Online Appendix:
Revisiting the Interest Rate Effects of Federal Debt

Michael D. Plante* Alexander W. Richter† Sarah Zubairy‡

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*Federal Reserve Bank of Dallas, 2200 N Pearl Street, Dallas, TX 75201 (michael.plante@dal.frb.org)
†Federal Reserve Bank of Dallas, 2200 N Pearl Street, Dallas, TX 75201 (alex.richter@dal.frb.org)
‡Texas A&M University, 4228 TAMU, College Station, TX, 77843 and NBER (szubairy@tamu.edu)

A DATA SOURCES

We use the following time-series provided by Haver Analytics:

1. **U.S. Treasury 15-year zero-coupon yield**
   End of period, monthly, percent (FYCCZFE@USECON)
2. **U.S. Treasury 10-year zero-coupon yield**
   End of period, monthly, percent (FYCCZAE@USECON)
3. **U.S. Treasury 5-year zero-coupon yield**
   End of period, monthly, percent (FYCCZ5E@USECON)
4. **Federal Reserve Treasury securities**
   Not seasonally adjusted, end of period, quarterly, billions (OA71TRE3@FFUNDS)
5. **Treasury Securities held by foreign official institutions**
   Not seasonally adjusted, end of period, quarterly, millions (FLPAD@FFUNDS)
6. **Gross Domestic Product**
   Seasonally adjusted annual rate, quarterly, billions (GDP@USECON)
7. **Domestic nonfinancial corporate dividends**
   Seasonally adjusted annual rate, quarterly, billions (FR10ACO5@FFUNDS)
8. **Market value of equity shares, households and nonprofit organizations**
   Not seasonally adjusted, end of period, quarterly, billions (PA15SMV5@FFUNDS)
9. **DKW expected average real short rate, 5-10 years ahead**
   End of period, monthly, percent (DKW5RSRE@USECON)
10. **DKW real term premium, 5-10 years ahead**
    End of period, monthly, percent (DKW5RTPE@USECON)
11. **DKW expected inflation, 5-10 years ahead**
    End of period, monthly, percent (DKW5EIE@USECON)
12. **DKW inflation risk premium, 5-10 years ahead**
    End of period, monthly, percent (DKW5IRPE@USECON)
13. **SPF 5-year ahead CPI inflation expectation**
    Quarterly, percent (ASACX5@SURVEYS)
14. **SPF 10-year ahead CPI inflation expectation**
    Quarterly, percent (ASACX10@SURVEYS)
15. **U.S. Treasury 3-month zero-coupon yield, 5-years ahead**
    End of period, monthly, percent (FZ3M5YE@USECON)

16. **Labor share, nonfinancial corporate sector**
    Seasonally adjusted, quarterly, percent (LXNCBL@USECON)
17. **Net stock, private fixed assets**
    End of period, annual, billions (EP@CAPSTOCK)
18. **Gross value added, businesses**
    Annual, billions (GDPBA@USNA)
19. **Gross value added, households and institutions**
    Annual, billions (GDPPA@USNA)

We also use the following data sources:

1. **FRB/US 10-year expected inflation**, quarterly, percent. Variable `PTR` in `histdata.txt` from the FRB/US data package. PTR is based on three sources. Through 1981Q1 it is constructed using the method proposed by Kozicki and Tinsley. From 1981Q2 to 1991Q1 it is based on the Hoey survey. Since 1991Q2, the source is the Survey of Professional Forecasters. Until 2007 it uses forecasts of CPI inflation with an adjustment that accounts for the average difference between the CPI and PCE inflation rates. PCE inflation forecasts have been used since they became available in 2007.

2. **CBO Budget and Economic Outlooks**, January 1976, December 1976, December 1977, January 1979, February 1980, July 1981, February 1982, February 1983, February 1984, February 1985, August 1985, February 1986, August 1986, January 1987, August 1987, February 1988, August 1988, January 1989, August 1989, January 1990, July 1990, January 1991, August 1991, January 1992, August 1992, January 1993, September 1993, January 1994, August 1994, January 1995, August 1995, December 1995, May 1996, January 1997, September 1997, January 1998, August 1998, January 1999, July 1999, January 2000, July 2000, January 2001, August 2001, January 2002, August 2002, January 2003, August 2003, January 2004, September 2004, January 2005, August 2005, January 2006, August 2006, January 2007, August 2007, January 2008, September 2008, January 2009, March 2009, August 2009, January 2010, August 2010, January 2011, August 2011, January 2012, March 2012, August 2012, February 2013, May 2013, February 2014, April 2014, August 2014, January 2015, March 2015, August 2015, January 2016, March 2016, August 2016, January 2017, June 2017, April 2018, January 2019, May 2019, August 2019, January 2020, March 2020, September 2020, February 2021, July 2021, May 2022, February 2023, May 2023, February 2024, June 2024, January 2025

3. **OMB Budget of the U.S. Government**, January 1983, February 1984, February 1985, February 1986, January 1987, February 1988, January 1989, January 1990, February 1991, January 1992, April 1993, February 1994, February 1995, March 1996, February 1997, February 1998, February 1999, February 2000, April 2001, February 2002, February 2003, February 2004, February 2005, February 2006, February 2007, February 2008, February 2009, February 2010, February 2011, February 2012, April 2013, March 2014, February 2015, February 2016, May 2017, February 2018, March 2019, February 2020, May 2021, March 2022, March 2023, March 2024

