) $\Delta CDS^{(5)}_{k,t}$	(3) $\Delta CDS^{(5)}_{k,t}$	(4) $\Delta CDS^{(5)}_{k,t}$	(5) $\Delta CDS^{(5)}_{k,t}$	(6) $\Delta CDS^{(5)}_{k,t}$	(7) $\Delta CDS^{(5)}_{k,t}$	(8) $\Delta CDS^{(5)}_{k,t}$
Local *Ret*	-2.13***	-1.13***		-1.47***	-1.08***	-1.32***	-0.98***	-0.81***
	(-4.91)	(-4.70)		(-4.46)	(-4.62)	(-6.93)	(-6.66)	(-5.99)
Δ Local *Vol*	6.92	4.04		7.82*	5.30	2.72**	1.56*	0.20
	(1.47)	(1.01)		(1.68)	(1.39)	(2.21)	(1.67)	(0.15)
Local FX	3.10***	2.37***		2.43***	2.12***	2.76***	2.32***	2.18***
	(8.50)	(7.28)		(8.06)	(7.39)	(9.19)	(7.66)	(6.96)
USA *Ret*		-5.81***			-3.59***			-1.25
		(-4.15)			(-2.88)			(-1.02)
Δ USA *Vol*		-1.07			1.49			1.31
		(-0.20)			(0.27)			(0.33)
Δ USA Gov 5y		11.52**			12.08**			8.19**
		(2.34)			(2.32)			(2.13)
USA Term Premia		-0.92			-0.79			-1.13*
		(-1.03)			(-1.15)			(-1.68)
Δ USA Bond Spread		7.02***			5.19**			2.88
		(3.12)			(2.40)			(1.25)
Δ USA CAPE		17.31***			11.84**			3.49
		(3.81)			(2.56)			(0.85)
$\Delta CDS_{lev,t}$			2.95***	1.90***	1.34***			
			(5.71)	(6.40)	(4.34)			
$\Delta CDS_{slo,t}$			28.38***	16.78***	10.23***			
			(5.12)	(5.38)	(2.99)			
$\Delta CDS^{(5)}_{USA,t}$						1.16***	0.68**	0.63**
						(3.00)	(2.54)	(2.52)
$\Delta CDS_{lev,t}$ w/o USA							1.20***	1.06***
							(6.51)	(5.96)
$\Delta CDS_{slo,t}$ w/o USA							23.24***	20.86***
							(3.57)	(3.10)
Observations	5354	5354	5354	5354	5354	5150	5150	5150
R^2	0.39	0.49	0.30	0.50	0.53	0.38	0.45	0.46

This table reports panel regressions of monthly changes in 5-year sovereign CDS spreads for emerging economies (BGR, BRA, CHL, CHN, COL, CZE, EST, HRV, HUN, IDN, ISL, ISR, KOR, MAR, MEX, MYS, PAN, PHL, POL, QAT, ROU, SGP, SVK, TUR, ZAF). Columns (1) and (6) include only domestic controls or U.S. sovereign CDS, columns (2) and (8) add U.S. financial variables, columns (3) and (7) use global CDS level and slope factors, and columns (4)-(5) combine domestic variables with global CDS factors, with column (5) also adding U.S. financial controls. All specifications include country fixed effects. Local controls are the domestic equity return, local market volatility, and the exchange-rate change against the U.S. dollar. U.S. financial variables include the U.S. excess equity return, changes in U.S. equity-market volatility, the 5-year Treasury yield, the term premium, corporate bond spreads, and the earnings-price ratio. Global CDS factors are constructed as GDP-weighted aggregates of country CDS curves. Section 3.3 and Appendix A provide details on the CDS series and estimation procedure. For the details on the local and U.S. variables see Augustin (2018). T-statistics, reported in parentheses, are based on Driscoll and Kraay (1998), with lag selection following Newey and West (1994). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

3.4. The heterogeneity of convenience yields

Following Jiang et al. (2025), I define the convenience yield for country k and maturity n as:

$$\underbrace{\lambda_{k,t}^{(n)}}_{\text{Convenience yield}} = \underbrace{y_{k,t}^{(n)}}_{\text{Bond yield}} - \underbrace{r_{k,t}^{(n)}}_{\text{Risk-free rate}} - \underbrace{\delta_{k,t}^{(n)}}_{\text{Default spread}} \tag{19}$$

I construct the country term structure of convenience yields, $\lambda_{k,t}^{(n)}$, at maturities of 6 months and 1, 3, 5, 7, and 10 years. I then form the corresponding global convenience-yield curve, $\lambda_{G,t}^{(n)}$, as the GDP-weighted average of country series at the daily frequency. From this global curve, I extract the level and slope factors, denoted $CY_{lev,t}$ and $CY_{slo,t}$. For this analysis, I use the USD CDS, but I repeat the analysis using EUR CDS in Appendix B.7. Appendix A provides details on the series' construction. I decompose country *convenience yields* as:

$$\lambda_{k,t}^{(n)} = \beta_{\lambda,k}^{(n)} \lambda_{G,t} + \tilde{\lambda}_{k,t}^{(n)} \tag{20}$$

where $\lambda_{k,t}^{(n)}$ is the country-specific convenience yield at maturity n, and the global convenience-yield block consists of a constant and the global convenience-yield level and slope factors, $\lambda_{G,t} = [1 \; CY_{lev,t} \; CY_{slo,t}]$. Figure 9 reports the R^2 from equation (20) across countries and maturities.

The results reveal substantially more heterogeneity than in the corresponding decompositions for *risk-free* rates and *credit-risk* spreads. Global convenience-yield factors explain a large share of the variation for several safer core euro-area sovereigns (France, Belgium, Germany, Austria, and the Netherlands). In some countries, such as Japan and Australia, the fit rises markedly with maturity, indicating that global convenience-yield forces become more relevant at longer horizons. In other cases, however, the opposite pattern emerges. The fit is weak throughout the curve for the United States, remains low for Finland and Ireland, and declines sharply with maturity for Portugal, Spain, and Italy. Unlike the cases of OIS rates and CDS spreads, there is no common monotonic pattern across countries. Convenience yields therefore retain a stronger country-specific component than either *risk-free* rates or *default* spreads. Put differently, the convenience-yield component is the least internationally synchronized part of sovereign yields, consistent with the view that safety, liquidity, collateral value and market segmentation remain partly local even in highly integrated bond markets. Results based on convenience yields constructed from CDS data denominated in euros are quantitatively and qualitatively similar, and are reported in Appendix B.7.

Figure 10 plots country-level *convenience yields* at the 1-year and 10-year maturities in the post-2008 sample. More negative values indicate a larger convenience premium. Three



Figure 9: Convenience yields: global and country decomposition

The figure reports a heatmap of the R^2 obtained from equation (20). Country-specific convenience yields, $\lambda_{k,t}^{(n)}$, are regressed on a constant and the global convenience-yield level and slope factors, $\lambda_{G,t} = [1 \; CY_{lev,t} \; CY_{slo,t}]$, across maturities from 6 months to 10 years. Darker cells indicate greater explanatory power of the global factors. Convenience yields are constructed using CDS data denominated in U.S. dollars. Section 3.4 and Appendix A provide details on the data and estimation procedure.

patterns stand out. First, convenience yields are negative for most countries and most of the sample, especially at the long end, indicating that sovereign bonds generally trade rich relative to the value implied by *risk-free* and *credit-risk* components alone. Second, there is substantial cross-country heterogeneity. Core euro-area issuers display persistently negative long-maturity convenience yields, whereas peripheral issuers show much more volatile dynamics, with pronounced dislocations around the euro-area crisis. Third, the final part of the sample reveals a new common pattern. After the Covid period, 1-year convenience yields become sharply more negative in several countries, slowly returning to zero after 2024. At the same time, the 10-year convenience component remains close to zero in a number of markets, most notably in the United States, and recovers only partially elsewhere. This contrast suggests that the convenience services embedded in sovereign debt have weakened and become more state-dependent.

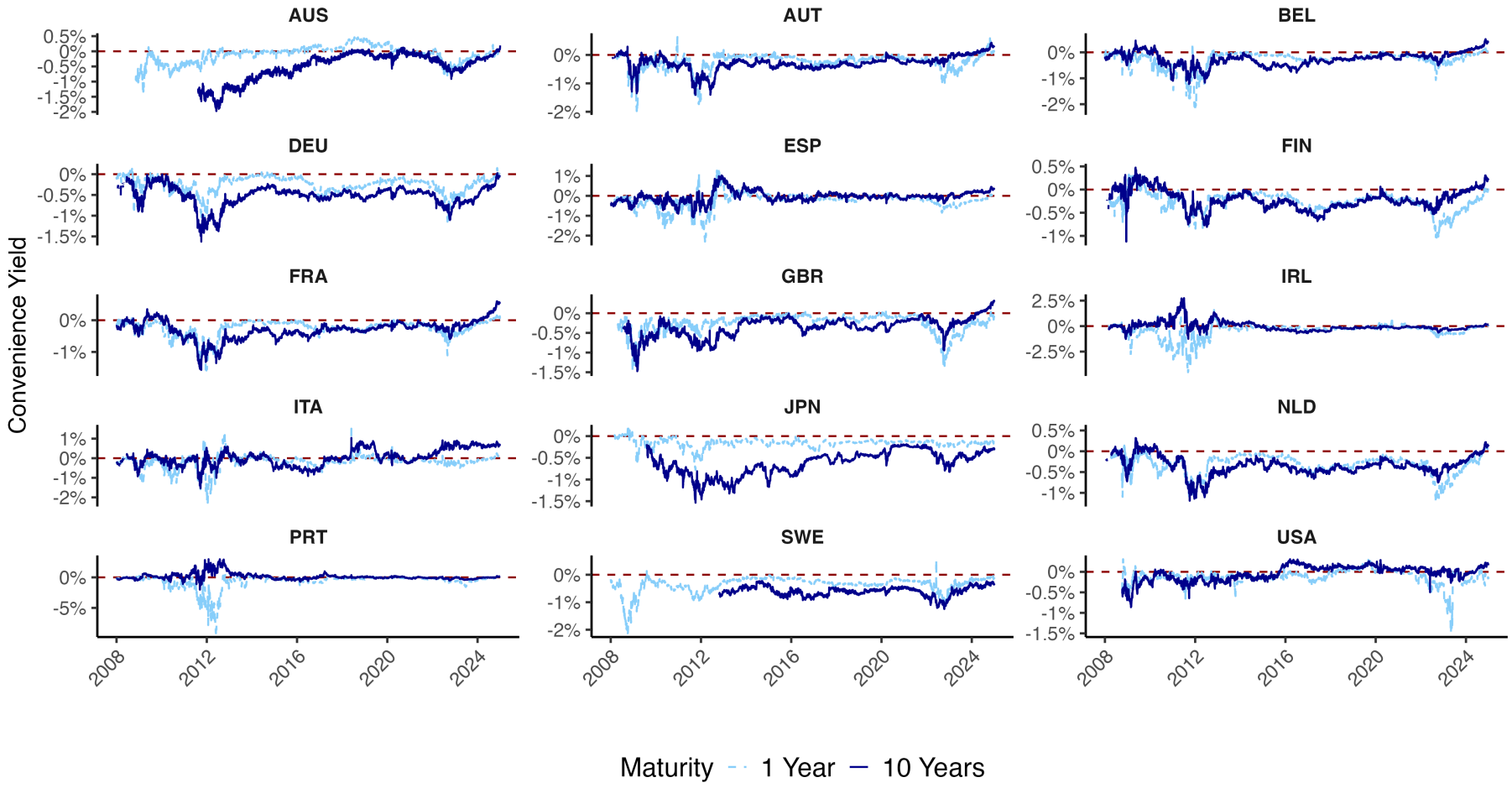


Figure 10: Convenience yields at the 1-year and 10-year maturities across countries

The figure plots country-level *convenience yields* ($\lambda_{k,t}^{(n)}$) at the 1-year and 10-year maturities from 2008 to 2025. The light-blue line denotes the 1-year series and the dark-blue line denotes the 10-year series. The red dashed line marks zero. More negative values indicate a larger convenience premium. Section 3.4 and Appendix A provide details on the data and estimation procedure.

3.5. The bond yields decomposition after the GFC

For each country, sovereign yields can be decomposed into a *risk-free* component, a *default-spread* component, and a *convenience-yield* component, each of which in turn contains a global and a country-specific part:

$$y_{k,t}^{(n)} = \underbrace{r_{k,t}^{(n)}}_{Risk-free} + \underbrace{\delta_{k,t}^{(n)}}_{Default} + \underbrace{\lambda_{k,t}^{(n)}}_{Convenience}$$

$$= [\underbrace{\beta_{r,k}^{(n)} r_{G,t}}_{Global\ r} + \underbrace{\tilde{r}_{k,t}^{(n)}}_{Country\ r}] + [\underbrace{\beta_{\delta,k}^{(n)} \delta_{G,t}}_{Global\ \delta} + \underbrace{\tilde{\delta}_{k,t}^{(n)}}_{Country\ \delta}] + [\underbrace{\beta_{\lambda,k}^{(n)} \lambda_{G,t}}_{Global\ \lambda} + \underbrace{\tilde{\lambda}_{k,t}^{(n)}}_{Country\ \lambda}]$$

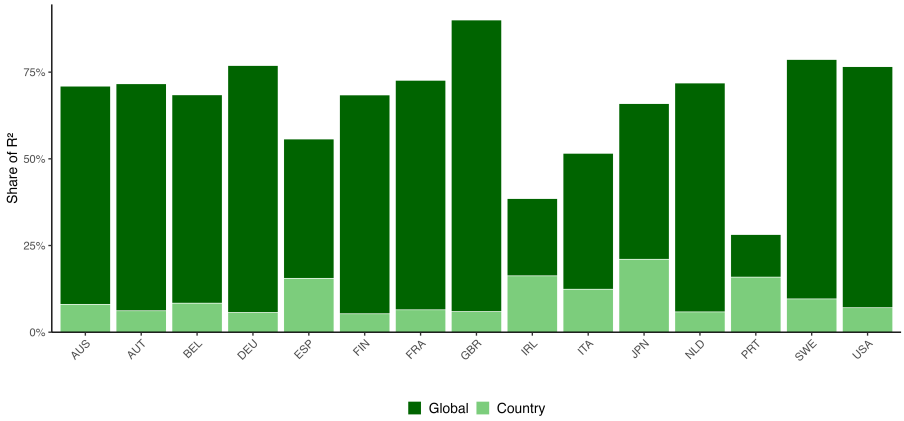
I quantify the contribution of each block using a Shapley R^2 decomposition. Figure 11 breaks the 10 years yields decomposition into its three building blocks.

Three results stand out. First, the global risk-free component is the dominant source of explained variation in nearly all countries. In most markets, it accounts for the largest single share of the fit, and it is especially large in countries such as the United Kingdom, the Netherlands, Sweden, and the United States. This result confirms the earlier evidence that long-horizon sovereign yields remain anchored by a common global risk-free force, even in the post-crisis period.

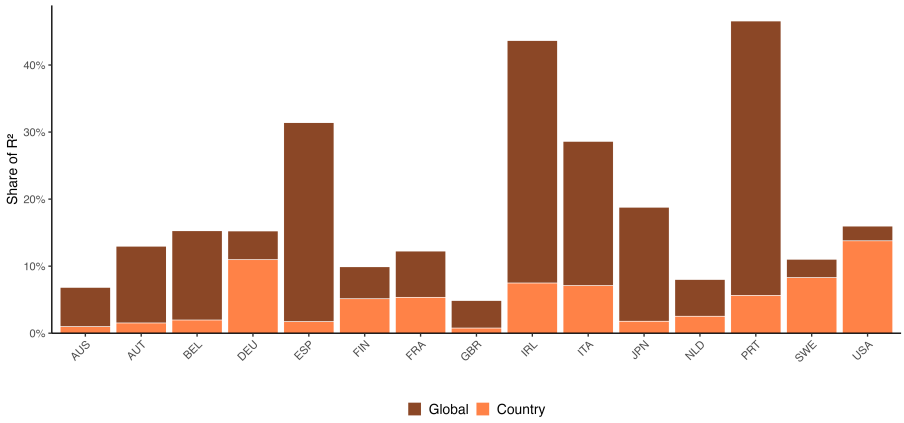
Second, global credit risk is quantitatively important, but unevenly so. Its contribution is particularly large in Ireland, Italy, Japan, Portugal, and Spain, while it is much smaller in markets whose sovereign debt is perceived as safer or more insulated from time-varying default-risk premia. This heterogeneity is economically revealing. It implies that the post-2008 weakening of simple global yield-factor models was not a collapse of global comovement per se; rather, it reflected cross-country differences in exposure to a common global credit cycle. In that sense, the post-crisis period looks less like a return to purely domestic bond pricing and more like a change in the composition of the relevant global force.

Third, global convenience-yield factors are small in almost all countries. Their contribution is visible in a few cases, but it remains modest relative to both the global risk-free component and, in several countries, the global credit component. By contrast, country-specific convenience yields are often materially larger than the corresponding global convenience block. This reinforces a central message of the paper: convenience yields are the least internationally synchronized component of sovereign bond pricing.

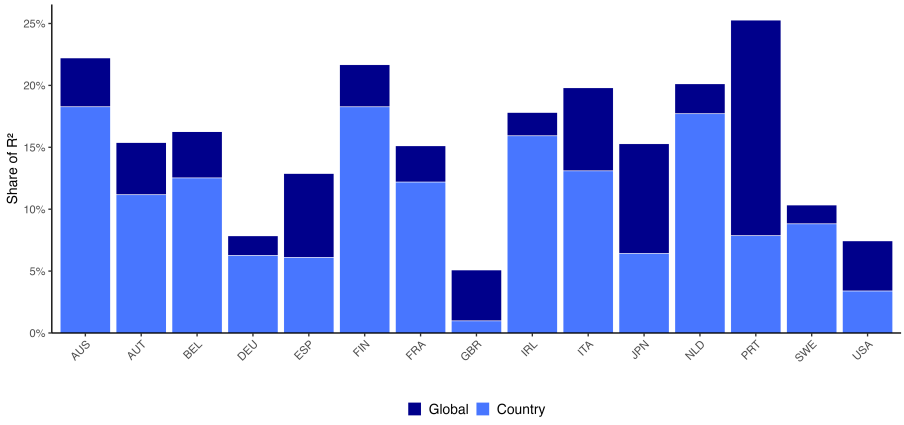
The country-specific components are informative as well. Country-specific risk-free variation is generally modest, but it becomes more relevant in Japan, Ireland, Portugal, and Spain, suggesting that the long end of the risk-free curve is not equally integrated across



(a) Risk-free-rate component



(b) Credit-spread component



(c) Convenience-yield component

Figure 11: Shapley decomposition of 10-year government bond yields by component
The figure decomposes the explained variation in 10-year government bond yields into global and country-specific shares within each of the three building blocks: the *risk-free rate*, *credit spread*, and *convenience yield*. In each panel, the dark bar denotes the global contribution and the light bar the country-specific contribution. Section 3.5 and Appendix A provide details on the data and estimation procedure.

issuers. Country-specific credit-risk variation is small in most countries, but remains visible in some peripheral sovereigns and in the United States. Country-specific convenience-yield variation, by contrast, is sizable in a broad set of markets, and in some cases dominates the global convenience contribution by a wide margin. This pattern indicates that local collateral value, market segmentation, and institutional demand remain important sources of sovereign-yield heterogeneity even after controlling for common global factors.

The figures also suggest several additional patterns that have received less attention in the literature. One is that Japan combines a relatively modest global risk-free share with a sizable global credit-risk share, an unusual mix for a country typically viewed as a safe issuer. Another is that Ireland, Italy, Portugal and Spain display an asymmetry between the credit and convenience blocks: global credit risk matters a great deal, but convenience remains largely country-specific. This suggests that, in stressed sovereigns, the pricing of default risk may globalize more quickly than the pricing of safety and collateral services. A third pattern is that the United States stands out not because the global component is weak overall, but because its explained variation is concentrated almost entirely in the risk-free block, with negligible role for global credit risk and only limited role for convenience. That configuration is consistent with a sovereign curve whose international pricing remains dominated by benchmark-rate dynamics rather than by time-varying credit risk and convenience premia.

Taken together, the decomposition delivers a clear message. The dominant global force in 10-year sovereign yields is the risk-free component; global credit risk is the second key driver and becomes especially important in countries more exposed to sovereign stress; convenience yields matter as well, but they remain much more local and heterogeneous. Long-term sovereign yield comovement is therefore driven primarily by common risk-free forces, while the main sources of cross-country divergence are differential exposure to global credit conditions and local convenience-yield forces. Appendix B.8 reports the same decomposition for 1-, 3-, and 5-year maturities. The broad pattern is similar, but the role of credit risk becomes progressively stronger as maturity increases. Overall, the evidence points to a quantitatively important role for both credit and convenience over the term structure, even though their degree of international synchronization differs sharply.

4. Policy Implications

The decomposition in this paper has direct implications for monetary policy, fiscal policy, and financial stability. The core lesson is that once sovereign yields are split into *risk-free*, *default*, and *convenience-yield* components, the interpretation of bond-market movements changes materially. This matters because government bond curves are used to infer expected policy rates, measure term premia, discount fiscal cash flows, assess debt sustainability, and evaluate the international transmission of financial conditions. The paper results suggest that these conventional uses are incomplete and that the relevant global force in sovereign bond markets is richer than the "standard *risk-free rate* models" suggest.

