

What Drives Brazilian Term Premia?

Evidence from Nominal, Real, and Inflation Risk Premia

Gustavo Silva Araujo^{*}

Lucas Hill[†]

Abstract

This paper investigates the macro-financial determinants of Brazilian term premia by decomposing the nominal term premium into the real term premium and the inflation risk premium. We jointly estimate nominal and real yield curves using the affine framework of Abrahams et al. (2016), implemented through the linear-regression approach of Adrian, Crump, and Moench (2013), and include an observable factor that captures relative liquidity in inflation-indexed bonds. The decomposition reveals that the macro-financial relationships observed for the aggregate nominal premium reflect economically distinct underlying channels. The real term premium is positively associated with the U.S. real interest rate, the slope of the U.S. yield curve, public debt, and the exchange rate, and negatively associated with the domestic policy rate and survey-based inflation expectations. By contrast, the inflation risk premium is positively associated with inflation expectations, the policy rate, and global risk aversion. Thus, variables associated with the nominal premium may operate through different, and sometimes offsetting, real-rate and inflation-risk channels. Time-series evidence further shows that the relationships of the nominal premium and its components with domestic monetary, inflation, fiscal, and external factors vary substantially over time. The results deepen the monetary-policy interpretation of movements in long-term Brazilian yields and show why the aggregate nominal term premium can be an incomplete guide to the risks priced by investors in emerging-market government bonds.

Keywords: Yield curve; term premium; real term premium; inflation risk premium; monetary policy; emerging markets.

JEL codes: E43; E44; E52; G12; H63.

^{*} Banco Central do Brasil and FGV EPGE Brazilian School of Economics and Finance

[†] SPX Capital.

1. Introduction

Long-term nominal interest rates combine expectations about future short-term real rates and inflation with compensation for bearing risks over the investment horizon. This distinction is particularly important in emerging markets, where changes in long yields may reflect shifts in monetary-policy expectations, inflation credibility, fiscal risk, or external financial conditions. A movement in the nominal yield alone cannot identify which of these forces is responsible. Even the nominal term premium, obtained after removing expected future nominal short rates, remains an aggregate object that combines economically different sources of risk.

Recent research has made considerable progress in estimating the Brazilian nominal term premium and identifying its macro-financial correlates. Costa Filho (2023) examines the determinants of the 10-year nominal term premium using an alternative affine term structure model, while Araujo et al. (2025) apply the ACM framework to the five-year nominal term premium. Araujo et al. (2025) show that domestic interest rates, inflation expectations, public debt, U.S. interest rates, the exchange rate, and global volatility help explain the premium embedded in Brazilian nominal bonds. That evidence is informative, but it leaves open a central question in monetary economics: when the nominal premium changes, is the market repricing real-rate risk, inflation risk, or both? The aggregate nominal premium cannot answer this question because it combines the real term premium and the inflation risk premium. The model follows the joint affine decomposition of Abrahams et al. (2016), operationalized with the linear-regression procedure of Adrian, Crump, and Moench (2013). It uses prices of fixed-rate federal government bonds and inflation-indexed bonds together with an observable measure of relative liquidity. The liquidity measure controls for differences between the two market segments but plays only a limited quantitative role in the decomposition of Brazilian yields. The reference maturity for the determinants analysis is five years, a segment that balances economic relevance, data quality, and market liquidity.

This paper lies at the intersection of two strands of the literature. The first concerns the estimation and macro-financial determinants of nominal term premia, particularly in emerging markets (Iania et al., 2021; Ozbek and Talasli, 2020; Aguilar-Arguez et al., 2022; Araujo et al., 2025). The second comprises studies that jointly model nominal and inflation-indexed yield curves to separate expected inflation, real-rate risk compensation, and inflation risk compensation (Abrahams et al., 2016; Vicente and Kubudi, 2018; Caldeira and Cordeiro, 2026). Although both strands provide important insights into the behavior of long-term interest rates, they have remained largely separate in the Brazilian literature. We connect them by examining whether the macro-financial variables associated with the Brazilian nominal term premium operate through the real term premium, the inflation risk premium, or both.

Our central result is that different macro-financial forces underlie movements in the two components of the nominal term premium. The real term premium is positively associated with the U.S. real interest rate, the slope of the U.S. yield curve, public debt, and the USD/BRL exchange rate, while it is negatively associated with the Selic policy rate and survey-based inflation expectations. By contrast, the inflation risk premium is positively associated with inflation expectations, the Selic policy rate, and the VIX. These differences are not a minor statistical detail. They imply that changes in the aggregate nominal premium may arise from fundamentally different underlying risks and that aggregate relationships can conceal offsetting effects across the real and inflation components.

The contrasting Selic and inflation-expectations coefficients illustrate the economic importance of this decomposition. Both variables are positively associated with the inflation risk premium but negatively associated with the real term premium. Viewed only through the nominal premium, these opposing relationships may be obscured or difficult to interpret. Once the premium is decomposed, its monetary-policy interpretation becomes clearer: a higher policy rate and higher inflation expectations are associated with greater compensation for inflation risk and, at the same time, lower compensation for real-rate risk, conditional on the other covariates. The coefficients represent reduced-form predictive associations rather than causal effects, but their cross-component pattern contains information that is unavailable in the aggregate nominal premium.

The results also connect Brazilian monetary dynamics to the broader emerging-market environment. The real premium is especially sensitive to global real rates, the slope of the U.S. yield curve, the exchange rate, and public debt. This pattern is consistent with an economy in which international discount rates, capital-flow conditions, fiscal capacity, and currency depreciation affect the compensation required for exposure to long-duration real interest-rate risk. Inflation risk, by contrast, is more closely linked to domestic expectations and the policy rate, while also responding to global risk aversion. Thus, the emerging-market setting does not merely add volatility to the analysis. It helps explain why global and domestic variables enter different components of the nominal premium.

The paper makes three contributions. First, it provides a unified analysis of the determinants of the Brazilian nominal term premium and its real and inflation-risk components within the same no-arbitrage framework. To our knowledge, this is the first study for Brazil to examine systematically whether the determinants of the nominal term premium operate through real-rate risk, inflation risk, or both.¹ Second, it shows that earlier evidence on the determinants of the nominal term premium can be understood as the net outcome of two distinct channels: compensation for real-rate risk and compensation for inflation risk. Third, it examines how the relationships of the nominal term premium and its two components with the domestic policy rate, inflation expectations, fiscal variables, and external factors evolve over time. The emphasis is therefore not only on what predicts the nominal premium, but also on whether each predictive relationship reflects real-rate risk, inflation risk, or both.

The remainder of the paper is organized as follows. Section 2 reviews the related literature and develops the paper's monetary-economics motivation. Section 3 presents the joint nominal-real affine model and the decomposition of term premia. Section 4 describes the data, the Brazilian government-bond market, and the liquidity measure. Section 5 compares the estimated premia. Section 6 studies their determinants. Section 7 examines the time variation in the estimated relationships and discusses their monetary-policy and emerging-market interpretation. Section 8 concludes.

2. Related Literature and Economic Motivation

This section reviews the literature most closely related to our analysis and develops the economic motivation for the empirical investigation. Section 2.1 discusses the estimation of time-varying term premia, with particular emphasis on affine term structure models and their application to Brazil. Section 2.2 reviews the joint modeling of nominal and inflation-indexed yield curves and the distinction between real-rate and inflation-risk compensation. Section 2.3 places these components in an emerging-market context and discusses the domestic and global channels that may shape their dynamics.

2.1 Term-premium estimation

Modern empirical work on the term structure separates long-term yields into an expectations component and a time-varying term premium. The pure expectations hypothesis, under which long yields are averages of expected future nominal short rates, has been rejected in both advanced and emerging economies (Campbell and Shiller, 1991). In Brazil, evidence against the pure hypothesis provides a direct rationale for models in which risk compensation varies over time (Tabak and Andrade, 2003; Brito et al., 2004; Marcal and Pereira, 2007).

Affine term structure models impose cross-maturity restrictions consistent with the absence of arbitrage and allow expected future short rates to be separated from time-varying risk compensation (Duffie and Kan, 1996; Dai and Singleton, 2000; Duffee, 2002). However, conventional likelihood-based estimation can be numerically difficult. Adrian, Crump, and Moench (2013) develop a three-step linear-regression procedure that preserves the affine structure while making estimation transparent and computationally tractable. Their method has become a benchmark for extracting nominal term premia. Araujo et al. (2025) apply it to Brazilian fixed-rate government bonds and document a substantial role for both domestic and external variables in the five-year nominal premium.

A nominal-only model cannot separately identify real-rate and inflation risks. Joint models of nominal and inflation-indexed bonds address this limitation. Abrahams et al. (2016) develop a regression-based affine framework for jointly pricing nominal and inflation-indexed bonds with common factors while allowing for an observable liquidity factor in inflation-indexed securities. This setup decomposes nominal yields into expected real short rates, expected inflation, the real term premium, and the inflation risk premium, while separately accounting for relative liquidity in inflation-indexed bonds. The approach is especially suitable for our question because all risk components are estimated within a common no-arbitrage environment.

2.2 Real-rate and inflation-risk compensation

The distinction between the real term premium and the inflation risk premium is economically consequential. The real term premium compensates investors for bearing uncertainty associated with future real short rates and the valuation of long-duration real payoffs. It may therefore respond to monetary-policy uncertainty, global real rates, fiscal conditions, and external financing constraints. The inflation risk premium compensates nominal-bond investors for exposure to inflation outcomes that affect the real value of nominal payoffs, particularly when those outcomes occur in adverse economic states. It is therefore naturally linked to inflation expectations, uncertainty about future inflation, central-bank credibility, and the distribution of inflation outcomes.

For Brazil, Vicente and Kubudi (2018) estimate nominal and real curves jointly using survey information and show that jointly modeling the two segments helps extract inflation compensation. Caldeira and Cordeiro (2026) use a price-based joint decomposition and emphasize inflation forecasting. Our emphasis differs from these studies because we use the decomposition to investigate the macro-financial determinants of each source of risk compensation. In that sense, the paper extends the determinants literature rather than treating the decomposition primarily as a forecasting device.

This perspective also clarifies the relation with Araujo et al. (2025). Their analysis of the nominal term premium provides a natural benchmark and a consistent set of explanatory variables for examining its underlying components. We extend that analysis by investigating whether the macro-financial variables

associated with the nominal term premium are related to the real term premium, the inflation risk premium, or both. Because the nominal term premium is the sum of these two components, the comparison reveals whether an aggregate association reflects real-rate risk, inflation risk, or potentially offsetting relationships across the two.

2.3 Emerging-market channels

Emerging-market term premia are shaped by the interaction of local fundamentals and global financial conditions. Evidence for emerging economies highlights inflation, market liquidity, macroeconomic uncertainty, global risk, and U.S. term premia as relevant drivers (Ozbek and Talasli, 2020; Iania et al., 2021; Aguilar-Arguez et al., 2022). Brazil provides a useful setting because it combines a deep domestic government-bond market with historically large variation in inflation, policy rates, fiscal indicators, exchange rates, and exposure to global risk cycles.

The emerging-market interpretation suggests several cross-component relationships to be examined empirically. U.S. real yields and the slope of the U.S. yield curve may be particularly relevant to real-rate risk compensation. Currency depreciation can raise real financing costs and interact with fiscal and external vulnerability, but it may also affect inflation risk through exchange-rate pass-through. Public debt may be more closely connected to long-horizon real-rate compensation when investors view fiscal developments as altering future real rates, taxation, or debt supply. Conversely, inflation expectations and the policy rate may be particularly informative about inflation-risk compensation. The sign of the policy-rate relationship is ultimately an empirical question because a higher Selic may signal both a stronger stabilization response and greater underlying inflationary pressure.

These considerations guide the interpretation of the empirical analysis that follows. The central comparison is whether the same macro-financial variables are associated with the real term premium and the inflation risk premium in similar ways or whether the decomposition reveals distinct relationships that are concealed by the aggregate nominal premium. Because the analysis identifies conditional predictive associations rather than structural causal effects, the results should be interpreted as evidence on the composition of risk compensation, not as causal estimates of the underlying transmission mechanisms.