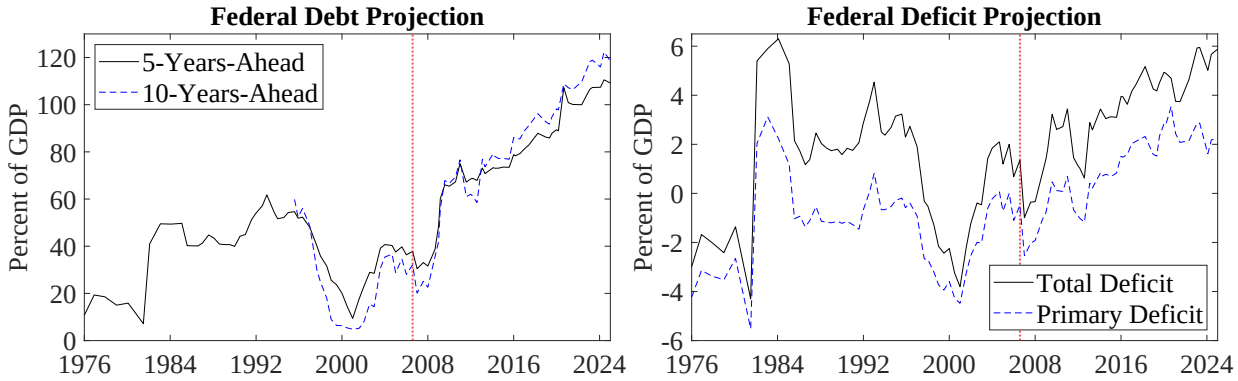
CBO Data Collection For each report, we collect current-year and 5-year-ahead projections for federal debt held by the public, the total deficit (−), net interest spending, and fiscal year GDP (or GNP before 1992). We also collect 10-year-ahead projections from each report after they became available in August 1995. The primary deficit is computed by adding net interest spending to the total deficit. The debt, total deficit, and primary deficit are divided by fiscal year GDP or GNP. We manually compute the shares rather than using the projected shares, so the ratios are more precise.

Prior to the February 1984 report, some of the data is not provided and must be inferred. When fiscal year GNP is unavailable, we use the projection for the total deficit as a share of GNP. We then compute fiscal year GNP from that share in order to determine the debt and primary deficit as a share of GNP. When the debt projection is unavailable, it is computed by adding the cumulative total deficit over a n-year horizon to the actual level of debt in the preceding fiscal year. When the total deficit is unavailable, it is computed as the difference between total revenues and total outlays. In January 1976, neither fiscal year GNP nor the fiscal shares are provided, so we use the projection for calendar-year GNP, which tends to equal fiscal year GNP over a 5-year horizon.

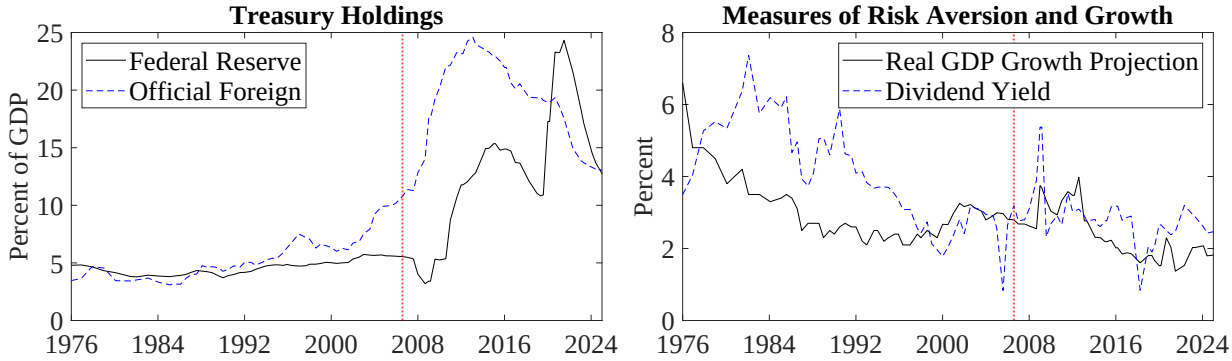
Finally, we collect CBO projections for real GDP growth for the current-year, 5-years-ahead, and 10-years-ahead. Many of the recent reports do not include fiscal year real GDP. However, the CBO has maintained an archive for all the projections since January 2000, available at `https://www.cbo.gov/data/budget-economic-data` under the header "Historical Data and Economic Projections". For each projection, we compute growth rates using the level of fiscal year GDP. In situations when the economic projection is not updated when a new Budget and Economic Outlook is released, we assume the economic projection has not changed from the latest forecast. For example, an update to the Budget and Economic Outlook was released in May 2023, but economic projections were not updated until July 2023. In this case, we assume the May 2023 real GDP projection is the same as it was in the most recent projection provided in February 2023. Prior to January 2000, projections of fiscal year real GDP/GNP growth are taken from each Budget and Economic Outlook report. We use projections of calendar year GNP growth in the few instances before 1985 when fiscal year GNP growth was not provided. Figures 1 and 2 plot these projections and the other variables used in our regressions. Figure 3 provides longer-term projections of debt.

