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Why Have Long-term Treasury Yields Fallen Since the 1980s? Expected Short Rates and Term Premiums in (Quasi-) Real Time

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Final Version

Abstract

Treasury yields have fallen since the 1980s. Standard decompositions of Treasury yields into expected short-term interest rates and term premiums suggest term premiums account for much of the decline. In an alternative real-time decomposition, term premiums have fluctuated in a stable range, while long-run expected short-term interest rates have fallen. For example, a real-time decomposition of the 10-yr. Treasury yield shows term premiums essentially equal in late 2013 and 2023, while the long-run value of expected short-term interest rates is estimated to have fallen in a manner similar to the FOMC's Summary of Economic Projections and estimates from research on long-run neutral interest rates. These results suggest standard decompositions may overstate the role of term premiums in fluctuations of the yield curve.

Keywords: Term structure model, Recursive and rolling least squares; Real-time data

JEL Codes: E43, E44, E47

Key Takeaways

- Standard decompositions of the Treasury yield curve attribute much of the trend decline in long-term yields to term premiums. This decomposition enters discussions of yield curve developments by policymakers, practitioners, and the media.
- The standard decomposition is based on the entire history of data. Using data only available in real time suggests no trend in term premiums. Rather, the trend decline is attributed to a decline in the long-run expected value of short-term interest rates.
- The finding that a real-time decomposition of the yield curve attributes the decline in Treasury yields can be derived using simple methods and connects yield-curve decompositions to the monetary-policy discussion of a decline in the equilibrium interest rate.

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1. Introduction

Because Treasury securities are a core global asset, the movements in associated long-term yields have wide ranging implications. Higher yields on Treasury securities affect the cost of government debt. These costs may be significant given the increase over the past two decades in the level of U.S. federal government debt relative to the size of the economy. In 2023, the shift to higher yields has decreased the value of Treasury securities held by investors and institutions. For example, losses on Treasury securities contributed to weaknesses at some sizable U.S. banks that failed in 2023. Higher long-term interest rates broadly affect financial conditions. Financial conditions affect aggregate demand. As a result, higher long-term interest rates are a factor in central banks' pursuit of price and economic stability.

For these reasons, efforts to understand the yield curve are common. A predominant set of tools used in discussions of the yield curve are models that decompose the yield curve into expected short-term interest rates and term premiums. For example, such models are published by the Federal Reserve System and reported in Federal Reserve publications. According to standard versions of such models, a sizable component of movements in long-term Treasury yields reflects changes in term premiums. For example, commentators suggested that a return of fiscal or inflation fears may have contributed to higher long-term interest rates through higher term premiums.[1] More significantly, these models also show a large downward trend in term premiums from the early 1990s (or earlier) to 2022. These decompositions are common in discussions of economists and financial analysts.

This research uses this standard approach to understand movements in the yield curve. In contrast to the typical implementation of the approach, the analysis herein only uses information available in real time. That is, the typical implementation estimates a model over a long sample—for example, from the early 1960s to the present day. This long-sample model is then used to explain history—the model looks back in time and provides a decomposition. The alternative used herein estimates the model only with data up to a point in time. For example, the decomposition of the 10-year Treasury yield in January 1992 uses data up to January 1992, but not subsequent data. This real time approach arguably better captures the information available to investors buying

[1] For example, Cummins (2023) and Wieladek (2023) in The Financial Times, McCormick (2023) in The Washington Post, and Timiraos (2023) in The Wall Street Journal.

and selling Treasury securities at a given point in time. This more realistic information set may provide a more realistic view of expected short-term interest rates and hence of the decomposition of long-term yields into expected short rates and term premiums.

The results from the alternative approach are very different from those of the typical approach. The term premium in the alternative approach has not declined since the early 1990s. This finding suggests that explanations of the trend decline in term premiums related to inflation risk, fiscal policy, or other factors may be explanations of a fact that is not a fact. The term premium in 2023 is in the range that has prevailed since 1990. Under this reasoning, fears of a return to higher (pre-2010s) term premiums leading to persistently higher Treasury yields are unfounded.

The reason for the different results is simple. Long-term Treasury yields decline notably from the early 1990s through the early 2020s. Short-term interest rates also generally declined over this period. An approach using real-time information to construct expected short-term interest rates must estimate the average level of short rates that is likely to prevail. Using real-time information, this average declines from the early 1990 to the early 2020s. As a result, the expected short-rate component of the 10-year Treasury yield from a model decomposition declines over this period. A consequence of this trend decline in the expected short rate is a (relatively) steady average term premium from the alternative models herein. Importantly, a trend decline in the expected short-term interest rate is consistent with a decline in inflation and in the neutral long-run real interest rate. Research points to a decline in the neutral long-run real interest rate. In addition, policymakers appear to perceive a decline in the neutral long-run interest rate, as indicated by projections from the Federal Open Market Committee's (FOMC) Summary of Economic Projections.

Related literature: Many studies have examined related issues.

The core contribution of this analysis is to highlight the sensitivity of decompositions of the 10-year Treasury yield to real time, or one-sided, data. Cochrane (2007) forcefully makes this point. The contribution herein builds on Cochrane (2007) and demonstrates the salience of this insight to data over the decade and a half since that earlier analysis. The analysis herein is tied more closely to the models of Kim and Wright (2005) and Adrian, Crump, and Moench (2013)—models that are widely followed by the press and investors.[2] Along this dimension, the analysis builds on Laubach, Tetlow, and Williams (2007) and Orphanides and Wei (2012), who considered the

[2] Durham (2015) discusses related issues.

importance of real-time data for the predictions of standard term structure models. This analysis moves beyond that earlier work in two ways. First, I emphasize comparisons between simple implementations of term structure models, which match existing (more complex) term structure models, to clarify results for non-experts. Second, I emphasize the evolution of the empirical importance of the findings related to real-time implementation, as this importance has increased substantially over the past decade or two.

