Can U.S. Treasury Markets Add and Subtract?*

Roberto Gómez-Cram   Howard Kung   Hanno Lustig

September 26, 2023

Abstract

The daily releases by the CBO of cost projections for individual U.S. spending and tax bills contain valuable news about primary surpluses that are priced in by U.S. Treasury markets. In a daily event window, news of lower future surpluses that is extracted from these projections decreases the realized nominal return on the portfolio of Treasurys. The expected return on government debt increases as the convenience yields decrease and the term premia increases. The effect on realized and expected returns increases even after the initial news release. Using a present value framework, we account for the bond return response and its subsequent drift in a model with Bayesian investors who use the cost releases to learn about the evolution of the surplus process.

*Gomez-Cram: Stern School of Business, New York University and London Business School, rg4811@stern.nyu.edu. Kung: London Business School and CEPR, hkung@london.edu. Lustig: Stanford Graduate School of Business, NBER and CEPR, hlustig@stanford.edu. We thank Miguel Chumbo for excellent research assistance.

1 Introduction

The U.S. Constitution mandates that all federal taxation and spending requires legislation enacted by Congress. Therefore, the federal government's primary surpluses—revenues minus expenditures—are inextricably tied to a collection of legislative bills. The executive and legislative branches decide upon the sources and uses of funds across legislative proposals through the federal budgeting process. This process has evolved into a complex web of decisions over the past two centuries.[1] The fiscal discipline imposed by the budgetary process varies depending on the budget rules and the enforcement mechanisms in place at the time.[2]

An important source of budgetary news is the Congressional Budget Office (CBO), an independent agency created by the Congressional Budget Act of 1974 to improve transparency and provide detailed communication about the federal budget process to the public. Each year, the CBO provides hundreds of real-time cost estimates for legislative proposals at horizons of up to ten years, with comprehensive cost projections starting in 1997. Legislative changes account for the majority of the aggregate CBO surplus revisions. We evaluate the informational content of these legislative changes by analyzing how the valuation of the public debt changes in response to the releases of cost projections at the bill level.

The government budget identity equates the market value of public debt to the present value of future surpluses. Revisions to the budget should be priced into aggregate bond valuations. In daily event windows, we find that cost releases of a spending bill that decrease (increase) the present value of future surpluses lower (raise) the nominal debt portfolio return, suggesting that there is valuable news in the cost releases to bond investors.

The estimated effects persist and grow in magnitude as the event window is expanded progressively from daily to several months after the cost release. When analyzing the components of the realized portfolio return by maturity, we find that the treasury returns

[1] Saturno (2023) provides a detailed historical account of the federal budgeting process.

[2] For example, the Budget Enforcement Act of 1990 created spending caps for discretionary spending and introduced deficit-reducing provisions to offset proposed spending or tax cuts. These budget reforms coincided with a reduction in deficits and the debt burden. These enforcement mechanisms were not renewed in 2002, which was followed by a large reversal in fiscal discipline.

respond in the same direction across all maturities. However, the largest and most significant responses are from Treasurys with a maturity in excess of five years.

In our sample spanning 1997 to 2022, legislation contributing to larger deficits dominates the legislative events. The start of our sample marks the reversal in the fiscal discipline throughout most of the 1990s. Since the late 1990s, the U.S. has witnessed deepening deficits and an increasing debt/GDP ratio, causing concerns about the sustainability of the federal budget process. Around 81% of proposed legislation reduces the present value of surpluses. We find that these concerns about worsening deficits extracted from individual bills contributed to a significant decline in the value of public debt. The cumulative effect on days of cost releases of legislative proposals increasing future deficits lowers the realized Treasury portfolio return by around 16% in our sample.

We next investigate if the news about future surpluses from cost releases affects expected returns. To this end, we decompose the expected nominal debt portfolio return into the short rate, convenience yield, default risk, and nominal term premia components. We find that cost releases about higher deficits increase nominal term premia and decrease convenience yields, but have insignificant effects on short rates and default risk. The responses of nominal term premia and convenience yields persist and intensify from days to months after the cost releases, with the effects concentrated in legislative proposals that increase deficits, and the responses are increasing with maturity. Overall, these results suggest that government discount rates respond in the opposite direction as realized returns to surplus news, but the effects are persistent for both realized and expected returns.

The release of projections that imply higher deficits generates lower convenience yields, consistent with downward sloping demand for the convenience services of Treasurys (Krishnamurthy and Vissing-Jorgensen, 2012). The release of projections that imply higher deficits also leads to significant increases in both inflation expectations, long-term nominal interest rates, and nominal term premia, which are fiscal adjustment mechanisms highlighted in models of the fiscal theory with long-term debt.[3] Most of the response in long-term yields is due to nominal term premia adjusting rather than short rates, which

[3]See, for example, Cochrane (2001) and Corhay, Kind, Kung, and Morales (2023).

is consistent with our decomposition of the nominal discount rate of the government portfolio.

These fiscal effects on long Treasury yields are quantitatively important. The deficit news released between 1997 and 2022 increased the 10-year nominal yield by around 3.5% in our sample. Over the same period from 1997 to 2022, Fed policy has imputed a secular downward drift to long-term bond yields (Hillenbrand, 2021). The cumulative fiscal effect on the 10-year yield is roughly the same magnitude as the cumulative effect of FOMC days. The FOMC announcements effectively offset the entire effect of the fiscal shocks. Put differently, the cumulative fiscal effect on Treasury returns is of the same magnitude as the cumulative positive returns on FOMC days documented by Hillenbrand (2021). The cumulative fiscal effects of larger deficits on Treasury returns and yields increased after 2008. Interestingly, most of the FOMC-induced drift was concentrated after the start of the Great Financial Crisis in 2008, which marked the start of the Fed's large-scale asset purchases, suggesting that the Fed may have been leaning against the fiscal wind.[4]

For a typical cost release of a bill, the bond market response increases to 3.36 cents per dollar of spending in PDV after one quarter. The bond market response seems muted when benchmarked against the intertemporal budget identity. This implies that either (i) a large fraction of the cost of the bill is priced in already, or (ii) investors anticipate some future policy actions that will unwind some of these effects.[5] We examine these two channels in a present value framework with Bayesian investors that use cost releases and debt projections to learn about the surplus process.

Our present value framework links the revisions to the market value of public debt to surplus news from enacted and future legislation separately, discount rate news, and news about long-term debt. We specify latent autoregressive processes for the two surplus components and discount rates that the investor learns about using incoming financial market data and budget projections. The CBO gives direct projections of the surpluses from enacted legislation today up to a horizon of ten years and of debt at a ten-year

[4] Hall and Sargent (2022) compare U.S. fiscal and monetary policy during the pandemic and the world wars.

[5] A final possibility is that the bond market response is too small to enforce the intertemporal budget identity.

horizon, which are two of the terms in the present value framework. We assume that the investor simultaneously learns about potential biases in the CBO projections by comparing the projections to realized data.