Figure 1: Time series used in the regression models

(a) Federal debt and deficit projections

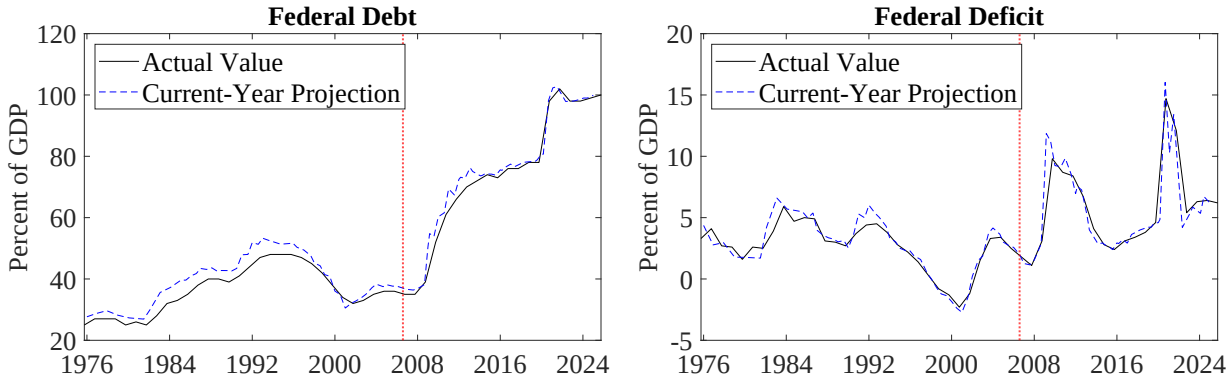


(b) Control variables



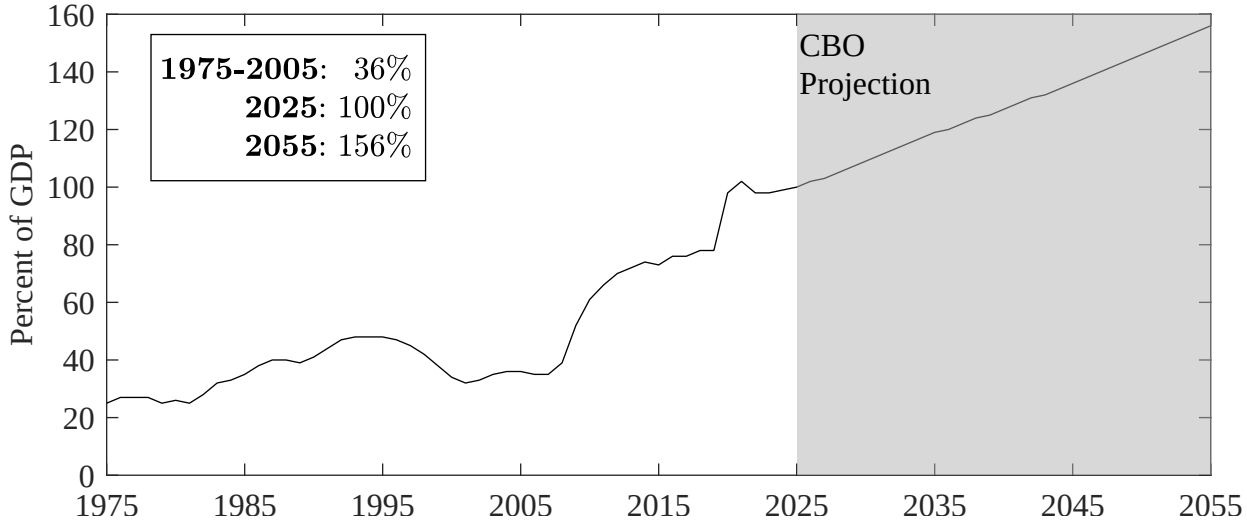
Notes: The dashed vertical line represents the last data point in the Laubach sample. For the projections, the horizontal axis denotes the fiscal year in which the projection was made by the CBO. For other variables, the horizontal axis denotes the calendar year. The real GDP/GNP growth projection is 5-years-ahead.

Figure 2: Comparison of actual and current-year projections of federal debt



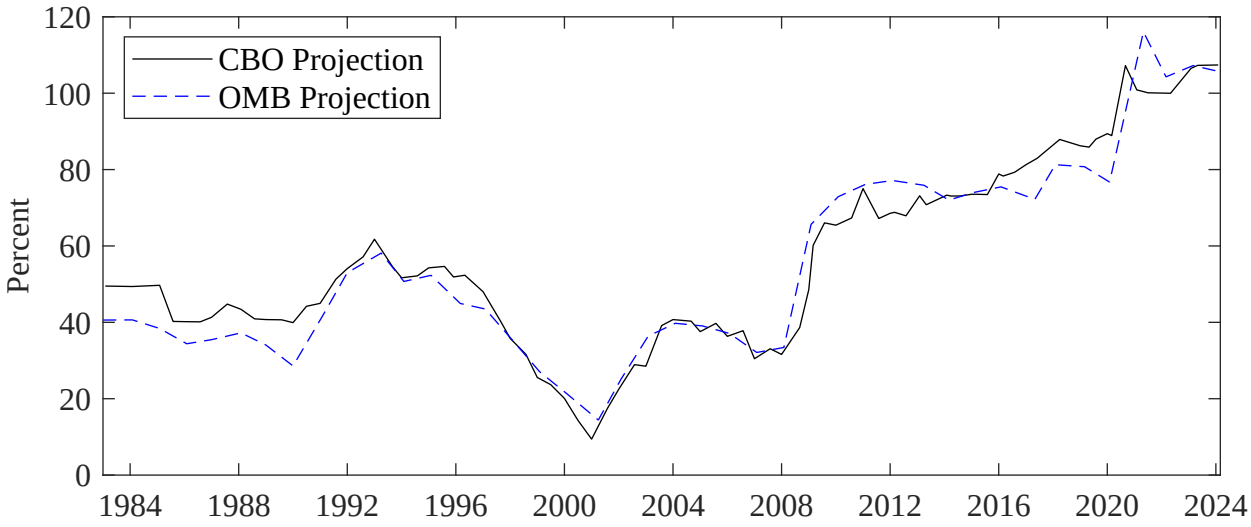
Notes: The dashed vertical line represents the last data point in the Laubach sample.

Figure 3: Long-term projections of federal debt



Notes: The projection is from the March 2025 Long-Term Budget Outlook published by the CBO.