3. Methodology

This section presents the empirical framework used to estimate and decompose Brazilian term premia. Section 3.1 summarizes the regression-based affine term structure model of Adrian, Crump, and Moench (2013). Section 3.2 describes the joint estimation of nominal and real yield curves following Abrahams et al. (2016) and defines the nominal term premium, the real term premium, and the inflation risk premium. Section 3.3 explains how relative liquidity in inflation-indexed bonds is incorporated into the joint model. Finally, Section 3.4 presents the reduced-form approach used to investigate the macro-financial determinants of the three premia.

3.1 The ACM framework

Let X_t denote a K -dimensional vector of pricing factors extracted from the yield curves. Under the physical probability measure, the factors follow a first-order vector autoregression:

$$X_{t+1} = \mu + \Phi X_t + v_{t+1}, \quad v_{t+1} \sim N(0, \Sigma) \quad (1)$$

The absence of arbitrage implies an exponentially affine stochastic discount factor. With essentially affine prices of risk, the market price of factor innovations is written as:

$$\lambda_t = \Sigma^{-1/2}(\lambda_0 + \lambda_1 X_t). \quad (2)$$

The log excess holding return on a bond can then be represented as a function of lagged factors, contemporaneous factor innovations, a convexity adjustment, and a pricing error. The ACM estimator proceeds in three linear steps. First, the VAR is estimated and factor innovations are recovered. Second, excess returns are regressed on lagged factors and contemporaneous innovations to estimate risk exposures. Third, the market prices of risk are recovered from cross-sectional regressions. The procedure yields model-implied yields under the physical and risk-neutral measures and therefore separates expected short-rate paths from term premia. For a complete derivation of the model, the no-arbitrage restrictions, and the three-step estimator, see Adrian, Crump, and Moench (2013).

For a nominal zero-coupon bond with maturity m , let $MIY_{t,m}^{Nom}$ denote the model-implied nominal yield and $RNY_{t,m}^{Nom}$ the corresponding risk-neutral nominal yield. The nominal term premium is defined as:

$$TP_{t,m}^{Nom} = MIY_{t,m}^{Nom} - RNY_{t,m}^{Nom} \quad (3)$$

The risk-neutral yield is computed under the risk-neutral dynamics implied by the estimated model. The difference between the model-implied and risk-neutral yields therefore measures the compensation investors require for bearing nominal interest-rate risk over the bond's maturity.

3.2 Joint nominal and real estimation

We implement the joint nominal-real affine term structure model of Abrahams et al. (2016), which extends the regression-based approach of Adrian, Crump, and Moench (2013) to the joint pricing of nominal and inflation-indexed bonds. A common state vector prices nominal and inflation-indexed government bonds. In the empirical implementation, three principal components summarize the nominal yield curve. Two additional principal components summarize the variation in the real yield curve after it has been orthogonalized with respect to the nominal factors and the observable liquidity measure. The sixth factor is the liquidity indicator itself. The resulting state vector therefore contains three nominal factors, two real-curve-specific factors, and one liquidity factor. This structure permits common shocks to affect both markets while preserving information specific to the real segment.

The joint system is estimated at a daily frequency using one-month nominal excess holding returns for bond maturities between six and 120 months and one-month real excess holding returns for maturities between 24 and 120 months. The real segment begins at 24 months because short-maturity inflation-indexed bonds are particularly affected by indexation lags and sparse issuance. Model-implied yields and term-premium estimates are converted from log rates into annualized simple rates for consistency with Brazilian market conventions. For the determinants analysis, the daily five-year premium estimates are averaged over each calendar month, as described in Section 4.1.

The real term premium is defined analogously to the nominal term premium as the difference between the model-implied real yield and its risk-neutral counterpart. The inflation risk premium is then defined as the difference between the nominal and real term premia at the same maturity:

$$IRP_{t,m} = TP_{t,m}^{Nom} - TP_{t,m}^{Real} \quad (4)$$

Hence, the nominal term premium satisfies the accounting identity:

$$TP_{t,m}^{Nom} = TP_{t,m}^{Real} + IRP_{t,m} \quad (5)$$

All three premia are expressed under the same rate convention, and the inflation risk premium is computed as the difference between the nominal and real term premia, ensuring that equation (5) holds by construction. This identity is central to the empirical design. It provides three related dependent variables and makes it possible to examine whether an aggregate nominal association reflects real-rate risk, inflation risk, or offsetting relationships across the two components.

3.3 Relative-liquidity factor

Inflation-indexed and nominal government bonds may differ in liquidity. Ignoring these differences could cause liquidity compensation to be incorrectly attributed to the inflation risk premium. Following Abrahams et al. (2016), we therefore include an observable relative-liquidity factor constructed from secondary-market information.

The first signal is the log ratio of trading volume in nominal bonds to trading volume in inflation-indexed bonds. The second is the positive square root of the aggregate fitting-error measure for the real zero-coupon yield curve, obtained from the Nelson-Siegel-Svensson objective function. Both signals are smoothed, winsorized, and standardized. When trading-volume data adequately represent secondary-market activity, the two standardized signals are combined with equal weights. For ease of interpretation, Figure 1 reports the inverse volume ratio, namely the trading volume of inflation-indexed bonds relative to that of nominal bonds.

The direction of the liquidity comparison is particularly relevant in Brazil. Unlike the early U.S. TIPS market, Brazilian inflation-indexed bonds represent a substantial share of federal public debt and frequently exhibit considerable trading volume relative to fixed-rate securities. Figure 1 illustrates the relative importance of inflation-indexed bonds in secondary-market trading, while Figure 2 compares the share of inflation-indexed securities in the public debt of Brazil and the United States. Together, these figures show that inflation-indexed bonds constitute a significant and comparatively liquid segment of the Brazilian government-bond market.

Despite the importance of this market segment, the estimated liquidity component is quantitatively small relative to the other components of the yield decomposition. As shown in Figure 3, liquidity compensation accounts for only a small share of the modeled nominal yield across maturities. We therefore retain the relative-liquidity factor to avoid confounding inflation risk compensation with liquidity differences between nominal and inflation-indexed bonds, but do not treat liquidity as a central object of the empirical analysis.

Figure 1. Ratio of trading volume in inflation-indexed bonds to trading volume in fixed-rate bonds.

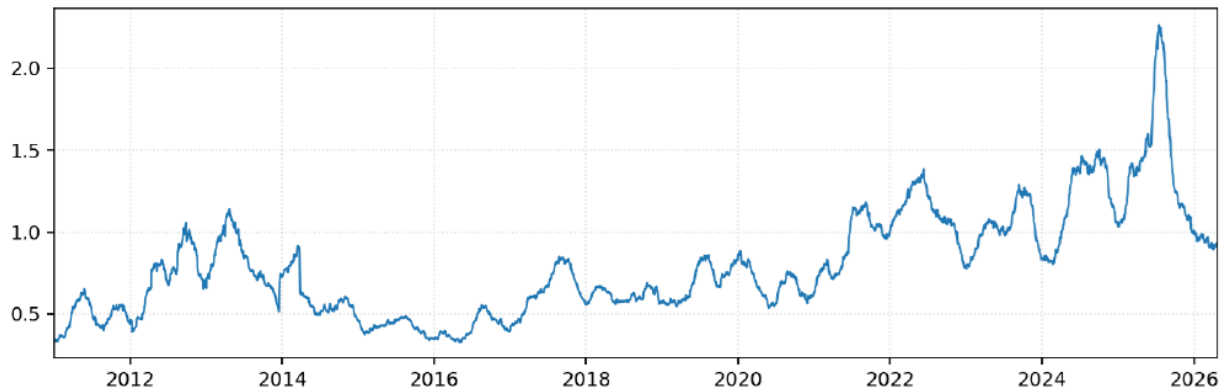


Figure 2. Share of inflation-indexed securities in federal public debt: Brazil and the United States.

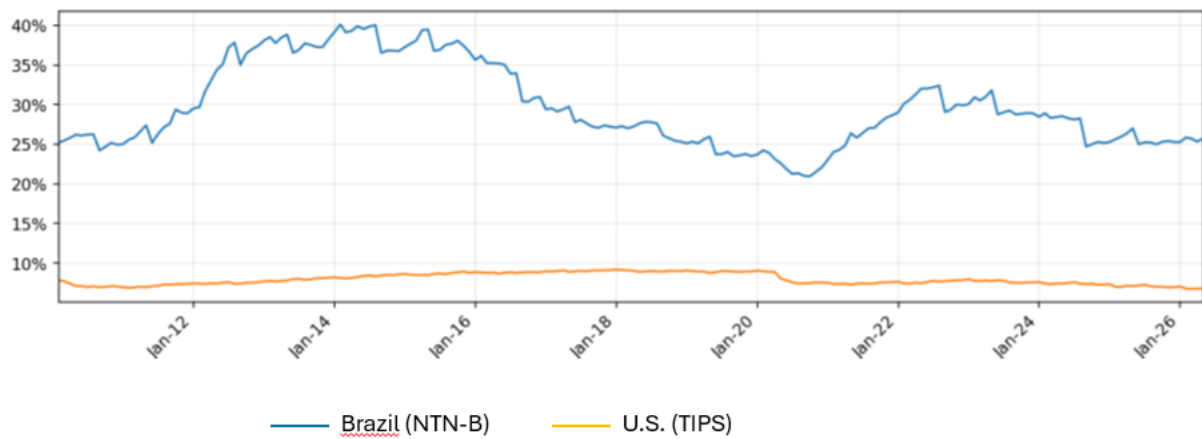
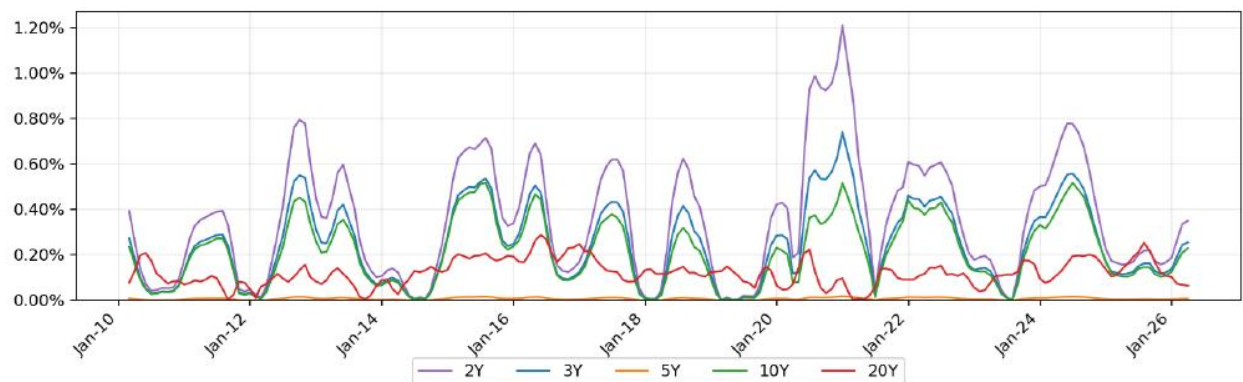


Figure 3. Estimated liquidity component as a share of the modeled nominal yield, by maturity.



3.4 Reduced-form determinants

We estimate separate monthly reduced-form regressions for the five-year nominal term premium, real term premium, and inflation risk premium:

$$TP_t^j = \alpha^j + \beta_1^j \pi_{t-1} + \beta_2^j i_{t-1} + \beta_3^j i_{t-1}^* + \beta_4^j f_{t-1} + \beta_5^j y_{t-1} + \beta_6^j s_{t-1} + \beta_7^j E_{t-1} + \beta_8^j C_{t-1} + \beta_9^j V_{t-1} + \varepsilon_t^j \quad (6)$$

In this specification, TP_t^j denotes premium j , where j refers to the nominal term premium, the real term premium, or the inflation risk premium. The explanatory-variable groups represent inflation or inflation expectations (π), domestic interest rates (i), U.S. interest rates (i^*), fiscal conditions (f), economic activity (y), equity-market conditions (s), the exchange rate (E), commodity prices (C), and global volatility (V). All explanatory variables enter with a one-month lag. The notation is intended to summarize the groups of macro-financial variables considered across specifications; not all variables are included simultaneously in every model.

Financial-price variables enter as monthly percentage changes when appropriate, whereas interest rates, inflation variables, debt ratios, and the VIX enter in levels. Section 4 provides the precise definition and transformation of each regressor.

All models are estimated by ordinary least squares with Newey-West heteroskedasticity- and autocorrelation-consistent standard errors. The coefficients should be interpreted as conditional predictive associations rather than structural causal effects. Lagging the regressors mitigates contemporaneous simultaneity concerns but does not provide an external source of identification.