The parameter estimates from the learning model show a gradual increase in the investor's estimates of the persistence parameters and a declining unconditional mean parameter governing the surplus processes, capturing how the investor is revising their beliefs about the deepening deficits unfolding over the sample. The investor's forecasts of the present value of surpluses are decomposed into the contributions from enacted and future legislation. Both components exhibit an initial drop at the start before leveling off. The contributions from future surpluses exhibit reversals at the end of the sample, potentially reflecting beliefs of fiscal consolidations over the next decade. The parameter learning in our present value framework about increasing persistence and decreasing levels of surpluses generates bond value drifts in response to cost releases documented in the first part of the paper.

We relate to the empirical literature linking government debt valuations to surplus news using budget identities (e.g., Berndt, Lustig, and Yeltekin (2012), Jiang, Lustig, Van Nieuwerburgh, and Xiaolan (2019), Jiang, Lustig, Van Nieuwerburgh, and Xiaolan (2021), Cochrane (2022), Hilscher, Raviv, and Reis (2022), Collin-Dufresne, Hugonnier, and Perazzi (2023), and Campbell, Gao, and Martin (2023)). We distinguish our paper from this literature along several dimensions. First, we infer surplus news from the releases of CBO cost projections at the bill level. This data allows us to measure granular surplus news at a daily frequency and employ a high-frequency identification approach. Using this high-frequency, granular approach, we find a significant response of Treasury valuations to news about future surpluses. In contrast, using only aggregate data at quarterly frequencies, Jiang et al. (2021) finds no evidence that the valuation of Treasurys responds to news about future surpluses.[6] Second, we decompose surplus news into contributions from enacted legislation versus from future legislation. Third, we document significant bond value drifts following cost releases, which we explain in a present value framework with parameter learning about the surplus process.

[6]This discrepancy is partly due to time aggregation effects, but could also be driven by the actions of the Fed over this sample, which may have been actively counteracting the effects of these fiscal shocks.

Our approach to measuring surplus news at the bill level and extracting relevant information from cost projections is connected to narrative approaches of constructing fiscal shocks (e.g., Romer and Romer (2010), Ramey (2011), Mertens and Ravn (2012), Guajardo, Leigh, and Pescatori (2014), Alesina, Favero, and Giavazzi (2019), Drautzburg (2020), and Bianchi, Gomez-Cram, and Kung (2021)). We complement this literature by showing that significant fiscal news is communicated regularly through the information provided by the CBO cost projections at the bill level.

Our present value framework relates to models featuring learning about long-run features in macroeconomics data (e.g., Croce, Lettau, and Ludvigson (2015), Collin-Dufresne, Johannes, and Lochstoer (2016), Farmer, Nakamura, and Steinsson (2021), and Kozlowski, Veldkamp, and Venkateswaran (2020)). We build on this literature by showing that Bayesian investors who are learning about persistent deficits through incoming cost releases in a present value framework can generate bond price drifts.

In traditional macro models, monetary policy has no bearing on long-term real rates. To anchor short rates central bankers rely on measures of the equilibrium real rate that are assumed to be invariant with respect to monetary policy (See, e.g., work by Laubach and Williams, 2003; Holston, Laubach, and Williams, 2017, on rstar). Recently, there has been more evidence that monetary policy impacts long-term real rates (Hanson and Stein, 2015; Bianchi, Lettau, and Ludvigson, 2022; Hillenbrand, 2021). Our findings suggest that the Fed may have been actively neutralizing the effect of fiscal news on long-term real rates, especially after the GFC.

2 Data and Measurement

This section describes the data on government cost projections and bond returns used in our main analysis.

2.1 Expected present value of government surplus

The Congressional Budget Act of 1974 (CBA) established centralized budgeting with revenue and spending targets specified in the budget resolution. The CBA also created the Congressional Budget Office (CBO), which provides an independent agency for providing the cost estimates of enacted legislation and other budgetary information. It accomplishes this by generating hundreds of annual cost estimates that evaluate the potential impact of proposed legislation on the federal budget. The CBO promotes transparency by posting its cost estimates on its website (cbo.gov), granting access to Members of Congress, their staff, and the public.

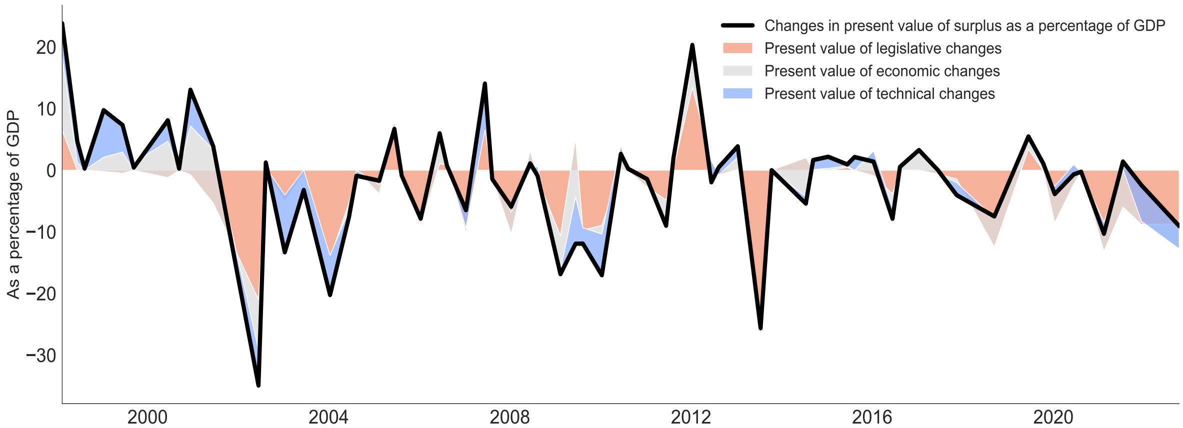
One of CBO's mandated obligations is to produce the annual Budget and Economic Outlook, presenting baseline projections of the surplus or deficit for the upcoming decade. This report is typically published at the beginning of the year and undergoes revisions in March and July. The baseline projections are not intended as forecasts of budgetary or economic outcomes; rather, they represent CBO's assessment of how the budget and the economy would evolve under existing laws. Hence, the baseline serves as a reference point for evaluating the potential effects of proposed legislation.

Figure 1 shows the changes in the present value of the CBO's surplus projection between two consecutive reports, where negative values indicate an increase in deficits. The changes in the present value of the surplus have been scaled by Gross Domestic Product (GDP). The black line in the figure reveals significant revisions in the CBO's 10-year cumulative projections between consecutive reports, with a standard deviation of 9.3%, despite an average time gap of 140 days between reports.

Figure 1 further breaks down the revisions in the expected future surpluses into three distinct components. The red-shaded area represents revisions attributed to legislative changes resulting from laws enacted since the agency published its prior baseline projections. This category accounts for the majority of changes in the CBO baseline projections, contributing to 56% of the variance in surplus changes. The remaining 44% of the variance in surplus changes is equally accounted for by the second and third categories, namely economic changes and technical changes. Economic changes arise from revisions made to the agency's economic forecast, which includes adjustments to incorporate the macroeconomic effects of recently enacted legislation. Technical changes serve as a residual category, capturing revisions to projections that are neither legislative nor economic in nature.