For monetary policy, the findings imply that changes in long-term yields cannot be interpreted solely through the lens of expected short rates or conventional term premia, but that central banks observing the same increase in long yields may face very different underlying shocks. This distinction is especially relevant for unconventional monetary policy.[31] Furthermore, this perspective helps clarify an important friction in the international monetary-policy spillover literature. One influential view, associated with the global financial cycle, emphasizes the dominant role of U.S. monetary policy and U.S. financial conditions in shaping global asset prices and risk-taking (Miranda-Agrippino and Rey, 2020; Miranda-Agrippino and Ricco, 2021). More recent work points to a broader and more multi-polar system, in which ECB policy and different policy instruments also generate meaningful cross-border spillovers (Miranda-Agrippino and Nenova, 2022; Georgiadis and Jarociński, 2025). My decomposition fits naturally with a richer view: sovereign-yield spillovers are not only about the United States, nor are they well summarized by a generic global term premium; part of what is often measured as international term-premium variation can instead reflect a common sovereign *credit-risk* component. More broadly, the results suggest that monetary policy should be understood as a global and increasingly multipolar phenomenon, transmitting through multiple channels and multiple priced components of sovereign yields.

The fiscal implications are equally important. If sovereign yields embed time-varying *default* premia and *convenience yields*, then the cost of public debt cannot be understood from the *risk-free* curve alone. The fiscal consequences of debt accumulation depend not only on the expected path of interest rates, but also on the extent to which government debt continues to provide safety, liquidity, and collateral services. These findings add to the recent work linking sovereign valuation to fiscal risk and convenience services, including Croce et al.

[31] Asset purchases, collateral policy, and balance-sheet interventions affect not only expected rates, but also the scarcity value of safe sovereign debt and the pricing of sovereign risk, as emphasized by Greenwood and Vayanos (2014), Krishnamurthy and Vissing-Jorgensen (2015), Pelizzon et al. (2016), and Krishnamurthy, Nagel and Vissing-Jorgensen (2018)

(2012), Blanchard (2019), Croce, Nguyen and Raymond (2021), Jiang et al. (2024b), Jiang et al. (2026), and Chen et al. (2025).

The findings also speak directly to financial stability and the sovereign-bank "doom loop". After 2008, sovereign stress is not purely domestic: a substantial share of sovereign yield comovement is driven by *global credit risk*, while persistent country-specific *convenience-yield* variation implies that local collateral demand, market segmentation, and institutional structure remain central for the heterogeneous transmission of stress across countries. This interpretation sharpens an important friction in the doom-loop literature. One branch emphasizes domestic transmission: sovereign stress weakens domestic banks because they hold domestic public debt, and this feeds back into credit supply and real activity, as in Bocola (2016). Another branch emphasizes broader system-wide fragility and the need for institutional redesign, as in Brunnermeier et al. (2016). This paper's evidence suggests that both views are incomplete on their own.[32] The pricing of sovereign *credit risk* has a strongly global component, so the common shock is international. Its incidence, however, depends on country-specific exposure, local banking structures, and *convenience-yield* conditions.

Taken together, the paper helps resolve three tensions in the literature. First, rather than viewing global sovereign-yield transmission as essentially about the United States, the results are more consistent with a broader global financial and credit cycle in which U.S. policy remains central, but not exclusive. Second, Instead of interpreting all non-expectations variation in long rates as term premia, the evidence suggests that sovereign *credit risk* should be separated explicitly, especially after the Global Financial Crisis. Third, the results suggest that sovereign stress is neither purely domestic nor entirely systemic; rather, the decomposition points to an intermediate structure: the common shock is global, but its effect depends on country-specific *sovereign risk* and local *convenience-yield* conditions. In this sense, decomposing sovereign yields into *risk-free*, *default*, and *convenience* components is not just an accounting exercise. It changes how we read the yield curve, how we interpret monetary and fiscal transmission, and how we think about the international financial integration and its complex fragility.

[32] In my view, the relevant doom loop is neither purely domestic nor purely global. It is global in the factor that prices sovereign stress, but local in the balance-sheet mechanisms through which that stress is absorbed and amplified. This perspective is also consistent with Beber, Brandt and Kavajecz (2009), Pelizzon et al. (2016), Krishnamurthy, Nagel and Vissing-Jorgensen (2018), Du, Hébert and Li (2023), and D'Avernas and Vandeweyer (2024), all of which emphasize that sovereign-bond pricing is inseparable from collateral markets, intermediary balance sheets and the provision of safe assets.

5. Conclusion

This paper studies the global and country-specific drivers of sovereign bond yields using historical and high-frequency data for advanced economies. I begin with a no-arbitrage term structure framework with global and local forces and show that "standard *risk-free rate* models" explain a large share of international yield comovement, especially in the postwar era and during the Great Moderation. After the Global Financial Crisis, however, this interpretation becomes incomplete: long-maturity yields remain highly correlated across countries even as the explanatory power of standard global yield factors declines. The reason is that sovereign yields are composite objects, and the relevant global forces extend beyond the *risk-free* component. I therefore decompose sovereign yields into *risk-free* rates, *default spreads*, and *convenience yields*, each with global and country-specific components. Three central findings emerge. First, the *risk-free* component remains the most global part of the yield curve. Second, *global credit risk* is the missing force behind a substantial share of post-crisis long-maturity comovement. It is especially important for stressed sovereigns, while U.S. sovereign credit is less tightly connected to the global credit block than the credit risk of many other advanced economies. Third, *convenience yields* are much more heterogeneous and remain strongly shaped by local factors. I also document a decline across maturities in U.S. *convenience yields*, followed by a broader erosion in *convenience* values across countries and maturities after 2024.

The policy implication is immediate: sovereign bond markets cannot be interpreted through *risk-free* rates alone. Once *credit risk* and *convenience yields* move, shifts in government bond yields no longer reflect only expected policy paths, but also changes in sovereign safety, collateral value and fiscal capacity. The paper also opens several directions for future work. A natural next step is to estimate a fully structural international term structure model that jointly prices *risk-free* rates, sovereign *credit risk*, and *convenience yields*, and that allows the latter two components to interact with intermediary balance sheets, reserve demand and exchange-rate risk. Another is to study more directly the recent erosion of convenience values across maturities and its implications for debt management, reserve-currency status and the changing role of government bonds in the global financial system. An important question for future research is which investors drive the time variation in *convenience yields*, that is, which agents are willing to pay a changing premium over time to hold those bonds. Moreover, if the *convenience* premium on sovereign debt is no longer stable, then one of the key pillars of advanced-economy public finance may be more fragile than recent models suggest.

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Appendix

A. Data Sources and Construction

In this section, I provide a full description of the data collection and the series used in the analysis of the paper.

A.1. Yields

Historical Low-frequency Decomposition. I use the Global Macro Database, from Müller et al. (2025), to collect annual data on short (S) and long (L) term nominal interest rates, denoted $Y_{k,t}^{(S)}$ and $Y_{k,t}^{(L)}$ respectively, for the 20 advanced economies over the past 175 years.

Modern High-frequency Decomposition. I collect daily data on government bond yields at different maturities for the period 1970–2025. The database contains data on 20 **developed economies**: Australia (AUS), Canada (CAN), Switzerland (CHE), Denmark (DNK), United Kingdom (GBR), Japan (JPN), Norway (NOR), New Zealand (NZL), Sweden (SWE), United States of America (USA) and the Euro Area (Austria (AUT), Belgium (BEL), Germany (DEU), Spain (ESP), Finland (FIN), France (FRA), Ireland (IRL), Italy (ITA), Netherlands (NLD) and Portugal (PRT)). I collect yields data from January 1970 to December 2025 from Refinitiv Eikon Datastream, Bloomberg, Organisation for Economic Co-operation and Development (OECD), International Monetary Fund (IMF), World Bank (WB) and national statistics for the below countries and maturities. I build daily bond yield series for each country at different maturities according to the following procedure. I collect data for: 3, 6 months, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 years. When daily data are not available on Datastream, I use the series in central bank databases (at the daily level) and from Bloomberg. If data are not available on these three databases, as an alternative source, I replace them with the daily values from the OECD, IMF, and WB databases and, as a last resort, the monthly observations by the same sources. Yields of the following maturities and countries are available with heterogeneous time-period length. Data availability for different maturities is also heterogeneous across and within countries. I plot the country yields for 3 months and 1, 3, 5, 7, 10 years in Figure A.1.

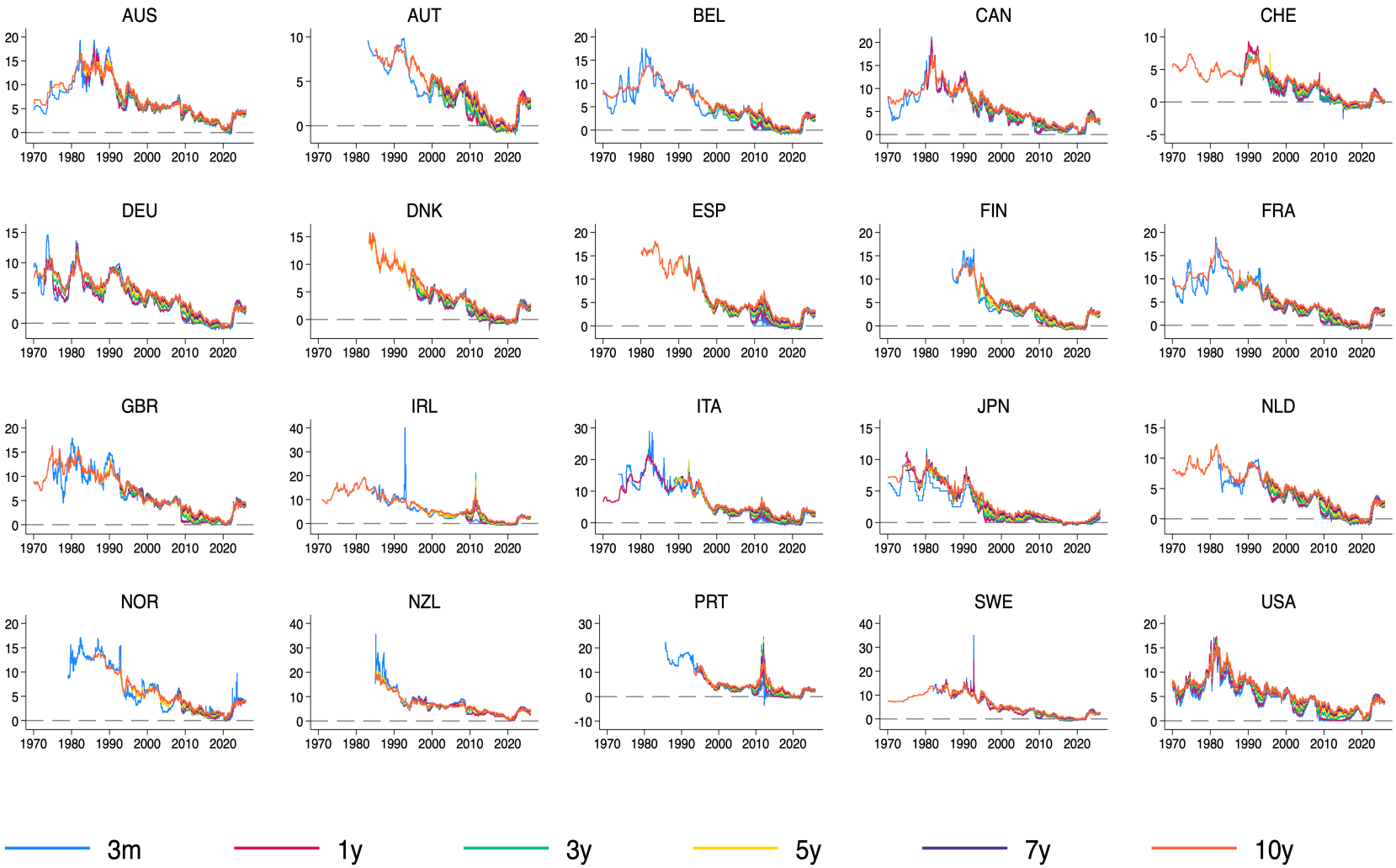


Figure A.1: Country government bond yields at selected maturities

The figure plots country government bond yields for the 20 advanced economies at 3 months and 1, 3, 5, 7, and 10 years. Appendix A.1 provides measurement details and sources.

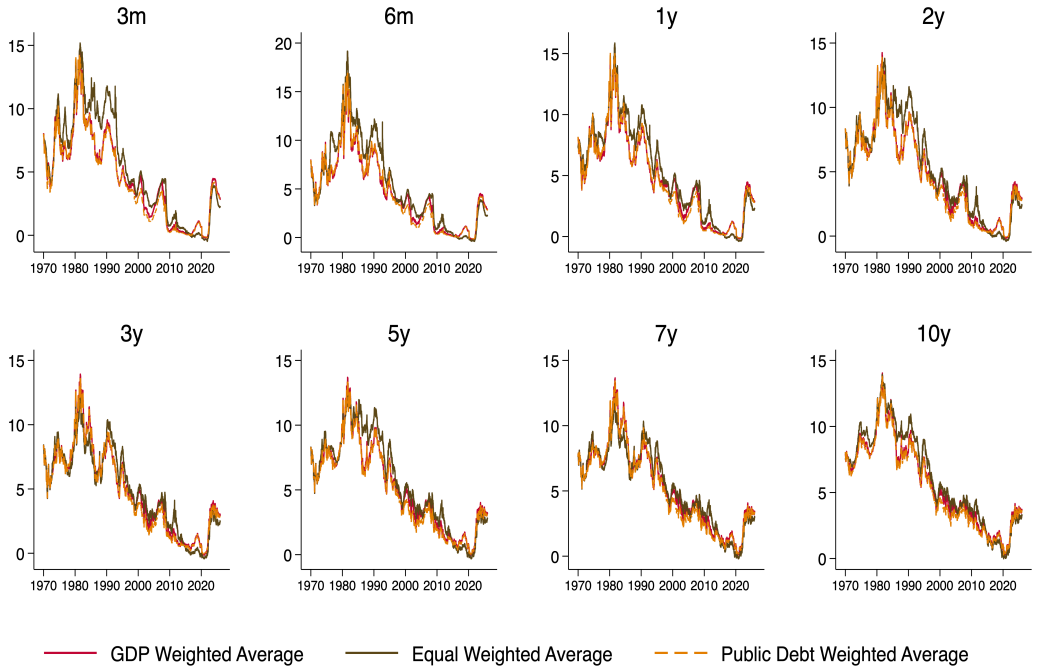
Global Government Bond Yields. I construct three proxies series for daily *Global Government Bond Yields* at different Maturities, *using only the data on the 20 advanced economies*. For each maturity, I follow three approaches: GDP weighted Average, Public Government Debt weighted average and Equal weighted Average. Data for GDP and debt are described in Appendix A.2. Figure A.2a show the three series over time, for different maturities. I keep only the 3,6 Months and 1, 2, 3, 5, 7, 10 Years maturities because they are available for most of the countries going back in time. I use the series from the first Proxy (GDP weighted Average) to construct the *Global Factors* [$\mathbf{X}_{G,t}$: Government Bonds Level, Slope (and Curvature)]. In my view, this methodology is more appropriate, as it considers the influences of individual countries' dynamics on the global component in relation to their participation in the global economy, and it is used for the rest of the analysis.[33]

Level, Slope and Curvature of Global Government Bond Yields. As in Piazzesi (2010), I apply the Principal Components Analysis (PCA) on the (GDP weighted Average) Yields to estimate the Global Level, Slope and Curvature. I use $K = 8$ maturities (3,6 Months and 1, 2, 3, 5, 7, 10 Years) for the period January 1970 to December 2025. I interpret the first component as the **Level factor**, the second as **Slope factor** and the third as **Curvature factor**. I plot the Level, Slope and Curvature of World Government Bond Yields over time in Figure A.2b. A full description of the PCA Analysis is reported in Appendix A.6.

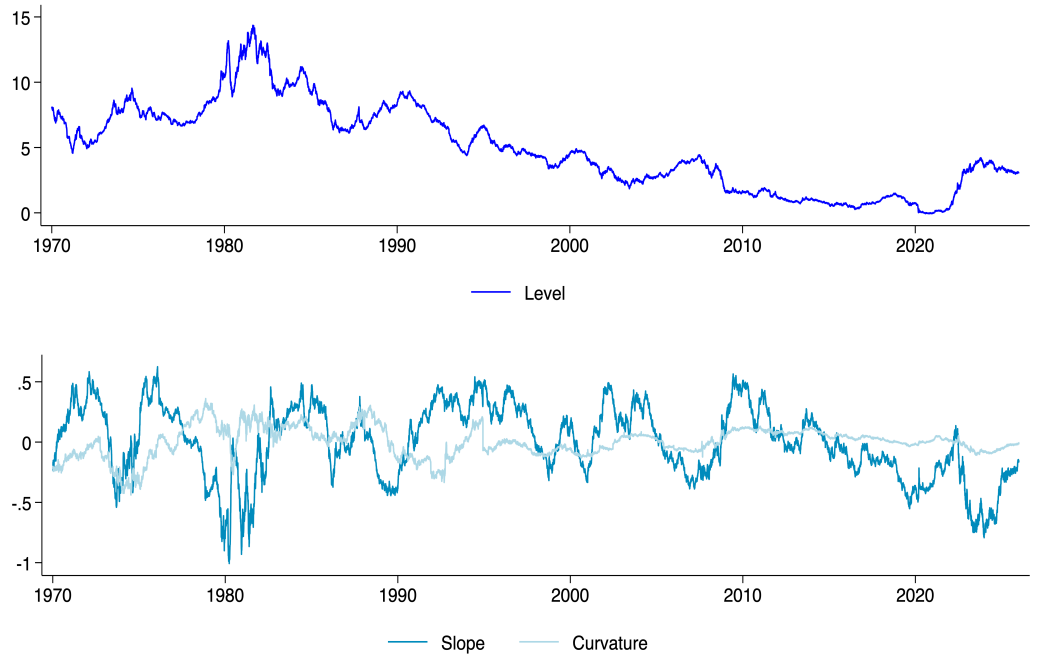
A.2. Gross domestic product and public debt

I use Refinitiv Eikon (including Datastream) to retrieve GDP (current US$) collected by World Bank. I calculate the GDP of the Euro Area as the aggregate sum of the GDPs of all Euro Area member states present in the dataset. Furthermore, I compute the share of the Global GDP for each country as the ratio of the Country GDP over the sum of the GDPs of all countries present in the dataset. I then present the series, with Euro Area countries treated as a single entity, in Figure A.3a. In Figure A.3b, I display the contribution to Euro Area GDP series for each Euro Area country individually over time. For the Public Debt, I use the Public Debt over GDP series from IMF and multiply the ratio for the GDP (current US$) series to obtain the Public Debt (current US$) series.

[33]Gross Domestic Product (GDP) has been utilized as a proxy for assessing the impact of individual countries on the global component; however, the alternative proxy using Government Public Debt is highly correlated (99%) and produces almost identical (untabulated) results. The proxy that use a simple weighted average of the yields show pronounced deviations from the other two, suggesting that it gives relevance to yields fluctuations in the small economies. Using this proxy would overestimate the influences of individual countries' dynamics on the global component, independently of their participation in the international economy.