A closely related contribution of the analysis herein is the emphasis on the trend decline in short-term interest rates. In the literature on the term structure of interest rates, Kozicki and Tinsley (1999) is an early example of work demonstrating how term structure decompositions are sensitive to approaches to emphasizing the long-run expected value of short-term interest rates, The literature on a trend decline in the neutral long-run interest rate has expanded substantially since Kozicki and Tinsley (1999) and Cochrane (2007). A decline in the neutral long-run interest rate has been central in discussions of monetary policy strategy over past fifteen years. Important contributions include Kiley and Roberts (2017), Bernanke, Kiley, and Roberts (2019), Bernanke (2020), and Clarida (2022). This literature builds on the substantial body of empirical work documenting a decline in the neutral long-run interest rate (e.g., Laubach and Williams, 2003; Holston, Laubach, and Williams, 2017; Kiley, 2020a and 2020b).

Finally, previous research, most notable Bauer and Rudebusch (2020), has developed explicit term structure models with a time-varying long-run neutral real interest rate. Kiley (2020b) reviews related literature. This analysis presents a simpler alternative to these models and concentrates directly on the historical evolution of estimates of expected short rates and the term premium from a real-time, or one-sided, approach. The simpler approach, which abstracts from the technicalities associated with arbitrage-free term-structure (AFTS) models, broadly matches the results from AFTS models. But the simpler approach provides clearer connections, especially for those not directly involved in term-structure modeling, to the many discussions of long-term interest rates and term premiums in financial market discussions, the press, and policy work at central banks.

Plan for the remainder of the article: Section 2 discusses the standard approach to decomposing the 10-year Treasury yield into expected short rates and a term premium. Section 3 presents the core results. Section 4 discusses implications and section 5 concludes.

2. Decomposing the Yield Curve

2.1 Data

The data considered consist of constant maturity, zero-coupon yields on Treasury securities constructed using the approach of Gurkaynak, Sack and Wright (2007). These data are published regularly on the Federal Reserve Board's website and are the focus of related studies. For example, the analyses of Kim and Wright (2005) and Adrian, Crump, and Moench (2013) also use these data, and estimates of term premiums from these approaches are regularly reported on the websites of the Federal Reserve Board and the Federal Reserve Bank of New York, respectively.[3]

The analysis uses yields for maturities of one, three, five, and ten years. Yields at these maturities are available from January 1962 to the present. This facilitates estimation of one sided, or real time, models because data is available for sufficiently long periods to allow reliable estimation, as discussed in section 3. Data at a weekly or monthly frequency is used in the analysis. The analysis will refer to the one-year yield as the short-term interest rate. Other studies use interest rates on shorter maturity instruments—for example, one-month or three-month instruments—as the measure of short-term interest rates. The empirical analysis will demonstrate that the results herein mimic those in other studies closely when similar estimation approaches (that is, full sample approaches) are used. This result illustrates that the simpler focus herein on one-to-ten-year maturities is not a factor differentiating my results from those in other analyses.

Figure 1 presents the data. Several empirical regularities are clear. Yields at all maturities were relatively low in the early 1960s, generally rose through the early 1980s, and fell thereafter. Yields fell to very low historical levels in the 2010s and rose somewhat in 2023. For example, the 10-year Treasury yield briefly rose to 5 percent in 2023, a level it had not reached since 2007. In addition to these broad trends, the figure highlights the high degree of comovement in yields of different maturities. This comovement emphasizes the likely importance of only a few factors in accounting for the dynamics of the term structure of interest rates. The standard model(s) used to understand movements in the term structure uniformly use approaches with a small number of factors as explanatory variables.

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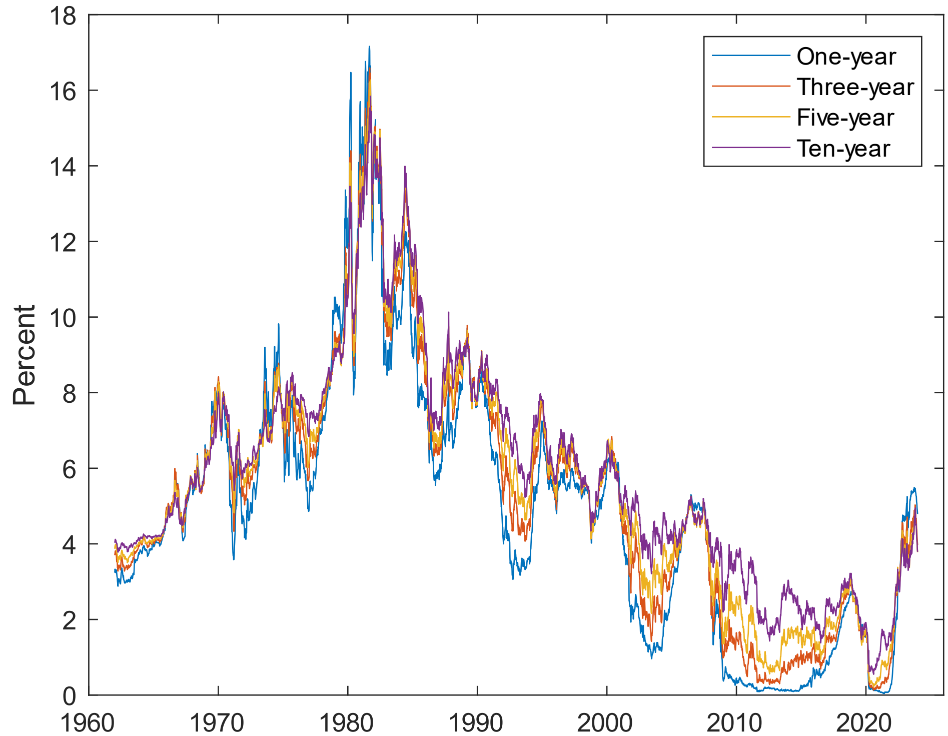
[3] The data appendix provides further information on the data. Li, Meldrum, and Rodriguez (2017) compare Kim and Wright (2005) and Adrian, Crump, and Moench (2013).

Figure 1: Yields on Treasury securities of different maturities, January 1962-December 2023



Source: Federal Reserve Board, accessed via FRED (Federal Reserve Bank of St. Louis). See data appendix.

2.2 The Standard Model

The standard approach to understanding yield curve dynamics starts with the Expectations Hypothesis, as in Cochrane (2007).