We estimate seven specifications that progressively expand the information set. The specifications introduce survey-based inflation expectations, replace the U.S. nominal yield with the five-year TIPS yield, combine the TIPS yield with the U.S. 10-year-minus-2-year slope, add domestic long-term financing, fiscal, and activity variables, and finally include a broader set of financial and external controls. The seventh specification is a data-reduced version of the broad sixth specification, retaining variables that are statistically significant at the 10 percent level.

Specifications estimated with a common information set provide a consistent basis for comparing coefficients across the nominal term premium, the real term premium, and the inflation risk premium. Because the three premia satisfy an accounting identity, using the same sample and the same set of regressors allows the aggregate nominal relationship to be mapped directly into its real and inflation-risk components. We also report outcome-specific parsimonious specifications to summarize the strongest conditional predictors of each premium. Because variable selection is outcome-specific, comparisons across the parsimonious specifications are interpreted cautiously.

4. Data and Measurement

This section describes the data used to estimate the joint term structure model and investigate the macro-financial determinants of the three premia. Section 4.1 presents the nominal and inflation-indexed government-bond data, the construction of the zero-coupon yield curves, and the choice of the five-year reference maturity. Section 4.2 describes the domestic and international macro-financial variables used in the determinants analysis, together with their sources and transformations. Section 4.3 evaluates the fit of the joint model and presents pricing-error diagnostics for the nominal and real yield curves.

4.1 Government-bond data and yield curves

The bond sample comprises Brazilian fixed-rate federal government securities, LTNs and NTN-Fs, and inflation-indexed securities, NTN-Bs. Prices and yields are obtained primarily from the Brazilian Financial and Capital Markets Association (ANBIMA). Inflation-adjustment values for NTN-Bs and secondary-market trading volumes are obtained from the Banco Central do Brasil. Bloomberg quotations are used for complementary information and consistency checks when necessary.

The joint nominal-real sample begins in February 2010, when both the real yield curve and the information required to construct the relative-liquidity factor become available, and extends through June 19, 2026. The common sample permits direct comparison of the nominal term premium, the real term premium, and the inflation risk premium over an identical set of dates.

We construct daily nominal and real zero-coupon yield curves using the Nelson-Siegel-Svensson specification as a cross-sectional interpolation method. The fitted curves provide yields at constant maturities, while principal components extracted from these curves constitute the state variables of the joint affine term structure model.

Nominal and real zero-coupon yield curves and the corresponding term premia are estimated at a daily frequency. For the determinants analysis, the daily estimates of the five-year nominal term premium, real term premium, and inflation risk premium are averaged over each calendar month. This procedure follows Araujo et al. (2025), reduces the influence of idiosyncratic daily movements, and aligns the estimated premia with the monthly periodicity of the macro-financial regressors.

The final monthly observation is based on the daily premium estimates available through June 19, 2026. Because all explanatory variables enter with a one-month lag, the June 2026 premium observation is matched with macro-financial information from May 2026. The inclusion of this partial-month average allows the determinants analysis to use all available term-premium information.

The empirical analysis focuses on the five-year maturity. This maturity is sufficiently long to capture economically meaningful risk compensation and matches the maturity examined in Araujo et al. (2025), facilitating comparison with earlier evidence on the determinants of the Brazilian nominal term premium. At the same time, the five-year maturity avoids the greater sparsity of very long fixed-rate government bonds during the earlier part of the sample. Evidence across maturities is nevertheless reported to assess whether the main patterns are specific to a single point on the yield curve.

4.2 Macroeconomic and financial variables

The explanatory dataset combines domestic macroeconomic variables, Brazilian financial-market indicators, fiscal variables, and measures of international financial conditions. The domestic variables include realized and expected inflation, the Selic policy rate, the Long-Term Rate (TLP), public-debt indicators, the primary balance, economic activity, equity-market conditions, and the USD/BRL exchange rate. Survey-based inflation expectations are obtained from the Banco Central do Brasil's Focus Survey.

International variables include U.S. nominal and real interest rates, the slope of the U.S. yield curve, developed-market equity returns, commodity prices, the U.S. dollar index, and the VIX. These variables capture different dimensions of the external environment relevant to an emerging economy, including global real discount rates, the international term structure of interest rates, international equity-market conditions, commodity-price movements, broad dollar fluctuations, and global risk aversion.

Survey-based inflation expectations enter only after the term-premium model has been estimated. They are not imposed as identifying restrictions on the physical dynamics of the joint affine system. This separation allows survey expectations to be examined as potential determinants of the estimated premia without mechanically influencing their construction. Similarly, the TLP is interpreted as an institutional measure of long-term domestic financing conditions rather than as a market-based risk-free interest rate. Before the introduction of the TLP in January 2018, the Long-Term Interest Rate (TJLP) is used to construct a continuous series.

Financial-price variables, including the equity indexes, exchange rates, and commodity prices, enter as monthly percentage returns. Interest rates, inflation variables, public-debt ratios, the primary balance, the IBC-Br output gap, and the VIX enter in levels. All explanatory variables are lagged by one month relative to the dependent variable. This timing convention mitigates contemporaneous simultaneity concerns, although it does not provide an external source of causal identification.

Table 1 reports the definition, unit of measurement, transformation, and source of each macro-financial variable used in the empirical analysis. To preserve comparability with Araujo et al. (2025), we retain the same variable definitions and sequence of empirical specifications whenever data availability permits. The estimation period is adapted to the common sample required by the joint nominal-real model.

Table 1. Definitions, transformations, and sources of macro-financial variables

Variable	Definition	Unit	Transformation	Source
IPCA inflation	Twelve-month accumulated change in the Broad National Consumer Price Index	%	Level	IBGE / Banco Central do Brasil
Focus inflation expectations	Median survey expectation for IPCA inflation one year ahead	% p.a.	Level	Banco Central do Brasil, Focus Survey
Selic	Brazilian monetary policy rate	% p.a.	Level	Banco Central do Brasil
TLP	Brazilian Long-Term Rate; the TJLP is used before the	% p.a.	Level	BNDES / Banco Central do Brasil

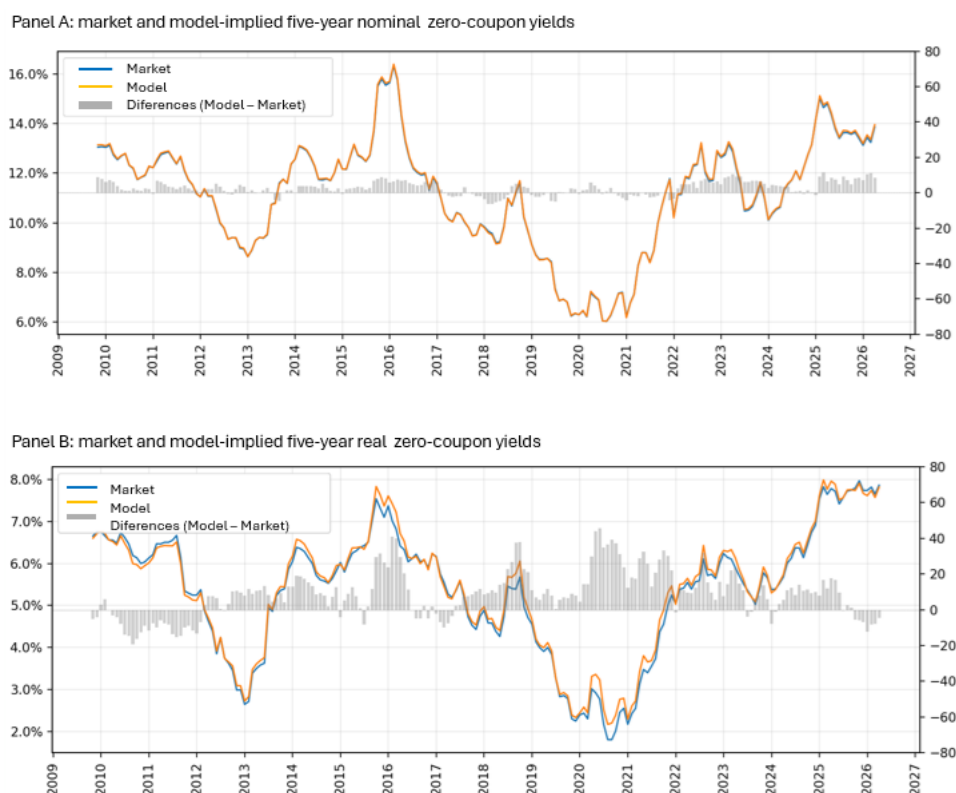
	introduction of the TLP in January 2018			
U.S. 10-year Treasury yield	Yield on the 10-year U.S. Treasury security	% p.a.	Level	Federal Reserve / Bloomberg
U.S. 5-year TIPS yield	Yield on five-year U.S. Treasury Inflation-Protected Securities	% p.a.	Level	Federal Reserve / Bloomberg
U.S. yield-curve slope	Difference between the 10-year and 2-year U.S. Treasury yields	Percentage points	Level	Federal Reserve / Bloomberg
Primary balance	Public-sector primary balance	% of GDP	Level	Banco Central do Brasil
Gross public debt	General government gross debt as a share of GDP	% of GDP	Level	Banco Central do Brasil
Net public debt	Public-sector net debt as a share of GDP	% of GDP	Level	Banco Central do Brasil
IBC-Br output gap	Output gap estimated as the cyclical component of the seasonally adjusted monthly IBC-Br series using the Hodrick-Prescott filter	Percentage deviation from trend	Level	Banco Central do Brasil
Ibovespa	B3 benchmark equity index	Index points	Monthly percentage return	B3 / Bloomberg
MSCI Developed Markets	MSCI index for developed equity markets	Index points	Monthly percentage return	MSCI / Bloomberg
USD/BRL exchange rate	Brazilian reais per U.S. dollar	BRL per USD	Monthly percentage return	Banco Central do Brasil
DXY	U.S. Dollar Index against a basket of major currencies	Index points	Monthly percentage return	ICE / Bloomberg
CRB	FTSE/CoreCommodity CRB Index	Index points	Monthly percentage return	Bloomberg
WTI	West Texas Intermediate crude oil price	USD per barrel	Monthly percentage return	Bloomberg
VIX	CBOE index of implied volatility derived from S&P 500 options	Index points	Level	CBOE / Bloomberg

Notes: IPCA denotes the Broad National Consumer Price Index; TLP denotes the Long-Term Rate; TJLP denotes the Long-Term Interest Rate; TIPS denotes Treasury Inflation-Protected Securities; DXY denotes the U.S. Dollar Index; CRB denotes the FTSE/CoreCommodity CRB Index; and WTI denotes West Texas Intermediate. Financial-price variables enter as monthly percentage returns, whereas interest rates, inflation variables, public-debt ratios, the primary balance, the IBC-Br output gap, and the VIX enter in levels. All explanatory variables are lagged by one month relative to the dependent variable.

4.3 Model fit and pricing-error diagnostics

Figure 4 compares the model-implied five-year nominal and real yields with the corresponding zero-coupon yields obtained from the Nelson-Siegel-Svensson curves. The model-implied yields closely track the fitted curves in both market segments, although the fit is generally tighter for nominal yields. The close correspondence at the five-year maturity indicates that the joint affine model captures the main time-series variation in the nominal and inflation-indexed market segments relevant to the determinants analysis.

Figure 4. Nelson-Siegel-Svensson and model-implied five-year zero-coupon yields: nominal bonds (Panel A) and inflation-indexed bonds (Panel B).