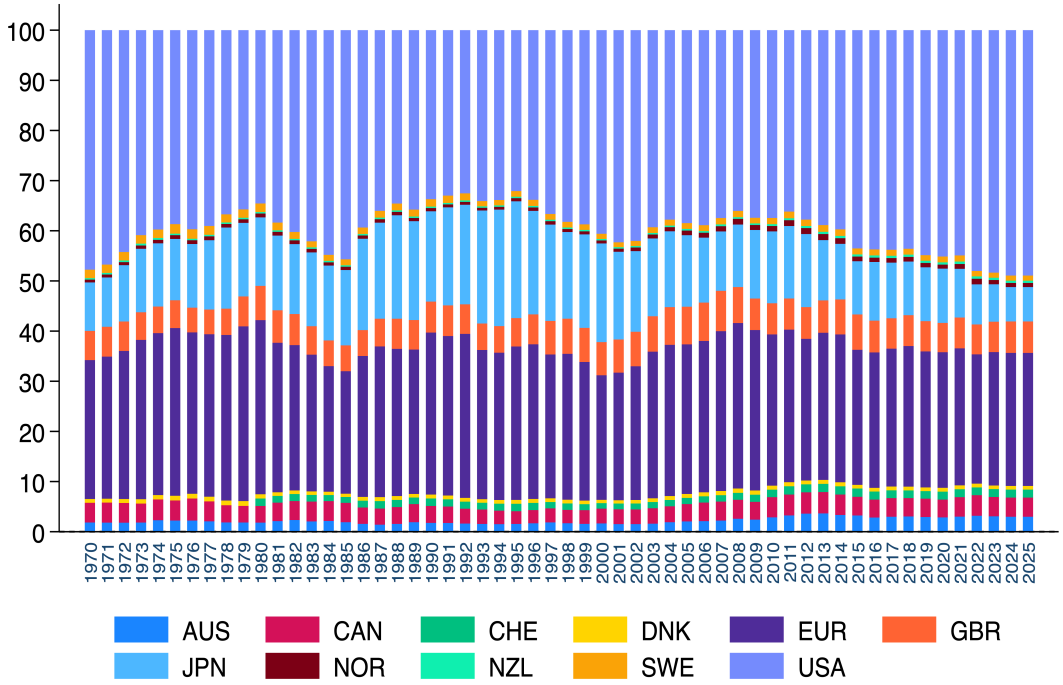
(a) Alternative proxies for the global bond yield curve



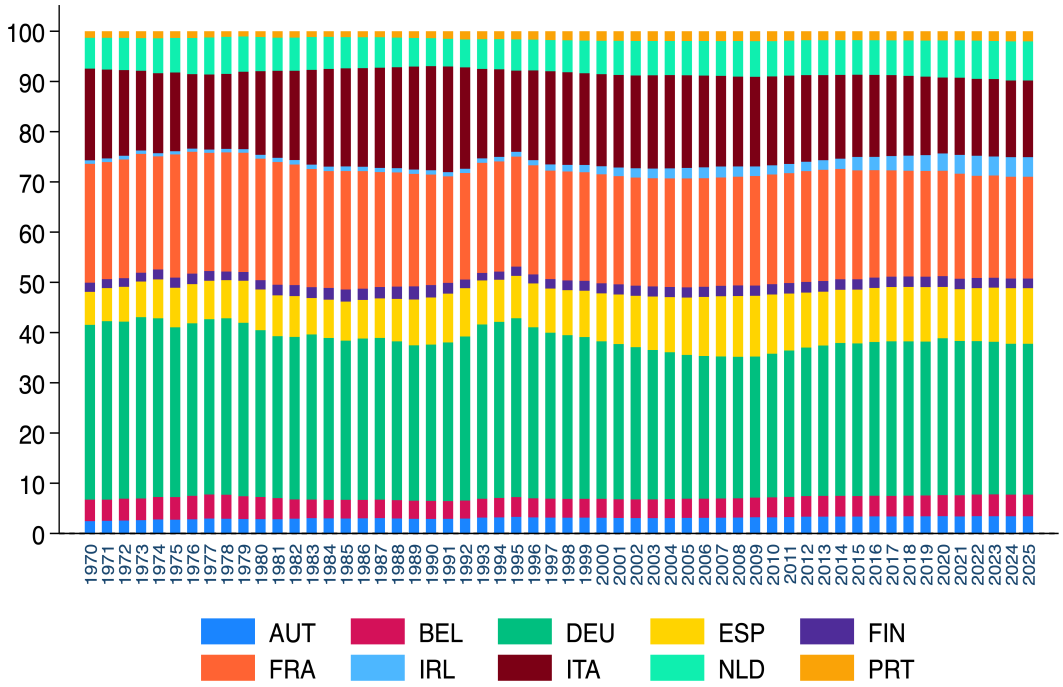
(b) Global level, slope, and curvature factors

Figure A.2: Global government bond yields

Panel (a) plots three alternative constructions of the global government bond yield curve based on GDP weights, public-debt weights, and equal weights. Panel (b) reports the corresponding global level, slope, and curvature factors extracted from the GDP-weighted yield curve using principal components analysis. Appendix A.1 provides measurement details and sources.



(a) Share of global GDP



(b) Share of euro-area GDP

Figure A.3: Country contribution to global GDP

Panel (a) shows the GDP shares of the countries included in the global sample, with euro-area members aggregated into a single area. Panel (b) reports the composition of euro-area GDP by member country over time. Appendix A.2 provides measurement details and sources.

A.3. Long-run global inflation

To measure inflation, I employ a recent database published by the World Bank (Ha, Kose and Ohnsorge (2023)) which collect monthly year-on-year CPI inflation for the advanced economies. I use the monthly series for the "Official Core Consumer Price Index" (CCPI). I extended the series for 2024 and 2025 monthly data using OECD series on Consumer Price Index. Furthermore, I construct GDP weighted average series for Global (20 advanced economies) and Euro-Area Inflation. For the long-run inflation trend, the prevailing consensus in empirical macroeconomics models inflation as an $I(1)$ process. This assumption would produce accurate forecasts and correctly capture the evolution of inflation expectations, as shown in Stock and Watson (2007). From a macroeconomic perspective, the resulting time-varying π_t^* can be viewed as the perceived inflation target of the central bank. Empirical proxies for trend inflation have been constructed from surveys, statistical models, or a combination of the two (see, for example, Stock and Watson (2016) and the references therein).

I use the inflation expectations term π_t^* in the Cieslak and Povala (2015), which measure:

$$\pi_t^* = (1 - v) \sum_{i=0}^{t-1} v^i \pi_{t-i}$$

where π_t is year-on-year CPI inflation, with the year-over-year inflation in month t computed as: $\pi_t = \ln(CPI_t/CPI_{t-1})$. I set the parameter $v = 0.98$, as in Cieslak and Povala (2015). In Figure A.4, I plot the 20 advanced economies inflation series and the relative proxies for country and global trend inflation. I interpolate the monthly series to daily frequency using a last-observation-carried-forward approach. It is noteworthy that, although with different levels, countries have similar dynamics over the sample period. There are big fluctuations around the 1970-1990 period, with a strong decline for all the countries after 1990 and stable low values after the GFC.

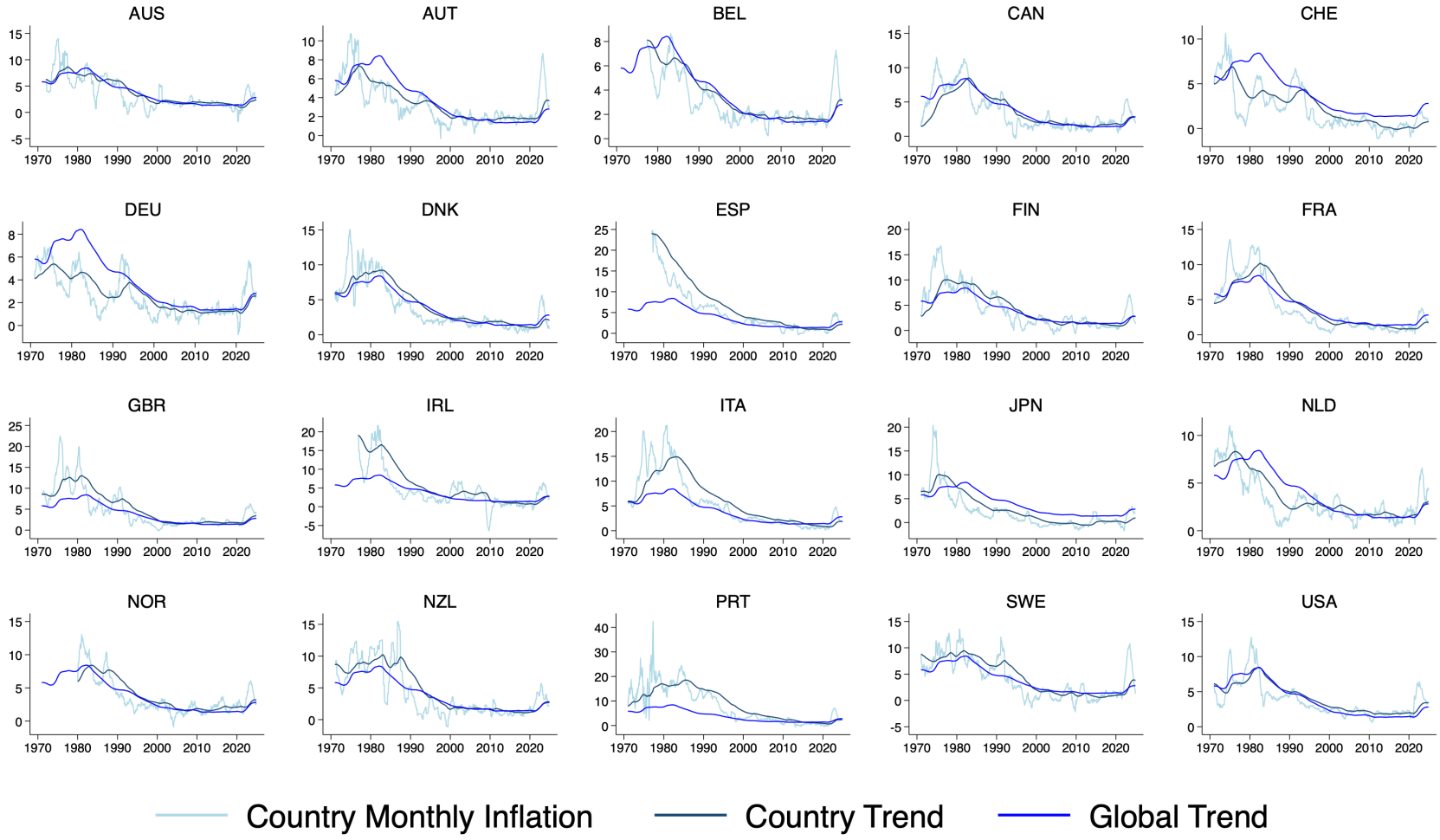


Figure A.4: Monthly inflation and long-run country and global inflation trends

The figure plots monthly core inflation together with the corresponding trend-inflation measures for the countries in the sample and for the global aggregate. Appendix A.3 provides measurement details and sources.

A.4. Real natural rates

As a proxy for the real natural rate r_t^*, literature provides a variety of estimates; see Kiley (2020) for a review of the literature. Depending on the model proposed, it can contain a convenience yield trend, as in (Del Negro et al., 2017, 2019). Some models extract long-run real rate trends from time series models identified with Bayesian methods, while others are based on simple New Keynesian macro models and use the Kalman filter to infer the neutral real interest rate.[34] I employ, as also suggested by Bauer and Rudebusch (2020), a model-free estimate of $r_{k,t}^*$. I use Data on Risk-Free Rate Proxies for Australia, Canada, Switzerland, Denmark, United Kingdom, Japan, Norway, New Zealand, Sweden, United States of America and the Euro Area. The three commonly used series for the 3 Months *Nominal* risk-free rate ($i_{k,t}^{3m}$) are: IBOR rates, Government Bond Yields, Overnight Index Swap (OIS) and the Central Bank Policy Rates.[35] When available, before 2008, I use these rates following the priority: IBOR, Government Bond, OIS, Policy Rate. After 2008, I prioritize OIS and Government Bond, due to the credit risk embedded in the IBOR rates and the gradual switch to OIS as benchmark risk-free rate proxies. I subtract Long-Run inflation to obtain real rates:

$$r_{k,t} = i_{k,t}^{3m} - \pi_{k,t}^*$$

Following Cieslak and Povala (2015) approach and as suggested by Bauer and Rudebusch (2020), I compute a simple model-free estimate of $r_{k,t}^*$, which is an EWA of past real rates:[36]

$$r_{k,t}^* = (1-v)\sum_{i=0}^{t-1} v^i r_{k,t}$$

Results for each country, the euro area and global (WRD) natural rates proxies are presented in Figure A.5.[37] Similarly to inflation, I notice that, although with different levels, countries have similar dynamics over the sample period. There are big fluctuations around the 1970-1990 period, with a strong decline for all the countries after 1990 and stable low (and mostly negative) values after the GFC.

[34] For the first category, Del Negro et al. (2017) estimates a linear state space model with common trends. For the second category, they estimate the level of the real rate consistent with real output at potential and inflation at target. Some examples are Laubach and Williams (2003) and Holston, Laubach and Williams (2017).

[35] IBOR rates are imperfect benchmarks due to their indicative and unsecured nature while Government Bonds could have additional benefits that make their value lower. Overnight Index Swap are indexed to (Overnight) unsecured rate, involving little credit, while policy rate can be driven by monetary policy necessity and deviate from risk-free rate values.

[36] I set the v parameters at $v = 0.999$, which is the daily version of the monthly parameter (0.98)

[37] The global and euro area natural rate are computed as EWA of GDP-weighted past real rates.

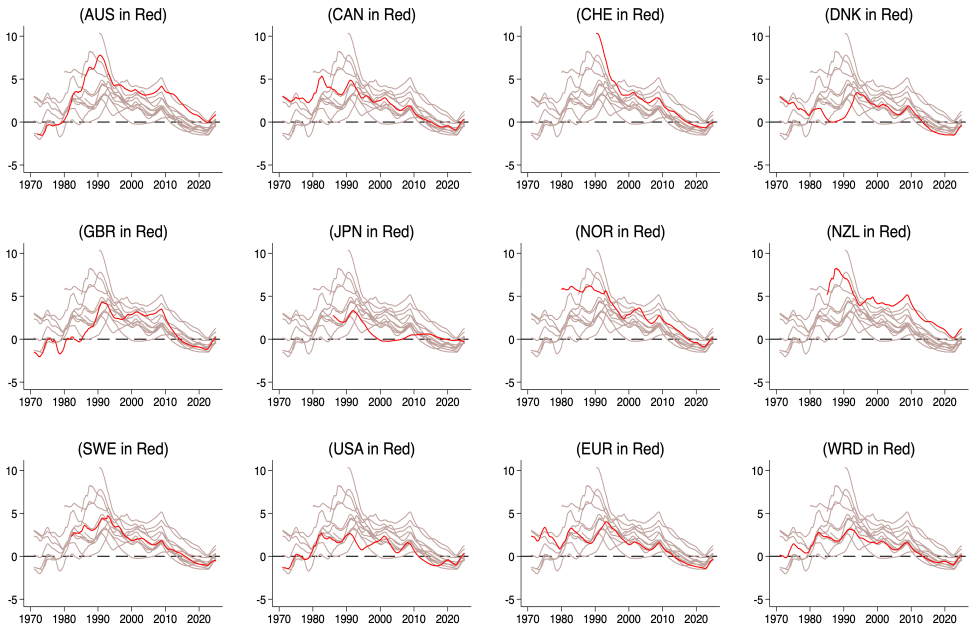


Figure A.5: Global natural rates over time

The figure reports the model-free estimates of country and global real natural rates constructed from smoothed real short rates. Appendix A.4 provides measurement details and sources.

A.5. Global macro trends

The Fisher equation suggests that the trend or equilibrium nominal short rate, i_t^*, is equal to:

$$i_t^* = \pi_t^* + r_t^*$$

where r_t^* is the real natural rate, π_t^* is the long-run inflation. As in Bauer and Rudebusch (2020), the *"star"* in rates represents the long run trends. If inflation or the real interest rate contain long-run trend components, then nominal interest rates will also be driven by these same macroeconomic trends. The country nominal short rate, $i_{k,t}^*$, is equal to:

$$i_{k,t}^* = \pi_{k,t}^* + r_{k,t}^*$$

where $r_{k,t}^*$ is the real natural rate and $\pi_{k,t}^*$ is the long-run inflation described in the previous sections. The corresponding global nominal short rate is equal to:

$$i_{G,t}^* = \pi_{G,t}^* + r_{G,t}^*$$

The series for country nominal short rate ($i_{k,t}^*$) and global nominal short rate ($i_{G,t}^*$) are plotted in Figure 4.

A.6. Level, slope and curvature of world government bond yields

According to Piazzesi (2010), traditional factor analysis already delivers much of the intuition for what drives yields. Principal components can be computed from levels and changes in yields. For this analysis, I use yields in level. I apply the same methodology in Piazzesi (2010) to estimate Level, Slope and Curvature of World Government Bond Yields. I use $K = 8$ maturities (3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y) computed using GDP-weighted global yields for the January 1970 to December 2025 period. Data used in the PCA are described in Appendix A.1 and are plotted in Figure A.2a. I compute the cumulative percentage in the variation of yields explained by the first k principal components. Results are presented in Table A.1.

Table A.1: PCA results for global government bond yields

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	7.878	7.789	0.985	0.985
Comp2	0.089	0.074	0.011	0.996
Comp3	0.014	0.004	0.002	0.998
Comp4	0.010	0.006	0.001	0.999
Comp5	0.004	0.002	0.001	0.999
Comp6	0.002	0.002	0.000	1.000
Comp7	0.001	0.001	0.000	1.000
Comp8	0.000	.	0.000	1.000

The table reports the eigenvalues and explained-variance shares from the principal components analysis of the GDP-weighted global yield curve. Appendix A.6 provides measurement details and sources.

The table shows that the first $k = 3$ principal components already explain over 99.8% of the total variation. These numbers are in line with those for the U.S. in Piazzesi (2010). After extracting the principal components of the yield curve, I normalize them to obtain economically interpretable *level* and *slope* factors. For the level factor, I first compute the cross-maturity average yield $\left(M_t = \frac{1}{8}\sum_{n\in\{3m,6m,1y,2y,3y,5y,7y,10y\}} Y_t^{(n)}\right)$ and then rescale the first principal component so that it matches the sample mean $(\bar{M})$ and standard deviation (σ_M) of $\left[M_t : \widetilde{PC}_{1,t} = \bar{M} + \frac{\sigma_M}{\sigma_{PC_1}}\left(PC_{1,t} - \bar{PC}_1\right)\right]$. This transformation preserves the information in the first principal component while expressing it in the same units as the average yield curve. For the slope factor, I normalize the sign of the second principal component so

that positive values correspond to a steepening of the term structure.[38] Figure A.6 plots the coefficients of the first $k = 3$ principal components (or loadings) as function of the maturity of the World Government Bond Yields (in months). This figure looks very similar to the loadings of principal components of yield in Piazzesi (2010). The interpretation of these principal components in terms of level, slope, and curvature goes back to Litterman and Scheinkman (1991). The loadings of the first principal component are horizontal. This pattern means that changes in the first principal component correspond to parallel shifts in the yield curve. This principal component is therefore called the **Level factor**. The loading of the second principal component is upward sloping. Changes in the second principal component thus rotate the yield curve. This means the second component is a **Slope factor**. The loading of the third principal component is hump shaped. The hump occurs at intermediate maturities. The third principal component therefore affects the curvature of the yield curve, which is why it is called the **Curvature factor**.

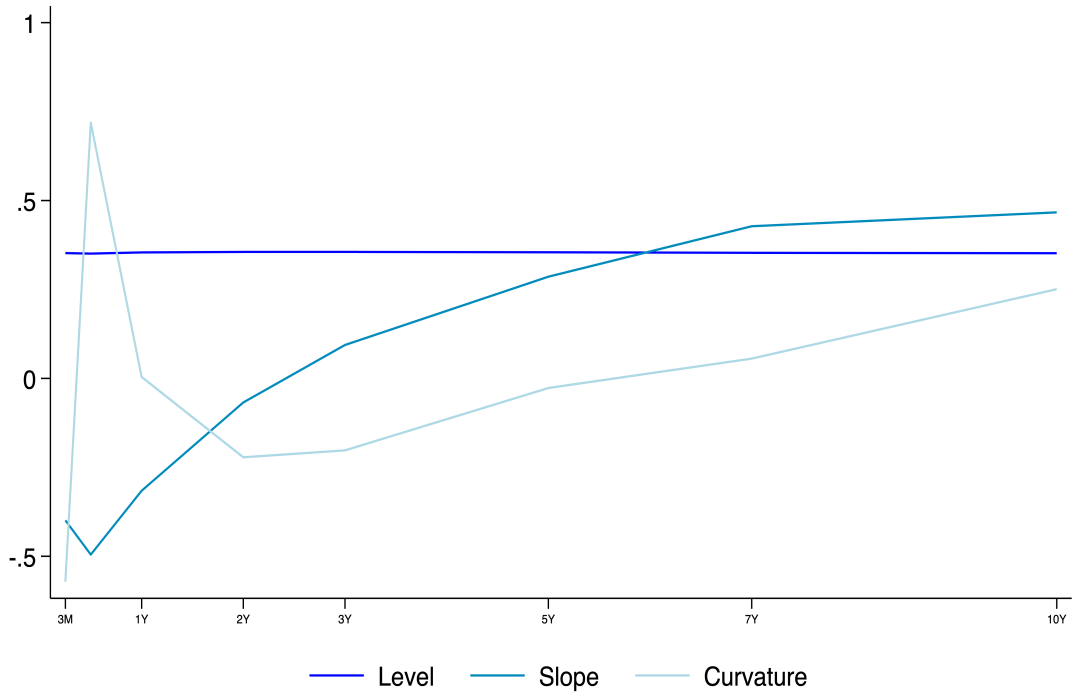


Figure A.6: PCA loadings for the global yield curve

The figure plots the loadings of the first three principal components of the GDP-weighted global yield curve across maturities. Appendix A.6 provides measurement details and sources.

[38] Since principal components are identified only up to sign, the raw second component may have the opposite interpretation depending on the sample. I therefore choose its sign using the estimated eigenvector loadings, and multiply the factor by -1 whenever necessary. This normalization does not affect the statistical content of the PCA, but ensures that the second factor has a consistent economic interpretation as the slope of the yield curve.

A.7. Model macro trends and cycle components construction

The model described in Section 2.1 assumes that, for each country, the state variables are N linear combinations of yields in the vector $X_{k,t}$, that can be decomposed into their global and country-specific components:

$$\mathbf{X}_{k,t} = \underbrace{[\theta_k \overline{\mathbf{X}} + \overline{x}_k]}_{Constant} + \underbrace{[\theta_k \gamma \tau_t + \gamma_k \tau_{k,t}]}_{Macro\ Trends} + \underbrace{[\theta_k \tilde{\mathbf{X}}_t + \tilde{x}_{k,t}]}_{Cyclical\ Component}$$

Macro Trends. Following Davis, Fuenzalida, Huetsch, Mills and Taylor (2024), I estimate country and global proxies for long-run rate, from Appendix A.5, and use them to construct:

- Global (Macro) Trend ($\tau_t = i^*_{G,t}$)
- Country (Macro) Trend (deviations) as ($\tau_{k,t} = i^*_{k,t} - \alpha_k - \beta_k i^*_{G,t}$)

The series for country nominal short rate ($i^*_{k,t}$) and global nominal short rate ($i^*_{G,t}$) are plotted in Figure 4. Figure A.7 shows the Country (Macro) Trend (deviations) dynamics.