Figure 4: Comparison of alternative 5-year-ahead projections of federal debt



OMB Data Collection For each report, we collect 5-year-ahead projections for federal debt held by the public and fiscal year GDP (or GNP before 1992). Debt is divided by fiscal year GDP or GNP. We manually compute the shares rather than using the projected shares so the ratios are more precise. For the 1983 and 1984 reports, the summary tables only provide debt and GNP forecasts three years into the future. In these cases, we compute the debt by adding the deficit under the proposed budget (including outlays of off-budget federal entities) to the debt for the preceding year. We determined the fiscal year GNP by dividing outlays by outlays as a share of GNP. Figure 4 compares the OMB objections to the CBO projections.

Data Transformations

1. **5-year-ahead, 5-year Treasury rate**

$$E_t i^{(5)}_{t+5} = 100 \times \left(\left(\frac{(1 + FYCCZAE_t/100)^{10}}{(1 + FYCCZ5E_t/100)^5} \right)^{1/5} - 1 \right)$$

2. **10-year-ahead, 5-year Treasury rate**

$$E_t i^{(5)}_{t+10} = 100 \times \left(\left(\frac{(1 + FYCCZFE_t/100)^{15}}{(1 + FYCCZAE_t/100)^{10}} \right)^{1/5} - 1 \right)$$

3. **5-year-ahead, 10-year Treasury rate**

$$E_t i^{(10)}_{t+5} = 100 \times \left(\left(\frac{(1 + FYCCZFE_t/100)^{15}}{(1 + FYCCZ5E_t/100)^5} \right)^{1/10} - 1 \right)$$

4. **5-year-ahead, 5-year inflation rate**

$$E_t \pi^{(5)}_{t+5} = 100 \times \left(\left(\frac{(1 + ASACX10_t)^{10}}{(1 + ASACX5_t)^5} \right)^{1/5} - 1 \right)$$

5. **Dividend yield**

$$divyld_t = 100 \times \frac{FR10ACO5_t}{PA15SMV5_t}$$

6. **DKW nominal term premium**

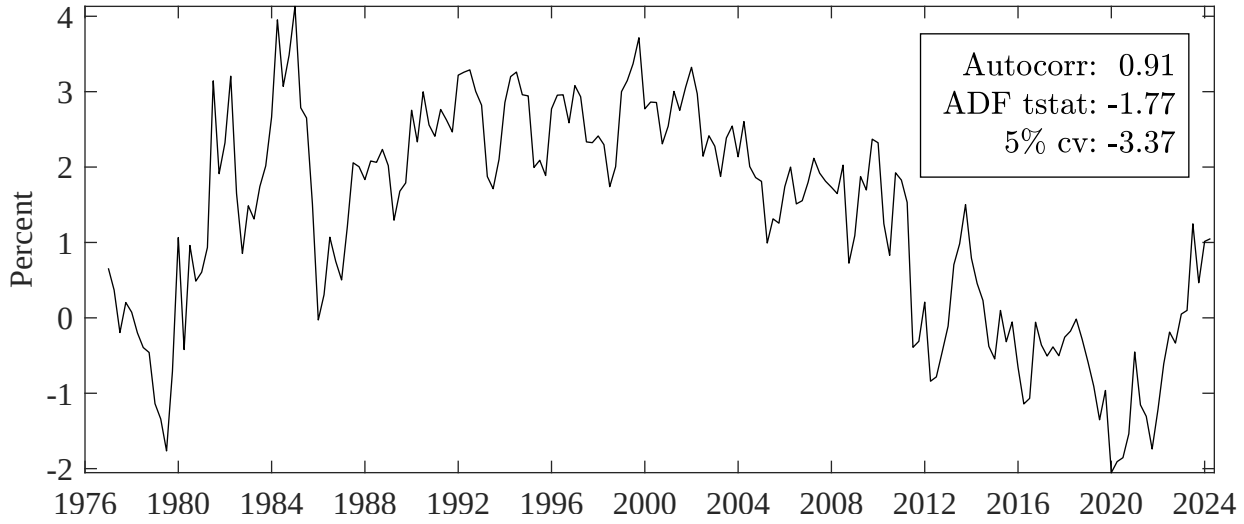
$$dkw^{tp}_t = DKW5RTPE_t + DKW5IRPE_t$$

7. **Capital-to-output Ratio**

$$k_t = \frac{EP_t}{GDPBA_t + GDPPA_t}$$

B ADDITIONAL EMPIRICAL RESULTS

Figure 5: Dynamic OLS residuals



Notes: Regression is the 5-year-ahead, 5-year Treasury rate on expected inflation with 3 leads and lags.

Table 1: Stationarity properties of the data

(a) Phillips-Ouliaris cointegration test

	Full Sample (1976-2025)			Laubach Sample (1976-2006)		
Frequency	t-stat	5% cv	p-value	t-stat	5% cv	p-value
Quartly Data	−2.38	−3.37	0.35	−3.65	−3.39	0.03
CBO Releases	−1.88	−3.40	0.58	−3.40	−3.46	0.06