Denote the price of a one-year zero-coupon Treasury security in period t by P_t^1. The associated one-year (continuously compounded) yield, y_t^1, equals $-ln(P_t^1)$. Consider an investment strategy which consists of rolling over the investment in one-year Treasuries for N periods. The expected N-period yield (at one-period rate), $\widehat{y_t^N}$, from this strategy is given by equation 1 (where E{} is the expectations operator based on period t information—that is, the terms within {} are evaluated at their expected values):

$$\widehat{y_t^N} = E\left\{\frac{1}{N}\sum_{j=1}^{N} y_{t+j}^1\right\} = E\left\{-\frac{1}{N} ln \prod_{j=1}^{N} P_{t+j}^1\right\}. \qquad (1)$$

Under the Expectations Hypothesis, the yield on a N-year zero-coupon Treasury security would equal this expected yield from rolling over investments in one-year Treasury securities. This is what would be expected, for example, if investors are risk neutral and have rational expectations. An Expectations Hypothesis measure of the term premium on an N-year zero-coupon Treasury security, $tp_t^{N,EH}$, is the deviation of the yield on the security, y_t^N, from this expected yield, i.e.,

$$tp_t^{N,EH} = y_t^N - \widehat{y_t^N}. \tag{2}$$

In practice, most discussions of the dynamics of the yield curve and of decompositions of the yield curve into expected short-term interest rates and term premiums follow a slightly more complicated structure called affine term structure modeling, which more explicitly accounts for deviations from risk neutrality and hence on the influences of risks on term premiums.

Consider the example from Cochrane (2007). A vector of state variables—i.e., the fundamentals driving the yield curve denoted by X_t—follows an autoregressive process of order 1 (an AR(1) process) given by

$$X_t = \theta X_{t-1} + \Omega e_t, \tag{3}$$

where e_t are the (independent and identically distributed) shocks to the fundamentals with unit variance, θ is a matrix of parameters governing autoregressive dynamics, and Ω is a matrix scaling the shocks (and hence contributing to the variance of the fundamentals).

The discounting of payoffs in the future and the impact of deviations from risk neutrality is determined by the stochastic discount factor, as in standard asset pricing models (e.g., Cochrane (2009)). Affine models assume that the stochastic discount factor, M_t, is an exponential function of the state variables and shocks as in equations 4 and 5:

$$M_t = exp(-aX_t - \omega_t{}'\omega_t - \omega_t' \, e_t) \tag{4}$$

$$\omega_t = \omega_0 + \omega_1 X_t \, . \tag{5}$$

In equations 4 and 5, the coefficient vectors a, ω_0, and ω_1 determine the loadings in the stochastic discount factor on the state variables.

The price of an N-period zero-coupon bond is therefore

$$P_t^N = E\left\{\prod_{j=1}^{N} M_{t+j}\right\} = E\left\{exp\left(\sum_{j=1}^{N} -aX_{t+j} - \omega_{t+j}{}'\omega_{t+j} - \omega_{t+j}' \, e_{t+j}\right)\right\}. \tag{6}$$

Assuming the shocks to the state vector are governed by a multivariate Normal distribution, the evaluation of the expectation of the stochastic discount factor implies that the price of the N-period zero-coupon bond is given by

$$\widetilde{P_t^N} = exp(-A_N - B_N X_t) \quad (7)$$

and the model-implied yield on the N-period zero-coupon bond, , is given by

$$\widetilde{y_t^N} = A_N + B_N X_t. \quad (8)$$

In equations 7 and 8, the coefficient matrices A and B are functions of the parameters governing the AR(1) dynamics of the state variables and the relationship between the stochastic discount factor and the state variables.

An important property implied by equation 8 is that yields are linear functions of the state variables and inherit the AR(1) dynamics of the state variables. (Note that restricting the dynamics to involve only one lag is only for presentational convenience, as a vector autoregression with any number of lags can be rewritten as an AR(1) by redefining the state vector to include additional lags.) This implies that a vector autoregression of yields uncovers the true dynamics of yields if the number of yields equals the number of state variables. As a result, affine models of this type can be estimated using only information on a small number of yields. For example, it is typical for models of this type to assume that yields are governed by two or three factors. In some cases, these factors are explicitly modeled as the level, slope, and curvature of the yield curve. In other specifications, the factors are not explicitly captured by such observable concepts and the unobservable factors are estimated via techniques such as the Kalman filter. In such cases, the unobserved factors often look like level, slope, or curvature factors. These concepts and results permeate the literature and can be seen in, for example, Ang and Piazzesi (2003), Kim and Wight (2005), Cochrane (2007), Gurkaynack and Wright (2012), Adrian, Crump, and Moench (2013), and Joslin, Li, and Singleton (2013).

Because the yield curve is an AR(1) in this standard model, consistent estimates of yield curve dynamics—that is, the reduced-form dynamics—can be obtained via a vector autoregression in yields or yield factors. Most of the literature follows a different approach and explicitly estimates the parameters of the underlying structural model. This structural estimation approach may be more efficient—that is, may yield better estimates of parameters—in small samples. This potential increase in efficiency occurs because imposition of restrictions on yield curve dynamics, if valid, sharpen statistical inference by exploiting information in the cross section and time series of yields. In practice, these more complex approaches do not yield clearly improved inference. As argued in Cochrane (2007) and demonstrated in Joplin, Li, and Singleton (2013), the restrictions implied by the structural models are essentially non-binding and hence do not, in general, yield notable efficiency gains.[4] The next section will illustrate how a simple vector autoregression in yield factors delivers results comparable to widely followed affine term structure models.

2.3 A Decomposition into Expected Short Rates and Term Premiums

Given a model of yields, the term premium on the N-period bond implied by the model can be defined as the difference between the model implied yield, $\widetilde{y_t^N}$, and the sequence of expected short-term interest rates

$$tp_t^{N,A} = \widetilde{y_t^N} - \widehat{y_t^N}. \quad (9)$$

This decomposition is analogous to that presented for the Expectations Hypothesis in equation 2. The potential difference across the approaches in equation 2 and equation 9 is the use of the model implied yield $\widetilde{y_t^N}$, rather than observed yield, to construct the term premium. In practice, this difference is not important quantitatively important (at most times) because fitting errors between model implied and observed yields are usually small. The approaches could also differ in the method used to project the future values used in measurement of the expected sequence of future short rates $\widehat{y_t^N}$. To the extent affine models impose little restriction on the dynamics of the yield curve, simple implementation of the Expectations Hypothesis and affine term structure models will yield broadly similar results.