Global Cycles. Global Cycles $\tilde{\mathbf{X}}_t$ are estimated as the residuals of the regression:

$$\mathbf{X}_{G,t} = \overline{\mathbf{X}} + \gamma \tau_t + \tilde{\mathbf{X}}_t$$

where $\mathbf{X}_{G,t}$ are the Global Level and Slope, from Appendix A.6, and τ_t is the Global Equilibrium Nominal Rate computed before. Figure A.8 plots their dynamics over time.

Country Cycles. The country cycle component is estimated as a residual of the regression of the country yields at maturity n on the global and country macro trends and the global cycles:

$$\underbrace{[\tilde{x}_{k,t}]}_{Country\ Cycle} = Y^{(n)}_{k,t}/\mathbf{B}^{(n)}_k - \mathbf{A}^{(n)}_k/\mathbf{B}^{(n)}_k - \underbrace{[\theta_k \gamma \tau_t]}_{Global\ Trend} - \underbrace{[\theta_k \tilde{\mathbf{X}}_t]}_{Global\ Cycle} - \underbrace{[\gamma_k \tau_{k,t}]}_{Country\ Trend}$$

Overall, global macro-trend components become increasingly synchronized over time, with cross-country dispersion narrowing markedly from the 1990s onward. By contrast, cyclical yield components remain transitory and more volatile, showing episodic spikes around major stress events. Residual heterogeneity is especially pronounced at long maturities after the Global Financial Crisis, consistent with a partial re-emergence of country-specific forces in sovereign bond markets.

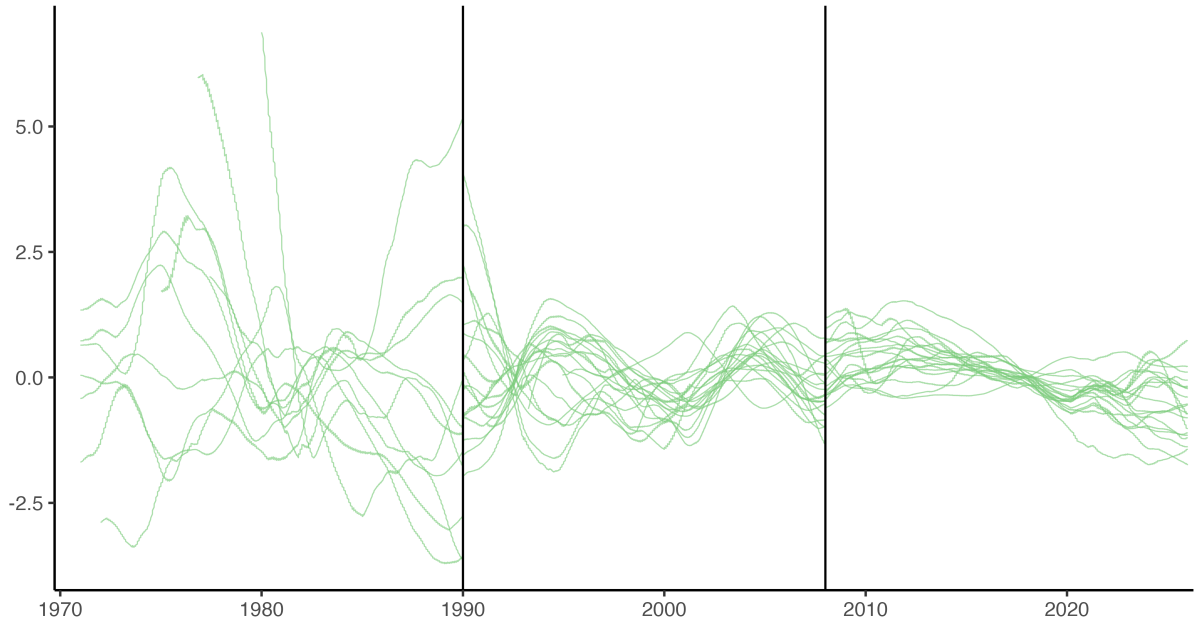


Figure A.7: Country macro-trend deviations over time

The figure plots the country-specific macro-trend deviations from the global equilibrium nominal rate. Appendix A.7 provides measurement details and sources.

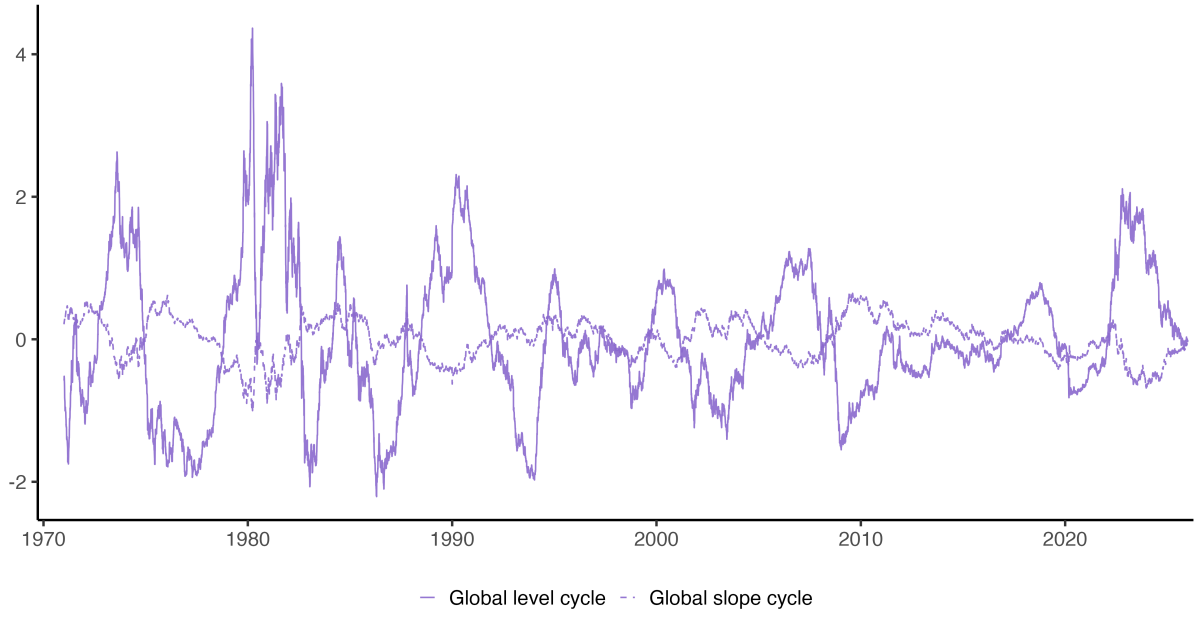
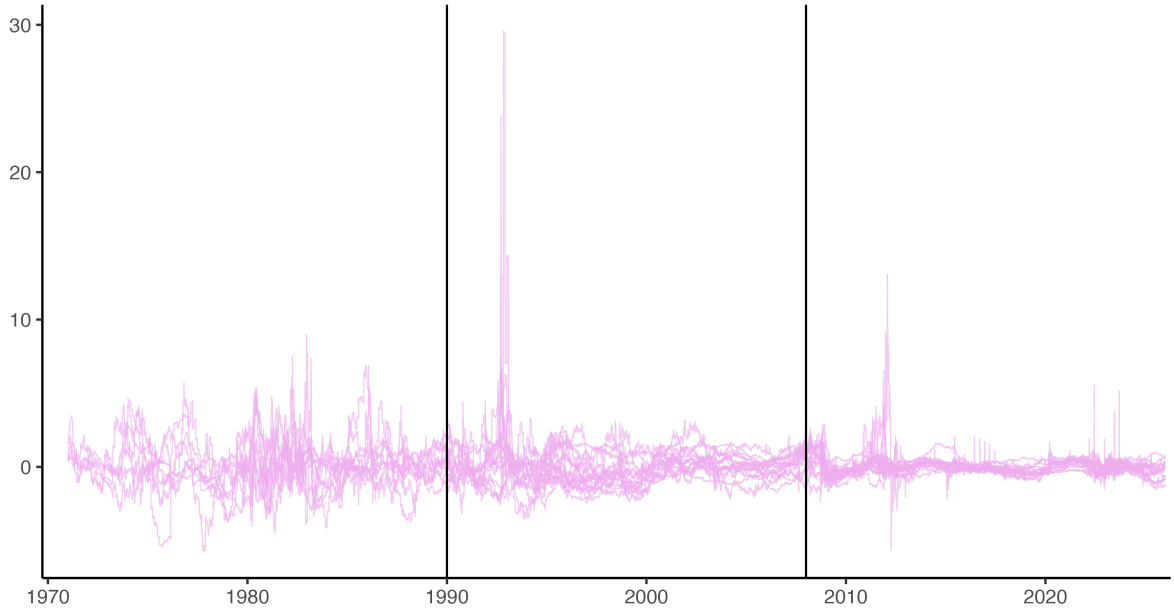
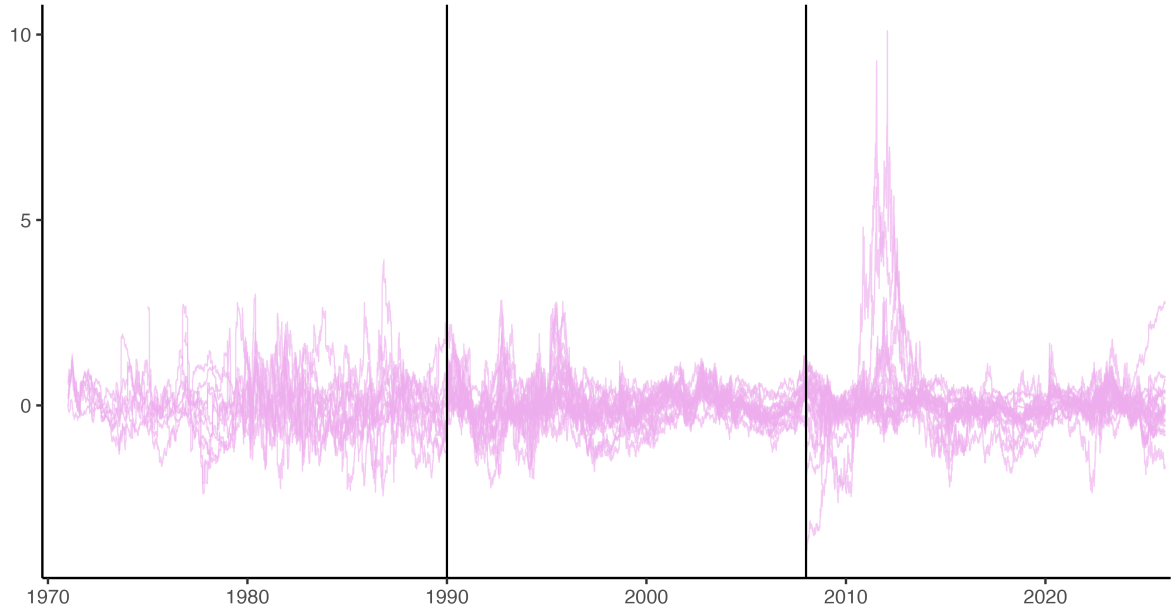


Figure A.8: Global cyclical level and slope components over time

The figure plots the estimated global cyclical components of the level and slope factors after removing the global macro trend. Appendix A.7 provides measurement details and sources.



(a) Short-term rates (3 Months)



(b) Long-term rates (10 years)

Figure A.9: Country cyclical components of sovereign yields

The figure plots the estimated country-specific cyclical components of sovereign yields at short and long maturities. Appendix A.7 provides measurement details and sources.

A.8. Volatility and uncertainty data

To capture the role of uncertainty and volatility in global yield dynamics in Section 2.4, I assemble a set of proxies that span different frequencies, asset classes, and macroeconomic aggregates. These series are used as controls in the augmented regressions of equation (10) and serve to distinguish the explanatory power of standard uncertainty measures from that of global credit risk.

Economic Policy Uncertainty. As a broad measure of policy-related uncertainty, I use the U.S. Economic Policy Uncertainty (EPU) index of Baker et al. (2016), available at daily frequency.[39]

Market volatility. I construct two daily measures of global equity market volatility. The first, *G20 Mkt GARCH*, is the conditional variance from a GARCH(1,1) model estimated on GDP-weighted G20 market log-returns, $r_{G,t} = \sum_{k=1}^{K} w_k \ln(P_{k,t}/P_{k,t-1}) = \ln(P_{G,t}/P_{G,t-1})$. Specifically, I estimate:

$$r_{G,t} = \mu + \varepsilon_t, \qquad \varepsilon_t \mid \mathcal{F}_{t-1} \sim \mathcal{N}(0, \sigma_t^2), \qquad \sigma_t^2 = \omega + \alpha\, \varepsilon_{t-1}^2 + \beta\, \sigma_{t-1}^2$$

and use the fitted conditional standard deviation σ_t as the volatility proxy. The second, *G20 Mkt 30d Vol*, is a non-parametric alternative computed as the rolling 30-day standard deviation of GDP-weighted G20 market daily log-returns. As an additional monthly measure, I use the Expected Market Volatility (EMV) index of Baker et al. (2016), which is based on the frequency of newspaper articles discussing stock market volatility.

Macroeconomic volatility. To capture volatility in macroeconomic fundamentals, I estimate GARCH models on quarterly inflation and consumption growth. For each of the 20 advanced economies k, I fit an AR(1)-GARCH(1,1) specification:

$$x_{k,t} = \phi_0 + \phi_1\, x_{k,t-1} + u_{k,t}, \qquad u_{k,t} \mid \mathcal{F}_{t-1} \sim \mathcal{N}(0, h_{k,t}^2), \qquad h_{k,t}^2 = \omega_k + \alpha_k\, u_{k,t-1}^2 + \beta_k\, h_{k,t-1}^2$$

where $x_{k,t}$ is, in turn, quarterly GDP-weighted global CPI inflation or real consumption growth.[40] The resulting conditional volatilities, *Inflation GARCH* and *Consumption GARCH*,

[39] The EPU index is constructed from newspaper coverage of policy-related economic uncertainty and it is the most widely used text-based uncertainty proxy in the macro-finance literature.

[40] The AR(1) component removes predictable variation, so that the GARCH filter captures time-varying uncertainty in the unpredictable component of each series.

are interpolated to daily frequency using a last-observation-carried-forward approach to align with the other proxies used in Section 2.4.

A.9. CDS daily data

Using Refinitiv Eikon, I collect data on the Country Term-Structure of Credit Default Swaps (CDS) ($CDS_k^{(n)}$), for 6 months and 1,3,5,7,10 years maturity. I then construct the Global Term-Structure of CDS: ($CDS_G^{(n)}$) at daily level for 6 months and 1,3,5,7,10 years maturity. I compute the Global Level and Slope of Term-Structure of Global CDS: CDS_{level}, CDS_{slope}. I describe and plot them in Appendix A.12. I collect CDS data denominated in both U.S. dollars and euros. In the main analysis (Section 3), I use USD CDS; robustness results using EUR CDS are reported in Appendix B.6 and B.7.

A.10. Overnight index swap (OIS) data

Following Jiang et al. (2025), I proxy the nominal *risk-free* rate with Overnight Index Swap (OIS) rates, under the assumption that the OIS zero rate $OIS_{k,t}^{(n)}$ provides a good measure of the benchmark nominal *risk-free* rate for country k and does not embed a convenience yield. Using Refinitiv Eikon, I collect the Country Term-Structure of Overnight Index Swap (OIS) ($OIS_{k,t}^{(n)}$) for 6 months and 1,3,5,7,10 years maturity. For euro-area countries, I follow Jiang et al. (2025) and use a common EUR OIS curve. I then construct the corresponding global OIS term structure, $OIS_{G,t}^{(n)}$, as the GDP-weighted average of country OIS series at the daily frequency. I compute the Global Level and Slope of Term-Structure of Global OIS: $OIS_{lev,t}$ and $OIS_{slo,t}$. I describe and plot them in Appendix A.12.

A.11. Convenience yields construction

Following Jiang et al. (2025), I define the convenience yield for country k and maturity n as the residual wedge between the sovereign bond yield, the *risk-free rate*, and the *default spread*:

$$\lambda_{k,t}^{(n)} = y_{k,t}^{(n)} - r_{k,t}^{(n)} - \delta_{k,t}^{(n)}$$

where $y_{k,t}^{(n)}$ is the sovereign bond yield, $r_{k,t}^{(n)}$ is the OIS rate (Section A.10), and $\delta_{k,t}^{(n)}$ is the CDS data (Section A.9), all at maturity n. I construct the country term structure of convenience yields, $\lambda_{k,t}^{(n)}$, at maturities of 6 months and 1, 3, 5, 7, and 10 years. I then form the corresponding global convenience-yield curve, $\lambda_{G,t}^{(n)}$, as the GDP-weighted average of country series at the daily frequency. I compute the Global Level and Slope of Term-Structure of Global Convenience Yields: $CY_{lev,t}$ and $CY_{slo,t}$. I describe and plot them in Appendix A.12.

A.12. Level, slope and curvature of global risk-free, credit risk and convenience yields

Following the same procedure described in Appendix A.6, I estimate the level and slope factors for the risk-free rate, credit risk, and convenience yields.[41] Figure A.10 plots the resulting global factors. The risk-free-rate factors display the familiar medium-run decline and subsequent normalization pattern. The credit-risk factors are much more volatile, with large spikes during the Global Financial Crisis and the European sovereign debt crisis. The convenience-yield factors are also highly persistent, but they exhibit richer cyclical variation than the risk-free factors, with a pronounced drop in the early part of the sample and a gradual recovery later on. Importantly, the USD- and EUR-based series move almost one-for-one, suggesting that the underlying factors are robust to the currency denomination of CDS contracts.

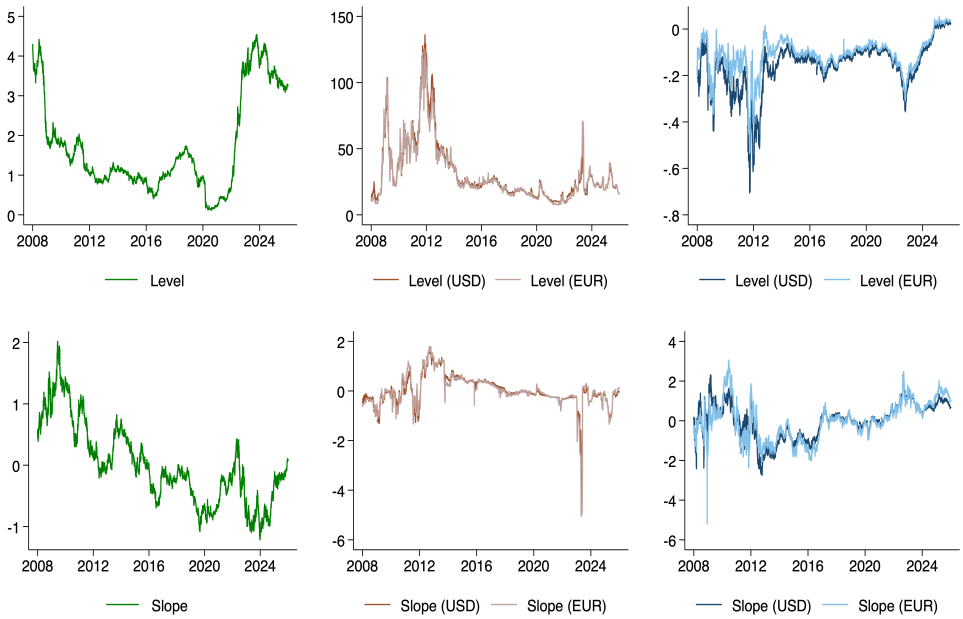


Figure A.10: Global level and slope factors for the risk-free rate, credit risk, and convenience yields
The figure reports global factors extracted from the GDP-weighted term structures of the risk-free rate, credit risk, and convenience yields over 2008-2025. The left column plots the global risk-free level and slope factors; the middle column plots the corresponding credit-risk factors using CDS data in USD and EUR; and the right column plots the convenience-yield factors constructed from the same two CDS-denomination measures. Appendix A.12 provides measurement details and sources.

[41] I use $K = 8$ maturities (3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, and 10Y) constructed from GDP-weighted series over the January 2008 to December 2025 period. Data used in the PCA are described in Appendices A.9, A.10, and A.11. After extracting the first two principal components, I normalize them to obtain economically interpretable *level* and *slope* factors as described in Appendix A.6. To avoid redundancy, I do not report the factor loadings, which are very similar to those obtained for the yield curve itself.