Next, we use the cost estimates for proposed legislation to reconstruct the aggregate

Fig. 1. **Changes in expected surplus or deficits [-] as a percentage of GDP**



Notes: The figure shows changes in the present value of the CBO's surplus projection between two consecutive Budget and Economic Outlook reports, where negative values indicate an increase in deficits. The changes in the present value of the surplus have been scaled by GDP. The figure further breaks down the revisions in the expected future surpluses into three distinct components. The red-shaded area represents revisions attributed to legislative changes. The gray-shaded area denotes economic changes, while the blue-shaded area denotes technical changes.

legislative changes and capture the timing of public cost estimate disclosures.

2.2 Bill-Level Expected Cost Estimates

CBO is legally required to generate cost estimates for legislation at specific junctures during the legislative process. We analyze all bills introduced or passed by Congress spanning the 105th Congress (1997-1998) to the 117th Congress (2021-2022), totaling 15,050 unique bills within this sample period. For each bill, we obtained the corresponding CBO-published cost estimates, which show how federal outlays and revenues would change if the legislation was implemented as proposed, compared to projected future values under current law. In total, we acquired 15,533 unique cost estimates, with a median bill having one unique cost estimate.

Each cost estimate is presented as a pdf document detailing the projected effects of the proposed legislation on three key components of the federal budget for the current year and the next decade: discretionary spending, mandatory (or direct) spending, and federal revenues.[7] Using standard expression searches, we extract these components and

[7]For bills authorizing discretionary activities or programs (requiring subsequent funding), cost estimates typically offer budgetary details for a 5-year period as directed by the Budget Act. Alternatively,

compute the estimated impact on surplus, representing the net total of expected changes in revenues and spending. We also obtain the bill number, title, legislative status, and the date when the CBO published each estimate. From congress.gov, we obtain all important actions for each bill, including key dates before the bill was enacted, (e.g., committee meeting dates and when the bill was first introduced in the House and Senate).

We compute the present value at time t of a nominal cost estimate of bill i (PV_{it}) divided by the most recent nominal GDP value (P_tY_t), according to:

$$\texttt{pv}_{it} \equiv \frac{PV_{it}}{P_tY_t} = \frac{1}{P_tY_t}\sum_{k=1}^{T}\frac{\bar{S}_{it+k}}{(1+\bar{r})^k}, \tag{1}$$

where T is the CBO forecast horizon (usually 10 years), $\bar{S}_{it+k}$ is the projected nominal surplus (if positive) or deficit (if negative) contribution of bill i in period $t+k$, and $\bar{r}_t$ is the nominal government discount rate. We compute $\bar{r}$ as the average government debt portfolio return over the previous five years, and we assume the discount rate is constant over the forecast horizon. The construction of the portfolio return is described in Section 2.3.

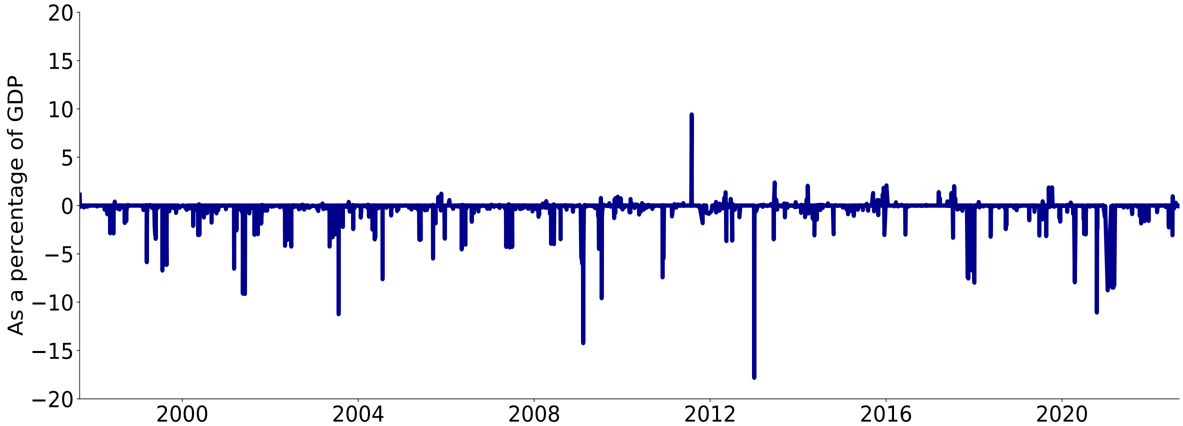
Figure 2 plots the daily series of the changes to the present value of future surpluses from new legislation ($\texttt{pv}_{it}$). Each individual bar corresponds to an estimate of a specific bill.[8] Negative values indicate increases in deficits. The figure shows that most of the bills in our sample are projected to contribute to higher deficits. Specifically, 81% of the new bills are expected to lower surpluses (increase deficits). On average, the change in the present value of deficits for a particular bill is approximately 0.089% of GDP. However, the figure reveals a notable variation between bills, with a standard deviation of 0.76% of GDP.

We can evaluate the significance of cost estimates at the bill level by combining the estimates for all bills enacted between two successive Budget and Economic Outlook reports. This aggregated series of cost estimates should closely align with the legislative changes depicted in Figure 1, as both series track the modifications to the deficit arising

for bills that affect mandatory spending or revenues, provisions in other laws stipulate a 10-year period.

[8]For the raw series, depicting the anticipated impact on surplus for each proposed legislation in the current year and the following decade, please refer to Figure A.2 in the Appendix.

Fig. 2. **Changes in the Present Value of Surpluses from Individual Bills**



Notes: This figure shows the present value of expected surpluses or deficits (indicated by [-]) scaled by GDP. Each individual bar represents an estimate for a specific bill. The dataset encompasses 15,533 unique cost estimates, spanning from the 105th Congress (1997-1998) to the 117th Congress (2021-2022).

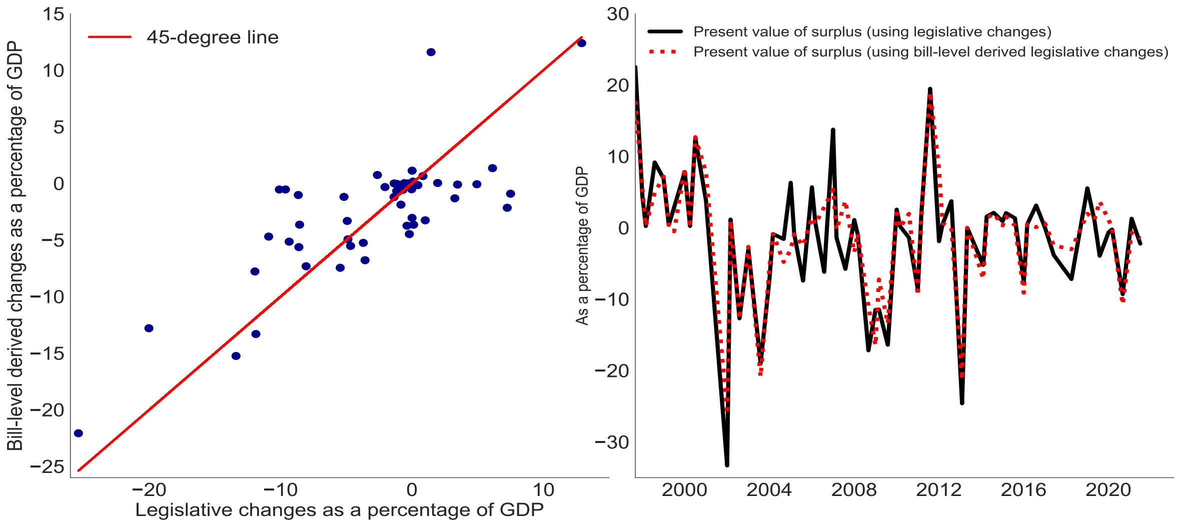
from recently enacted laws. Creating these cost estimates from scratch has the advantage of pinpointing the exact moment of their public release.