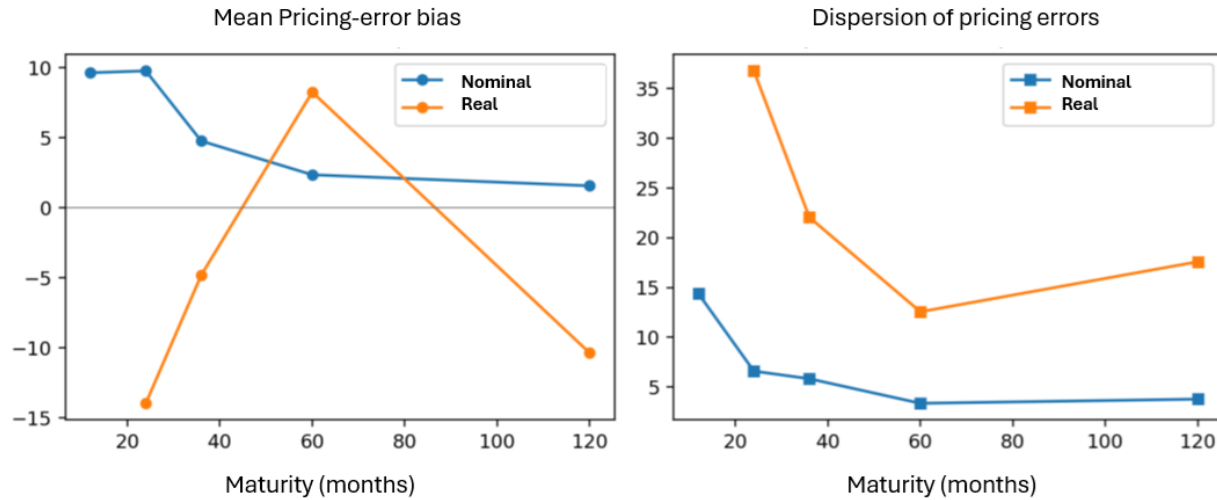
Notes: The figure compares five-year zero-coupon yields obtained from the Nelson-Siegel-Svensson curves with the corresponding yields implied by the joint affine term structure model. Panel A presents nominal yields, and Panel B presents real yields derived from inflation-indexed bonds. Yields are expressed as annual percentages. The sample runs from February 2010 through June 19, 2026.

Figure 5 presents the mean and dispersion of pricing errors across maturities for the nominal and real yield curves. Pricing errors are generally smaller in the nominal segment. In the real segment, both the mean pricing error and its dispersion are largest at 24 and 36 months. This pattern is consistent with the relatively sparse issuance of short-maturity inflation-indexed bonds and the effects of inflation-indexation lags on bonds approaching maturity.

At the five-year maturity, pricing errors are appreciably smaller than at the shortest real maturities. This result provides additional support for using five years as the reference maturity in the determinants analysis. The selected maturity combines economic relevance with comparatively reliable measurement in both the nominal and inflation-indexed market segments.

Pricing errors also display persistence over time and should therefore not be interpreted as independent noise around the fitted curves. Nonetheless, their magnitude at the five-year maturity is sufficiently small for an analysis centered on broad time-series movements and monthly macro-financial associations. Estimates for the shortest real maturities should be interpreted more cautiously.

Figure 5. Pricing errors across maturities: mean error (Left Panel) and error dispersion (Right Panel).



Notes: Pricing errors are defined as the difference between the zero-coupon yields obtained from the Nelson-Siegel-Svensson curves and the corresponding model-implied yields. The figure reports the mean and dispersion of pricing errors by maturity for nominal and inflation-indexed bonds. Errors are expressed in basis points.

5. Nominal and Real Term Premia and the Inflation Risk Premium

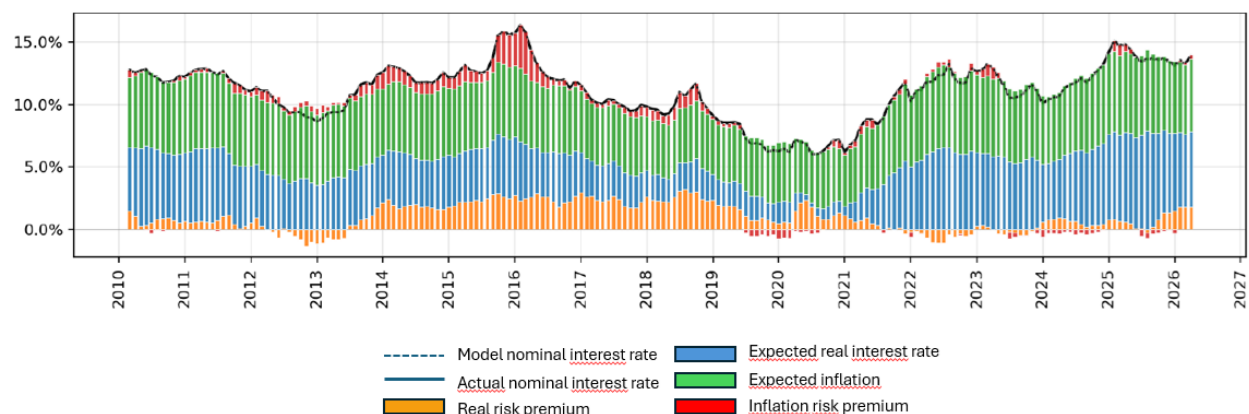
This section presents the term-premium estimates generated by the joint nominal-real model. Section 5.1 examines the decomposition of the five-year nominal yield into expectations and risk-compensation components. Section 5.2 compares the dynamics of nominal, real, and inflation risk premia across maturities. Section 5.3 describes the pricing factors used in the joint model and reports specification tests for their relevance in the bond-return equations.

5.1 Decomposition of the five-year nominal yield

Figure 6 presents the decomposition of the five-year nominal yield into expected real short rates, expected inflation, the real term premium, and the inflation risk premium. Relative liquidity is controlled for in the pricing block for inflation-indexed bonds. The decomposition separates expected macroeconomic paths from the compensation investors require for bearing uncertainty around those paths. It also provides the accounting bridge between the literature on aggregate nominal term premia and the component-level analysis developed in this paper.

The decomposition shows substantial variation in both risk components over the sample. The nominal term premium cannot be understood as a scaled version of either component. At some points, real-rate risk accounts for a larger share of nominal risk compensation; at others, inflation risk is more prominent. The two components can also move in opposite directions, illustrating why movements in the aggregate nominal premium need not have a unique economic interpretation.

Figure 6. Decomposition of the five-year nominal yield into expectations and risk-compensation components.



5.2 Dynamics across maturities

Figure 7 presents the slope of the nominal term-premium curve, measured as the difference between the 10-year and 2-year nominal term premia. The slope is not always positive and displays episodes of compression, steepening, and inversion. The affine model does not impose monotonicity on term premia. An inverted term-premium curve arises when the difference between the model-implied and risk-neutral yields is smaller at longer maturities. Comparable inversions around the pandemic have been documented in other markets, so a negative slope should not automatically be interpreted as evidence of model misspecification.

Figure 7. Slope of the nominal term-premium curve: 10-year minus 2-year premium.



Figure 8 compares real term premia across maturities, while Figure 9 reports their 24-month rolling volatility. The long end of the real term-premium curve displays a distinctive pattern: the 20-year real term premium is often below the corresponding premia at shorter maturities, even though its rolling volatility can be higher. One possible interpretation is segmentation and preferred-habitat demand in the inflation-indexed bond market. Brazilian pension funds and other long-duration investors may exert sustained demand for long-maturity NTN-Bs, compressing their yields relative to model-implied risk-

neutral rates. This interpretation is suggestive and does not substitute for a structural preferred-habitat model, but it cautions against interpreting a lower long-maturity real term premium as evidence of lower underlying uncertainty.

Figure 8. Real term premia across maturities.



Figure 9. 24-month rolling volatility of real term premia across maturities.

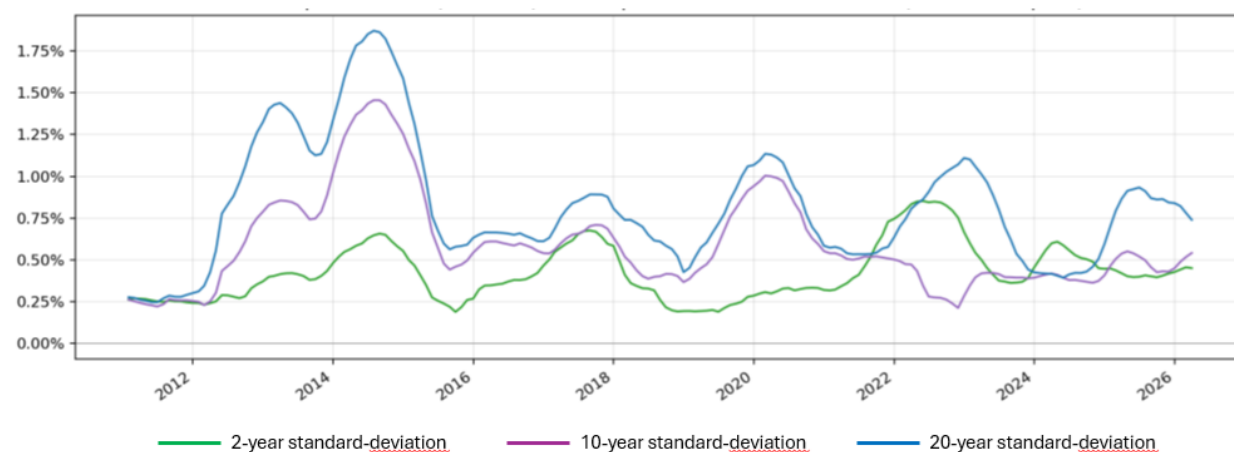


Figure 10 compares inflation risk premia across maturities with Brazil's official inflation target, while Figure 11 presents the slope of the inflation-risk-premium curve, measured as the difference between the 20-year and 10-year premia. Inflation risk premia at several maturities decline before and during the period in which the official inflation target was gradually reduced. The timing is consistent with improved anchoring of long-term inflation expectations, although the descriptive evidence does not identify a causal effect of changes in the inflation target. Later in the sample, shorter-maturity inflation risk premia become more responsive to renewed inflationary pressures and changes in the monetary-policy environment, while the slope at the very long end remains comparatively contained.

Figure 10. Inflation risk premia across maturities and Brazil's official inflation target.

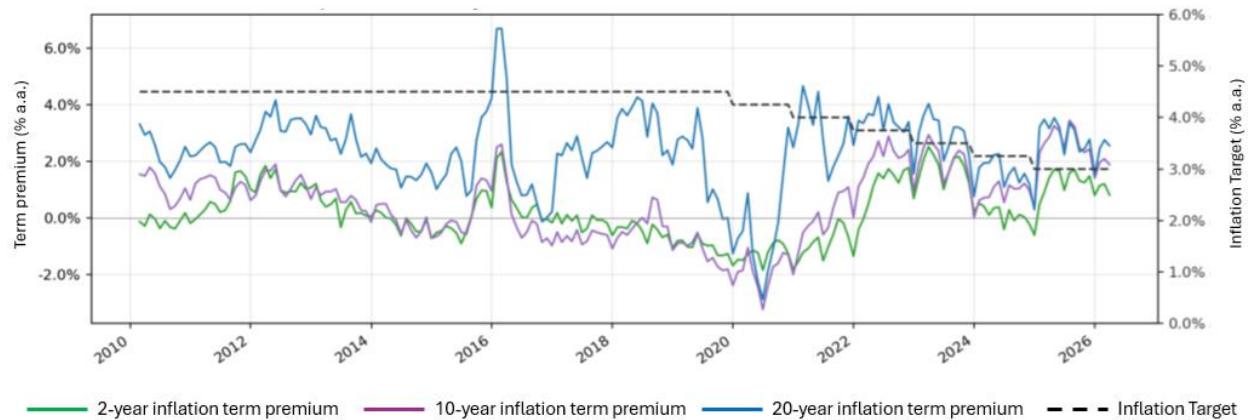
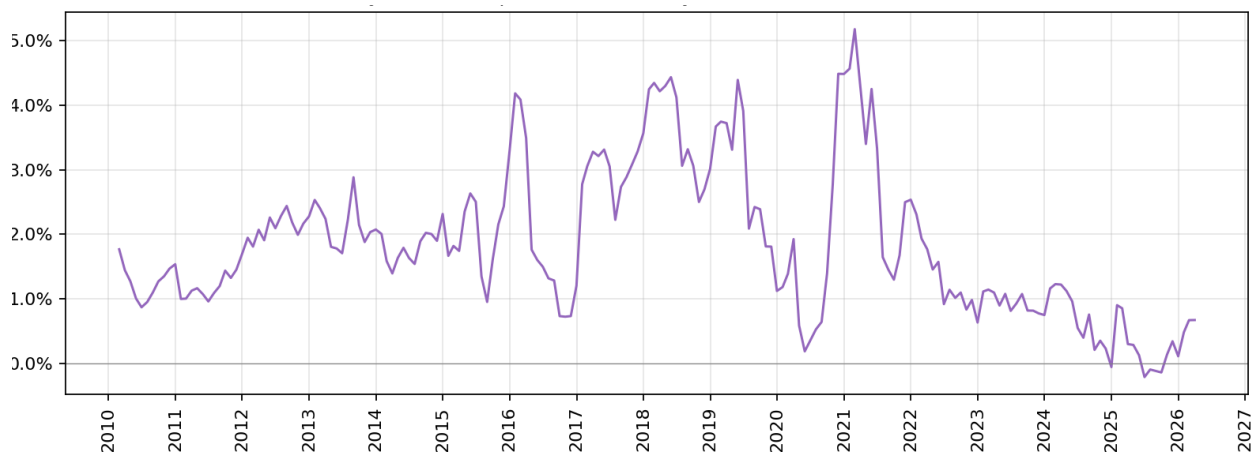


Figure 11. Slope of the inflation-risk-premium curve: 20-year minus 10-year premium



5.3 Pricing factors

Figure 12 presents the six pricing factors used in the joint nominal-real model. The first three principal components summarize the dominant variation in the nominal yield curve and broadly correspond to level, slope, and curvature. The fourth and fifth factors are the first two principal components extracted from the residual variation in the real yield curve after controlling for the nominal factors and relative liquidity. The sixth factor is the observable relative-liquidity indicator.