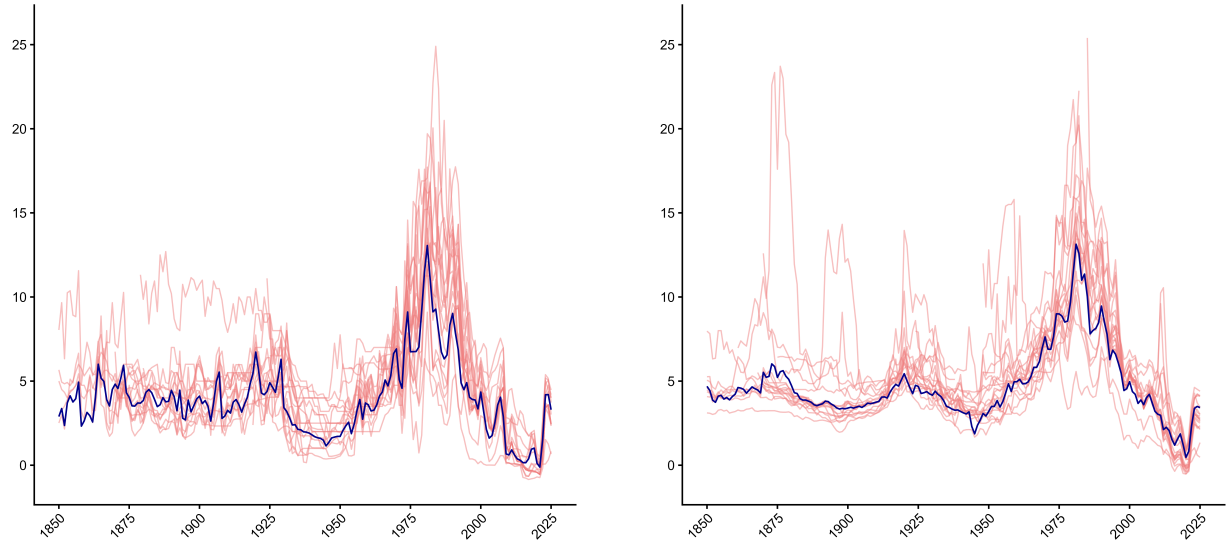
B. Additional empirical results

B.1. Historical Low-frequency global decomposition

I use the Global Macro Database, from Müller et al. (2025), to collect annual data on short-(S) and long-(L) term nominal interest rates, denoted $Y_{k,t}^{(S)}$ and $Y_{k,t}^{(L)}$ respectively, for the 20 advanced economies over the past 175 years. Following the approach in Dahlquist and Hasseltoft (2013), I construct the global rate factors as GDP-weighted cross-sectional averages of local yields:

$$Y_{G,t}^{(n)} = \sum_{k=1}^{K} w_{k,t}\, Y_{k,t}^{(n)} \qquad n \in \{S, L\} \tag{21}$$

where $w_{k,t} \equiv \text{GDP}_{k,t} \big/ (\sum_{k=1}^{K} \text{GDP}_{k,t})$ and $K = 20$. Figure B.11 plots the resulting global short and long rates together with their country-level counterparts. Figure B.11 highlights



(a) Short-term rates

(b) Long-term rates

Figure B.11: Global short and long term interest rates.

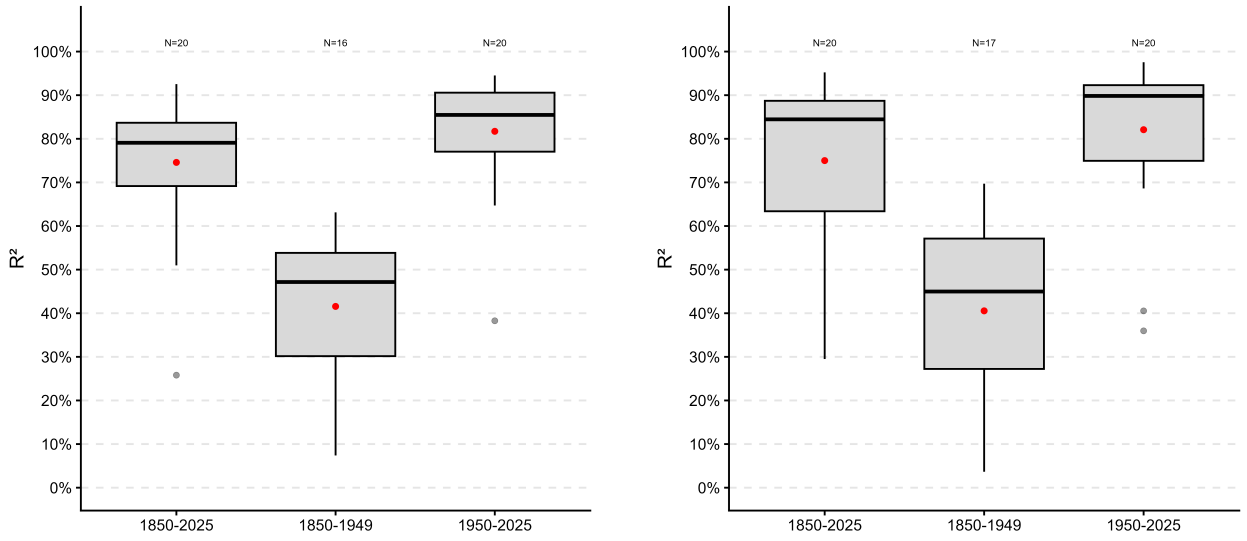
The figure plots short and long term interest rates for the 20 advanced economies. The country specific rates are in red, while the global rate is in blue. Appendix B.1 and A provide measurement details and sources.

pronounced common movements in interest rates alongside meaningful country-specific deviations. The global short rate fluctuates around roughly 4% until the end of World War II, rises sharply during the 1970s to nearly 15%, and then declines secularly from the early 1980s onward, eventually approaching the effective lower bound. Global long rates display smaller cyclical fluctuations but a similar broad pattern. Country-level yields tend to co-move with

the global series, yet large and persistent departures are common in the pre-World War II period, particularly at long maturities. To quantify the importance of global forces in domestic interest-rate fluctuations, I estimate for each country k and each maturity $n \in \{S, L\}$ the regression:

$$Y_{k,t}^{(n)} = \alpha_k + \beta_k^S Y_{G,t}^{(S)} + \beta_k^L Y_{G,t}^{(L)} + \varepsilon_{k,t} \tag{22}$$

where $Y_{k,t}^{(n)}$ denotes the country-specific short or long rate and $Y_{G,t}^{(S)}$ and $Y_{G,t}^{(L)}$ are the corresponding global factors.[42] The coefficients β_k^S and β_k^L measure each country's exposure to the global factors, while the R^2 summarizes the share of domestic rate variation accounted for by those factors. Table B.2 reports the country-level R^2, while Figure B.12 summarizes their cross-sectional distribution (mean, median, and interquartile range) in the full sample and in the pre- and post-1950 subsamples.



(a) Short-term rates

(b) Long-term rates

Figure B.12: Cross-sectional distribution of variance explained by global factors

The figure plots cross-sectional distribution [mean (red point), median (black horizontal line), and interquartile range] of the R^2 from equation (22) in the full sample and in the pre- and post-1950 subsamples. Appendix B.1 and A provide details on the construction of the series and the estimation procedure.

The results show that the global component is economically important, especially in the postwar period. In the full sample, the two-factor global block explains on average 74.6% of the variation in local short rates (median 79.1%) and 75.0% of the variation in local long

[42] The model proposed in Section 2.1 uses linear combinations of the global yields as global state variables. In the historical sample, we do not have the entire term structure of the Global Yields, but only the short and long maturity. Then, I use $Y_{G,t}^{(S)}$ and $Y_{G,t}^{(L)}$ directly in equation (22).

Table B.2: R^2 of regressions of country short and long rates on G20 factors

	Short			Long		
Country	(1850–2015)	(1850–1949)	(1950–2025)	(1850–2015)	(1850–1949)	(1950–2025)
AUS	0.774	0.540	0.773	0.844	0.496	0.861
AUT	0.757		0.874	0.889		0.889
BEL	0.854	0.317	0.945	0.887	0.138	0.968
CAN	0.919		0.915	0.952	0.678	0.976
CHE	0.510	0.527	0.650	0.471	0.651	0.686
DEU	0.585	0.254	0.725	0.650	0.129	0.744
DNK	0.836	0.333	0.878	0.878	0.313	0.916
ESP	0.791	0.448	0.831	0.482	0.450	0.927
FIN	0.717	0.203	0.809	0.394	0.037	0.405
FRA	0.882	0.409	0.945	0.868	0.272	0.919
GBR	0.838	0.600	0.903	0.846	0.226	0.922
IRL	0.925		0.935	0.909		0.908
ITA	0.828	0.074	0.893	0.809	0.330	0.873
JPN	0.258	0.155	0.383	0.295	0.571	0.360
NLD	0.829	0.623	0.870	0.879	0.489	0.910
NOR	0.811	0.495	0.839	0.815	0.503	0.829
PRT	0.703	0.631	0.762	0.585	0.283	0.751
NZL	0.651		0.647	0.727		0.697
SWE	0.791	0.538	0.840	0.918	0.697	0.941
USA	0.658	0.503	0.927	0.905	0.629	0.937

The table reports country-by-country fit from regressions of short and long nominal rates on the two global historical factors. Columns compare the full sample with the pre-1950 and post-1950 subsamples. Appendix B.1 and A provide measurement details and sources.

rates (median 84.5%). The strength of comovement increases sharply after 1950: the mean R^2 rises from 41.6% in 1850–1949 to 81.7% in 1950–2025 for short rates, and from 40.5% to 82.1% for long rates.[43] In the post-1950 sample, most countries exhibit very tight linkage to global factors ($R^2 \geq 80\%$ for 14 of 20 short-rate and long-rate series), whereas no country reaches 80% in the pre-1950 subsample. To summarize, historical low-frequency decompositions show that global forces account for a substantial share of cross-country rate fluctuations, particularly in the modern period. As emphasized by Stulz (2005), postwar liberalization transformed segmented national financial systems into increasingly integrated markets, with sharp growth in cross-border asset holdings and international securities transactions.In parallel, Davis et al. (2024) document stronger cross-country comovement in macro trends, with natural rates and inflation trend partly driven by a global component, while local forces remain more relevant at higher frequencies.[44] Together, these findings suggest that since World War II, government bond yields have become increasingly driven by global factors rather than purely country-specific shocks, even if market integration remains incomplete.

[43] Consistent with this shift, the cross-sectional interquartile range moves up markedly, from [0.301, 0.538] to [0.770, 0.906] for short rates and from [0.272, 0.571] to [0.749, 0.923] for long rates.

[44] The start of the modern sample also coincides with the 1951 Treasury-Federal Reserve Accord, which restored the Federal Reserve's monetary policy independence by ending its obligation to peg interest rates for fiscal financing purposes. This institutional shift marked an important step toward the modern global monetary regime, and the literature often links subsequent central banks independence and credibility to the stabilization of long-run inflation expectations around the world.

B.2. Modern global decomposition

To quantify the importance of global forces in domestic yields fluctuations in the modern sample, I estimate for each country k and each maturity n the regression:

$$Y_{k,t}^{(n)} = \alpha_k + \beta_k Y_{G,t} + \varepsilon_{k,t} = \alpha_k + \beta_k^L Level + \beta_k^S Slope + \varepsilon_{k,t} \tag{23}$$

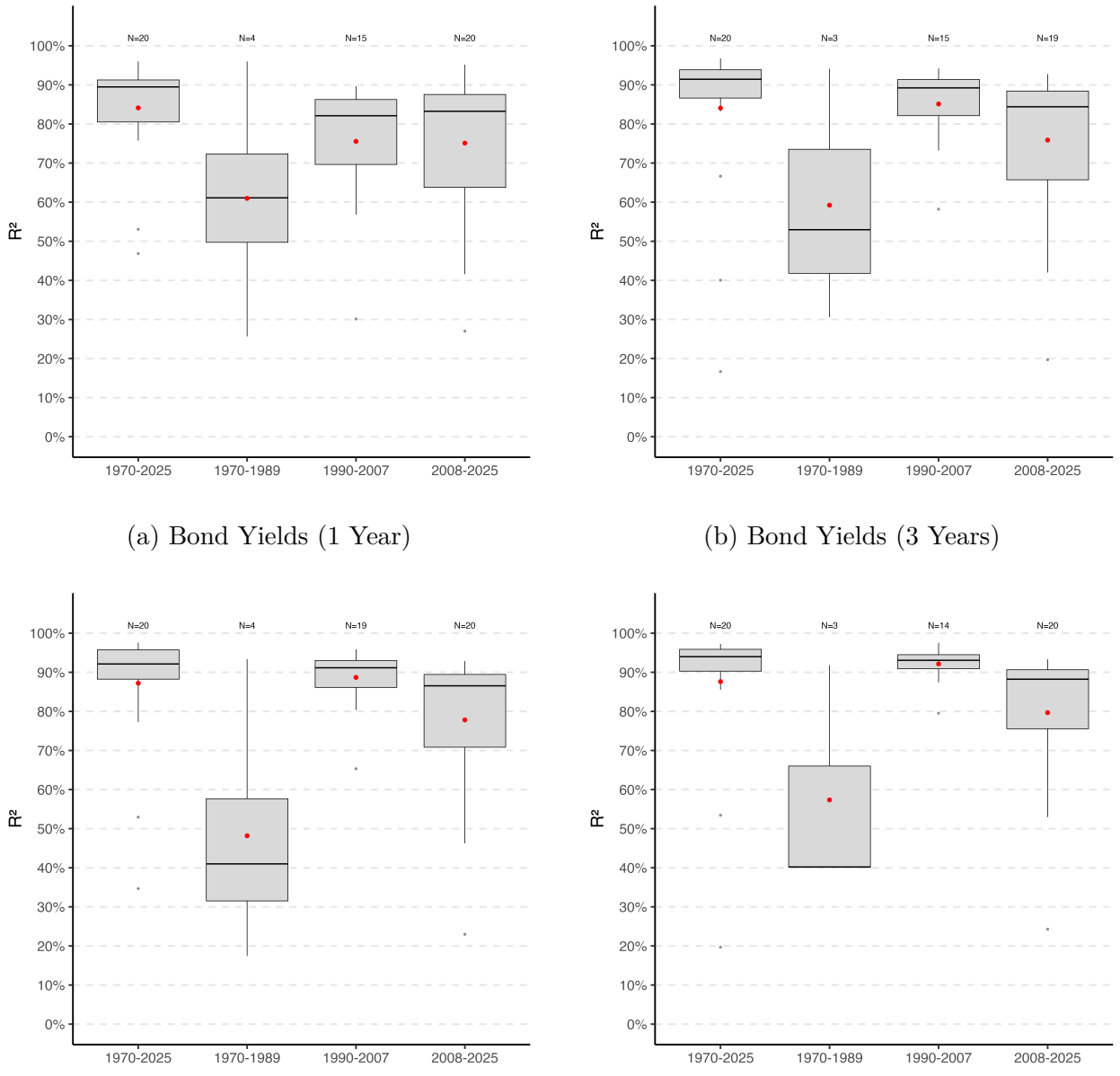
where $Y_{k,t}^{(n)}$ denotes the country-specific yield at maturity n and $Y_{G,t}$ is the vector with the global level and slope. The coefficients β_k measure each country's exposure to the global factors, while the R^2 provides a summary of the share of domestic yield variation accounted for by the global component. Table B.3 reports the country-level R^2 for short (3 months) and long (10 years) maturities. The results show that the global component is economically important in the modern sample, especially at long maturities. Over the full period 1970-2025, the global factors explain on average 83.9% of the variation in 3-month yields across countries (median 85.8%) and 88.6% of the variation in 10-year yields (median 91.5%). The subsample evidence points to substantial time variation in comovement. In 1970-1989, the global factors account for a markedly smaller share of domestic fluctuations, about 50.0% for 3-month yields and 55.4% for 10-year yields on average, while cross-sectional dispersion is wide. Comovement strengthens sharply in 1990-2007, when the global factors explain 75.0% of 3-month yield variation on average and 93.3% of 10-year yield variation; indeed, all countries with available data exhibit very tight long-rate linkage in this period ($R^2 \geq 80\%$ for 20 out of 20 long-rate series). After 2008, the explanatory power for short rates remains similar on average (75.8%), whereas long-rate comovement weakens somewhat (81.3%) and becomes more heterogeneous.

Table B.3: R^2 of regressions of country short and long rates on global factors

Country	Short (3 months)				Long (10 years)			
	(1970-2025)	(1970-1989)	(1990-2007)	(2008-2025)	(1970-2025)	(1970-1989)	(1990-2007)	(2008-2025)
AUS	0.687	0.213	0.718	0.718	0.852	0.367	0.918	0.923
AUT	0.890		0.773	0.772	0.951		0.965	0.893
BEL	0.924	0.793	0.782	0.839	0.970	0.879	0.967	0.842
CAN	0.928	0.812	0.882	0.937	0.971	0.883	0.940	0.944
CHE	0.791		0.660	0.650	0.804	0.022	0.944	0.756
DEU	0.752	0.340	0.762	0.841	0.894	0.281	0.976	0.915
DNK	0.844		0.627	0.747	0.960		0.955	0.892
ESP	0.790			0.745	0.921	0.671	0.925	0.574
FIN	0.881		0.804	0.763	0.963		0.947	0.914
FRA	0.932	0.746	0.800	0.848	0.964	0.860	0.968	0.903
GBR	0.880	0.424	0.858	0.938	0.914	0.391	0.951	0.939
IRL	0.791		0.536	0.763	0.857	0.626	0.952	0.557
ITA	0.903	0.496	0.828	0.730	0.847		0.904	0.595
JPN	0.728	0.125	0.841	0.430	0.856	0.236	0.933	0.768
NLD	0.824		0.781	0.841	0.936	0.598	0.971	0.905
NOR	0.819	0.080	0.556	0.820	0.875		0.882	0.941
PRT	0.871		0.899	0.459	0.521		0.870	0.303
NZL	0.695		0.612	0.630	0.782		0.836	0.897
SWE	0.892		0.825	0.763	0.916	0.480	0.923	0.890
USA	0.950	0.967	0.700	0.921	0.959	0.906	0.928	0.904

The table reports country-level fit from regressions of sovereign yields on the global level and slope factors in the modern sample. Results are shown separately for short and long maturities and for the main subsamples used in the paper. Appendix B.2 and A provide measurement details and sources.

I repeat the analysis for 1, 3, 5 and 7 years. Figure B.13 summarizes their cross-sectional distribution (mean, median, and interquartile range) in the full sample and in the (1970-1989), (1990-2007) and (2008-2025) subsamples. I notice that, in the last subsample, the average R^2 decreases with maturity while its cross-sectional dispersion increases.



(a) Bond Yields (1 Year)

(b) Bond Yields (3 Years)

(c) Bond Yields (5 Years)

(d) Bond Yields (7 Years)

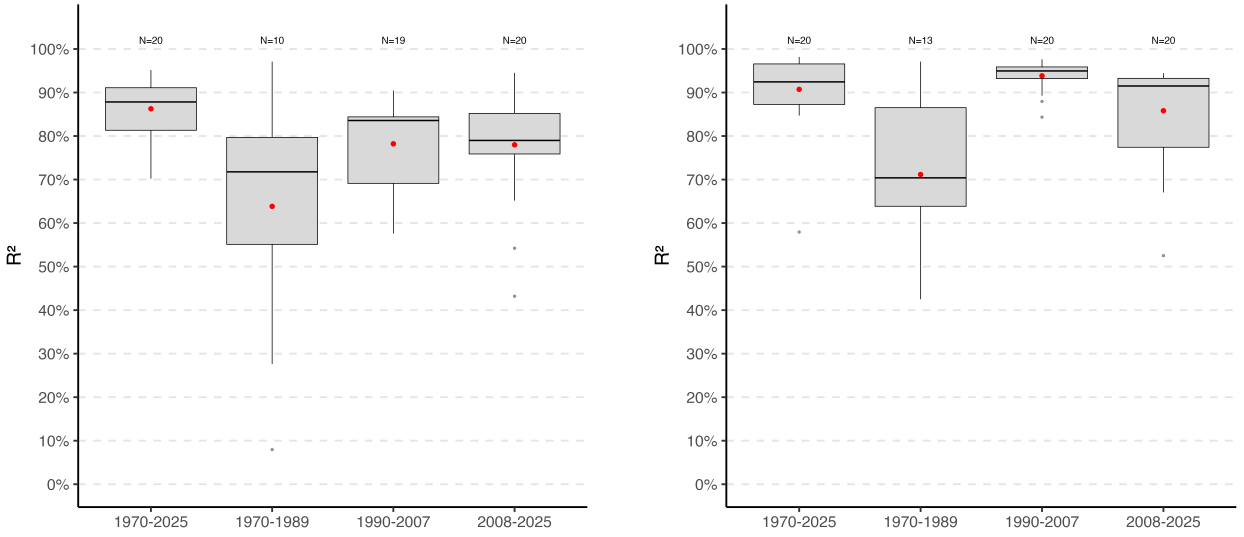
Figure B.13: Cross-sectional variance explained by the global factors for additional maturities

The figure plots the cross-sectional distribution of R^2 values from equation (23) for 1-, 3-, 5-, and 7-year yields. Each panel reports the mean, median, and interquartile range in the full sample and in the three modern subsamples. Appendix B.2 and A provide measurement details and sources.

To investigate the relevance of the Curvature Factor in explaining global dynamics, I estimate for each country k and each maturity n the regression:

$$Y_{k,t}^{(n)} = \alpha_k + \beta_k Y_{G,t} + \varepsilon_{k,t} = \alpha_k + \beta_k^L Level + \beta_k^S Slope + \beta_k^C Curvature + \varepsilon_{k,t} \tag{24}$$

where $Y_{k,t}^{(n)}$ denotes the country-specific yield at maturity n and $Y_{G,t}$ is the vector with the global level, slope and curvature. The coefficients β_k^L, β_k^S, β_k^C measure each country's exposure to the global factors, while the R^2 provides a summary of the share of domestic yield variation accounted for by the global component. Figure B.14b summarizes their cross-sectional distribution (mean, median, and interquartile range) in the full sample and in the (1970-1989), (1990-2007) and (2008-2025) subsamples. Results remain unchanged with respect to the case with only Level and Slope.