3. Reconsidering the Standard Decomposition

3.1 Replicating the Standard Decomposition

I consider the yields shown in figure 1—one-year, three-year, five-year, and ten-year yields. The variables used to predict yields—that is, the state vector X_t—are the one-year yield, the level of the yield curve (measured as the average in a time period of one-, three-, five-, and ten-year yields), the slope of the yield curve (measured as the difference between the ten-year and one-year yield),

[4] Macroeconomic analyses also use vector autoregressions to explain the yield curve, e.g., Rudebusch, Sack and Swanson (2006) and Evans and Marshall (2007).

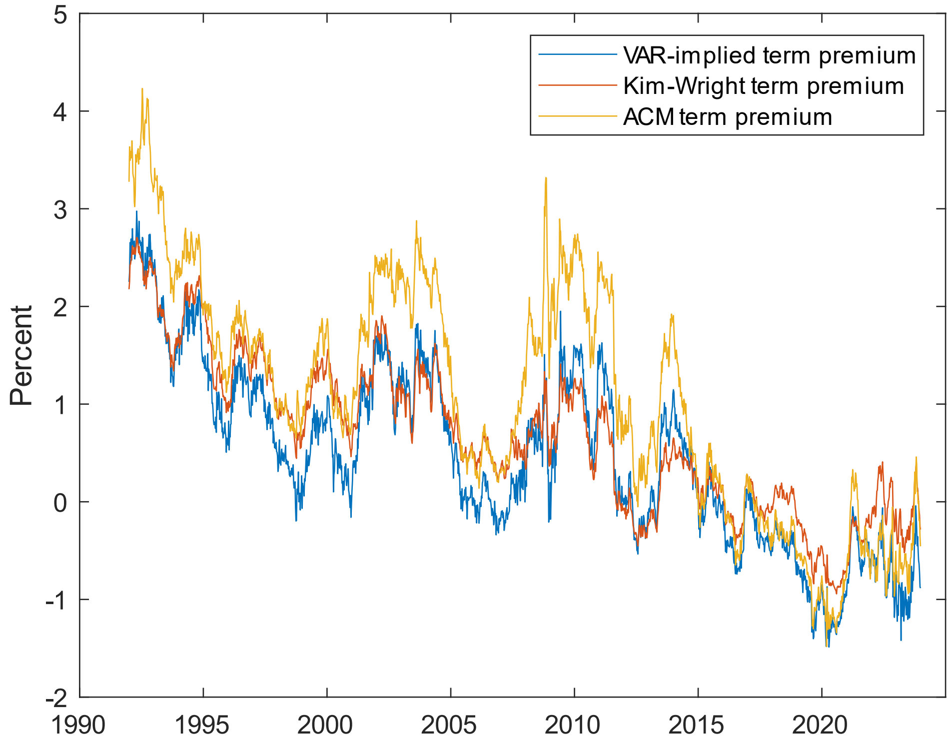
and the curvature of the yield curve (measured as the difference between the five-year yield and the average of the one-year and ten-year yield).

Given this set of variables for forecasting, a vector autoregression of the form shown in equation 3 is estimated. The analysis is carried out using weekly and monthly data. For the specification with weekly data, twelve lags of the variables are used to estimate dynamics and construct forecasts. For the specification with monthly data, three lags of the variables are used to estimate dynamics and construct forecasts. In both cases, the estimation sample spans the entire range shown in figure 1—January 1962 to December 2023. The consideration of the entire sample implies that information from, for example, December 2023 is used to construct forecasts for earlier periods, such as the early 1990s, through the effect of this data on estimated parameters, including the long-run level of the state variables. This implies that, for example, data from December 2023 informs the estimate of the average long-run level of the one-year yield used to construct expected short-term rates and term premiums in earlier decades.

The decomposition constructed is based on the Expectations Hypothesis presented in equation 2. In the decomposition of an N-period zero-coupon bond, the N-period forecast of the expected one-year yield (the short-term rate in this analysis) is derived from the estimated vector autoregression. The N-period term premium is constructed as the difference between the observed yield and this forecast. As noted in the previous section and in both Cochrane (2007) and Joslin, Li, and Singleton (2013), this approach is likely to mimic a decomposition from affine models because affine models are close to unrestricted vector autoregressions. In the approach herein, where the state variables imply no fitting error of the 10-yr. Treasury yield (because the state variables implicitly include the 10-yr. yield), the term premiums as defined in equations 2 and 9 are identical when the vector autoregression does not impose the restrictions implied by equations 4 to 8.

Figure 2 presents the term premium estimated by this approach for the period from January 1990 to December 2023 based on weekly data. The figure also includes the term premium estimates from the Kim-Wright (2007) and Adrian, Crump, and Moench (2013) models. The estimate from the approach herein and the Kim-Wright model overlap very closely, and the broad contour of the Adrian, Crump, and Moench estimate tracks that of the other measures.

Figure 2: Alternative estimates of term premiums,
December 31, 1991 to December 29, 2023



Source: Federal Reserve Board, Federal Reserve Bank of New York, and author's calculations. See data appendix.

Table 1 reports the correlation matrix from of the three term-premium estimates. The measures are highly correlated, with correlation coefficients on a weekly basis exceeding 0.90. This high degree of comovement is apparent in figure 2, where both the long-run decline between the early 1990s and mid-2010s and the high-frequency ups and downs are similar across measures.