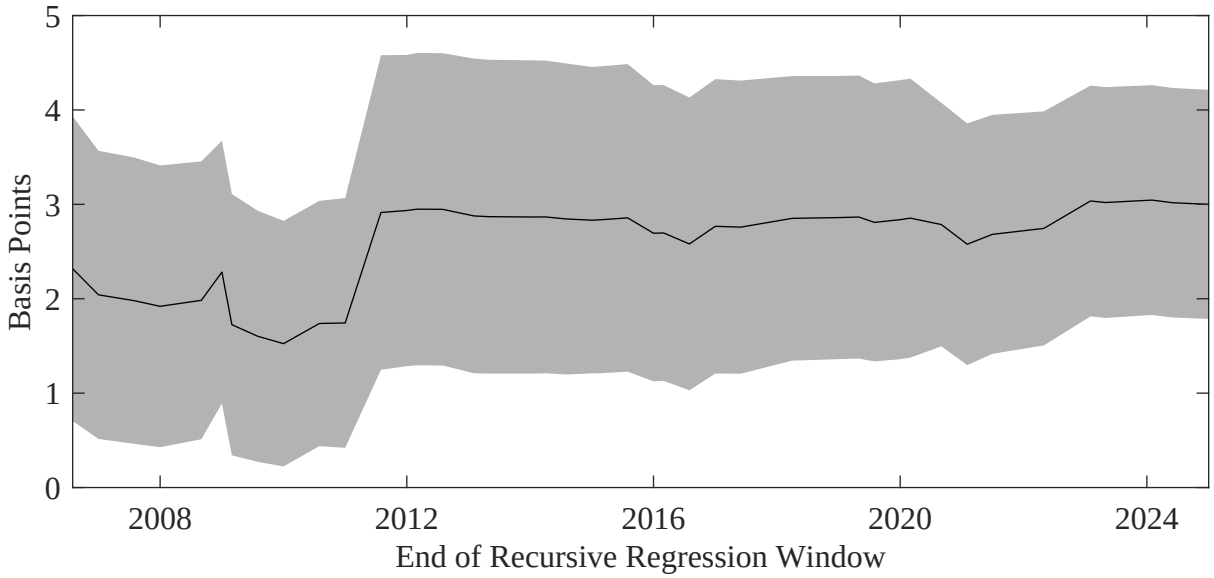
(b) Augmented Dickey-Fuller unit root test

	Full Sample (1976-2025)			Laubach Sample (1976-2006)		
Variable	t-stat	5% cv	p-value	t-stat	5% cv	p-value
Federal Debt	−0.59	−2.89	0.87	−2.15	−2.92	0.23
Total Deficit	−2.51	−2.89	0.12	−2.46	−2.92	0.13
Primary Deficit	−2.43	−2.89	0.14	−2.77	−2.92	0.07
Fed Holdings	−1.31	−2.89	0.60	−0.97	−2.92	0.74
Foreign Holdings	−1.11	−2.89	0.69	0.75	−2.92	0.99

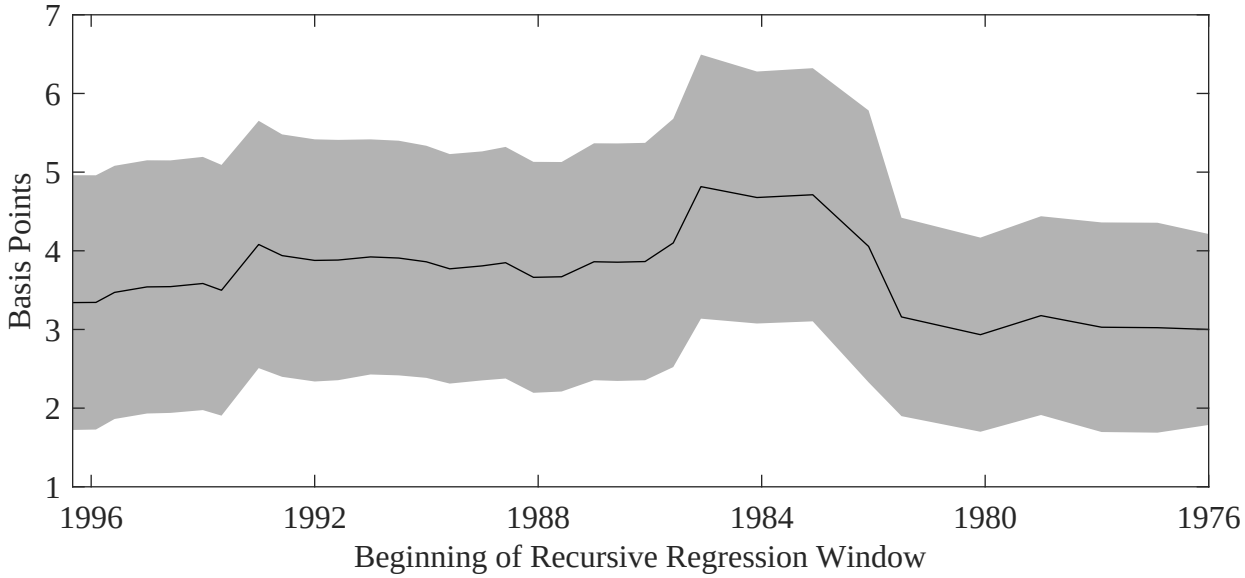
Notes: The cointegration test is based on a regression of the 5-year-ahead, 5-year Treasury rate on expected inflation. The unit root test is applied to all independent variables in our baseline regression model. The debt and deficit are 5-year-ahead projections by the CBO expressed as a percent of GDP (or GNP before 1992). Fed and foreign holdings of Treasury securities are realized values expressed as a percent of GDP.