(a) Short-term Bond Yields (3 months)

(b) Long-term Bond Yields (10 years)

Figure B.14: Cross-sectional variance explained by global level, slope, and curvature

The figure plots the cross-sectional distribution of R^2 values from equation (24) when the global curvature factor is added to the benchmark specification. The panels report the mean, median, and interquartile range for short and long maturities across the full sample and the three modern subsamples. Appendix B.2 and A provide measurement details and sources.

B.3. The modern subsample failures of the global factor: short-term results

In order to investigate the impact of each component on yields, I provide a Shapley R^2 decomposition of equation 25. Accordingly, I decompose the yields into:

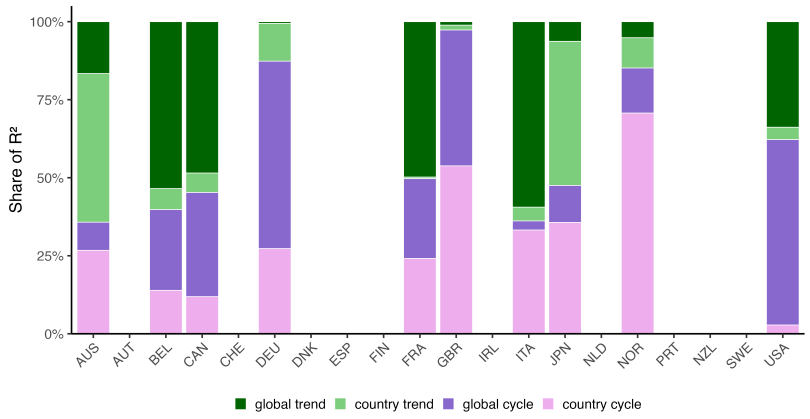
$$Y_{k,t}^{(n)} = \overline{\mathbf{A}}_k^{(n)} + \mathbf{B}_k^{(n)} \left\{ \underbrace{[\theta_k \gamma \tau_t]}_{\textit{Global Trend}} + \underbrace{[\theta_k \tilde{\mathbf{X}}_t]}_{\textit{Global Cycle}} + \underbrace{[\gamma_k \tau_{k,t}]}_{\textit{Country Trend}} + \underbrace{[\tilde{x}_{k,t}]}_{\textit{Country Cycle}} \right\} \tag{25}$$

Figure B.15 plots the decomposition at short maturity. It shows that the dynamics of 3-month sovereign yields are dominated by the global trend component throughout the sample, even more strongly than in the case of long-term rates. In 1970-1989, the decomposition remains somewhat heterogeneous across countries, with country-specific and cyclical components contributing meaningfully in some cases, although the global trend is already the main driver in many economies. In 1990–2007, the global trend becomes overwhelmingly dominant across almost all countries, indicating a very high degree of synchronization in short-term rate dynamics, while in the post-2008 period this pattern broadly persists, with only a modest re-emergence of the global cycle and, for a subset of countries, the country-specific trend component.

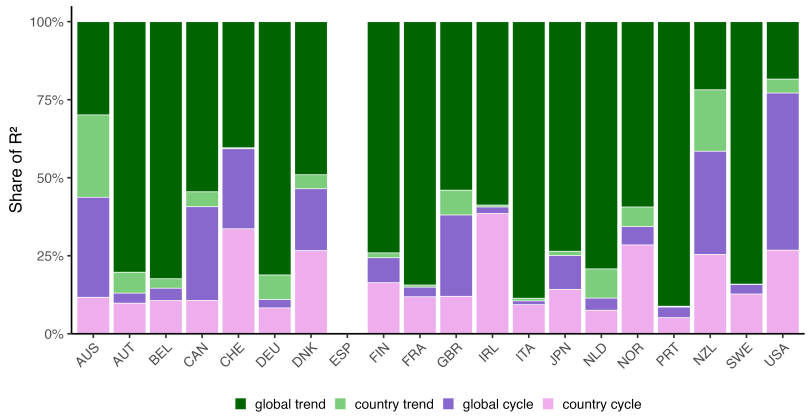
B.4. The missing global component in the (2010-2025) sample

The model in Section 2.1 has two natural limitations: it does not incorporate heteroskedasticity or credit risk. This section therefore examines the role of both in a reduced-form setting. I collect a range of global proxies for uncertainty and volatility, including daily measures (EPU, G20 market GARCH, and G20 market 30-day volatility), a monthly measure (EMV), and quarterly measures of inflation and consumption volatility based on GARCH estimates. To proxy for credit risk, I also collect the country term structure of credit default swaps, ($CDS_k^{(n)}$), at maturities of 6 months and 1, 3, 5, 7, and 10 years. I then construct the corresponding global CDS term structure, ($CDS_G^{(n)}$), as the GDP-weighted average of country CDS series at the daily frequency. From this global CDS curve, I extract the CDS level and slope factors, denoted CDS_{level} and CDS_{slope}. Appendix A provides further details on the data and estimation procedures.

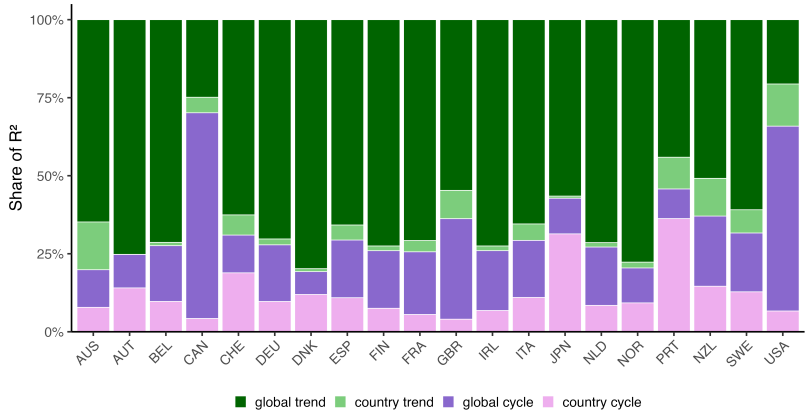
To assess the incremental role of global uncertainty, volatility, and credit risk in domestic yield fluctuations after the Global Financial Crisis, I augment the baseline global-factor specification in the 2010-2025 subsample. For each country k and each maturity n, I first



(a) Short-term Bond Yields (3 months)



(b) Short-term Bond Yields (3 months)



(c) Short-term Bond Yields (3 months)

Figure B.15: Short-term Bond Yields (3 months) Shapley R^2 Decomposition

The figure reports the Shapley R^2 decomposition of equation 25 for 3-month sovereign yields in the three modern subsamples. It shows the contribution of the global trend, global cycle, country trend, and country cycle components. Appendix B.3 and A provide measurement details and sources.

estimate the country component as:

$$Y_{k,t}^{(n)} = \alpha_k^{(n)} + \beta_k^{(n)} \mathbf{X}_{G,t} + v_{k,t}^{(n)}$$

Then, I investigate the role global uncertainty, volatility, or credit risk in explaining the country residuals:

$$v_{k,t}^{(n)} = \delta_k^{(n)} + \gamma_k^{(n)} \mathbf{\Gamma_{G,t}} + \varepsilon_{k,t}^{(n)} \tag{26}$$

where $Y_{k,t}^{(n)}$ denotes the country-specific yield at maturity n, $\mathbf{X}_{G,t}$ is the vector of global level and slope factors, and $\mathbf{\Gamma_{G,t}}$ contains, in turn, one proxy for global uncertainty, volatility, or credit risk. The R^2 summarizes the share of country residuals variation explained by the global uncertainty, volatility, and credit risk proxies: $[\delta_k^{(n)} + \gamma_k^{(n)} \mathbf{\Gamma_{G,t}}]$. Figure B.16 reports the cross-sectional distribution of R^2 (mean, median, and interquartile range) for the 2010-2025 subsample, adding each proxy separately to the baseline specification.

The results are stark. Augmenting the benchmark model with standard proxies for uncertainty and volatility adds little explanatory power at either the 1-year or 10-year maturity, leaving the cross-sectional distribution of R^2 largely unchanged. By contrast, adding global CDS_{level} and CDS_{slope} factors shifts the distribution upward, with especially pronounced gains and tighter cross-country dispersion at the long end. This evidence suggests that, in the post-2008 period, an important share of sovereign yield comovement reflects a global credit-risk component that is not spanned by broader measures of uncertainty or volatility.

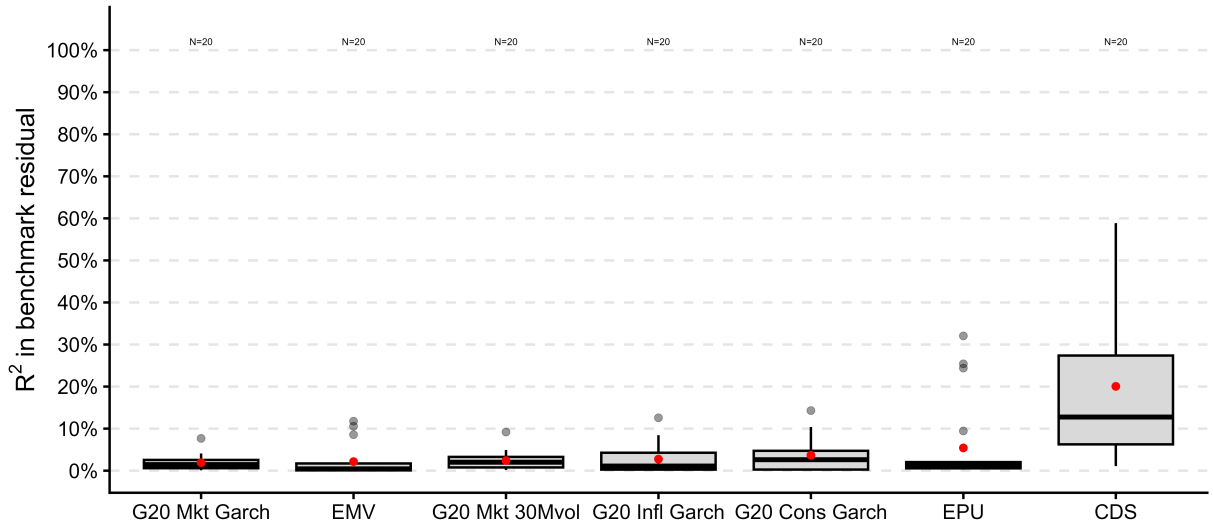
B.5. Global risk-free rates and macro trends

Following Jiang et al. (2025), to proxy for the risk-free rate I use Overnight Index Swap (OIS) data, assuming that the OIS zero rate $OIS_{k,t}^{(n)}$ is a good proxy for the benchmark nominal risk-free rate for country k and that it carries no convenience yield. I collect the Country Term-Structure of Overnight Index Swap (OIS) ($OIS_{k,t}^{(n)}$) for 6 months and 1,3,5,7,10 years maturity. A full description of the series and the estimation method is provided in Appendix A. To investigate the relationship between the risk-free rate and the macro-trends around the world, I estimate the following regressions:

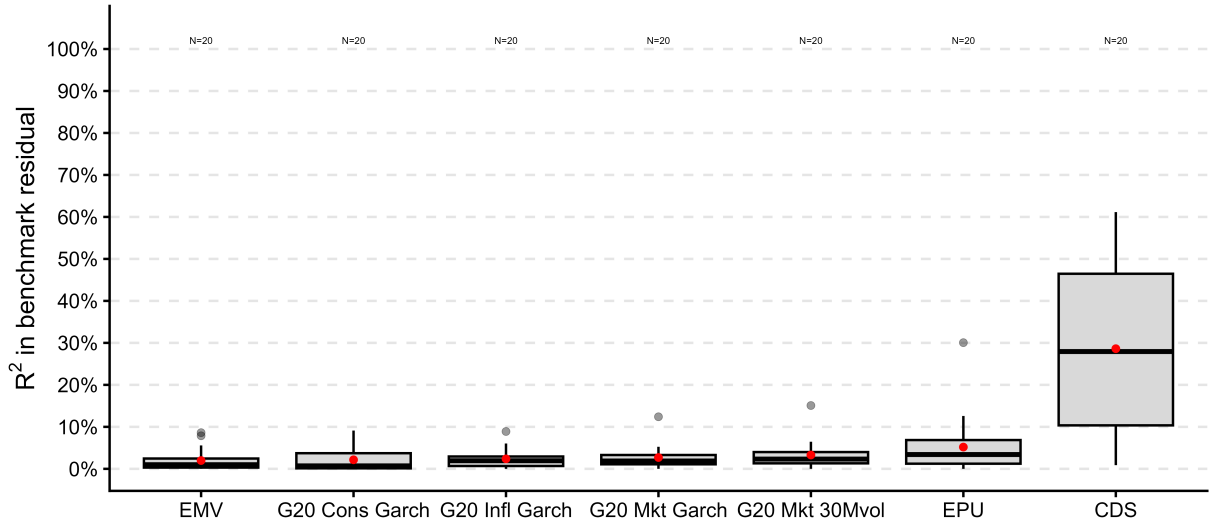
$$r_{k,t}^{(n)} = \alpha + \beta_k i_{k,t}^{*} + \varepsilon_{k,t}^{(n)} \tag{27}$$

$$r_{k,t}^{(n)} = \alpha + \beta_k i_{G,t}^{*} + \varepsilon_{k,t}^{(n)} \tag{28}$$

where $r_{k,t}^{(n)}$ is the country k OIS at maturity n ($OIS_{k,t}^{(n)}$) and ($i_{k,t}^{*}$) and ($i_{G,t}^{*}$) are the proxy for the macro trends (nominal long-run interest rates). Figure B.17 reports a heatmap of the R^2 obtained from equations (27) and (28). It shows that the global macro trends



(a) Short-term rates (1 year)



(b) Long-term rates (10 years)

Figure B.16: Cross-sectional distribution of variance explained by global factors

The figure plots the cross-sectional distribution (mean, median, and interquartile range) of the R^2 from equation (26) in the 2010-2025 subsample for 1-year and 10-year yields. Each bar adds, one at a time, the corresponding proxy for uncertainty, volatility, or credit risk in equation (26). Section 2.4 and Appendix A provide details on the construction of the series and the estimation procedure.

explain most of the variation in country-specific OIS yields, with particularly strong fit for the long maturities and the euro area, the United Kingdom, and Japan. Results improve only for some countries and mainly at short maturities using the country trends, while I observe a disconnect between the risk-free rate in Japan and its macro trends. Furthermore, in several countries, the fit rises with maturity, indicating long run convergence to global factors affecting risk-free rates dynamics.

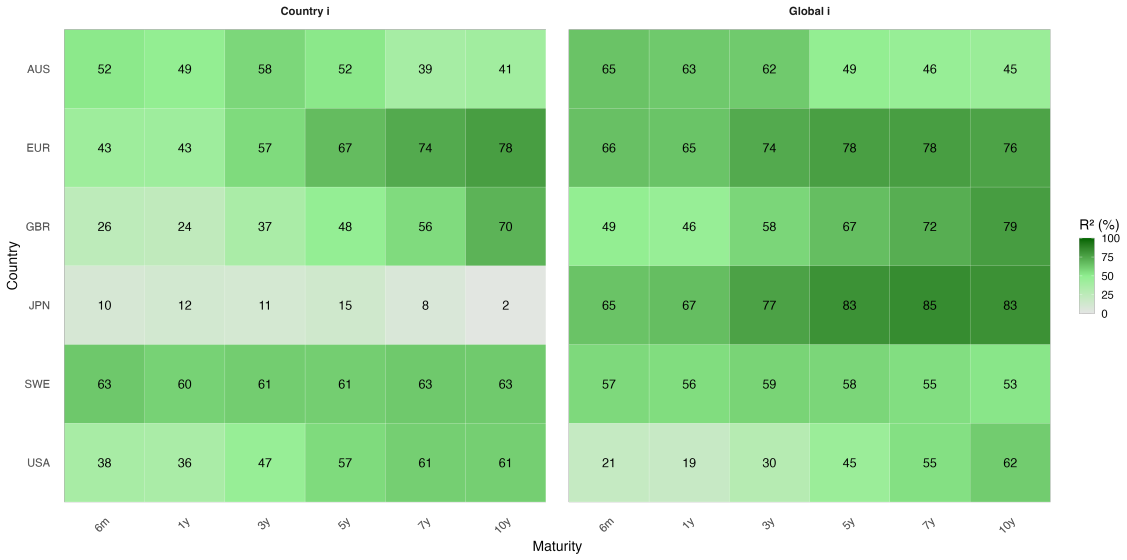


Figure B.17: Risk-free rate and macro-trend fit

The figure reports a heatmap of the R^2 values from equations (27) and (28). The left panel regresses $r_{k,t}^{(n)}$ on country equilibrium nominal rates ($i_{k,t}^*$), while the right panel uses the global nominal rate ($i_{G,t}^*$); darker cells indicate a stronger fit. Appendix B.5 and A provide measurement details and sources.

B.6. Credit Risk as a Global Factor: results using EUR CDS

Following Jiang et al. (2025), I proxy credit risk using the term structure of credit default swap (CDS) spreads. Appendix A provides details on the construction of these series. For this analysis, I use the EUR CDS. I decompose the default spread for country k and maturity n as:

$$\delta_{k,t}^{(n)} = \beta_{\delta,k}^{(n)} \delta_{G,t} + \tilde{\delta}_{k,t}^{(n)} \tag{29}$$

where $\delta_{k,t}^{(n)}$ denotes the country-specific CDS spread at maturity n, that is, $CDS_{k,t}^{(n)}$, and the global credit-risk block is given by a constant and the global CDS level and slope factors ($\delta_{G,t} = [1 \; CDS_{lev,t} \; CDS_{slo,t}]$). Figure B.18 reports the heatmap of R^2 values from equation (29). The results show that global CDS factors explain a substantial share of national CDS variation, and that their explanatory power generally rises with maturity. This pattern

suggests that global credit forces are particularly important for the long end of sovereign default-risk curves. Overall, the evidence points to a sizable global component in sovereign credit risk, especially at medium and long maturities, which is robust to the currency denomination of CDS.

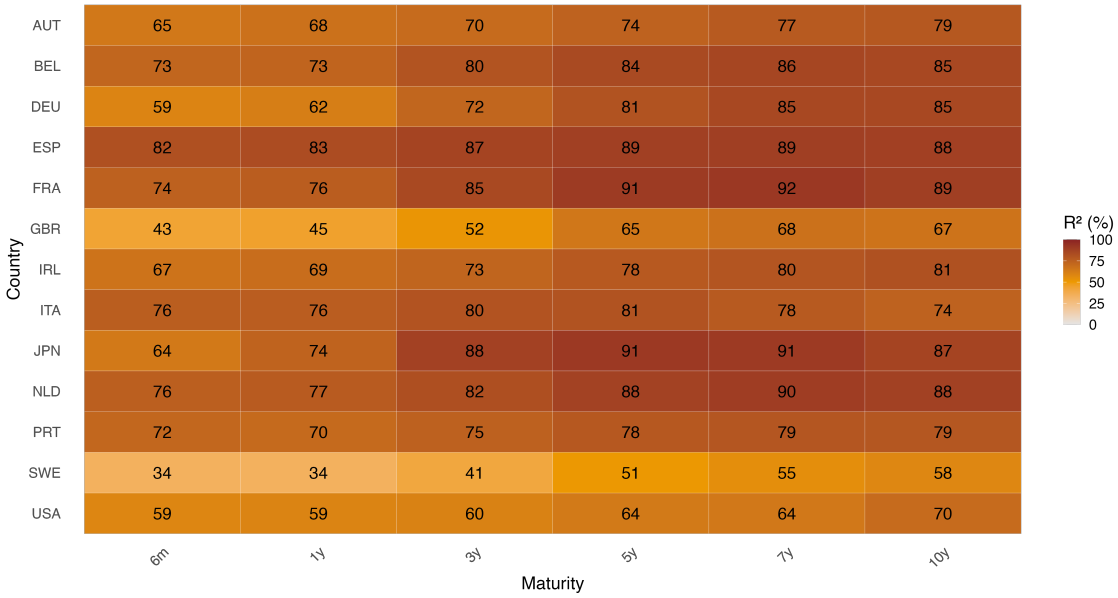


Figure B.18: Credit risk: global and country decomposition (EUR CDS)

The figure reports a heatmap of the R^2 values obtained from equation (29) using EUR CDS data. Darker cells indicate stronger global comovement. Appendix B.6 and A provide measurement details and sources.

B.7. The heterogeneity of convenience: results using EUR CDS

Following Jiang et al. (2025), I define the convenience yield for country k and maturity n as

$$\underbrace{\lambda_{k,t}^{(n)}}_{\text{Convenience yield}} = \underbrace{y_{k,t}^{(n)}}_{\text{Bond yield}} - \underbrace{r_{k,t}^{(n)}}_{\text{Risk-free rate}} - \underbrace{\delta_{k,t}^{(n)}}_{\text{Default spread}} \tag{30}$$

In this section I use EUR CDS data to construct the country term structure of convenience yields, $\lambda_{k,t}^{(n)}$, at maturities of 6 months and 1, 3, 5, 7, and 10 years. I then form the corresponding global convenience-yield curve, $\lambda_{G,t}^{(n)}$, as the GDP-weighted average of country series at the daily frequency, and extract the level and slope factors. Appendix A provides details on the construction of these series. I decompose country convenience yields as

$$\lambda_{k,t}^{(n)} = \beta_{\lambda,k}^{(n)} \lambda_{G,t} + \tilde{\lambda}_{k,t}^{(n)} \tag{31}$$

where $\lambda_{k,t}^{(n)}$ denotes the country-specific convenience yield at maturity n, and the global convenience-yield block is given by a constant and the global convenience-yield level and slope factors ($\lambda_{G,t} = [1 \; CY_{lev,t} \; CY_{slo,t}]$). Figure B.19 reports the heatmap of R^2 values from equation (31). Results based on euro-denominated CDS inputs are quantitatively and qualitatively similar. Overall, the euro-denominated results reinforce the main conclusion: convenience yields contain a small global component and remain substantially more heterogeneous and country-specific than either risk-free rates or default spreads.