To illustrate this relationship, the left panel of Figure 3 presents a binned scatter plot between the present value of legislative changes and the present value of bill-derived changes, both scaled by GDP. The figure depicts the two series closely tracking each other, aligning near the 45-degree line represented by the red line. Furthermore, as seen in the right panel of Figure 3, both legislative changes (represented by the black straight line) and bill-derived cost estimates (represented by the red dotted line) produce a series of changes in the present value of the CBO surplus projection that closely follow each other with a correlation above 90%.

2.3 Data on treasury returns

We compute a series of daily returns of marketable debt held by the public as in Hall and Sargent (2011). To set the notation, let B_t denote the market value of government debt at time t. B_t can be calculated by disentangling all coupon and principal payments from outstanding treasuries and pricing them as the discounted sum of future cash flows. In other words, $B_t = \sum_{j=1}^{n} q_{t+j}^t b_{t+j}^t$, where b_{t+j}^t represents the total nominal debt payment committed for j years from time t. This includes all principal and coupon

Fig. 3. **Bill-level expected changes in surplus or deficit [-] versus legislative changes**



Notes: The left panel shows a binned scatter plot between the present value of legislative changes and the present value of bill-derived changes, both scaled by GDP. The bill-derived changes are computed by combining the estimates for all bills enacted between two successive Budget and Economic Outlook reports. The right panel shows the present value of the CBO surplus projection using the legislative changes series (illustrated by the black line) and the bill-derived changes (represented by the red dotted line).

payments guaranteed by the government to be paid at time $t+j$. The price of a one-dollar zero-coupon bond maturing at time $t+j$ is denoted by q^t_{t+j}.

For the empirical implementation, we utilize the daily prices and quantities of US Treasuries obtained from the Center for Research in Security Prices (CRSP). To compute b^t_{t+j} for each government note and bond, we rely on the publicly held outstanding amount (tdpubout), along with pertinent bond characteristics such as coupon rates and maturity dates. While CRSP does not provide this variable for bills (tdpubout is missing for bills), we follow Hall and Sargent (2011) and derive tdpubout for bills as a residual. This entails acquiring a monthly series of marketable public debt held by the public, maturing within one year, from Table FD-5 of the Treasury Bulletin. Subsequently, we subtract the tdpubout value for bonds and notes maturing within one year. Furthermore, we assume that tdpubout for bills remains constant within each month and allocate it to each specific bill proportionally, based on the daily series of the total amount outstanding (tdtotout) for which we have CRSP observations. Finally, we obtain the day of coupon and principal payment from treasurydirect.gov.

To compute q^t_{t+j}, we fit a zero-coupon forward curve using coupon bond prices, following the approach of Gürkaynak, Sack, and Wright (2007). Furthermore, we extend the yield curve to maturities of less than one year by incorporating market yields on US Treasury securities at constant maturities of one month, three months, and six months and linear interpolating for the remaining maturities. In the supplementary analysis in the appendix, we employ the zero-coupon yield curve proposed by Liu and Wu (2021).

Given the values of b^t_{t+j} and q^t_{t+j} for each maturity at time $t+j$, we can compute the value-weighted average return on the nominal portion of debt as:

$$r_t = \sum_j^n r^j_{t-1,t}\omega^j_{t-1} \tag{2}$$

where $r^j_{t-1,t} = q^t_{t+j-1}/q^{t-1}_{t+j-1}$ and the weight, ω^j_{t-1}, depends on the market value of government debt outstanding for that specific maturity j on the previous day $t-1$ and it is given by:

$$\omega^j_{t-1} = \frac{q^{t-1}_{t+j-1}b^{t-1}_{t+j-1}}{\sum_{j=1}^n q^{t-1}_{t+j-1}b^{t-1}_{t+j-1}}. \tag{3}$$

The return can also be computed by first determining the closing market value of the government debt, subtracting any new issuance, and then dividing this by the market value at the close of the preceding day. These two methods yield almost indistinguishable debt-return series. An advantage of our approach, which directly utilizes estimates of b^t_{t+j} and q^t_{t+j}, is that it allows for a decomposition of returns by maturity in subsequent analyses.

2.4 Controlling for other news

In our main regression specification, we compute bond returns within a daily event window surrounding the CBO cost projections. The rationale behind this is that the CBO's cost releases introduce substantial news about future surplus within this window, enabling a high-frequency identification strategy. However, one concern is that other news that affects bond prices might systematically arise concurrently within this tight event window. Such news could not only impact bond prices but also precipitate the issuance of CBO cost estimates and correlate with the bill-specific present value of surpluses. To address potential concerns about these confounding effects, we incorporate a comprehensive set of controls in all our tests.

To control for news coinciding with the CBO cost projection dates, we sourced announcement dates for the top 50 macroeconomic indicators (e.g., FOMC announcements, Non-Farm Payrolls, and Consumer Price Index) from Bloomberg Professional Service. For every indicator, we calculate the news component by computing the difference between the actual and the median forecasted values and subsequently standardizing this difference using its standard deviation.

Bond prices at the start of the event window should already reflect all public information. However, to address concerns about price drifts preceding the CBO cost announcements, which might be indicative of the market assimilation of other news outside the event window, but potentially correlated with $\texttt{pv}_{it}$, we control for the cumulative bond return. This is computed over a weekly event window starting seven days before the cost release and ending the day before.

Finally, we also control for the previous day's aggregate market return, the slope of the yield curve (calculated as the difference between the 10-year and 2-year yields), the CBOE Volatility Index, the nominal short rate, the term premium for a 10-year zero-coupon bond, and the 5-year breakeven inflation rate. Additionally, we add dummy variables for NBER recession periods as well as for Democratic and Republican presidential tenures.

3 News in Cost Projections

This section documents that there is news relevant to bond investors in the cost projections at the bill level.