Figure 6: Recursive estimates of the interest rate effect of federal debt

(a) Forward recursive estimates



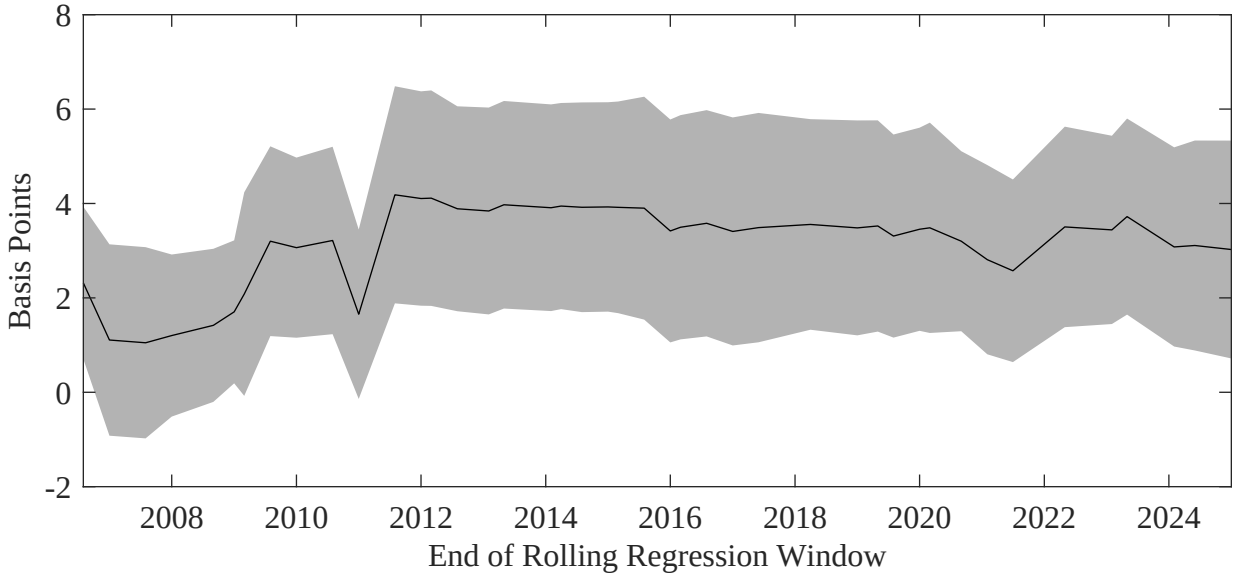
(b) Backward recursive estimates



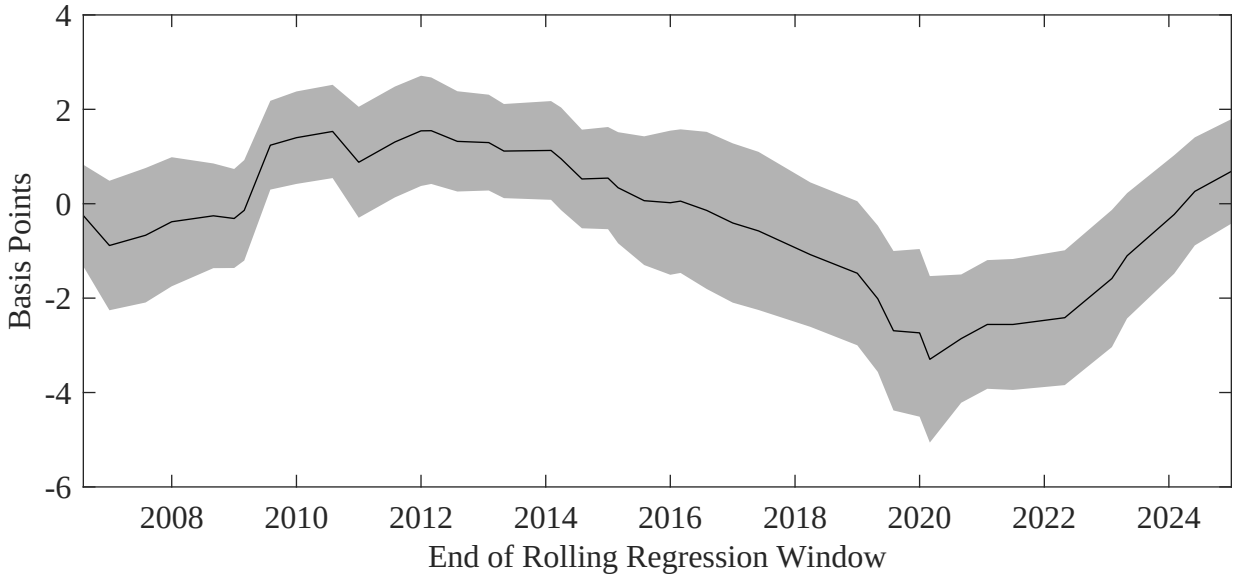
Notes: Data points are based on regressions of the 5-year-ahead, 5-year Treasury rate on the 5-year-ahead projection for federal debt and all controls (expected inflation, Federal Reserve and foreign holdings of Treasury securities as a share of GDP, the 5-year-ahead projection of real GDP/GNP growth, and the dividend yield). For the forward recursive estimates, the starting sample is from January 1976 to August 2006 and future observations are recursively added to the sample period until January 2025. For the backward recursive estimates, the starting sample is from May 1996 to January 2025 and past observations are recursively added to the sample period until January 1976. The shaded regions shows 95% confidence intervals.

Figure 7: Rolling window estimates of the interest rate effect of federal debt

(a) First differences



(b) Levels



Notes: Data points are based on regressions of the 5-year-ahead, 5-year Treasury rate on the 5-year-ahead projection for federal debt and all controls (expected inflation, Federal Reserve and foreign holdings of Treasury securities as a share of GDP, the 5-year-ahead projection of real GDP/GNP growth, and the dividend yield). The starting sample is from January 1976 to August 2006, the same as the Laubach sample. The regression window is then continuously shifted forward by one data point until the end of the sample.