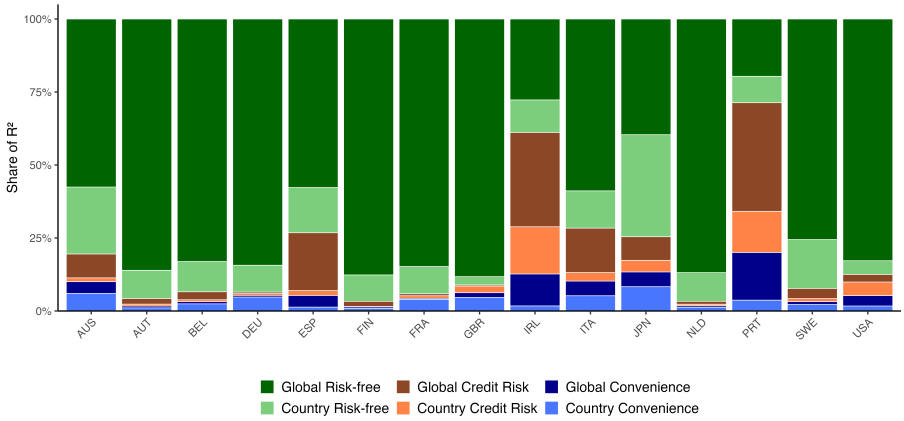
Figure B.19: Convenience yields: global and country decomposition (EUR CDS)
The figure reports a heatmap of the R^2 values obtained from equation (31) using convenience yields constructed with EUR CDS data. Darker cells indicate stronger global comovement. Appendix B.7 and A provide measurement details and sources.

B.8. The bond yields decomposition after the GFC

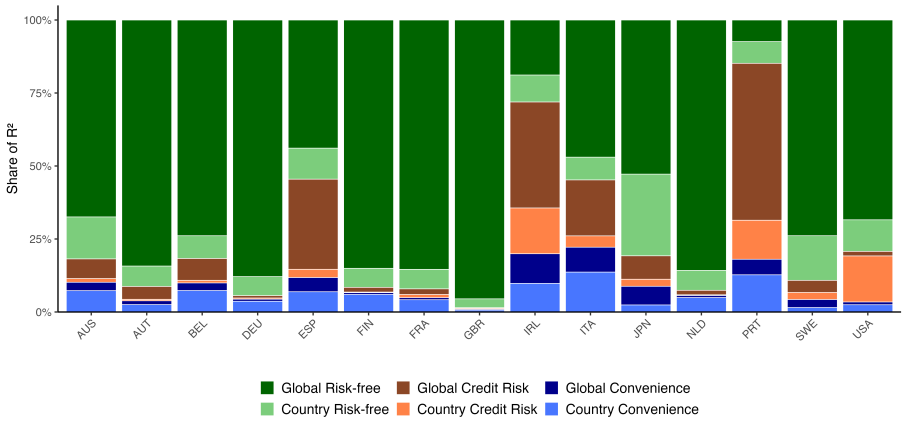
For each country, the sovereign yield can be decomposed into a *risk-free* component, a *default-spread* component, and a *convenience-yield* component, each of which can in turn be split into global and country-specific parts:

$$
\begin{aligned}
y_{k,t}^{(n)} &= \underbrace{r_{k,t}^{(n)}}_{Risk-free} + \underbrace{\delta_{k,t}^{(n)}}_{Default} + \underbrace{\lambda_{k,t}^{(n)}}_{Convenience} \\
&= [\underbrace{\beta_{r,k}^{(n)} r_{G,t}}_{Global\ r} + \underbrace{\tilde{r}_{k,t}^{(n)}}_{Country\ r}] + [\underbrace{\beta_{\delta,k}^{(n)} \delta_{G,t}}_{Global\ \delta} + \underbrace{\tilde{\delta}_{k,t}^{(n)}}_{Country\ \delta}] + [\underbrace{\beta_{\lambda,k}^{(n)} \lambda_{G,t}}_{Global\ \lambda} + \underbrace{\tilde{\lambda}_{k,t}^{(n)}}_{Country\ \lambda}]
\end{aligned}
$$

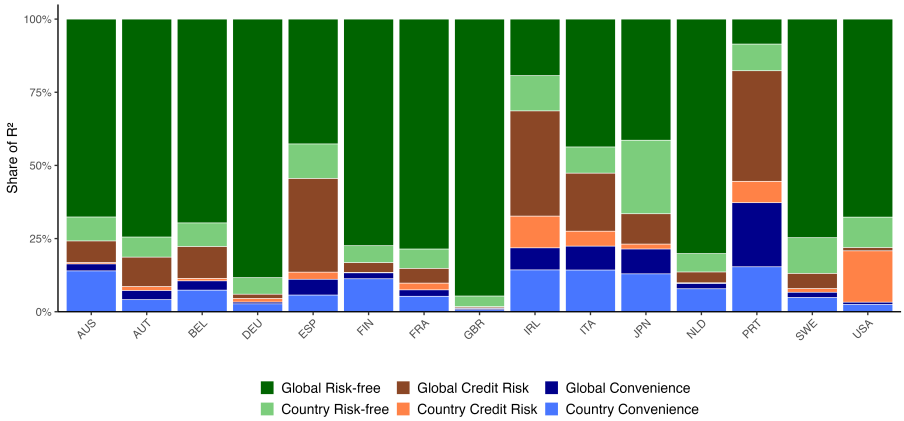
Following the approach in Section 3.5, I quantify the contribution of each block using a Shapley R^2 decomposition. As for Section 3.5, I use the USD CDS series for the decomposition. Figure B.20 reports the decomposition for 1-, 3-, and 5-year sovereign yields. It shows that the main conclusions from the 10-year decomposition are already visible at shorter maturities, but they become stronger and economically cleaner as maturity increases. At the 1-year horizon, the decomposition is dominated almost everywhere by the global risk-free block. Credit risk is present, but its role is concentrated in a relatively small set of countries, while convenience yields account for only a limited share of explained variation in most cases. This pattern is consistent with the view that short-horizon sovereign pricing remains largely pinned down by common benchmark-rate forces. At the 3-year maturity, the picture becomes richer. The global credit-risk block expands in several countries, especially those more exposed to sovereign stress, while the global convenience block becomes somewhat more visible, although still clearly secondary. By the 5-year maturity, this reallocation is more pronounced. The global risk-free component remains the largest block in most countries, but the global credit component becomes quantitatively important in a broader set of markets and, in some cases, rivals or exceeds the contribution of the local non-risk-free blocks. The convenience-yield component remains the most heterogeneous part of the decomposition. A notable maturity pattern emerges from the three figures. What globalizes with maturity is not only the risk-free component; the credit component globalizes as well. By contrast, convenience does not display the same monotonic internationalization. This is an interesting feature of the data. It suggests that as one moves out along the curve, sovereign debt increasingly loads on common discount-rate and global credit conditions, but the valuation of safety and collateral services remains much more issuer-specific. A second pattern is that the countries that stand out at long maturities already begin to separate from the rest at intermediate maturities. In particular, peripheral European sovereigns and Japan display an earlier rise in the contribution of the credit block than core issuers do. This suggests that the maturity at which sovereign risk becomes globally priced is itself heterogeneous across countries.



(a) Shapley decomposition of 1-year government bond yields



(b) Shapley decomposition of 3-year government bond yields



(c) Shapley decomposition of 5-year government bond yields

Figure B.20: Shapley decomposition of government bond yields across maturities

The figure decomposes the explained variation in 1-, 3-, and 5-year government bond yields into global and country-specific shares within each of the three building blocks: the *risk-free rate*, *credit spread*, and *convenience yield*. In each panel, the darker bar denotes the global contribution and the lighter bar the country-specific contribution. Section B.8 and Appendix A provide details on the data and estimation procedure.

C. A Term Structure Model with Risk-free, Credit Risk and Convenience Yields

This appendix derives the dynamic term structure model underlying the yield decomposition in Section 3. Building on a general version of the Jiang et al. (2025) model, sovereign bond yields are decomposed into a *risk-free rate*, a *default spread*, and a *convenience yield* component.

Connection to the main text. The state vector $X_{k,t}$ used here nests the state variables $\mathbf{X}_{k,t}$ from Section 2.1, augmented with credit-risk and convenience-yield drivers. The reduced-form yield equation $\mathbf{Y}_{k,t}^{(n)} = \mathbf{A}_k^{(n)} + \mathbf{B}_k^{(n)}\mathbf{X}_{k,t}$ (Eq. 6) is a special case of the affine pricing results derived below when default and convenience components are shut down. The empirical decomposition in Section 3 uses OIS rates (Appendix A.10) as the risk-free proxy, CDS spreads (Appendix A.9) as the default proxy, and the residual (Appendix A.11) as the convenience yield, which correspond to the three model-implied components $r_{k,t}^{(n)}$, $\delta_{k,t}^{(n)}$, and $\lambda_{k,t}^{(n)}$ derived here.

Roadmap. Section C.1 presents the state dynamics under the physical measure and introduces the pricing kernel (SDF). Section C.2 derives the risk-free term structure. Section C.3 introduces default risk and the Duffie–Singleton equivalent representation. Section C.4 adds convenience yields. The final two subsections combine these components into the full yield decomposition and derive the closed-form affine recursion.

Notation. Throughout this appendix, I use three tiers of bond prices and their corresponding affine loadings: (i) $\bar{P}_{k,t}^{(n)}$ with loadings $(\bar{A}_{k,n}, \bar{B}_{k,n})$ for *risk-free* bonds (no default, no convenience); (ii) $\hat{P}_{k,t}^{(n)}$ with loadings $(\hat{A}_{k,n}, \hat{B}_{k,n})$ for *defaultable* bonds (default risk but no convenience); and (iii) $P_{k,t}^{(n)}$ with loadings $(A_{k,n}, B_{k,n})$ for *sovereign* bonds (default risk and convenience yield). All prices are exponential-affine in the state vector $X_{k,t} = [X_{G,t},\ \tilde{x}_{k,t}]'$, which collects global and country-specific factors.

For convenience, I restate the key pricing equations from Section 3 before deriving each component in detail.

Risk-free Component. I define the nominal pricing kernel $M_{k,t,t+n}$ for country k at horizon n. The price of an n-period risk-free zero-coupon bond must satisfy the Euler equation:

$$r_{k,t}^{(n)} = -\frac{1}{n}\log \mathbb{E}_t\left[\bar{P}_{k,t}^{(n)}\right] = -\frac{1}{n}\log \mathbb{E}_t\left[M_{k,t,t+n}\right]$$

Default Component. I introduce the possibility of sovereign default for country k, denoting by $\chi_{k,t+1} = L_k \mathcal{H}_{k,t+1}$ the event of government default at time $t+1$ in country k. The price of an n-period risky bond is:

$$\begin{aligned}\hat{P}_{k,t}^{(n)} &\equiv \mathbb{E}_t\left[M_{k,t+1}[\mathcal{I}_k(\tau > t+1) + (1-L_k)\cdot \mathcal{I}_k(t < \tau \leq t+1)]\cdot \hat{P}_{k,t}^{(n-1)}\right] \\ &\equiv \mathbb{E}_t\left[M_{k,t+1}\left[1 - L_k\mathcal{H}_{k,t+1}\right]\cdot \hat{P}_{k,t}^{(n-1)}\right] \equiv \mathbb{E}_t\left[M_{k,t+1}\left(1-\chi_{k,t+1}\right)\cdot \hat{P}_{k,t}^{(n-1)}\right]\end{aligned}$$

Convenience Component. Sovereign bonds carry a country- and tenor-specific Euler equation wedge, $w_{k,t}^{(n)}$, which represents how much risk-adjusted return investors are willing to forgo to hold the bonds of country k. The price of an asset with convenience yield, will be discounted adding (to the pricing equation) the term:

$$CY_{k,t}^{(n)} = e^{\left(-w_{k,t}^{(n)}\right)}$$

Government Bond Pricing. Sovereign bonds contain a *risk-free*, *default* and *convenience* component. I generalize the Euler equations for bonds with maturity 1 and n as:

$$\begin{aligned}P_{k,t}^{(1)} &= \mathbb{E}_t\left[M_{k,t,t+1}\left(1-\chi_{k,t+1}\right)e^{-w_{k,t}^{(1)}}\right] \\ P_{k,t}^{(n)} &= \mathbb{E}_t\left[M_{k,t,t+1}\left(1-\chi_{k,t+1}\right)e^{-w_{k,t}^{(n)}}P_{k,t+1}^{(n-1)}\right]\end{aligned}$$

I substitute for $P_{k,t+1}^{n-1}$ using the same equation one step ahead, and keep substituting until maturity hits 0 (where $P_{k,t+n}^{0} = 1$). Doing this recursion, I obtain a generalized formula for bonds with maturity n as:

$$\mathbb{E}_t\left[M_{k,t,t+n}\prod_{j=1}^{n}\left(1-\chi_{k,t+j}\right)e^{\left(-\sum_{j=1}^{n} w_{k,t+j-1}^{n-j+1}\right)}\right] = P_{k,t}^{(n)}$$

Government Bond Yields Decomposition. I decompose the sovereign bond yields in country k into their *risk-free rate* $r_{k,t}^{(n)}$, *default spread* $\delta_{k,t}^{(n)}$, and *convenience yield* $\lambda_{k,t}^{(n)}$ components:

$$\boxed{y_{k,t}^{(n)} = -\frac{1}{n}\log\left[P_{k,t}^{(n)}\right] = r_{k,t}^{(n)} + \delta_{k,t}^{(n)} + \lambda_{k,t}^{(n)}} \tag{32}$$

where:

- The *risk-free rate*:

$$r_{k,t}^{(n)} = -\frac{1}{n}\log \mathbb{E}_t\left[M_{k,t,t+n}\right] = \beta_{r,k}^{(n)} r_{G,t} + \tilde{r}_{k,t}^{(n)} \tag{33}$$

- The *default spread*:

$$\delta_{k,t}^{(n)} = -\frac{1}{n}\log \mathbb{E}_t\left[M_{k,t,t+n}\prod_{j=1}^{n}(1-\chi_{k,t+j})\right] + \frac{1}{n}\log \mathbb{E}_t\left[M_{k,t,t+n}\right] = \beta_{\delta,k}^{(n)}\delta_{G,t} + \tilde{\delta}_{k,t}^{(n)} \tag{34}$$

- The *convenience yields*:

$$\begin{aligned}\lambda_{k,t}^{(n)} = &-\frac{1}{n}\log \mathbb{E}_t\left[M_{k,t,t+n}\prod_{j=1}^{n}\left(1-\chi_{k,t+j}\right)e^{\left(-\sum_{j=1}^{n} w_{k,t+j-1}^{n-j+1}\right)}\right] + \\ &+\frac{1}{n}\log \mathbb{E}_t\left[M_{k,t,t+n}\prod_{j=1}^{n}\left(1-\chi_{k,t+j}\right)\right] = \beta_{\lambda,k}^{(n)}\lambda_{G,t} + \tilde{\lambda}_{k,t}^{(n)}\end{aligned} \tag{35}$$

C.1. State dynamics under the physical measure

Let $X_{k,t} \in \mathbb{R}^m$ collect $(m = g + k)$ global (g) and local (k) pricing factors (including credit and convenience drivers). Under the physical measure $\mathbb{P}$, the state follows a Gaussian VAR(1):

$$X_{k,t+1} = \mu_k + \Phi_k X_{k,t} + \Sigma_k \varepsilon_{k,t+1} \qquad \varepsilon_{k,t+1} \sim \mathcal{N}(0, I_m) \tag{36}$$

with $(\mu_k, \Phi_k, \Sigma_k)$ conformable. I decompose $X_{k,t}$ into a global $(X_{G,t})$ and a country-specific $(\tilde{x}_{k,t})$ component, such that $X_{k,t} = [X_{G,t},\ \tilde{x}_{k,t}]'$. The parameters ($\mu_k$ and Φ_k) determine the country exposure to global factors and the dynamics of the country-specific component. For each country k, I define the one-period nominal stochastic discount factor (SDF):

$$M_{k,t,t+1} = e^{\left(-r_{k,t}^{(1)} - \frac{1}{2}\Lambda_{k,t}'\Lambda_{k,t} - \Lambda_{k,t}'\varepsilon_{k,t+1}\right)} \tag{37}$$

where the (one-period) risk-free short rate is affine in $X_{k,t}$:

$$r_{k,t}^{(1)} = \delta_{0,k} + \delta_{1,k}' X_{k,t} \tag{38}$$

and the market price of risk is affine in $X_{k,t}$:

$$\Lambda_{k,t} = \lambda_{0,k} + \lambda_{1,k} X_{k,t} \tag{39}$$

Given (36)–(37) with (39), I define the risk-neutral innovation:

$$\varepsilon^{\mathbb{Q}}_{k,t+1} \equiv \varepsilon_{k,t+1} + \Lambda_{k,t} \tag{40}$$

so that $\varepsilon^{\mathbb{Q}}_{k,t+1} \sim \mathcal{N}(0, I_m)$ under $\mathbb{Q}$. Substituting (40) into (36) yields the risk-neutral state dynamics for country k:

$$X_{k,t+1} = \mu^{\mathbb{Q}}_k + \Phi^{\mathbb{Q}}_k X_{k,t} + \Sigma_k \varepsilon^{\mathbb{Q}}_{k,t+1} \qquad \mu^{\mathbb{Q}}_k \equiv \mu_k - \Sigma_k \lambda_{0,k} \qquad \Phi^{\mathbb{Q}}_k \equiv \Phi_k - \Sigma_k \lambda_{1,k} \tag{41}$$

C.2. Risk-free rate component

I define the nominal pricing kernel $M_{k,t,t+n}$ for country k at each horizon n. I assume that both global and country specific shocks affect the nominal discount rate, such that I can decompose the rate into a country-specific and global component:[45]

$$r^{(n)}_{k,t} = -\frac{1}{n} \log \mathbb{E}_t \left[M_{k,t,t+n} \right] = -\frac{1}{n} \log \mathbb{E}_t \left[e^{\left(\sum_{j=1}^{n} m_{k,t+j-1} \right)} \right]$$

To derive closed-form solutions for the term structure of risk-free rates, I conjecture that log zero-coupon bond prices $\bar{p}^{(n)}_{k,t}$ are affine in the state vector $X_{k,t}$, such that

$$\begin{aligned} \bar{p}^{(n)}_{k,t} &= \log(\bar{P}^{(n)}_{k,t}) = -\bar{A}_{k,n} - \bar{B}_{k,n} X_{k,t} \\ &\downarrow \\ r^{(n)}_{k,t} &= n^{-1} \left(\bar{A}_{k,n} + \bar{B}_{k,n} X_{k,t} \right) \\ &= n^{-1} \left(\bar{A}_{k,n} + \bar{B}_{k,n} [X_{G,t},\ \tilde{x}_{k,t}]' \right) = [\beta^{(n)}_{r,k} r_{G,t} + \tilde{r}^{(n)}_{k,t}] \end{aligned}$$

where $\beta^{(n)}_{r,k} r_{G,t} = n^{-1} \left(\bar{A}_{k,n} + \bar{B}_{k,n} [X_{G,t}]' \right)$ and $\tilde{r}^{(n)}_{k,t} = n^{-1} \bar{B}_{k,n} [\tilde{x}_{k,t}]'$. The one-period nominal risk-free rate is linear in the state vector $X_{k,t}$:

$$r^{(1)}_{k,t} = -\log \mathbb{E}_t \left[M_{k,t,t+1} \right] = -\log \mathbb{E}_t \left[e^{(m_{k,t+1})} \right] = \bar{A}_{k,1} + \bar{B}_{k,1} X_{k,t} = \delta_{0,k} + \delta'_{1,k} X_{k,t}$$

[45] The model in Jiang et al. (2025) is focused on the Eurozone. They assume that when capital markets in the Eurozone are integrated, there is a common nominal pricing kernel for all member countries at each horizon h. In this case, only union-wide shocks affect the nominal discount rate, whereas idiosyncratic shocks to one particular country do not. Even if risk-sharing between Eurozone countries is incomplete, they assume that investors agree on the price of risk-free bonds denominated in Euro. While I assume that Eurozone share the same risk-free rate, I generalize the formula for country k, assuming that pricing kernel has a global and country specific component, in line with the empirical evidence on short rates in my sample.

In the empirical analysis, I proxy $r_{k,t}^{(n)}$ with the OIS term structure described in Appendix A.10 and Section 3.