3.1 Effect on realized returns

Our goal is to identify the effect of changes in expected surpluses contained in the CBO cost estimates on the nominal return on the government debt portfolio. Specifically, we estimate

$$r_t = a + b \cdot \texttt{pv}_{it} + \epsilon_t, \tag{4}$$

Table 1. **Surpluses and Government Bond Returns**

	Current returns		Future returns: $\sum_{j=1}^{H} r_{t+j}$ horizon in days			
			30	60	90	120
Coefficient	(1)	(2)	(3)	(4)	(5)	(6)
$\texttt{pv}_{it}$	1.45	1.44	6.68	10.47	13.87	16.63
	[2.19]	[2.07]	[2.15]	[1.95]	[2.31]	[2.45]
R^2 in %	0.10	4.93	4.81	10.51	13.64	15.23
Observations	2,989	2,988	2,988	2,988	2,983	2,964
Controls	No	Yes	Yes	Yes	Yes	Yes

Notes: This table presents regression results for the equation:

$$\sum_{t}^{H} r_t = b \cdot \texttt{pv}_{it} + controls_t + c_t + \epsilon_t,$$

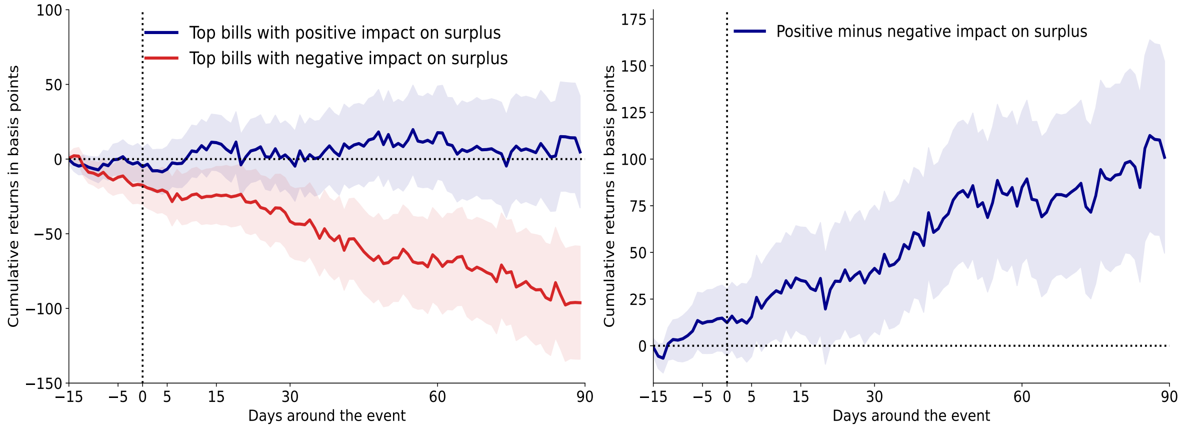
where r_t is the daily nominal return on the government debt portfolio computed using procedures similar to Hall and Sargent (2011). $\texttt{pv}_{it}$ denotes the change in surplus by bill i on day t scaled by GDP. In columns (2) through (6), we use various controls. We use news announcements of the top 50 macroeconomic indicators as contemporaneous controls. We also control for lagged daily returns from $t-6$ to $t-1$, and the following lagged macro variables available at the daily frequency: CBOE Volatility Index, 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity, Federal Funds Effective Rate, 10-Year Breakeven Inflation Rate, Term Premium on a 10 Year Zero Coupon Bond. The daily return r_t is in basis points, while $\texttt{pv}_{it}$ is in percent (as a percentage of GDP). t-statistics are in squared brackets.

where $\texttt{pv}_{it}$ represents the change in the present value of the aggregate expected surplus to GDP attributed to the newly-enacted bill i as reported by the CBO on day t. This series is illustrated in Figure 2. The variable r_t refers to the cumulative return on the government portfolio on day t and the succeeding business day, accounting for cost projections potentially released post-market close. The variable ϵ_t is an error term, and a and b are parameters. The parameter of interest is b, which measures the effect of a one percent change in the scaled present value of the expected surplus on the return of the government debt.

Column 1 of Table 1 presents our estimates of b. The estimated coefficient for $\texttt{pv}_{it}$ suggests that a 1% increase in the present value of surpluses to GDP corresponds to an average increase of about 1.45 basis points in the return of the government bond portfolio (t-statistic = 2.19). This suggests that rising expected government surpluses lead to an increase in bond returns while growing deficits decrease them.[9] Column 2 of Table 1

[9]If the release were entirely unanticipated, does not convey any information about future policy

Fig. 4. **Event-study plot: Days around the CBO publication date**



Notes: This figure displays the impact of surplus news on government bond portfolio returns for various event windows. Firstly, we sort bills into 20 bins based on their effect on the government surplus. Then, for the first and last bins, we calculate the cumulative bond return from 15 business days before the legislative events to 90 business days afterward. The blue and red shades represent the 90% error bands. The CBO Cost Estimates were published on day 0.

presents the estimates of b after incorporating the controls. Notably, the introduction of these refined controls has a minimal effect on the point estimate of 1.45. This estimate decreases slightly to 1.44, with a t-statistic of 2.07.

3.2 Persistence of effects

We show that the estimated effects persist and grow in magnitude as we progressively widen the event window from days to months following the CBO cost releases.

Figure 4 shows the cumulative excess bond returns on the days surrounding the CBO cost releases. To calculate excess returns, we subtract the one-month nominal rate from the return of the government bond portfolio. Subsequently, we classify the bills into 20 bins based on their effect on the present value of the surplus. Then, for the first and last bins, we calculate the cumulative bond return from 15 business days before the legislative events to 90 business days afterward. The CBO cost estimates are published on day 0. The blue and red shades represent the 90% error bands.

The left panel of Figure 4 shows that, prior to CBO cost releases, bond prices do

actions, and investors are fully rational, then the intertemporal budget identity would imply a coefficient equal to $100 \times \frac{Y}{D}$.

not exhibit different trends, regardless of whether bills are expected to increase deficits or surpluses. However, after releases that project major deficit increases, bond returns significantly drift downward in the following three months. Conversely, on the days after bills that result in an increase in expected surpluses, bond returns slightly drift upward, albeit statistically insignificant. The right panel of Figure 4 emphasizes this asymmetry, presenting the cumulative return on the difference, highlighting the distinct post-release trends for surplus-increasing versus deficit-increasing bills.

Columns 3 to 6 in Table 1 present the regression estimates. We regress the cumulative H-step-ahead bond return, denoted as $\sum_{j=1}^{H} r_{t+j}$, on the continuous measure of the present value of surplus. Aligned with the findings in Figure 4, the magnitude of the estimated coefficient for $\texttt{pv}_{it}$ increases as the returns are aggregated over subsequent months. Specifically, a 1% increase in $\texttt{pv}_{it}$ corresponds to a 6.68 basis point increase in bond returns (t-statistic = 2.15) during the following month. This effect increases to 16.63 basis points over the span of 4 months (t-statistic = 2.45). Notably, these magnitudes are four to ten times larger than the immediate estimated effects presented in Section 3.

3.3 Decomposition of the effects by maturity

The effect of the present value of surplus on the return of the government bond portfolio is primarily due to its impact on debt over 5 years, with only minimal effects observed for shorter maturities.

We decompose the bond return detailed in equation (2) into four distinct maturity groups. These segments comprise treasuries maturing within a year, represented by $\sum_{j=0}^{1y} r_t^j \omega_{t-1}^j$, those with maturities spanning from 1 to 4 years, $\sum_{j=1y}^{4y} r_t^j \omega_{t-1}^j$, bonds and notes maturing between 4 and 10 years, $\sum_{j=4y}^{10y} r_t^j \omega_{t-1}^j$, and finally, bonds with maturities extending beyond 10 years, articulated by $\sum_{j=10y}^{30y} r_t^j \omega_{t-1}^j$. Cumulatively, these segments represent the aggregate return r_t.