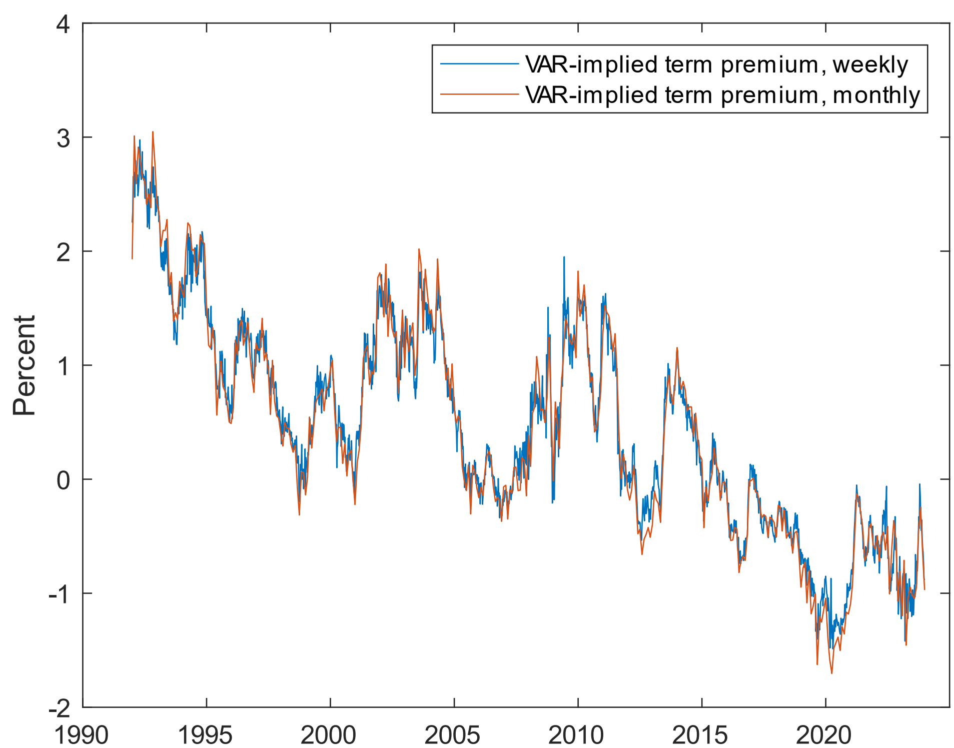
Table 1: Correlation of weekly term premium estimates, December 31, 1991 to December 25, 2023

	VAR-implied term premium	*Kim-Wright term premium*	*Adrian, Crump, and Moench term premium*
VAR-implied term premium	1.00		
Kim-Wright term premium	0.95	1.00	
Adrian, Crump, and Moench term premium	0.97	0.90	1.00

Source: Federal Reserve Board, Federal Reserve Bank of New York, and author's calculations. See data appendix.

Figure 3 presents the term premium using the simple decomposition from the vector autoregression for the weekly data (as in figure 2) and the monthly data. The weekly and monthly approaches produce very similar results. The remainder of the analysis will focus on the approach using monthly data.

Figure 3: Term premiums estimated using weekly or monthly data, December 1991 to December 2023



Source: Author's calculations. See data appendix.

3.2 An Alternative Decomposition Using Rolling or Recursive Real-time Samples

An important assumption in the previous section was the full-sample estimation approach. Estimation of the parameters used to construct expected short-term interest rates via a full-sample approach implies that expected short-term interest rates include full knowledge that the high average levels of interest rates in the 1980s and early 1990s would be followed by lower interest rates in the 2000s and 2010s. For example, the average level of interest rates—a key component of expected interest rates—are sensitive to the sample period used to estimate the average.

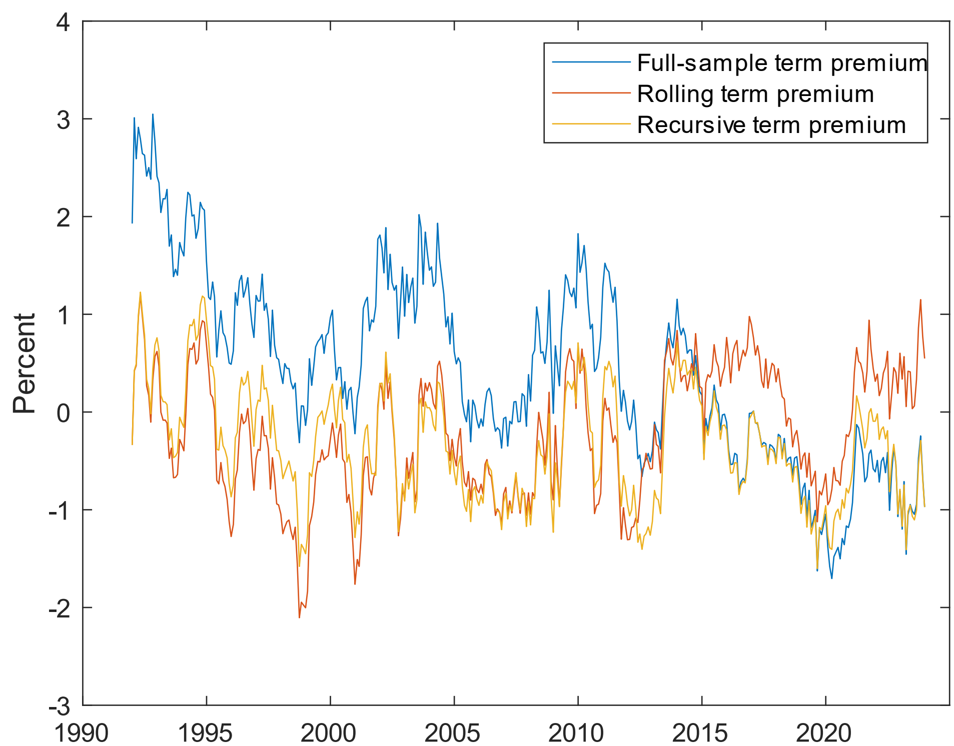
A natural alternative to estimation with the full sample of data is a one-sided, or real time, approach. In this case, parameters used to construct estimates of expected short rates are estimated with data up to the period for which the expectation is computed. For example, a one-sided approach assumes that expected interest rates in the years following January 2001 use data prior to that month (and not data for later periods). This approach does not allow the experience in 2010–when interest rates were much lower than in 2001–to affect expected interest rates in 2001 and thereby affect the decomposition of the yield curve into expected short-term interest rates and term premiums. The one-sided information arguably more accurately captures the information available when yields are determined.

Two one-sided approaches are natural candidates. A *rolling* approach uses a fixed-length estimation sample that rolls forward each period. For example, a 30-year rolling window would estimate parameters for January 1992 using data from January 1962 through December 1991; in February 1992, the data used to estimate parameters would span from February 1962 to January 1992. A *recursive* approach uses an expanding sample period, with the start date used in estimation held fixed and the end date moving forward as time passes, For example, a recursive approach would estimate parameters for January 1992 using data from the start of the sample, January 1962, through December 1991, and would add data for January 1992 to the sample used to estimate parameters and form projections in February 1992.