C.3. Default spread component

I introduce the possibility of sovereign default, denoting by $\chi_{k,t+1} = L_k \mathcal{H}_{k,t+1}$ the event of government default at time $t+1$ in country k.[46] In reduced-form models, default is modeled via an intensity (hazard rate) under the pricing measure. In discrete time, a standard specification is:[47]

$$\Pr^{\mathbb{Q}}(\tau_k \in (t, t+1] \mid \tau_k > t,\ X_t) = 1 - e^{-h_{k,t}} \qquad h_{k,t} = h_{0,k} + h'_{1,k} X_t \tag{42}$$

with $h_{k,t} \geq 0$. Conditional survival probability is $e^{(-h_{k,t})}$. In this model, default conditional expectation equals:

$$\mathbb{E}_t^{\mathbb{Q}}[1 - \chi_{k,t+1}] = 1 - L_k \left(1 - e^{-h_{k,t}}\right) = (1 - L_k) + L_k e^{-h_{k,t}}$$

which is generally *not* exponential-affine in X_t. The affine-credit literature therefore typically proceeds by working with an *effective default discount spread* $s_{k,t}$ that is specified to be affine, so that defaultable bond prices remain exponential-affine (for example see Duffie and Singleton (1999)). I use the law of iterated expectations to show that risky bond prices without convenience yields, would follow the recursion:

$$\begin{aligned}
\hat{P}_{k,t}^{(n)} &\equiv \mathbb{E}_t \left[M_{k,t+1} [\mathcal{I}_k(\tau > t+1) + (1 - L_k) \cdot \mathcal{I}_k(t < \tau \leq t+1)] \cdot \hat{P}_{k,t}^{(n-1)} \right] \\
&\equiv \mathbb{E}_t \left[M_{k,t+1} \left(1 - \chi_{k,t+1}\right) \cdot \hat{P}_{k,t}^{(n-1)} \right] \equiv \mathbb{E}_t \left[M_{k,t+1} \left[1 - L_k \mathcal{H}_{k,t+1}\right] \cdot \hat{P}_{k,t}^{(n-1)} \right] \\
&\approx E_t \left[e^{\sum_{j=1}^{n} m_{k,t+j-1,t+j} - L_k \cdot h_{k,t+j}} \right]
\end{aligned}$$

where I follow Duffie and Singleton (1999) by applying a first-order Taylor approximation of $\log(1 - L_k \mathcal{H}_{k,t})$ around zero. The key identification step is:

$$\log\left(1 - L_k \mathcal{H}_{k,t}\right) \approx -L_k \cdot h_{k,t} \tag{43}$$

[46] If the government defaults at time t we can assume all debt is wiped out with zero recovery, as in Jiang et al. (2025), or having a positive rate which can be time-varying or time-invariant.

[47] For example, following Augustin, Chernov, Schmid and Song (2021), we can connect the default intensity to $\mathcal{H}_{k,t}$, the conditional default probability of a given reference entity at time t via $\mathcal{H}_{k,t} \equiv \text{Prob}\left(\tau = t \mid \tau \geq t; \mathcal{F}_t\right) = 1 - e^{-h_{k,t}}$, where $\mathcal{F}_t$ denotes all the available information available at time t, with the exception of credit events. This implies that the probability of survival (no credit event) until time t is: $\mathcal{S}_{k,t} \equiv \text{Prob}\left(\tau > t \mid \mathcal{F}_t\right) = \mathcal{S}_0 \prod_{j=1}^{t} \left(1 - \mathcal{H}_{k,j}\right), \quad t \geq 1$

This approximation is accurate when default probabilities are small, a condition satisfied for the advanced economies in my sample. The approximation ensures that defaultable bond prices remain exponential-affine in the state vector. To formalize this, I define an *effective default spread* $s_{k,t}$ and impose that it is affine:

$$s_{k,t} = s_{0,k} + s_{1,k}' X_{k,t} \tag{44}$$

I then impose the standard Duffie and Singleton (1999) *equivalent* representation:[48]

$$\hat{P}_{k,t}^{(n)} = \mathbb{E}_t^{\mathbb{Q}}\Big[\exp\Big(-r_{k,t}^{(1)} - s_{k,t}\Big)\hat{P}_{k,t+1}^{(n-1)}\Big] \tag{45}$$

To interpret the default component, I solve for:

$$\begin{aligned}\delta_{k,t}^{(n)} &= -\frac{1}{n}\log \mathbb{E}_t\left[M_{k,t,t+n}\prod_{j=1}^{n}\Big(1 - L_k\mathcal{H}_{k,t+j}\Big)\right] + \frac{1}{n}\log \mathbb{E}_t\left[M_{k,t,t+n}\right] = \tilde{y}_{k,t}^{(n)} - r_{k,t}^{(n)} \\ &\approx -\frac{1}{n}\log E_t\left[e^{\sum_{j=1}^{n} m_{k,t+j-1,t+j} - L_k \cdot h_{k,t+j}}\right] + \frac{1}{n}\log \mathbb{E}_t\left[e^{\left(\sum_{j=1}^{n} m_{k,t+j-1}\right)}\right]\end{aligned}$$

where, $(\delta_{k,t}^{(n)} = \hat{y}_{k,t}^{(n)} - r_{k,t}^{(n)})$ is default-spread component as the yield difference between this defaultable-no-wedge bond and the risk-free bond.

[48] This representation nests reduced-form default: informally, $s_{k,t}$ corresponds to the log-discount implied by the conditional expectation of $(1 - \chi_{k,t+1})$ under $\mathbb{Q}$,

$$s_{k,t} \approx -\log\Big(\mathbb{E}_t^{\mathbb{Q}}[1 - \chi_{k,t+1} \mid X_t]\Big)$$

When default risk is small, the usual first-order approximation yields $s_{k,t} \approx L_k h_{k,t}$, motivating an affine $s_{k,t}$ when $h_{k,t}$ is affine. This affine formulation replaces the random indicator payoff by an equivalent default-adjusted discount spread $s_{k,t}$, yielding (45). A one-step exact identity would set

$$s_{k,t} = -\log\Big(\mathbb{E}_t^{\mathbb{Q}}[1 - \chi_{k,t+1} \mid X_{k,t}]\Big) = -\log\left(1 - L_k + L_k e^{-h_{k,t}}\right)$$

which is nonlinear in $X_{k,t}$ when $h_{k,t}$ is affine. The affine-credit approach instead specifies $s_{k,t}$ directly as affine (44) (or uses small-default approximations where $s_{k,t} \approx L_k h_{k,t}$), which preserves tractability and yields the closed-form affine recursions (54).

Imposing the standard Duffie and Singleton (1999) *equivalent* representation:

$$\begin{aligned}
\delta_{k,t}^{(n)} &= \hat{y}_{k,t}^{(n)} - r_{k,t}^{(n)} \\
&= n^{-1}\left(\hat{A}_{k,n} + \hat{B}_{k,n}X_{k,t}\right) - n^{-1}\left(\bar{A}_{k,n} + \bar{B}_{k,n}X_{k,t}\right) \\
&= n^{-1}\left(\hat{A}_{k,n} - \bar{A}_{k,n}\right) + n^{-1}\left(\hat{B}_{k,n} - \bar{B}_{k,n}\right)X_{k,t} \\
&= n^{-1}\left(\hat{A}_{k,n} - \bar{A}_{k,n}\right) + n^{-1}\left(\hat{B}_{k,n} - \bar{B}_{k,n}\right)[X_{G,t},\ \tilde{x}_{k,t}]' \\
&= \beta_{\delta,k}^{(n)}\delta_{G,t} + \tilde{\delta}_{k,t}^{(n)}
\end{aligned}$$

where $\beta_{\delta,k}^{(n)}\delta_{G,t} = n^{-1}\left(\hat{A}_{k,n} - \bar{A}_{k,n}\right) + n^{-1}\left(\hat{B}_{k,n} - \bar{B}_{k,n}\right)[X_{G,t}]'$ and $\tilde{\delta}_{k,t}^{(n)} = n^{-1}\left(\hat{B}_{k,n} - \bar{B}_{k,n}\right)[\tilde{x}_{k,t}]'$. In the empirical analysis, I proxy the default spread $\delta_{k,t}^{(n)}$ with the CDS term structure described in Appendix A.9. Under the small-default approximation (43), the affine effective spread $s_{k,t}$ maps directly to the observed CDS spread scaled by the loss-given-default L_k.

C.4. Convenience yields component

Sovereign bonds carry a country- and tenor-specific Euler equation wedge, $w_{k,t}^{(n)}$, which represents how much risk-adjusted return investors are willing to forgo to hold the bonds of country k.[49]. In a general formulation, I assume that country (k) convenience yields is affine:

$$w_{k,t}^{(n)} = \omega_{0,k}^{(n)} + \omega_{1,k}^{(n)\prime}X_{k,t} \tag{46}$$

I use the law of iterated expectations to show that risky bond prices with convenience yields follow the recursion:

$$\begin{aligned}
P_{k,t}^{(n)} &\equiv \mathbb{E}_t\left[M_{k,t+1}e^{-w_{k,t}^{(n)}}\left[\mathcal{I}_k(\tau > t+1) + (1-L_k)\cdot\mathcal{I}_k(t < \tau \leq t+1)\right]\cdot P_{k,t}^{(n-1)}\right] \\
&\equiv \mathbb{E}_t\left[M_{k,t+1}e^{-w_{k,t}^{(n)}}\left[1 - L_k\mathcal{H}_{k,t+1}\right]\cdot P_{k,t}^{(n-1)}\right] \equiv \mathbb{E}_t\left[M_{k,t+1}e^{\left(-w_{k,t}^{(n)}\right)}\left(1-\chi_{k,t+1}\right)\cdot P_{k,t}^{(n-1)}\right] \\
&\approx E_t\left[e^{\sum_{j=1}^{n} m_{k,t+j-1,t+j} - L_k\cdot h_{k,t+j} - w_{k,t+j}}\right]
\end{aligned}$$

[49] In Jiang et al. (2025), these Euler equation wedges $w_{k,t}^{(n)}$ measure how much the marginal investors value the extra safety and liquidity provided by country k sovereign bonds, compared to other bonds that promise identical payoffs. For these investors, the wedges do not represent arbitrage opportunities. Following Jiang et al. (2025) model, they are given by the marginal utility of bond holdings: $\mathbf{E}_t\left[\beta\frac{u'(c_{k,t+1})}{u'(c_{k,t})}\frac{P_{k,t+1}^{(n-1)}}{P_{k,t}^{(n)}}\right] = 1 - \frac{v_t'\left(q_{k,t}^{(n)}\right)}{u'(c_{k,t})}$

To interpret the convenience-yield component, I solve for:

$$\begin{aligned}\lambda_{k,t}^{(n)} &= -\frac{1}{n}\log\mathbb{E}_t\left[M_{k,t,t+n}\prod_{j=1}^{n}\left(1-L_k\mathcal{H}_{k,t+j}\right)e^{\left(-\sum_{j=1}^{n}w_{k,t+j-1}^{n-j+1}\right)}\right]+\frac{1}{n}\log\mathbb{E}_t\left[M_{k,t,t+n}\prod_{j=1}^{n}\left(1-L_k\mathcal{H}_{k,t+j}\right)\right]\\ &= y_{k,t}^{(n)}-\hat{y}_{k,t}^{(n)} = y_{k,t}^{(n)}-\delta_{k,t}^{(n)}-r_{k,t}^{(n)}\\ &\approx -\frac{1}{n}\log E_t\left[e^{\sum_{j=1}^{n}m_{k,t+j-1,t+j}-L_k\cdot h_{k,t+j}-w_{k,t+j}}\right]+\frac{1}{n}\log E_t\left[e^{\sum_{j=1}^{n}m_{k,t+j-1,t+j}-L_k\cdot h_{k,t+j}}\right]\end{aligned}$$

where $y_{k,t}^{(n)}$ is the government bond yield for country k at maturity n, and $\delta_{k,t}^{(n)}$ is the default spread from Appendix C.3. In a general formulation, where the country k convenience yield is affine:

$$\begin{aligned}\lambda_{k,t}^{(n)} &= y_{k,t}^{(n)}-\hat{y}_{k,t}^{(n)} = y_{k,t}^{(n)}-\delta_{k,t}^{(n)}-r_{k,t}^{(n)}\\ &= n^{-1}\left(A_{k,n}+B_{k,n}X_{k,t}\right)-n^{-1}\left(\hat{A}_{k,n}+\hat{B}_{k,n}X_{k,t}\right)\\ &= n^{-1}\left(A_{k,n}-\hat{A}_{k,n}\right)+n^{-1}\left(B_{k,n}-\hat{B}_{k,n}\right)X_{k,t}\\ &= n^{-1}\left(A_{k,n}-\hat{A}_{k,n}\right)+n^{-1}\left(B_{k,n}-\hat{B}_{k,n}\right)\left[X_{G,t},\ \tilde{x}_{k,t}\right]'\\ &= \beta_{\lambda,k}^{(n)}\lambda_{G,t}+\tilde{\lambda}_{k,t}^{(n)}\end{aligned}$$

where $\beta_{\lambda,k}^{(n)}\lambda_{G,t} = n^{-1}\left(A_{k,n}-\hat{A}_{k,n}\right)+n^{-1}\left(B_{k,n}-\hat{B}_{k,n}\right)\left[X_{G,t}\right]'$ and $\tilde{\lambda}_{k,t}^{(n)} = n^{-1}\left(B_{k,n}-\hat{B}_{k,n}\right)\left[\tilde{x}_{k,t}\right]'$. In the empirical analysis, I do not observe $\lambda_{k,t}^{(n)}$ directly. Instead, I compute the convenience yield as the residual $\lambda_{k,t}^{(n)} = y_{k,t}^{(n)}-r_{k,t}^{(n)}-\delta_{k,t}^{(n)}$, using the OIS and CDS proxies described in Appendix A.11.

C.5. Government bond yields decomposition

I decompose yields into their global and country components and disentangle the impact of the *risk-free*, *default* and *convenience* for each country:

$$\begin{aligned}y_{k,t}^{(n)} &= \underbrace{r_{k,t}^{(n)}}_{Risk-free}+\underbrace{\delta_{k,t}^{(n)}}_{Default}+\underbrace{\lambda_{k,t}^{(n)}}_{Convenience}\\ &= [\underbrace{\beta_{r,k}^{(n)}r_{G,t}}_{Global\ r}+\underbrace{\tilde{r}_{k,t}^{(n)}}_{Country\ r}]+[\underbrace{\beta_{\delta,k}^{(n)}\delta_{G,t}}_{Global\ \delta}+\underbrace{\tilde{\delta}_{k,t}^{(n)}}_{Country\ \delta}]+[\underbrace{\beta_{\lambda,k}^{(n)}\lambda_{G,t}}_{Global\ \lambda}+\underbrace{\tilde{\lambda}_{k,t}^{(n)}}_{Country\ \lambda}]\\ &= \underbrace{\left[\beta_{r,k}^{(n)}r_{G,t}+\beta_{\delta,k}^{(n)}\delta_{G,t}+\beta_{\lambda,k}^{(n)}\lambda_{G,t}\right]}_{Global\ Component}+\underbrace{\left[\tilde{r}_{k,t}^{(n)}+\tilde{\delta}_{k,t}^{(n)}+\tilde{\lambda}_{k,t}^{(n)}\right]}_{Country\ Component}\end{aligned}$$

I proceed in estimating a reduced-form version of the model, where the time series of country yields is a linear function of a vector of latent state variables. As for Section 2 and following Abbritti, Dell'Erba, Moreno and Sola (2013), I can consistently estimate the factor loadings $\mathbf{A}_k^{(n)}$ and $\mathbf{B}_k^{(n)}$ by simple OLS and thus to avoid the computational burden of estimating a fully specified affine term structure model. A natural next step is to estimate a fully structural international term structure model that jointly prices *risk-free* rates, sovereign *credit risk*, and *convenience yields*.

C.6. Affine closed-form: conjecture, recursion and interpretation

The sovereign bond recursion with default and convenience is

$$P_{k,t}^{(n)} = \mathbb{E}_t^{\mathbb{Q}}\Big[\exp\Big(- r_{k,t}^{(1)} - s_{k,t} - w_{k,t}^{(n)}\Big) P_{k,t+1}^{(n-1)}\Big] \qquad P_{k,t}^{(0)} \equiv 1 \tag{47}$$

Define the maturity-n *effective discount short rate*

$$\tilde{r}_{k,t}^{(n)} \equiv r_{k,t}^{(1)} + s_{k,t} + w_{k,t}^{(n)} \tag{48}$$

Then (47) is simply

$$P_{k,t}^{(n)} = \mathbb{E}_t^{\mathbb{Q}}\Big[\exp\Big(- \tilde{r}_{k,t}^{(n)}\Big) P_{k,t+1}^{(n-1)}\Big]$$

I conjecture exponential-affine prices:

$$P_{k,t}^{(n)} = \exp\Big(A_{k,n} + B_{k,n}' X_{k,t}\Big) = \exp\Big(A_{k,n} + B_{k,n}'[X_{G,t},\ \tilde{x}_{k,t}]'\Big) \quad A_{k,0} = 0 \quad B_{k,0} = 0 \tag{49}$$

Combine (38), (44), and (46) to write the one-step exponent as an affine function of $X_{k,t}$:

$$- r_{k,t}^{(1)} - s_{k,t} - w_{k,t}^{(n)} = \tilde{a}_{k,n} + \tilde{b}_{k,n}' X_{k,t} \tag{50}$$

$$\text{where} \quad \tilde{a}_{k,n} \equiv -\delta_{0,k} - s_{0,k} - \omega_{0,k}^{(n)} \qquad \tilde{b}_{k,n} \equiv -\delta_{1,k} - s_{1,k} - \omega_{1,k}^{(n)} \tag{51}$$

Substituting (49) into (47) gives

$$P_{k,t}^{(n)} = \exp\Big(A_{k,n-1}\Big) \exp\Big(\tilde{a}_{k,n} + \tilde{b}_{k,n}' X_{k,t}\Big)\ \mathbb{E}_t^{\mathbb{Q}}\Big[\exp\Big(B_{k,n-1}' X_{k,t+1}\Big)\Big] \tag{52}$$

Under (41), conditional on $X_{k,t}$, $X_{k,t+1}$ is Gaussian. Therefore, for any b,

$$\mathbb{E}_t^{\mathbb{Q}}\Big[\exp\Big(b' X_{k,t+1}\Big)\Big] = \exp\Big(b'(\mu_k^{\mathbb{Q}} + \Phi_k^{\mathbb{Q}} X_{k,t}) + \frac{1}{2} b' \Sigma_k \Sigma_k' b\Big) \tag{53}$$

If I apply (53) with $b = B_{k,n-1}$ and match coefficients on $(1, X_{k,t})$ in (49), this yields the standard ATSM recursion:

$$\boxed{\begin{aligned} A_{k,n} &= A_{k,n-1} + \tilde{a}_{k,n} + B'_{k,n-1}\mu_k^{\mathbb{Q}} + \frac{1}{2} B'_{k,n-1}\Sigma_k\Sigma'_k B_{k,n-1} \\ B_{k,n} &= \tilde{b}_{k,n} + (\Phi_k^{\mathbb{Q}})' B_{k,n-1} \end{aligned}} \qquad (A_{k,0}, B_{k,0}) = (0,0) \tag{54}$$

Thus yields are affine:

$$y_{k,t}^{(n)} = -\frac{1}{n}\log P_{k,t}^{(n)} = -\frac{1}{n}\Big(A_{k,n} + B'_{k,n}X_{k,t}\Big) = -\frac{1}{n}\Big(A_{k,n} + B'_{k,n}[X_{G,t},\ \tilde{x}_{k,t}]'\Big) \tag{55}$$

Risk-free price. If I set $s_{k,t} \equiv 0$ and $w_{k,t}^{(n)} \equiv 0$, then I obtain:

$$\bar{P}_{k,t}^{(n)} = \exp\Big(\bar{A}_{k,n} + \bar{B}'_{k,n}X_{k,t}\Big) = \exp\Big(\bar{A}_{k,n} + \bar{B}'_{k,n}[X_{G,t},\ \tilde{x}_{k,t}]'\Big) \tag{56}$$

with recursion (54) using

$$\tilde{a}_{k,n}^{r} = -\delta_{0,k} \qquad \tilde{b}_{k,n}^{r} = -\delta_{1,k}$$

Default-only price. Set $w_{k,t}^{(n)} \equiv 0$ but keep $s_{k,t}$. Then

$$\hat{P}_{k,t}^{(n)} = \exp\Big(\hat{A}_{k,n} + \hat{B}'_{k,n}X_{k,t}\Big) = \exp\Big(\hat{A}_{k,n} + \hat{B}'_{k,n}[X_{G,t},\ \tilde{x}_{k,t}]'\Big) \tag{57}$$

with recursion (54) using

$$\tilde{a}_{k,n}^{\delta} = -\delta_{0,k} - s_{0,k} \qquad \tilde{b}_{k,n}^{\delta} = -\delta_{1,k} - s_{1,k}$$

Government bond yield decomposition. Using (56)–(57) and the full price (49), define:

$$r_{k,t}^{(n)} \equiv -\frac{1}{n}\log \bar{P}_{k,t}^{(n)} \tag{58}$$

$$\delta_{k,t}^{(n)} \equiv -\frac{1}{n}\log \hat{P}_{k,t}^{(n)} + \frac{1}{n}\log \bar{P}_{k,t}^{(n)} \tag{59}$$

$$\lambda_{k,t}^{(n)} \equiv -\frac{1}{n}\log P_{k,t}^{(n)} + \frac{1}{n}\log \hat{P}_{k,t}^{(n)} \tag{60}$$

Then the yield decomposition holds identically:

$$y_{k,t}^{(n)} = \underbrace{r_{k,t}^{(n)}}_{Risk-free} + \underbrace{\delta_{k,t}^{(n)}}_{Default} + \underbrace{\lambda_{k,t}^{(n)}}_{Convenience}$$