Figure 12. Pricing factors in the joint nominal-real affine term structure model.

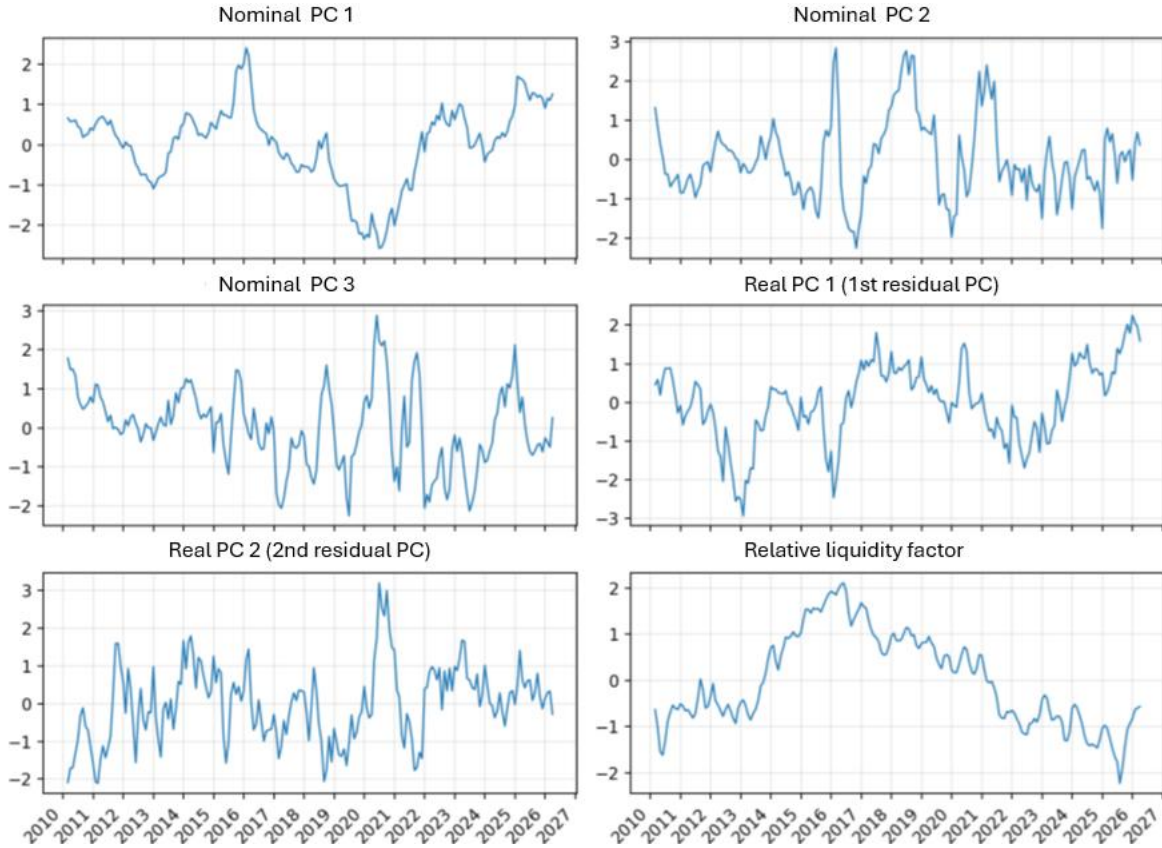


Table 2 reports Wald tests of the joint significance of factor loadings in the nominal and real excess-return equations. The tests generally reject the null hypothesis that the relevant factor exposures are jointly zero. The fourth and fifth factors display comparatively weaker explanatory content than the first three nominal factors, as may be expected for principal components extracted from residual real-curve variation. Nevertheless, they remain useful for distinguishing variation specific to the inflation-indexed segment from common nominal-curve movements.

Table 2. Wald tests of pricing-factor relevance in the excess-return equations

Factor	Wald statistic	Degrees of freedom	p-value
F1	2,521,560	11	< 0.0001
F2	2,848	11	< 0.0001
F3	310,992	11	< 0.0001
F4	17.28	11	0.0998
F5	23.08	11	0.0172
F6	258.89	11	< 0.0001

Notes: The table reports Wald tests of the joint null hypothesis that the exposure of excess bond returns to each pricing factor is equal to zero across the 11 return equations. F1-F3 are the three nominal principal components; F4 and F5 are the first and second residual real principal components; and F6 is the relative-liquidity factor. The values reproduce the table reported on page 34 of the dissertation.

6. Determinants of Term Premia

This section presents the main empirical results on the macro-financial determinants of Brazilian term premia. Section 6.1 establishes the aggregate nominal-term-premium benchmark. Sections 6.2 and 6.3 examine the determinants of the real term premium and the inflation risk premium, respectively. Section 6.4 compares the results across the three premia and highlights the distinct macro-financial relationships underlying the nominal aggregate. Finally, Section 6.5 assesses the economic magnitude and robustness of the results.

6.1 Aggregate nominal term premium

Table 3 reports the determinants of the five-year nominal term premium. In the initial specification, the Selic policy rate and the 10-year U.S. Treasury yield enter positively and significantly, and the model explains approximately three quarters of the variation in the nominal term premium. Adding Focus inflation expectations increases the adjusted R^2 and produces a positive and statistically significant coefficient on expected inflation, while current inflation becomes less robust. Replacing the U.S. nominal yield with the five-year TIPS yield and subsequently adding the U.S. 10-year-minus-2-year yield-curve slope shows that both the level of global real interest rates and the shape of the U.S. yield curve contain information about Brazilian nominal risk compensation.

Table 3. Determinants of the five-year nominal term premium.

<i>Variable</i>	<i>M1</i>	<i>M2</i>	<i>M3</i>	<i>M4</i>	<i>M5</i>	<i>M6</i>	<i>M7</i>
<i>Constant</i>	-0.0186*** (-2.61)	-0.0454*** (-3.68)	-0.0246*** (-3.44)	-0.0221*** (-3.29)	-0.0333*** (-4.86)	-0.0489*** (-3.16)	-0.0193*** (-3.45)
<i>IPCA inflation</i>	0.0293 (0.63)	-0.0777* (-1.77)	-0.0470 (-0.99)	0.0115 (0.27)	-0.0045 (-0.08)		
<i>Focus expectations</i>		0.4153*** (2.89)	0.3026** (2.17)	0.1776 (1.30)	0.2863** (2.23)	0.2921** (1.97)	0.1851 (1.25)
<i>Selic</i>	0.2620*** (7.54)	0.2397*** (7.37)	0.2504*** (5.08)	0.2307*** (4.90)	0.1345** (2.52)	0.2090*** (5.68)	0.2333*** (5.23)
<i>TLP</i>					0.1727*** (3.24)	0.0786 (1.21)	
<i>U.S. 5-year TIPS yield</i>			0.2494* (1.95)	0.4138*** (3.14)	0.5929*** (3.09)	0.4276*** (3.32)	0.3828*** (3.18)
<i>U.S. 10-year Treasury yield</i>	0.2755** (2.45)	0.3259*** (3.25)					
<i>U.S. yield-curve slope</i>				0.2716*** (2.91)	0.7717*** (4.60)	0.5652*** (5.05)	0.2604*** (2.75)
<i>Primary balance</i>					-0.1068 (-0.90)		
<i>Gross public debt</i>	-0.0045 (-0.63)	0.0137 (1.44)				0.0246 (1.54)	
<i>IBC-Br output gap</i>					-0.0375* (-1.71)		

<i>Ibovespa</i>						0.0031 (0.41)	
<i>MSCI Developed Markets</i>						-0.0144 (-0.96)	
<i>USD/BRL</i>	0.0112 (0.98)	0.0113 (0.93)	0.0036 (0.33)	0.0032 (0.32)	0.0102 (1.10)	0.0205** (2.45)	0.0147* (1.66)
<i>DXY</i>						-0.0460** (-2.16)	-0.0251 (-1.19)
<i>CRB</i>						-0.0145 (-0.60)	
<i>WTI</i>						0.0029 (0.71)	
<i>VIX</i>	0.0131 (1.13)	0.0192* (1.66)	0.0172 (1.48)	0.0143 (1.32)	0.0126 (0.94)	0.0067 (0.59)	
<i>Adjusted R²</i>	0.7438	0.7658	0.7455	0.7648	0.8141	0.7894	0.7619
<i>SIC</i>	9.89	9.96	9.90	9.96	9.91	9.94	9.97
<i>Observations</i>	198	198	198	198	156	198	198

Notes: Newey-West HAC *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. SIC denotes the Schwarz information criterion. Specification M5 contains fewer observations because of data availability; comparisons with adjacent specifications therefore reflect both changes in regressors and changes in the estimation sample.

In the broader specifications, the Long-Term Rate and the USD/BRL exchange rate also enter positively. The parsimonious specification retains the Selic rate, the five-year TIPS yield, and the U.S. yield-curve slope as statistically significant predictors, while the exchange rate is positive at the 10 percent significance level. Focus inflation expectations and the DXY remain in the selected specification but are not statistically significant. The selected set of predictors differs somewhat from that reported by Araujo et al. (2025), which uses a longer sample beginning in 2007 and estimates the nominal term premium from a nominal-only model. Nevertheless, the central benchmark result remains: the Brazilian nominal term premium is associated with both domestic monetary conditions and the international pricing environment.

6.2 Real term premium

Table 4 reports the determinants of the five-year real term premium. The initial specification already explains a meaningful share of its variation, with current inflation entering negatively and public debt positively. Explanatory power increases when the five-year TIPS yield and the slope of the U.S. yield curve are introduced. This pattern is consistent with an international discount-rate channel: higher U.S. real interest rates and a steeper U.S. yield curve are associated with greater compensation for exposure to Brazilian real interest-rate risk.

The parsimonious real-premium specification reveals a clear economic pattern. The five-year TIPS yield, the U.S. yield-curve slope, public debt, and the USD/BRL exchange rate enter positively, whereas Focus

inflation expectations and the Selic policy rate enter negatively. The positive coefficients on public debt and the exchange rate associate real term compensation with domestic fiscal conditions and external vulnerability. In an emerging economy, currency depreciation may tighten financing conditions, alter the returns required by foreign investors, and amplify uncertainty about future real financing costs. Higher public debt may also be associated with uncertainty about future real interest rates, taxation, debt supply, and fiscal adjustment.

The negative coefficients on the Selic rate and Focus inflation expectations should be interpreted conditionally and cautiously. They do not imply that higher inflation or monetary tightening generally improves real financing conditions. One possible interpretation is compositional: conditional on global interest rates, public debt, the exchange rate, and the other controls, higher inflation expectations and a higher policy rate are associated with a larger inflation-risk component and a smaller real term premium. Another possibility is that a higher Selic rate signals a stronger near-term policy response that reduces uncertainty about future real short rates. Because the regressions are reduced form, these coefficients provide evidence that the real and inflation-risk components exhibit different conditional relationships, rather than estimates of causal monetary-policy effects.

Table 4. Determinants of the five-year real term premium.