Table 2: Decomposition of the estimated interest rate effects of federal debt and deficits

	5y5y	r^*	tp_n	tp_r	$E\pi$
Federal Debt	3.47	1.01	1.86	1.39	0.51
	(1.61)	(0.49)	(0.98)	(0.72)	(0.25)
Total Deficit	23.63	6.51	12.80	9.54	3.39
	(9.43)	(3.04)	(5.64)	(4.18)	(1.54)
Primary Deficit	21.82	5.68	12.17	9.01	3.06
	(12.62)	(3.77)	(7.70)	(5.70)	(1.95)

Notes: Estimates based on regressions of interest rates, term premia, and expected inflation on alternative fiscal projections. The rows are projections of federal debt and deficits 5-years-ahead as a percent of GDP (or GNP before 1992). The columns are the 5-year-ahead, 5-year Treasury rate (5y5y) and the expected real short rate (r^*), the nominal term premium (tp_n), the real term premium (tp_r), and expected inflation ($E\pi$) from the DKW term structure model. The sample is from August 1995 to January 2025. The estimated coefficients are in basis points. The values in parentheses are robust standard errors.

Table 3: Estimates of the effect of federal debt and deficits on alternative interest rates

	5y10y	5y10y	5y3m	5y3m	Spread	Spread
Federal Debt	3.48	3.27	2.49	2.39	0.99	0.88
	(0.94)	(1.04)	(1.36)	(1.48)	(0.87)	(0.76)
Total Deficit	17.94	17.90	13.29	13.60	4.65	4.30
	(4.45)	(5.58)	(8.06)	(9.01)	(4.44)	(3.79)
Primary Deficit	16.17	15.36	9.24	8.59	6.94	6.77
	(5.13)	(6.21)	(7.64)	(8.35)	(5.05)	(4.33)
Extra Controls	No	Yes	No	Yes	No	Yes

Notes: The rows are projections of the federal budget 5-years-ahead as a percent of GDP (or GNP before 1992). The 5y10y columns use the 5-year-ahead, 10-year Treasury rate, the 5y3m columns use the 5-year-ahead, 3-month Treasury rate, and the Spread columns use the difference between the 5y10y rate and the 5y3m rate. The estimates are based on regressions of each interest rate on 5-year ahead projections of federal debt and deficits. The baseline model includes expected inflation as well as Federal Reserve and foreign holdings of Treasury securities as a share of GDP. The additional controls are the 5-year-ahead projection of real GDP growth (or GNP growth before 1992) and the dividend yield. The sample is from January 1976 to January 2025. The estimates are in basis points. The values in parentheses are robust standard errors.

Table 4: Estimates of the effect of federal debt and deficits using alternative fiscal projections

	5y5y		5y10y	
	CBO	OMB	CBO	OMB
Federal Debt (β_1)	3.61 (1.56)	3.06 (1.20)	3.43 (1.37)	2.76 (1.10)
Expected Inflation (β_2)	62.36 (43.63)	33.24 (30.57)	66.38 (42.44)	41.51 (27.99)
Fed Holdings (δ_1)	−4.75 (4.88)	−12.62 (4.93)	−4.53 (4.76)	−11.97 (4.88)
Foreign Holdings (δ_2)	−20.94 (8.87)	−12.29 (7.73)	−17.81 (7.81)	−11.40 (8.48)

Notes: The estimates are based on regressions of longer-term forward interest rates on 5-year ahead projections of federal debt as a share of GDP. The 5y5y columns use the 5-year-ahead, 5-year Treasury rate and the 5y10y columns use the 5-year-ahead, 10-year Treasury rate. The CBO columns use projections from the Congressional Budget Office. The OMB columns use projections from the Office of Management and Budget. The sample is from February 1988 to January 2024. OMB data is annual. CBO data is typically semiannual. The estimates are in basis points. The values in parentheses are robust standard errors.

Table 5: Estimates of the effect of federal debt and deficits using alternative inflation measures

	1976-2025		**1976-2019**		**2006-2025**			
Federal Debt	3.18 (1.22)	3.00 (1.21)	3.34 (1.31)	2.81 (1.47)	2.96 (2.53)	2.90 (2.71)	3.10 (2.51)	2.97 (2.69)
Total Deficit	16.85 (5.94)	16.83 (7.20)	17.72 (6.18)	16.48 (7.93)	27.55 (13.21)	28.23 (14.77)	27.80 (13.76)	28.47 (15.04)
Primary Deficit	14.01 (6.38)	13.08 (7.32)	15.37 (7.07)	12.61 (8.07)	22.86 (17.45)	22.94 (18.41)	23.59 (18.86)	23.15 (19.27)
Extra Controls	No	Yes	No	Yes	No	Yes	No	Yes

Notes: Estimates based on regressions of the 5-year-ahead, 5-year Treasury rate on alternative fiscal projections. The rows are debt and deficit projections 5-years-ahead as a percent of GDP (or GNP before 1992). The columns are measures of inflation expectations, either our baseline 10-year perceived target rate (PTR) of inflation or 5-year ahead, 5-year forward inflation from the Survey of Professional Forecasters (SPF). The extra controls are the 5-year-ahead projection of real GDP growth (or GNP growth before 1992) and the dividend yield. The estimates are in basis points. The values in parentheses are robust standard errors.