Table 2 presents the results. Each entry in the table is derived from a distinct OLS regression, as delineated in equation (4). Column 2 shows the effect of the present value of surplus on treasuries maturing within a year. The estimated effect is small and

Table 2. **Decomposition of the effects by maturity**

		Decomposition of the nominal returns, r_t, by maturity of obligation			
Coefficient	r_t (1)	Below 1 y (2)	1 y to 4 y (3)	5 y to 10 y (4)	Above 10 y (5)
$\texttt{pv}_{it}$	1.44	0.02	0.16	0.54	0.73
	[2.07]	[1.14]	[1.51]	[1.94]	[1.96]
R^2 in %	4.94	9.00	5.14	4.39	4.31
Observations	2,988	2,988	2,988	2,988	2,988
Controls	Yes	Yes	Yes	Yes	Yes

Notes: This table presents regression results for the equation:

$$r_t = b \cdot \texttt{pv}_{it} + controls_t + c_t + \epsilon_t,$$

where r_t is the daily nominal return on the government debt portfolio computed using procedures similar to Hall and Sargent (2011). $\texttt{pv}_{it}$ denotes the change in surplus by bill i on day t scaled by GDP. In all regressions, we use various controls. We use news announcements of the top 50 macroeconomic indicators as contemporaneous controls. We also control for lagged daily returns from $t-6$ to $t-1$, and the following lagged macro variables available at the daily frequency: CBOE Volatility Index, 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity, Federal Funds Effective Rate, 10-Year Breakeven Inflation Rate, Term Premium on a 10 Year Zero Coupon Bond. The column labeled with "Below 1 y" is $\sum_{j=0}^{1y} r_t^j \omega_{t-1}^j$; column labeled "1 y to 4 y" is $\sum_{j=1y}^{4y} r_t^j \omega_{t-1}^j$; column labeled "5 y to 10 y" is $\sum_{j=4y}^{10y} r_t^j \omega_{t-1}^j$; column labeled "Above 10 y" is $\sum_{j=10y}^{30y} r_t^j \omega_{t-1}^j$. The daily returns are in basis points, while $\texttt{pv}_{it}$ is in percent (as a percentage of GDP). t-statistics are in squared brackets.

statistically insignificant (b= 0.02; t-statistic = 1.28). As we progress through Columns 3 to 5, the estimated effects monotonically increase with the increasing maturity of the treasuries: 1-4 years (b= 0.16; t-statistic = 1.51), 5-10 years (b= 0.54; t-statistic = 1.94), and those maturing after 10 years (b= 0.73; t-statistic = 1.96). The combined effect across these maturities is 1.44, shown in Column 1, with roughly 0.87% of this magnitude arising from treasuries maturing beyond 5 years.

3.4 Economic relevance

We assess the economic relevance of our results by cumulating returns on the government debt portfolio on the release dates of bill-level cost projections. The idea of focusing on returns on days of CBO cost projection releases is to exploit the fact that these releases disseminate a substantial amount of fiscal news, which is the primary driver of returns on these specific days. By accumulating these returns throughout our sample period, we capture the aggregate effect on these particular dates.

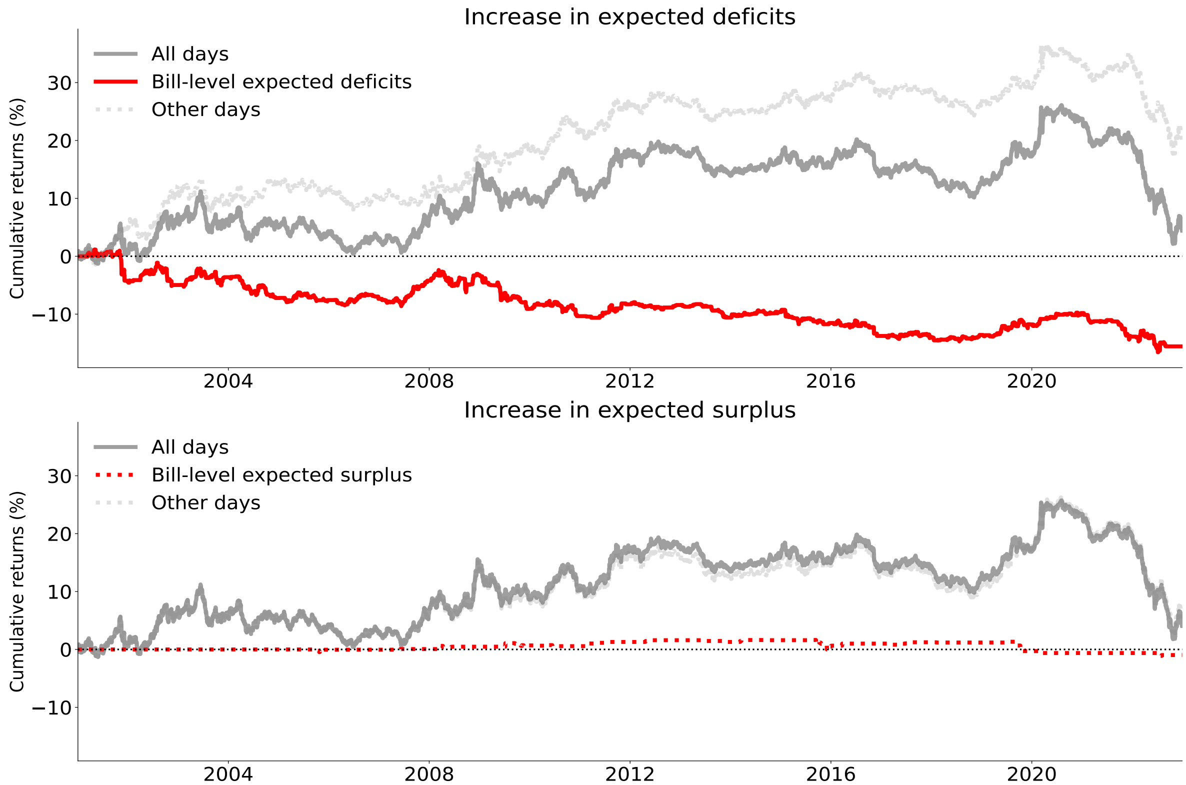
We divide the analysis between bills that are expected to increase deficits and those that are expected to increase surpluses, as these have opposite effects on the return on the government debt portfolio. Specifically, for the bills that are expected to increase deficits, we consider those with a present value of deficits above the median, as smaller bills are unlikely to move bond returns and may instead introduce noise in our analysis. Similarly, among bills anticipated to increase surpluses, we consider those with above median values. Overall, bills expected to increase deficits above median values represent approximately 20% of trading days with an average (median) present value of deficits of -0.49% (-0.04%). In contrast, bills expected to increase surpluses above the median account for around 14% of trading days, with an average (median) present value of surplus of 0.34% (0.05%).

The top panel of Figure 5 presents the results for bills expected to increase deficits. The dark gray line displays the cumulative return using all trading days between January 2000 and December 2022. The figure also contains two other lines, each representing cumulative returns calculated using a non-overlapping subset of days that together account for all trading days. The red line captures returns on CBO cost release dates when the expected increase in the present value of deficits exceeds median values. The light gray line pertains to the returns from the remaining trading days.