<i>Variable</i>	<i>M1</i>	<i>M2</i>	<i>M3</i>	<i>M4</i>	<i>M5</i>	<i>M6</i>	<i>M7</i>
<i>Constant</i>	0.0107 (1.56)	0.0121 (1.30)	0.0139** (2.21)	-0.0113* (-1.88)	-0.0121 (-1.50)	0.0014 (0.18)	0.0026 (0.36)
<i>IPCA inflation</i>	-0.1367*** (-4.78)	-0.1312*** (-3.48)	-0.1391*** (-3.95)	-0.1319*** (-5.70)	-0.1283*** (-5.94)		
<i>Focus expectations</i>		-0.0214 (-0.22)				-0.1804*** (-2.76)	-0.1814*** (-2.64)
<i>Selic</i>	-0.0463* (-1.69)	-0.0452* (-1.66)	-0.0409 (-1.26)	-0.0360 (-1.48)	-0.0558** (-2.00)	-0.0587** (-2.22)	-0.0740*** (-2.76)
<i>TLP</i>					0.0049 (0.13)	-0.0424 (-1.27)	
<i>U.S. 5-year TIPS yield</i>			0.0676 (0.71)	0.2196*** (2.58)	0.3361*** (3.55)	0.3474*** (4.39)	0.3508*** (4.14)
<i>U.S. 10-year Treasury yield</i>	0.1012 (1.46)	0.0986 (1.38)					
<i>U.S. yield-curve slope</i>				0.4812*** (5.58)	0.6696*** (6.86)	0.4781*** (5.38)	0.4774*** (5.09)
<i>Primary balance</i>					0.0295 (0.34)		
<i>Gross public debt</i>	0.0209*** (3.18)	0.0200*** (2.63)	0.0197*** (3.02)	0.0482*** (7.89)	0.0498*** (4.09)	0.0421*** (4.95)	0.0352*** (4.67)
<i>IBC-Br output gap</i>					-0.0112 (-1.43)		
<i>Ibovespa</i>						0.0032 (0.52)	

<i>MSCI Developed Markets</i>						-0.0127 (-1.31)	
<i>USD/BRL</i>	0.0122* (1.73)	0.0122* (1.74)	0.0103* (1.73)	0.0137** (2.47)	0.0058 (0.90)	0.0120* (1.85)	0.0136** (2.23)
<i>DXY</i>						-0.0253* (-1.69)	-0.0173 (-1.22)
<i>CRB</i>						-0.0095 (-0.60)	
<i>WTI</i>						0.0000 (0.00)	
<i>VIX</i>	0.0006 (0.07)	0.0003 (0.04)				-0.0094 (-0.92)	
<i>Adjusted R²</i>	0.5711	0.5691	0.5660	0.7097	0.7462	0.6615	0.6560
<i>SIC</i>	10.68	10.66	10.69	11.07	11.09	10.77	10.88
<i>Observations</i>	198	198	198	198	156	198	198

Notes: Newey-West HAC *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. SIC denotes the Schwarz information criterion. Specification M5 contains fewer observations because of data availability; comparisons with adjacent specifications therefore reflect both changes in regressors and changes in the estimation sample.

6.3 Inflation risk premium

Table 5 reports the determinants of the five-year inflation risk premium. These regressions achieve substantially greater explanatory power than the real-term-premium regressions. This difference should nevertheless be interpreted cautiously because the inflation risk premium is a model-based residual component obtained from the difference between the nominal and real term premia. In the initial specification, the Selic policy rate and current inflation enter positively and significantly. Once Focus inflation expectations are included, survey-based expectations remain positive and statistically significant across subsequent specifications, while current inflation loses statistical significance. This change in statistical relevance is economically meaningful: compensation for inflation risk at a five-year horizon is more closely associated with forward-looking inflation beliefs than with the latest observed inflation rate.

In the parsimonious specification, Focus inflation expectations, the Selic policy rate, and the VIX enter positively and significantly. The TLP remains in the equation but is not statistically significant. The positive coefficient on Focus expectations is consistent with higher expected inflation being accompanied by greater uncertainty about future inflation or a higher probability of adverse inflation outcomes for nominal-bond investors. The positive VIX coefficient indicates that global risk aversion is also associated with inflation-risk compensation. Episodes of global financial stress may increase the compensation investors require for exposure to adverse inflation and currency outcomes in an emerging economy.

The Selic coefficient is positive for the inflation risk premium but negative for the real term premium. This is one of the paper's clearest findings. A higher policy rate may coincide with heightened inflation concerns that increase inflation-risk compensation, even if the policy response limits uncertainty about future real short rates. Aggregate nominal-term-premium regressions combine these two opposing

relationships. Decomposing the nominal term premium is therefore essential for interpreting the monetary-policy information embedded in nominal bond yields.

Table 5. Determinants of the five-year inflation risk premium.

<i>Variable</i>	<i>M1</i>	<i>M2</i>	<i>M3</i>	<i>M4</i>	<i>M5</i>	<i>M6</i>	<i>M7</i>
<i>Constant</i>	-0.0293*** (-5.80)	-0.0575*** (-6.77)	-0.0594*** (-15.51)	-0.0585*** (-15.17)	-0.0626*** (-16.00)	-0.0503*** (-3.77)	-0.0614*** (-14.55)
<i>IPCA inflation</i>	0.1660*** (5.49)	0.0535* (1.89)	0.0206 (0.63)	0.0404 (1.01)	0.0695 (1.63)		
<i>Focus expectations</i>		0.4367*** (4.26)	0.4931*** (5.06)	0.4509*** (4.15)	0.4888*** (5.30)	0.4725*** (3.88)	0.4910*** (6.73)
<i>Selic</i>	0.3083*** (13.18)	0.2849*** (16.92)	0.3115*** (11.72)	0.3048*** (11.17)	0.2573*** (8.12)	0.2676*** (10.96)	0.3179*** (15.32)
<i>TLP</i>					0.0667** (2.13)	0.1210** (2.14)	0.0401 (1.47)
<i>U.S. 5-year TIPS yield</i>			0.1033 (1.18)	0.1588 (1.43)	0.2667* (1.84)	0.0802 (0.89)	
<i>U.S. 10-year Treasury yield</i>	0.1743** (2.19)	0.2273*** (4.07)					
<i>U.S. yield-curve slope</i>				0.0918 (1.11)	0.1454 (1.13)	0.0871 (0.95)	
<i>Primary balance</i>					-0.0330 (-0.46)		
<i>Gross public debt</i>	-0.0254*** (-4.91)	-0.0063 (-0.96)				-0.0175 (-1.27)	
<i>IBC-Br output gap</i>					-0.0068 (-0.47)		
<i>Ibovespa</i>						-0.0001 (-0.02)	
<i>MSCI Developed Markets</i>						-0.0017 (-0.17)	
<i>USD/BRL</i>	-0.0010 (-0.14)	-0.0010 (-0.13)	-0.0036 (-0.44)	-0.0038 (-0.48)	0.0055 (0.89)	0.0085 (1.27)	
<i>DXY</i>						-0.0208 (-0.99)	
<i>CRB</i>						-0.0050 (-0.32)	
<i>WTI</i>						0.0029 (0.76)	
<i>VIX</i>	0.0125* (1.72)	0.0189*** (3.02)	0.0187** (2.46)	0.0177** (2.47)	0.0112* (1.70)	0.0161** (2.12)	0.0170** (2.46)

<i>Adjusted R²</i>	0.9041	0.9221	0.9133	0.9145	0.9375	0.9198	0.9145
<i>SIC</i>	10.54	10.73	10.65	10.64	10.64	10.57	10.70
<i>Observations</i>	198	198	198	198	156	198	198

Notes: Newey-West HAC *t*-statistics are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. SIC denotes the Schwarz information criterion. Specification M5 contains fewer observations because of data availability; comparisons with adjacent specifications therefore reflect both changes in regressors and changes in the estimation sample.

6.4 A compact cross-premium comparison

Table 6 provides a compact comparison of the main determinants of the five-year nominal term premium, real term premium, and inflation risk premium. A plus or minus sign indicates a statistically significant positive or negative conditional association, respectively. “n.s.” indicates that a variable is included in the corresponding specification but is not statistically significant, whereas a dash indicates that the variable is not included. The table summarizes the cross-premium relationships and should be interpreted together with the complete coefficient estimates reported in Tables 3 through 5.

Table 6. Qualitative comparison of the determinants of five-year term premia.

Variable	Nominal premium	Real premium	Inflation risk premium	Primary interpretation
Selic	+	-	+	Opposing real and inflation channels
Focus inflation expectations	n.s.	-	+	Risk composition and inflation credibility
U.S. 5-year TIPS yield	+	+	n.s.	Global real discount-rate channel
U.S. 10Y-2Y slope	+	+	n.s.	Global term-structure channel
Gross public debt / GDP	n.s.	+	n.s.	Domestic fiscal and real-rate risk
USD/BRL	+ (10%)	+	n.s.	External vulnerability and required returns
VIX	n.s.	n.s.	+	Global risk aversion and inflation risk

Notes: A plus or minus sign indicates a statistically significant positive or negative conditional association, respectively. “n.s.” indicates that no statistically significant conditional association is identified for the corresponding premium. Statistical significance is evaluated at the 10 percent level or lower.

The comparison supports the paper’s central claim that the macro-financial relationships observed for the aggregate nominal term premium reflect two economically distinct components. U.S. real interest rates, the slope of the U.S. yield curve, public debt, and the USD/BRL exchange rate are primarily associated with the real term premium. By contrast, Focus inflation expectations, the Selic policy rate, and the VIX are more strongly associated with the inflation risk premium. These differences indicate that variables associated with the nominal term premium need not be related to its real and inflation-risk components in the same way.

The contrasting coefficients on the Selic rate and Focus inflation expectations are particularly informative. Both variables are positively associated with the inflation risk premium but negatively associated with the real term premium. Consequently, their relationships with the two components partially offset each other in the aggregate nominal term premium. The nominal coefficient should therefore be interpreted as the net result of distinct real-rate and inflation-risk relationships rather than as evidence of a single underlying source of risk compensation.

6.5 Economic magnitude and robustness

Statistical significance does not necessarily imply economic relevance. To compare variables measured in different units, we calculate the change in each premium associated with a one-standard-deviation increase in each statistically significant regressor retained in the parsimonious specification. Tables 7, 8, and 9 report these effects for the five-year nominal term premium, real term premium, and inflation risk premium, respectively.

Table 7 shows that the Selic policy rate produces the largest standardized change in the nominal term premium, followed by the five-year U.S. TIPS yield and the slope of the U.S. yield curve. A one-standard-deviation increase in the Selic rate is associated with an increase of 0.83 percentage points in the nominal term premium. The corresponding effects of the U.S. TIPS yield and the U.S. yield-curve slope are 0.41 and 0.25 percentage points, respectively. The standardized effect of the USD/BRL exchange rate is comparatively small, at 0.06 percentage points.

Table 7. Effect of a one-standard-deviation change on the five-year nominal term premium

Variable	Standard deviation	Effect (percentage points)
Selic policy rate	3.56%	0.83
U.S. five-year TIPS yield	1.08%	0.41
U.S. yield-curve slope (10-year minus 2-year)	0.96%	0.25
USD/BRL exchange rate	4.39%	0.06

Notes: Effects are calculated as the estimated coefficient multiplied by one standard deviation of the corresponding regressor. The table includes variables that are statistically significant in the parsimonious specification for the nominal term premium. The Selic rate, the U.S. five-year TIPS yield, and the U.S. yield-curve slope are measured in levels, while the USD/BRL exchange rate is expressed as a monthly percentage return. Effects are expressed in percentage points of the five-year nominal term premium.

Table 8 reveals a different pattern for the real term premium. The largest positive standardized effect is associated with the slope of the U.S. yield curve, followed by the five-year U.S. TIPS yield and gross public debt. A one-standard-deviation increase in the U.S. yield-curve slope is associated with a 0.46-percentage-point increase in the real term premium, while equivalent changes in the TIPS yield and gross public debt are each associated with increases of 0.38 percentage points. By contrast, one-standard-deviation increases in the Selic rate and Focus inflation expectations are associated with declines of 0.26 and 0.19 percentage points, respectively. The exchange-rate effect is positive but comparatively small, at 0.06 percentage points.