Both the rolling and recursive approaches are one-sided and hence arguably better capture the information available to market participants when yields are determined. There is an important difference between the approaches. The rolling approach ignores older information. Dropping old information may be appropriate if, for example, changes in the economy and/or financial markets lead to changes in the parameters determine yield curve dynamics, including the average level of interest rates. Research has suggested that the key determinants of the long-run level of interest rates—the long-run level of inflation and of the equilibrium real interest rate—have likely changed owing to shifts in societal understanding of the costs of inflation, demographic determinants of saving and investment, and other factors (e.g., Kiley 2020b). These considerations suggest value in a rolling approach, although more sophisticated approaches, such as those reviewed in Kiley (2020b), may be more appropriate. For the purposes of this analysis, the differences or similarities between full sample, rolling, and recursive approaches are the focus. The results will suggest directions for future research as discussed in the conclusion.

The implementation of each approach begins with a 30-year sample beginning in January 1962. The first period with a one-sided estimate is January 1992. Figure 4 presents the rolling, recursive, and full sample estimate of the term premium on a 10-yr. Treasury security (for monthly data, with the full sample estimate identical to that shown in figure 3).

Figure 4: Term premiums from full sample, rolling, and recursive approaches January 1992 to December 2023



Source: Author's calculations. See data appendix.

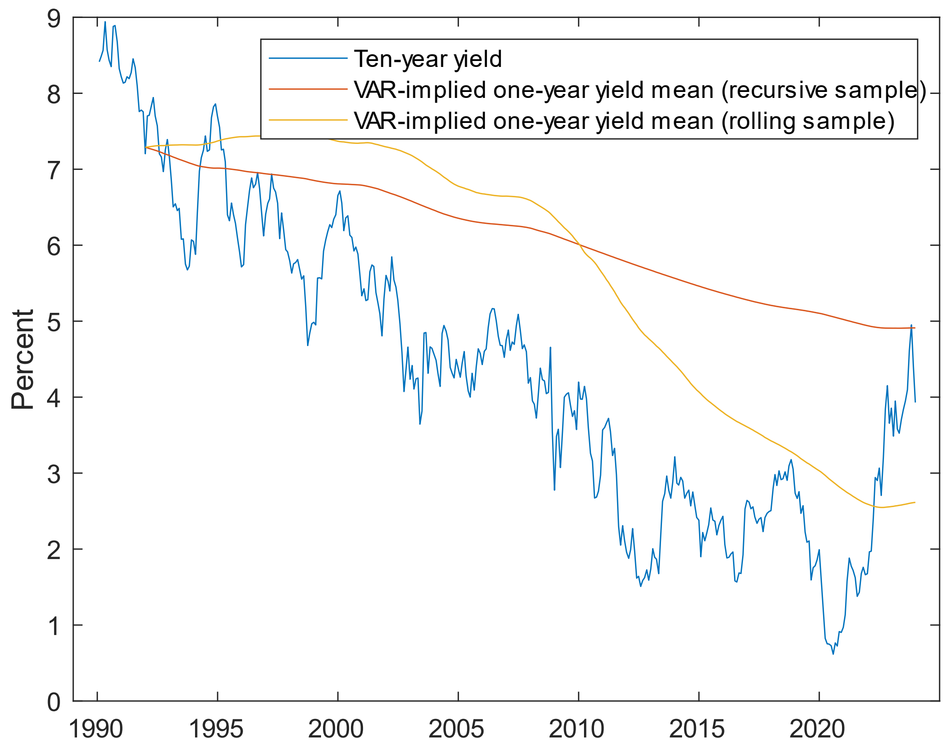
The difference between the full sample estimates and those from both the rolling and recursive approaches are notable. The significant difference is that the rolling and recursive estimates do not show a downward trend from the 1990s through 2020. Both the rolling and recursive estimates have largely moved sideways from the early 1990s through the present. For example, the estimates of the term premium were slightly negative in early 1992 according to the rolling and recursive approach, whereas the full sample approach produces a term premium of 2 percent in early 1992. (It is important to keep in mind that the recursive and rolling estimates are identical at the start of 1992, as each uses all available data up to that date; conversely, the recursive and full sample estimates are identical at the end of the sample, December 2023, as both approaches use all available data at the last data point.)

A corollary of the difference of the one-sided/real-time approaches from the full sample estimate is that these real-time estimates differ from the widely followed measures of Kim and Wright (2005) and Adrian, Crump, and Moench (2013). This follows from the close correspondence between the full-sample approach and the approaches of Kim and Wright (2005) and Adrian, Crump, and Moench (2013) documented in figure 2 and table 1.

The reason for the difference between real-time and full-sample approaches is simple. The average level to which short-term interest rates are expected to settle in the long run is a key determinant of the sequences of expected short-term interest rates that enter the decomposition of the yield curve into term premiums and expected short-term interest rates. Estimates of this average are highly sensitive to the sample period. This can be seen by examining the estimates of the long-run average level of the one-year Treasury yield from the recursive and rolling approaches (which are simple the means from the sample period used in estimation). Figure 5 presents the 10-yr Treasury yield and the long-run average level of the one-year Treasury yield from the recursive and rolling approaches. At the start of the estimation sample (early 1992), the average one-year Treasury yield is estimated to equal about 7¼ percent. Under the recursive approach (which adds subsequent data), the estimate of the average drops to below 5 percent by 2023, reflecting the lower level of interest rates after the 1980s. Under the rolling approach, the estimate of the average drops significantly, to just above 2½ percent. This steep decline largely occurs after the global financial crisis of 2008, reflecting the low level of interest rates and the 30-yr period used to inform the estimate (late 1993 through late 2023).

Overall, the one-sided estimates show essentially no trend in term premiums and attribute the trend decline in long-term interest rates to a decline in the expected average level of short-term interest rates. This decomposition differs substantially from the common approach.

Figure 5: The 10-year Treasury yield
and estimates of the long-run average of one-year Treasury yields



Source: Federal Reserve Board and author's calculations. See data appendix.

4. Implications of the Alternative Decomposition

The empirical results connect to two interrelated questions that have been important in academic, policy, and financial-market discussions of interest rates and the yield curve.