The red line in Figure 5 shows that on days with increases in the present value of deficits, the cumulative returns of the government debt portfolio tend to trend negatively. This result is in line with our prior analysis showing that a rise in expected deficits corresponds to a drop in bond returns. Quantitatively, the red line reflects a decrease of approximately -15.57% over our sample period. By comparison, during other days, returns exhibit an increase of around 19.98%, offsetting the deficit-related decline in returns.

Panel A of Table 3 shows the differences in the average daily return of the government debt portfolio for each of the three specified event days. On CBO cost release days, when the present value of deficits increases, the average daily return is -1.39 basis points (t-statistic =-2.16). On the contrary, on other days, the average return is 0.46 (t-statistic = 1.09). Notably, while average returns on CBO release days are significantly negative,

Fig. 5. **Bond Returns around Deficit and Surplus Projections**



Notes: This figure shows cumulative returns on the government debt portfolio using three different sets of days. In both panels, the dark gray line displays the cumulative return using all trading days. In the top panel, the red line computes cumulative returns using CBO cost release dates where the bill is expected to increase the present value of deficits above median values, and these dates do not coincide with FOMC meeting days. In the bottom panel, the red dotted line computes cumulative returns using CBO cost release dates where the bill is expected to increase the present value of surplus above median values, and these dates do not coincide with FOMC meeting days. Lastly, in both panels, the light gray lines compute cumulative returns using all remaining trading days. The sample period runs from January 2000 to December 2022.

the frequency of CBO release days is around one fourth of other days. This results in the net effects of these events largely canceling each other out. Consequently, the average return on all trading days, as reflected in the table's first column, is close to zero and lacks statistical significance.

The bottom panel of Figure 5 uses the same-day classification but now considers CBO cost projections that increase the present value of the surplus above its median value. The red dotted line indicates that the cumulative returns on such days remain near zero throughout our sample period. This observation aligns with Figure 4, which shows that returns do not exhibit significant upward movement on or around the days of

Table 3. **Return and Yield Changes around Bill-level Expected Deficits**

	All days	Bill-level expected deficits	Other days
	(1)	(2)	(3)
A. Nominal return on the government debt portfolio			
Mean in bps	0.08	-1.39	0.46
	[0.21]	[-2.16]	[1.09]
Observations	5,499	1,123	4,376
B. Bond risk premium on the government debt portfolio			
	(1)	(2)	(3)
Mean in bps	-0.01	0.14	-0.05
	[-0.28]	[1.38]	[-1.11]
Observations	5,495	1,116	4,379
C. Convenience yield on the government debt portfolio			
	(1)	(2)	(3)
Mean in bps	-0.01	-0.22	0.04
	[-0.10]	[-2.48]	[0.38]
Observations	3,056	549	2,507

Notes: Panel A shows the average daily return on the government debt portfolio over three distinct day sets. Column 1 covers all trading days, while Column 2 considers the CBO cost release dates where the bill is expected to increase the present value of deficits above the median values, and these dates do not coincide with FOMC meeting days. Column 3 includes all other trading days. Panels B and C use the same-day classifications, but compute the average term premia and convenience yields of the government debt portfolio, respectively.

CBO cost releases associated with an increase in the present value of surpluses.

Lastly, in Figure A.5 and Table A.3 in the appendix we present results using returns that fall within a 3-day window centered on the FOMC meeting days, as in Hillenbrand (2021). We find that the cumulative returns observed around cost projection release dates are comparable in magnitude to those around Federal Open Market Committee (FOMC) meetings, albeit with opposing signs.

3.5 Nominal discount rate channels

This section distinguishes the effects of the cost releases on the expected log nominal return to the government bond portfolio from the realized returns examined above. In the Appendix, we show that in a framework with a representative investor that derives utility from holdings of government bonds (e.g., Krishnamurthy and Vissing-Jorgensen (2012)) and partial government default, the Euler equation implies the following approximate expected return decomposition:

$$E_t[r_{t+1}] \approx \underbrace{i_t}_{\substack{\text{nominal}\\ \text{short rate}}} - \underbrace{\theta_t}_{\substack{\text{convenience}\\ \text{yield}}} + \underbrace{\gamma_t \delta_{t+1}}_{\substack{\text{expected}\\ \text{default loss}}} \underbrace{- \frac{1}{2}\text{Var}_t(r_{t+1}) - \text{Cov}_t(m^{\$}_{t+1}, r_{t+1}),}_{\text{bond risk premium}} \tag{5}$$

where i_t is the nominal short rate that depends on monetary policy, θ_t is a convenience yield, $\gamma_t \delta_{t+1}$ represents the expected default loss next period, and the final term captures nominal bond risk premia arising from a default risk premia, term premia, and portfolio rebalancing. We next examine how the cost projections affect these discount rate channels.

Bond risk premium. We construct the bond risk premium of the government debt portfolio, denoted as $\texttt{brp}_t$, by aggregating the term premia across Treasury yields of varying maturities and employing the portfolio weights ω^j_{t-1} outlined in equation (3):

$$\texttt{brp}_t = \sum_j^n \texttt{brp}^j_t \cdot \omega^j_{t-1}. \tag{6}$$

Here, $\texttt{brp}^j_t$ represents the term premium of a zero-coupon bond with maturity j. As $\texttt{brp}^j_t$ is not directly observable, we adopt, as a proxy for $\texttt{brp}^j_t$, the model-derived term premia measure of Adrian, Crump, and Moench (2013).

Panel A of Table 4 presents the results. We regress the daily changes in $\texttt{brp}_t$ onto the present value of surplus, $\texttt{pv}_{it}$, employing the full set of controls described in Section 2.4. We find that an increase in the present value of surplus corresponds to a decline in bond risk premium. While Column 1 shows an immediate, albeit statistically insignificant, effect of -0.13 on the bond risk premium (t-statistic = -1.17), Columns 2 through 5 demonstrate increasing magnitudes and significance in the effect as we cumulate changes over subsequent months. Notably, by the fourth month, an increase of 1% in the present value of surplus decreases the portfolio bond risk premium by about -1.88 basis points (t-statistic = -3.69).

Next, we evaluate the economic significance of the effects. Panel B of Table 3 presents the average daily change in the bond risk premium across two distinct sets of days as discussed in Section 3.4: CBO cost release dates leading to above-median deficit increases,

Table 4. **Surpluses and Nominal Discount Rate Components**

A. Term premia on the government debt portfolio

		Future term premia: $\sum_{j=1}^{H} \texttt{brp}_{t+j}$			
	Current	30 days	60 days	90 days	120 days
Coefficient	(1)	(2)	(3)	(4)	(5)
$\texttt{pv}_{it}$	-0.13	-0.32	-1.02	-1.55	-1.88
	[-1.17]	[-0.60]	[-1.78]	[-3.31]	[-3.69]
R^2 in %	3.47	9.17	14.47	20.79	26.22
Observations	2,968	2,968	2,968	2,963	2,944

B. Convenience yields on the government debt portfolio

		Future convenience yields: $\sum_{j=1}^{H} \theta_{t+j}$			
	Current	30 days	60 days	90 days	120 days
Coefficient	(1)	(2)	(3)	(4)	(5)
$\texttt{pv}_{it}$	-0.02	0.17	1.61	2.87	4.01
	[-0.15]	[0.17]	[2.47]	[2.68]	[2.93]
R^2 in %	13.95	25.45	31.22	41.77	52.46
Observations	1,569	1,556	1,547	1,533	1,514