Table 8. Effect of a one-standard-deviation change on the five-year real term premium

Variable	Standard deviation	Effect (percentage points)
Focus IPCA expectations (12 months)	1.04%	-0.19
Selic policy rate	3.56%	-0.26
U.S. five-year TIPS yield	1.08%	0.38
U.S. yield-curve slope (10-year minus 2-year)	0.96%	0.46
General government gross debt (% of GDP)	10.80%	0.38
USD/BRL exchange rate	4.39%	0.06

Notes: Effects are calculated as the estimated coefficient multiplied by one standard deviation of the corresponding regressor. The table includes variables that are statistically significant in the parsimonious specification for the real term premium. Focus inflation expectations, the Selic rate, the U.S. five-year TIPS yield, the U.S. yield-curve slope, and gross public debt are measured in levels, while the USD/BRL exchange rate is expressed as a monthly percentage return. Effects are expressed in percentage points of the five-year real term premium.

As shown in Table 9, the Selic policy rate has the largest standardized association with the inflation risk premium. A one-standard-deviation increase in the Selic rate is associated with a 1.13-percentage-point increase in the inflation risk premium. The corresponding effect of Focus inflation expectations is 0.51 percentage points, while a one-standard-deviation increase in the VIX is associated with an increase of 0.11 percentage points. These estimates reinforce the cross-premium evidence: the Selic rate and inflation expectations are associated with lower real term compensation but substantially higher inflation-risk compensation.

Table 9. Effect of a one-standard-deviation change on the five-year inflation risk premium

Variable	Standard deviation	Effect (percentage points)
Focus IPCA expectations (12 months)	1.04%	0.51
Selic policy rate	3.56%	1.13
VIX	5.18	0.11

Notes: Effects are calculated as the estimated coefficient multiplied by one standard deviation of the corresponding regressor. The table includes variables that are statistically significant in the parsimonious specification for the inflation risk premium. Focus inflation expectations and the Selic rate are measured in levels, while the VIX is measured in index points. Effects are expressed in percentage points of the five-year inflation risk premium.

Taken together, the standardized effects show that the economic importance of a macro-financial variable can differ sharply across the two components of the nominal term premium. Global real rates, the U.S.

yield-curve slope, and public debt are particularly relevant to the real term premium, whereas the domestic policy rate and inflation expectations have considerably larger associations with the inflation risk premium. The opposing real and inflation-risk effects of the Selic rate and Focus expectations also help explain why their aggregate nominal-premium coefficients may provide an incomplete account of the underlying repricing of risk.

The accounting identity between the three premia provides an additional consistency check. For any specification estimated using an identical sample, the same regressors, and the same treatment of the intercept, the coefficient associated with each regressor in the nominal-premium equation must equal the sum of the corresponding coefficients in the real-premium and inflation-risk-premium equations, up to numerical precision. This coefficient-by-coefficient restriction permits each aggregate nominal association to be decomposed directly into its real and inflation-risk components. Outcome-specific variable selection prevents the same equality from being applied directly across the parsimonious specifications, which contain different sets of regressors.

7. Time Variation and Economic Interpretation

This section examines how the macro-financial relationships documented in Section 6 evolve over time and discusses their implications for monetary policy in an emerging-market economy. Section 7.1 presents rolling-window estimates for the five-year nominal term premium, real term premium, and inflation risk premium. Section 7.2 interprets the time-varying evidence from a monetary-policy perspective, with particular attention to the distinction between real-rate risk compensation and inflation-risk compensation.

7.1 Rolling coefficients

Full-sample coefficients summarize average relationships, but Brazil's monetary, fiscal, and external environment changed considerably between 2010 and 2026. We therefore estimate the parsimonious specifications over rolling 60-month windows. The exercise is descriptive: a five-year window balances the need to capture time variation against the limited number of monthly observations.

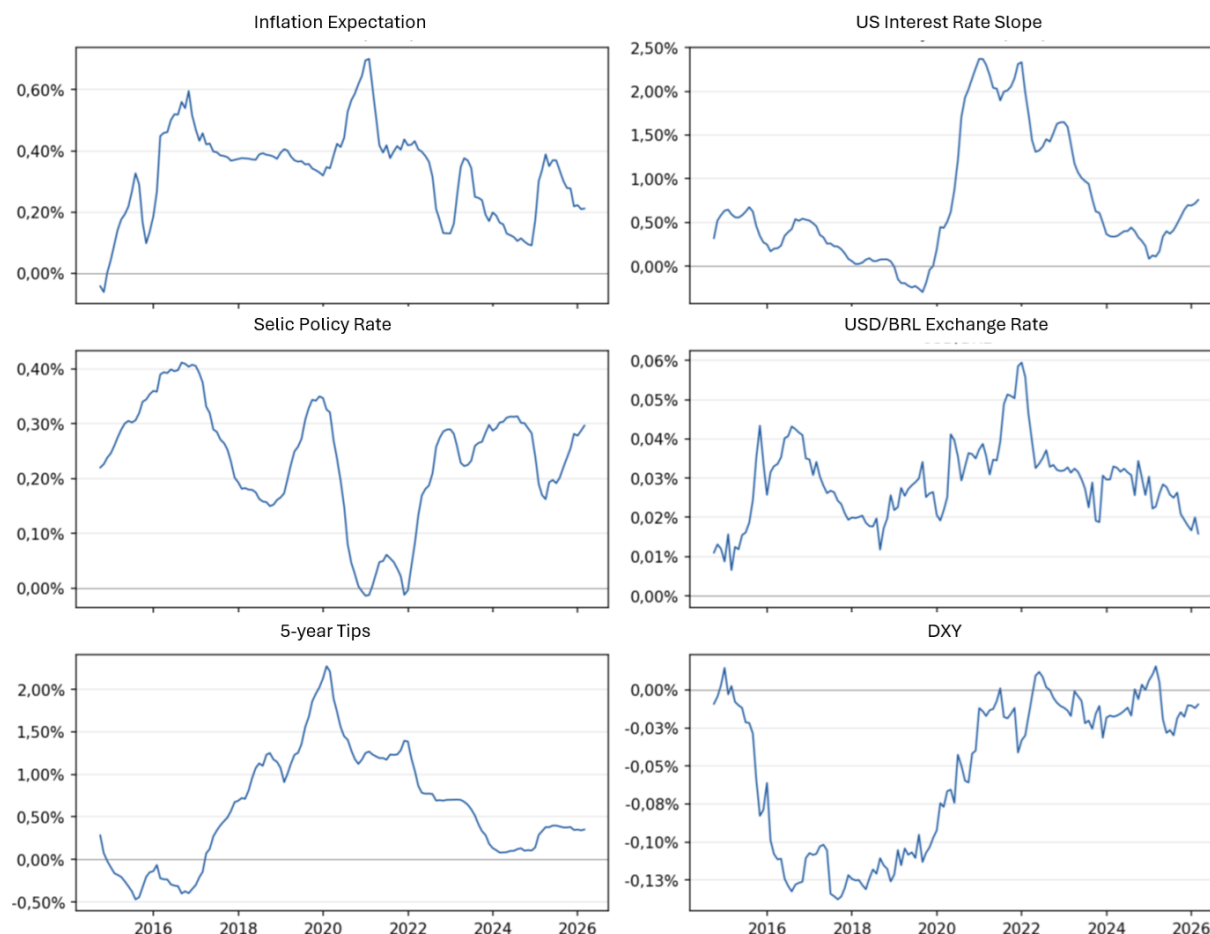
Figures 13, 14, and 15 present the rolling coefficient estimates for the five-year nominal term premium, real term premium, and inflation risk premium, respectively. The estimates vary considerably in magnitude over the sample and reveal important differences across the three premia. The Selic policy rate and Focus inflation expectations display particularly contrasting relationships with the real term premium and the inflation risk premium, while U.S. interest rates and the exchange rate are more closely associated with variation in the coefficients of the real term premium.

The rolling estimates reinforce the importance of decomposing the aggregate nominal term premium. A relatively stable relationship in the nominal-premium equation may conceal substantial variation in the corresponding real and inflation-risk relationships. Conversely, changes in the nominal-premium coefficients may reflect a changing balance between the two underlying components. The aggregate relationship may therefore remain stable even when the composition of risk compensation changes substantially over time.

This time variation is relevant for monetary policy. An increase in long-term nominal yields has different implications depending on whether the movement reflects expected future short rates, real term compensation, or inflation-risk compensation. An increase in the inflation risk premium is more directly

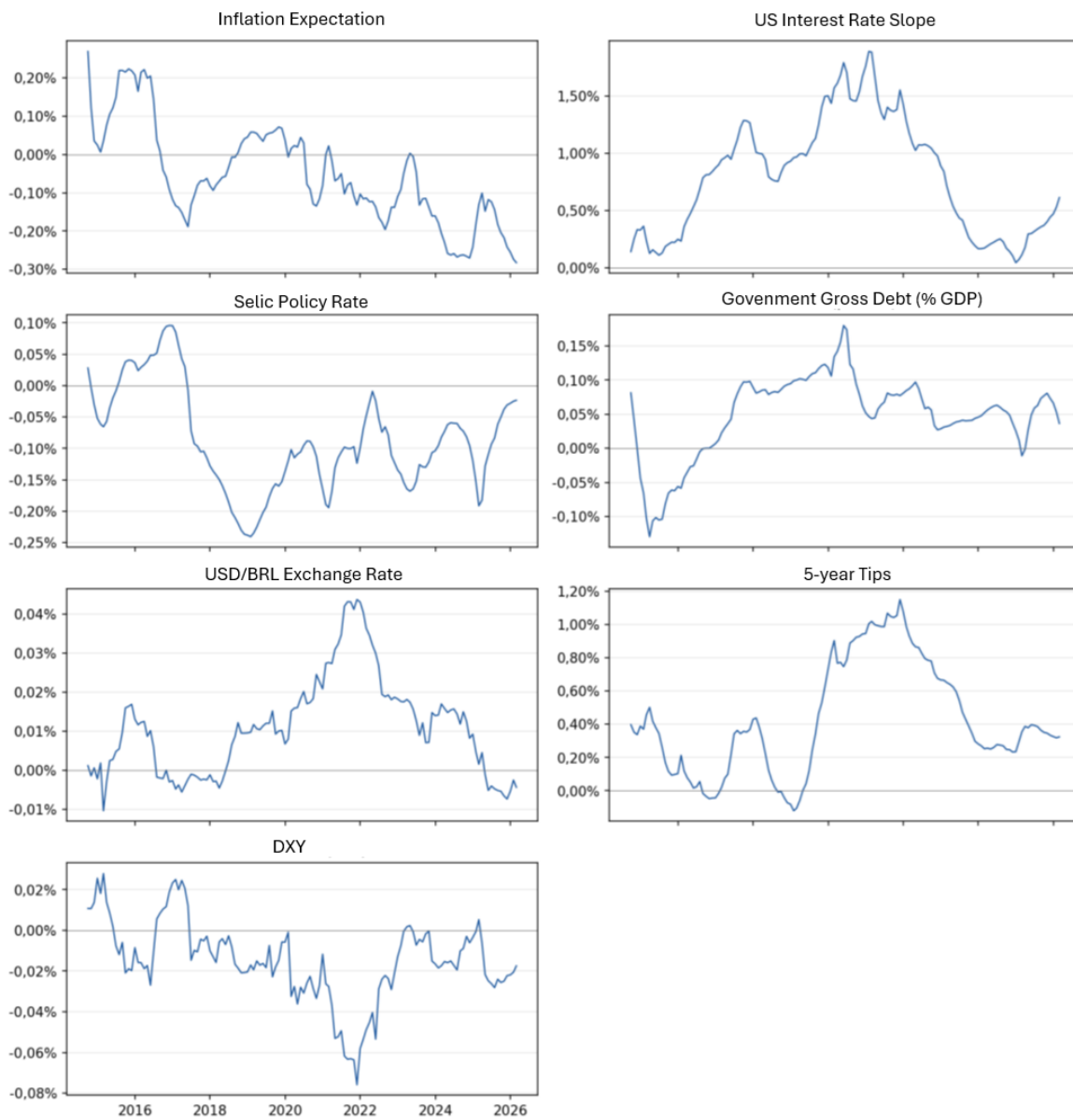
associated with uncertainty about future inflation and the credibility of nominal stabilization. An increase in the real term premium may instead be associated with higher global real interest rates, fiscal concerns, exchange-rate risk, or uncertainty about the future path of real short rates. The policy implications and communication challenges need not be the same in each case.