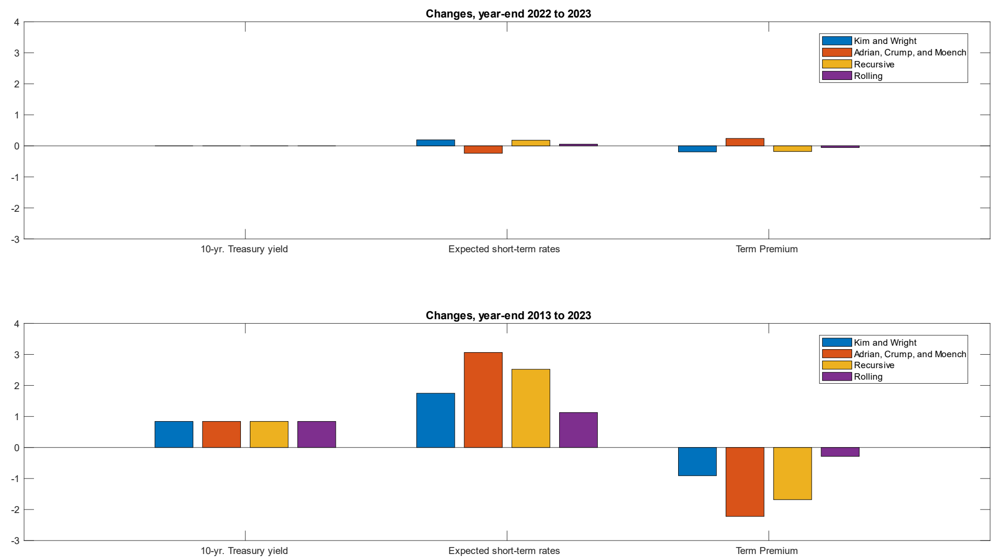
4.1 How much of the changes in long-term yields over various periods owes to term premiums?

The one-sided approaches differ from full sample estimates substantially over decades. However, the high frequency movements are much more similar. That is, the decomposition of changes in long-term interest rates into changes in term premiums and changes in the expected path of short-term interest rates are fairly similar over short horizon. This reflects the slow movements in the underlying trend in estimates of the long-run level of short-term interest rates that drive the differences between one-sided and full sample estimates. For example, the correlation between the monthly level of the full-sample estimate associated with the vector autoregression used in this research and the Kim-Wright (2005) term premium published by the Federal Reserve Board is 0.94. The analogous correlation for the one-sided rolling estimate herein is 0.11, essentially uncorrelated and far below the correlation for the full-sample approach. However, the correlation of the changes in the full-sample and one-sided approaches to estimating term premiums for monthly data with the change in the Kim-Wright (2005) term premium are 0.85 and 0.84, i.e., essentially identical. Over short windows like a month, changes in term premiums are very similar from the different approaches.

The similarity in high-frequency changes implies that the approaches deliver similar lessons for understanding the movements in the yield curve over relative short time periods, but assessments over longer time periods can be very different. To see this, the upper panel of figure 6 presents the decompositions of the change in the 10-yr. Treasury yield from December 2022 to December 2023. Note that this change equaled zero—on net, the 10-yr yield was unchanged over the period. The models all see a mix of factors and relatively small contributions from both term premiums and expected short-term interest rates.

Over a longer period, the picture is different. The lower panel of figure 6 presents the decompositions of the change in the 10-yr. Treasury yield from December 2013 to December 2023. Note that this change equaled 0.84 percentage point—on net, the 10-yr yield rose moderately over the period. The Kim-Wright (2005) and Adrian, Crump, and Moench (2013) models estimate that expected short-term interest rates rose by 2 percentage points or more over this period—that is, expected short-term interest rates are estimated to have risen by more than double the actual increase in 10-yr. Treasury yields. As a result, these models estimate a large decline in term premiums between 2013 and 2023. The recursive approach is similar, and this is expected as, in this case, the recursive approach is essentially the full sample approach (as only 10 additional years of data, or less than 1/6th of the sample, is added when expanding the sample from 2013 to 2023). In contrast, the rolling approach attributes the rise in the 10-yr. Treasury yield to higher expected short-term interest rates and sees little change in term premiums. Superficially, this seems like an advantage of the rolling approach, as it does not see large offsetting effects from expected short rates and term premiums. The difference owes to the effect rolling estimation has on long-run expected values of short-term interest rates, and hence the predictions of the approach for such values is of interest as discussed in the next subsection.

Figure 6: Decomposition of change in 10-yr Treasury yield over various periods



Source: Federal Reserve Board, Federal Reserve Bank of New York, and author's calculations.

4.1 How important is the long-run equilibrium level of short-term rates for yield curve movements?

The results from one-sided decompositions of the yield curve into expected short-term interest rates and term premiums connect directly with the literature on the long-run equilibrium interest rate. As discussed in reviews of this literature (e.g., Kiley, 2020b), the equilibrium real interest rate is the level of the real interest rate that balances saving and investment in the long run. Equivalently, the equilibrium real interest rate is the real interest rate consistent with stable inflation and aggregate demand equal to aggregate supply in the long run. These macroeconomic concepts are important for understanding policy issues such as whether monetary policy is accommodative and the long-run outlook for interest expense and related fiscal-policy issues.

Laubach and Williams (2003) developed approaches to gauging the equilibrium real interest rate. Following the financial crisis of 2008, evidence accumulated that the equilibrium real interest rate had fallen (e.g., Holston, Laubach, and Williams, 2017; Kiley, 2020a), although the statistical power of these techniques is questionable as estimation of long-run values is inherently difficult (e.g., Cochrane, 2007; Kiley, 2020a). These developments led to discussions of appropriate monetary policy strategies at low levels of real interest rates (e.g., Kiley and Roberts, 2017; Bernanke, Kiley, and Roberts, 2019; Bernanke, 2020; and Clarida, 2022).