Table 6: Quarterly interpolated estimates of the interest rate effects of federal debt and deficits

(a) Baseline estimates

	5-Year-Ahead, 5-Year Treasury Rate					
	Federal Debt		Total Deficit		Primary Deficit	
Fiscal Variable (β_1)	2.97	2.90	16.17	16.86	14.33	14.22
	(1.09)	(1.18)	(6.34)	(6.81)	(6.01)	(6.47)
Expected Inflation (β_2)	73.02	73.31	73.28	73.16	71.82	71.83
	(21.16)	(21.55)	(19.06)	(19.17)	(19.76)	(20.03)
Fed Holdings (δ_1)	−9.25	−9.20	−7.73	−7.72	−8.36	−8.36
	(3.84)	(3.96)	(4.34)	(4.27)	(4.27)	(4.32)
Foreign Holdings (δ_2)	−25.78	−25.39	−24.41	−24.89	−24.21	−24.14
	(8.06)	(8.24)	(7.18)	(7.45)	(7.32)	(7.59)
Expected Real GDP (δ_3)	–	−6.97	–	8.21	–	−1.09
		(24.02)		(21.65)		(22.66)
Dividend Yield (δ_4)	–	0.67	–	−0.29	–	0.01
		(6.92)		(6.90)		(6.91)

(b) Controlling for the lagged dependent variable

	5-Year-Ahead, 5-Year Treasury Rate					
	Federal Debt		Total Deficit		Primary Deficit	
Lagged 5y5y Rate (β_1)	−7.83	−8.30	−10.09	−10.07	−8.05	−8.21
	(9.14)	(8.85)	(8.24)	(8.01)	(8.70)	(8.46)
Fiscal Variable (β_2)	3.10	3.05	17.64	18.37	15.32	15.21
	(1.16)	(1.25)	(6.95)	(7.43)	(6.29)	(6.79)
Expected Inflation (β_3)	80.03	80.35	82.21	82.65	79.26	79.40
	(23.29)	(23.64)	(19.24)	(19.14)	(21.22)	(21.57)
Fed Holdings (δ_1)	−8.99	−8.87	−7.29	−7.24	−8.05	−8.01
	(3.68)	(3.78)	(4.43)	(4.31)	(4.29)	(4.29)
Foreign Holdings (δ_2)	−26.50	−26.14	−25.26	−25.86	−24.87	−24.88
	(8.53)	(8.72)	(7.29)	(7.66)	(7.53)	(7.92)
Expected Real GDP (δ_3)	–	−8.67	–	8.72	–	−1.46
		(25.95)		(23.55)		(24.80)
Dividend Yield (δ_4)	–	1.68	–	0.79	–	0.92
		(6.35)		(6.29)		(6.43)

Notes: The estimates are based on a regression of the 5-year-ahead, 5-year (5y5y) Treasury rate on projections of the federal debt and deficit 5-years-ahead that are linearly interpolated to a quarterly frequency. The sample is from January 1976 to January 2025. The estimated coefficients are in basis points. The values in parentheses are robust standard errors.

Table 7: Quarterly filtered estimates of the interest rate effects of federal debt and deficits

(a) Baseline estimates

	5-Year-Ahead, 5-Year Treasury Rate					
	Federal Debt		Total Deficit		Primary Deficit	
Fiscal Variable (β_1)	3.29	2.93	17.86	16.45	17.11	14.51
	(1.07)	(1.13)	(6.62)	(6.54)	(6.78)	(6.77)
Expected Inflation (β_2)	86.44	81.58	87.33	85.22	83.06	81.70
	(22.65)	(23.58)	(21.00)	(21.37)	(21.26)	(21.30)
Fed Holdings (δ_1)	−11.02	−10.10	−7.56	−7.63	−8.76	−8.40
	(3.78)	(3.92)	(4.32)	(4.34)	(4.21)	(4.41)
Foreign Holdings (δ_2)	−28.37	−25.62	−24.19	−24.15	−24.28	−22.74
	(8.25)	(8.53)	(7.20)	(7.89)	(7.32)	(8.04)
Expected Real GDP (δ_3)	–	−23.73	–	−6.91	–	−15.71
		(22.27)		(19.84)		(20.15)
Dividend Yield (δ_4)	–	3.32	–	0.52	–	0.37
		(7.07)		(7.00)		(7.05)

(b) Controlling for the lagged dependent variable

	5-Year-Ahead, 5-Year Treasury Rate					
	Federal Debt		Total Deficit		Primary Deficit	
Lagged 5y5y Rate (β_1)	−8.95	−9.44	−10.84	−10.97	−8.41	−8.83
	(9.21)	(9.09)	(8.17)	(8.05)	(8.66)	(8.53)
Fiscal Variable (β_2)	3.80	3.43	20.30	18.85	19.21	16.38
	(1.15)	(1.25)	(7.38)	(7.59)	(7.21)	(7.47)
Expected Inflation (β_3)	98.31	92.64	100.24	98.41	93.47	92.14
	(25.65)	(26.25)	(21.77)	(21.92)	(22.97)	(23.55)
Fed Holdings (δ_1)	−11.27	−10.05	−7.19	−7.11	−8.65	−8.06
	(3.64)	(3.91)	(4.48)	(4.55)	(4.29)	(4.55)
Foreign Holdings (δ_2)	−29.68	−25.84	−25.00	−24.45	−24.90	−22.55
	(8.90)	(8.90)	(7.28)	(8.34)	(7.52)	(8.52)
Expected Real GDP (δ_3)	–	−35.06	–	−13.32	–	−23.91
		(23.59)		(22.12)		(22.69)
Dividend Yield (δ_4)	–	5.37	–	2.01	–	1.63
		(6.48)		(6.32)		(6.63)

Notes: The estimates are based on a regression of the 5-year-ahead, 5-year Treasury rate on projections of the federal debt and deficit 5-years-ahead that are transformed to a quarterly frequency using the procedure in Shumway and Stoffer (1982), which uses the EM algorithm with the Kalman filter to produce a smoothed series for the missing observations. The baseline state space model includes the 5-year ahead fiscal projections, PTR inflation, and both Federal Reserve and foreign official holdings of U.S. Treasuries as a share of GDP. When the extra controls are included, we also transform real GDP/GNP growth to a quarterly frequency and include the dividend yield in the state space model. The sample is from January 1976 to January 2025. The estimated coefficients are in basis points. The values in parentheses are robust standard errors.