Figure 13. Rolling 60-month coefficient estimates for the five-year nominal term premium.



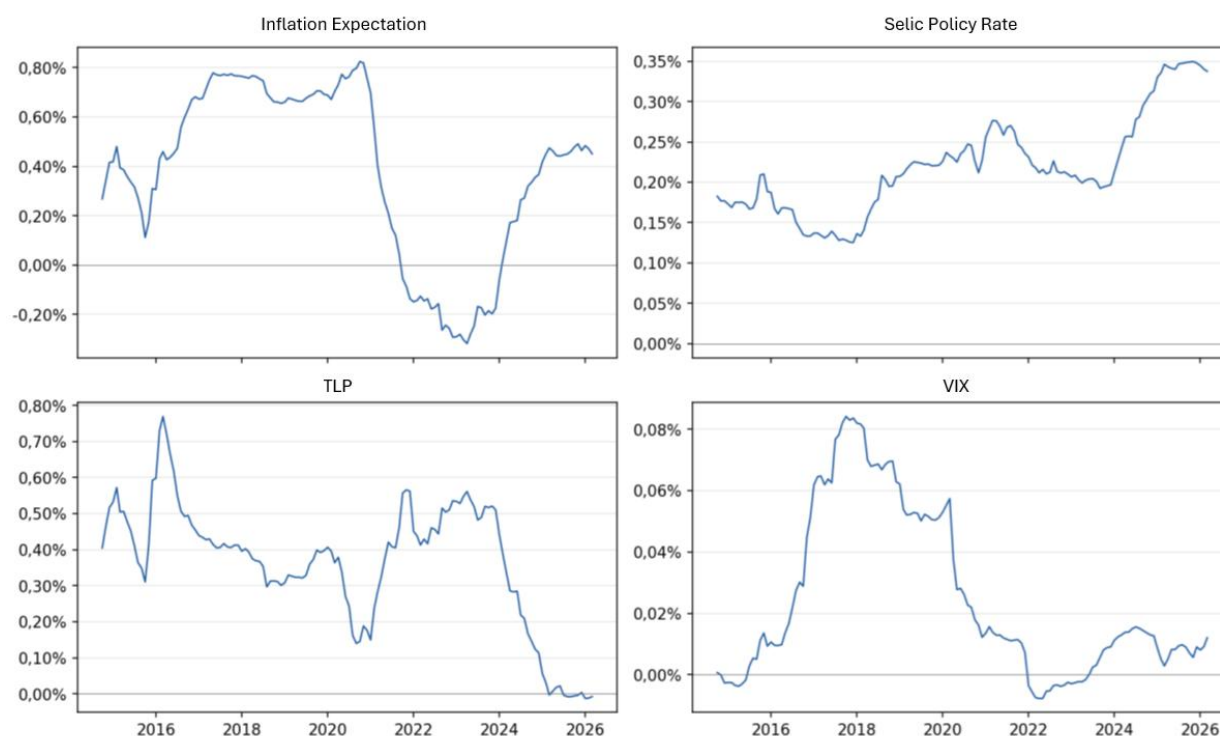
Notes: The figure reports coefficient estimates from the parsimonious specification using rolling 60-month estimation windows. Each point represents an estimate obtained from the preceding 60 monthly observations. The dependent variable is the monthly average of daily estimates of the corresponding five-year premium.

Figure 14. Rolling 60-month coefficient estimates for the five-year real term premium.



Notes: The figure reports coefficient estimates from the parsimonious specification using rolling 60-month estimation windows. Each point represents an estimate obtained from the preceding 60 monthly observations. The dependent variable is the monthly average of daily estimates of the corresponding five-year premium.

Figure 15. Rolling 60-month coefficient estimates for the five-year inflation risk premium.



Notes: The figure reports coefficient estimates from the parsimonious specification using rolling 60-month estimation windows. Each point represents an estimate obtained from the preceding 60 monthly observations. The dependent variable is the monthly average of daily estimates of the corresponding five-year premium.

7.2 Monetary-policy interpretation

The decomposition changes the economic interpretation of several familiar predictors of the nominal term premium. A positive aggregate relationship between the Selic policy rate and the nominal term premium does not imply that a higher policy rate is uniformly associated with all forms of risk compensation. In the component regressions, the Selic rate is positively associated with the inflation risk premium but negatively associated with the real term premium. Similarly, Focus inflation expectations are positively associated with the inflation risk premium and negatively associated with the real term premium. These patterns suggest that the composition of nominal risk compensation changes between real-rate risk and inflation risk as the monetary environment evolves.

The estimates do not establish that monetary-policy tightening causes the inflation risk premium to increase. The Selic rate is endogenous to inflationary conditions and may proxy for the severity and persistence of the shocks confronting the central bank. The positive relationship between the Selic rate and the inflation risk premium may therefore reflect the inflationary environment that makes monetary tightening necessary rather than an adverse causal effect of the policy response itself. Conversely, the negative relationship with the real term premium may reflect a stronger policy response that reduces uncertainty about future real short rates. These interpretations remain suggestive because the regressions identify conditional predictive associations rather than structural causal effects.

The time-varying estimates nevertheless provide useful diagnostic information. Conditional on the macro-financial controls included in the parsimonious specifications, the real term premium and the inflation risk

premium exhibit different relationships with domestic and external variables. The aggregate nominal term premium is therefore insufficient for determining whether a change in long-term risk compensation reflects uncertainty about real interest rates, inflation risk, or both.

From an emerging-market perspective, the sensitivity of the real term premium to U.S. real interest rates, the slope of the U.S. yield curve, public debt, and the exchange rate highlights the interaction between global discount rates and domestic vulnerability. By contrast, the sensitivity of the inflation risk premium to Focus inflation expectations, the Selic policy rate, and the VIX indicates that domestic inflation conditions, monetary-policy responses, and global risk aversion are more closely associated with inflation-risk compensation.

Taken together, the results imply that monetary authorities should monitor not only the level of long-term nominal interest rates and the aggregate nominal term premium, but also the composition of that premium. Similar movements in the nominal term premium may convey different economic signals depending on whether the underlying change is concentrated in real-rate risk compensation or inflation-risk compensation.

8. Conclusion

This paper investigates the macro-financial determinants of the Brazilian nominal term premium and its real and inflation-risk components. Using a joint affine model of nominal and inflation-indexed government-bond yields, we estimate the nominal term premium, the real term premium, and the inflation risk premium within a common no-arbitrage framework. We then examine their relationships with domestic monetary, inflation, fiscal, and external variables.

The central result is that the macro-financial relationships underlying the real term premium and the inflation risk premium differ substantially. The real term premium is positively associated with U.S. real interest rates, the slope of the U.S. yield curve, public debt, and the USD/BRL exchange rate, while it is negatively associated with the Selic policy rate and survey-based inflation expectations. By contrast, the inflation risk premium is positively associated with inflation expectations, the Selic policy rate, and global risk aversion. These differences imply that movements in the aggregate nominal term premium may reflect fundamentally different underlying risks.

The contrasting relationships of the Selic rate and Focus inflation expectations with the two components are particularly informative. Both variables are positively associated with the inflation risk premium but negatively associated with the real term premium. Their aggregate nominal-premium coefficients therefore reflect the net effect of opposing real-rate and inflation-risk relationships. An analysis confined to the nominal term premium may obscure this composition and provide an incomplete account of the risks being repriced by the bond market.

The results deepen earlier evidence on the determinants of the Brazilian nominal term premium. Previous research shows that domestic interest rates, inflation expectations, fiscal conditions, U.S. interest rates, the exchange rate, and global volatility are associated with nominal risk compensation. Our findings show that these relationships do not operate uniformly across the underlying components. Global real interest rates, the U.S. yield-curve slope, public debt, and currency movements are more closely associated with real-rate risk compensation, whereas inflation expectations, the domestic policy rate, and global risk aversion are more strongly associated with inflation-risk compensation.

The time-varying estimates further indicate that the relative importance of these relationships changes over the sample. This evidence is relevant for monetary policy because similar movements in long-term nominal interest rates or in the aggregate nominal term premium may convey different economic signals. A change concentrated in the inflation risk premium is more directly associated with inflation uncertainty and the credibility of nominal stabilization, whereas a change concentrated in the real term premium may reflect global discount rates, fiscal conditions, exchange-rate risk, or uncertainty about future real short rates.

These relationships should not be interpreted as structural causal effects. The Selic rate, inflation expectations, fiscal variables, and financial-market indicators are jointly determined with the economic environment in which term premia are observed. The decomposition instead provides diagnostic information about the composition of risk compensation. For an emerging-market central bank, monitoring that composition can improve the interpretation of long-term yields and help distinguish between changes associated with real-rate risk and those associated with inflation risk.

Overall, the findings show that the nominal term premium is an economically meaningful but incomplete summary of the risks priced in Brazilian government bonds. Its real and inflation-risk components respond to different macro-financial forces and may move in opposite directions. Distinguishing these components is therefore essential for understanding what changes in the Brazilian nominal yield curve reveal about monetary conditions, inflation risk, fiscal vulnerability, and the external financial environment.

References

- Abrahams, M., Adrian, T., Crump, R. K., Moench, E., and Yu, R. (2016). Decomposing real and nominal yield curves. *Journal of Monetary Economics*, 84, 182–200.
- Adrian, T., Crump, R. K., and Moench, E. (2013). Pricing the Term Structure with Linear Regressions. *Journal of Financial Economics*, 110(1), 110–138.
- Aguilar-Argaez, A., Diego-Fernandez, M., Elizondo, R., and Roldan-Pena, J. (2022). Term Premium Dynamics and Its Determinants: The Mexican Case. BIS Working Papers No. 993.
- Araujo, G. S., Vicente, J. V. M., and Gaglianone, W. P. (2025). Determinants of the Risk Premium in Brazilian Nominal Interest Rates. Banco Central do Brasil Working Paper Series No. 637.
- Brito, R. D., Duarte, A. J. M. A., and Guillén, O. T. C. (2004). Overreaction of Yield Spreads and Movements of Brazilian Interest Rates. *Brazilian Review of Econometrics*, 24(1), 1–55.
- Caldeira, J. F., and Cordeiro, W. C. (2026). Decomposing Nominal and Real Yield Curves and Inflation Forecasting: Evidence from Brazil. *Economics Letters*, 258, 112712.
- Campbell, J. Y., and Shiller, R. J. (1991). Yield Spreads and Interest Rate Movements: A Bird's Eye View. *Review of Economic Studies*, 58(3), 495–514.
- Costa Filho, A. (2023). Determinantes do prêmio de risco pela maturidade na curva de juros brasileira. *Revista Brasileira de Economia de Empresas*, 23(2), 33–48.
- Dai, Q., and Singleton, K. J. (2000). Specification Analysis of Affine Term Structure Models. *Journal of Finance*, 55, 1943–1978.
- Duffee, G. R. (2002). Term Premia and Interest Rate Forecasts in Affine Models. *Journal of Finance*, 57(1), 405–443.

- Duffie, D., and Kan, R. (1996). A Yield-Factor Model of Interest Rates. *Mathematical Finance*, 6(4), 379-406.
- Iania, L., Lyrio, M., and Moura, R. (2021). Bond Risk Premia in Emerging Markets: Evidence from Brazil, China, Mexico, and Russia. *Applied Economics*, 53(58), 6721-6738.
- Marçal, E. F., and Pereira, P. L. V. (2007). A estrutura a termo das taxas de juros no Brasil: testando a hipótese de expectativas. *Pesquisa e Planejamento Econômico*, 37(1).
- Ozbek, I., and Talasli, I. (2020). Term Premium in Emerging Market Sovereign Yields: Role of Common and Country-Specific Factors. *Central Bank Review*, 20(4), 169-182.
- Svensson, L. E. O. (1995). Estimating Forward Interest Rates with the Extended Nelson-Siegel Method. *Sveriges Riksbank Quarterly Review*, 3, 13-26.
- Tabak, B. M., and Andrade, S. M. (2003). Testing the Expectations Hypothesis in the Brazilian Term Structure of Interest Rates. *Brazilian Review of Finance*, 1(1), 19-38.
- Vicente, J., and Kubudi, D. (2018). Extracting Inflation Risk Premium from Nominal and Real Bonds Using Survey Information. *Journal of Economic Studies*, 45(2), 307-325.