The post GFC results emerging from these analyses point to a sizable decline in the short-run equilibrium real interest rate in the late 2010s—to below one percent—with some signs of an increase in the 2020s (Holston Laubach, and Williams, 2017; Kiley, 2020a, 2020b; Lubik and Matthes, 2015).[5] Such estimates for the equilibrium real interest rate suggest a short-term nominal interest rate below 3 percent. Policymakers appear to have adopted this view, as suggested by the projections of participants in the Federal Open Market Committee (FOMC). Figure 7 reports the median of projections for the long-run federal funds rate of participants reported in the Summary of Economic Projections since 2012, along with the level of the 10-yr. Treasury yield and the estimate of the average one-yr. Treasury yield associated with the rolling approach (which was presented in figure 5). The FOMC projection declined from over 4 percent in late 2012 to 2½ percent by the end of the 2010s (where it remained through September 2023). The decline in FOMC projections for the long-run federal funds rate follows a pattern similar to the average one-yr Treasury rate implied by the rolling approach to yield curve decomposition.

The similarity of the movements in real-time estimates of the long-run federal funds rate and the one-year average Treasury yield has three implications. First, the issues associated with decomposing the yield curve into term premiums and expected short-term interest rates are confronted broadly in economics, including in the setting of monetary policy, as the long-run course of interest rates has wide-ranging implications. Second, the similar contours from FOMC projections and the rolling approach highlights how the one-sided rolling approach taken herein tracks expectations of at least one important, and informed, set of financial-market participants—the FOMC. Finally, additional work on how changes in the long-run expected level of short-term interest rates affect our understanding of yield curve dynamics, as in this work and Cochrane (2007), Laubach, Tetlow, and Williams (2007), Orphanides and Wei (2012), and Bauer and Rudebusch (2020), is valuable.

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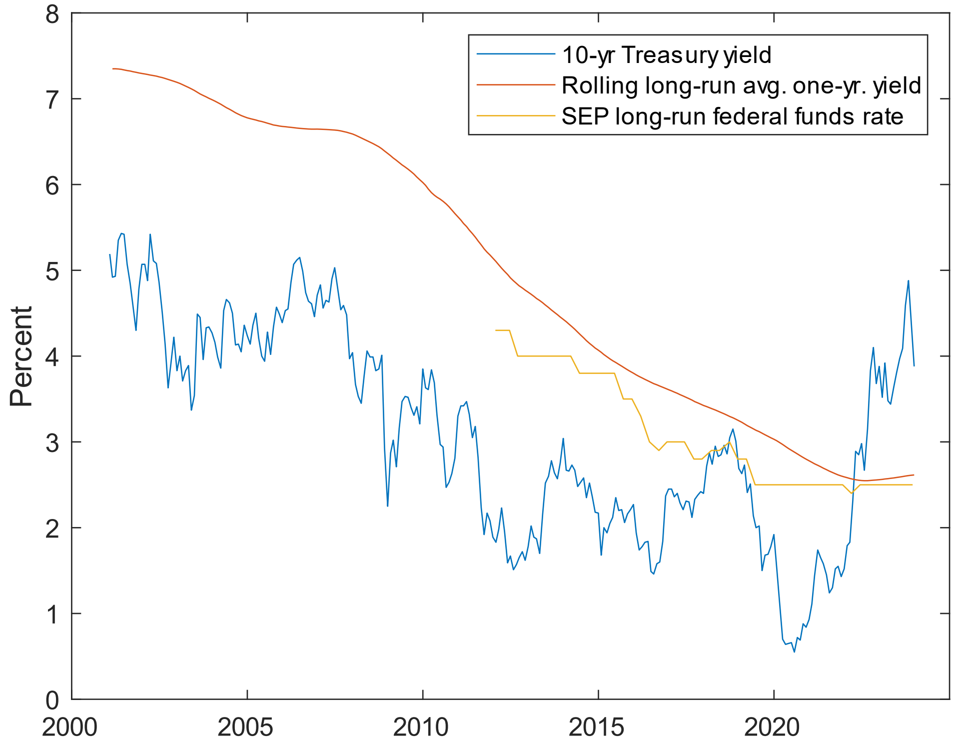
[5] The Federal Reserve Banks of New York and Richmond report estimates of the long-run neutral real interest rate at, respectively, https://www.newyorkfed.org/research/policy/rstar and https://www.richmondfed.org/research/national_economy/natural_rate_interest.

Figure 7: One-sided estimates of long-run short-term interest rates: Summary of Economic Projections and average of one-yr. Treasury yield over rolling 30-yr. window:



Source: Federal Reserve Board, Federal Open Market Committee, and author's calculations.

5. Conclusion

A decomposition of the Treasury yield curve using a one-sided, or real-time, approach yields several lessons. Term premiums do not show a downward trend, in contrast to common decompositions. Rather, term premiums have fluctuated in a stable range, while long-run expected short-term interest rates have fallen—consistent with work on changes in long-run neutral interest rates. These results suggest research and market commentary on yield curve decompositions may benefit from more attention on the long-run expected level of interest rates. Nonetheless, decompositions of movements in the yield curve over short horizons are less dependent on real-time considerations. For example, both the Kim-Wright (2005) (full sample) approach and one-sided approaches attribute the rise in the 10-yr Treasury yield in 2023 in roughly equally to increases in term premiums and expected short-term interest rates. The importance of a one-sided rolling is more significant for longer-run decompositions of the 10-yr. Treasury yield.

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Data Appendix

The data on U.S. Treasury yields comes from the Federal Reserve Board and is available at https://www.federalreserve.gov/data/nominal-yield-curve.htm. These data can also be downloaded from FRED at the Federal Reserve Bank of St. Louis. The data used in this analysis were accessed on January 12, 2024.

The data on the Kim and Wright model comes from the Federal Reserve Board and is available at https://www.federalreserve.gov/data/nominal-yield-curve.htm. The data used in this analysis were accessed on January 12, 2024.

The date on the Adrian, Crump, and Moench model comes from the Federal Reserve Bank of New York and is available at https://www.newyorkfed.org/research/data_indicators/term-premia-tabs#/overview. The data used in this analysis were accessed on January 12, 2023.

The data on the median of projections for the long-run value of the federal funds rate from the Summary of Economic Projections of the Federal Open Market Committee can be downloaded from FRED at the Federal Reserve Bank of St. Louis, referring the mnemonic FEDTARMDLR, at https://fred.stlouisfed.org/series/FEDTARMDLR. The data used in this analysis were accessed on January 12, 2024.