C. Nominal short rate

		Future short rate: $\sum_{j=1}^{H} i_{t+j}$			
	Current	30 days	60 days	90 days	120 days
Coefficient	(1)	(2)	(3)	(4)	(5)
$\texttt{pv}_{it}$	-0.00	-0.00	-0.00	0.00	-0.00
	[-0.91]	[-0.93]	[-0.50]	[0.13]	[-0.02]
R^2 in %	1.04	26.25	40.20	46.44	49.88
Observations	2,972	2,972	2,972	2,972	2,972

Notes: This table presents regression results for the equation:

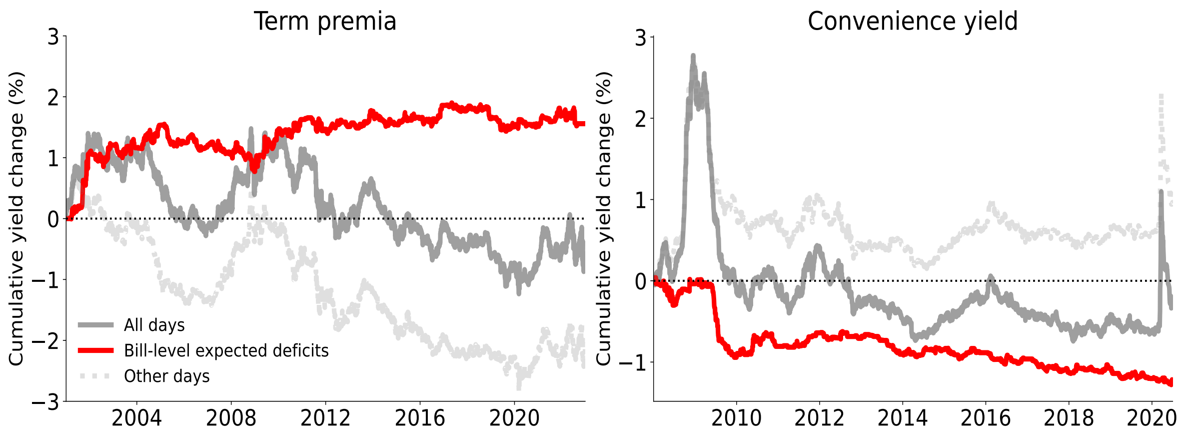
$$\sum_{t}^{H} \Delta x_t = b \cdot \texttt{pv}_{it} + controls_t + c_t + \epsilon_t,$$

where Δx_t is the daily change in term premia (Panel A), convenience yields (Panel B) and nominal short rate (Panel C). $\texttt{pv}_{it}$ denotes the change in surplus by bill i on day t scaled by GDP. In all regressions, we use various controls. We use news announcements of the top 50 macroeconomic indicators as contemporaneous controls. We also control for lagged daily returns from $t-6$ to $t-1$, and the following lagged macro variables available at the daily frequency: CBOE Volatility Index, 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity, Federal Funds Effective Rate, 10-Year Breakeven Inflation Rate, Term Premium on a 10 Year Zero Coupon Bond. Δx_t is in basis points, while $\texttt{pv}_{it}$ is in percent (as a percentage of GDP). t-statistics are in squared brackets.

and all other days. On CBO release dates linked with increased deficits, the average change in bond risk premium is positive at 0.14 (t-statistic = 1.38), as per Column 2. In contrast, Column 3 indicates a -0.05 average reduction on other days (t-statistic = -1.11).

Although these daily changes are not statistically significant on their own, aggregating

Fig. 6. **Term Premia and Convenience Yields around Deficit Projections**



Notes: The dark gray line shows the cumulative change in term premia (left plot) and convenience yields (right plot). The red line shows the cumulative change surrounding CBO cost estimates below median values (but not FOMC days). The light gray denotes the cumulative changes around other days.

them throughout our sample, as visualized in the left panel of Figure 6, underscores their economic importance. Specifically, the bond risk premiums increased approximately 1.56% during the CBO release dates, which increased the present value of deficits, and fell by about -2.16% on other days.

Convenience yields. To measure the convenience yield of the government debt portfolio, denoted as θ_t, we aggregate the convenience yields across different maturities using portfolio weights, ω_{t-1}^j:

$$\theta_t = \sum_j^n \theta_t^j \cdot \omega_{t-1}^j, \tag{7}$$

where θ_t^j represents the convenience yield at maturity j.

In the Internet Appendix, we show that the bond yield for a given maturity j depends on the nominal risk-free rate i_t, the default spread CDS_t^j, and the convenience yield θ_t^j. When comparing bond yields between U.S. treasuries and corporate bonds, we can isolate the common nominal risk-free rate and derive a measure of the U.S. convenience yield from nominal yield spreads and CDS spreads as follows:

$$\theta_t^j = (y_t^j - y_{t,corporate}^j) - (CDS_t^j - CDS_{t,corporate}^j). \tag{8}$$

We use the spread between Treasuries and corporate bonds for the first term and the spread between credit default swaps (CDS) on the U.S. government and corporate CDS for the second. Due to data constraints, our analysis ranges from December 2007 to December 2022 and considers two bond maturities: medium (5 years) and long (10 years). We have adjusted the portfolio weights to ensure they sum to one while preserving the relative proportion between the nominal debt maturing in 5 and 10 years. Lastly, we use Baa-rated bonds for the corporate yield and follow Vissing-Jorgensen and Krishnamurthy (2011) to derive the CDS for similar-rated corporate bonds.

Panel B of Table 4 presents the results. We find that the convenience yield of the government debt portfolio tends to decline with a decrease in the present value of surpluses (or an increase in deficits). The immediate effect of the convenience yield to changes in the present value of surplus, as shown in Column 1, is small and statistically insignificant. However, Columns 2 through 5 reveal that as we track cumulative changes in the convenience yield across the ensuing months, the estimated effect grows in magnitude, turning both positive and statistically significant. For example, by month four, a 1% increase in the present value of surpluses increases the convenience yield of the portfolio by approximately 4.01 basis points (t-statistic = 2.93).

Panel C of Table 3 reports the average daily change in convenience yield in the two distinct subsets of days, previously defined in Section 3.4. Column 2 shows that on CBO release dates leading to an increase in the present value of deficits, the average change in the convenience yield equals -0.22 basis points, which is statistically significant (t-statistic = -2.48). On the contrary, Column 3 shows that during other days, the average daily change in θ_t is 0.04 basis points; however, this is not statistically significant (t-statistic = 0.38). Considering all days, the average change in yields is slightly negative, but similarly lacks statistical significance (t-statistic = -0.10).

The right panel of Figure 6 shows the cumulative change in convenience yield in the two distinct event days. The red line shows that the convenience yield on the government debt portfolio persitently declined on days marked by a rise in the present value of deficits. By the end of our sample period, this cumulative decrease is approximately -1.23%. Compared to the other days, the convenience yield increased by about 0.93%.

Nominal short rate. For the nominal short rate, we utilize the one-month Treasury bill rate sourced from Ibbotson Associates. Panel C of Table 4 presents the results. We find that the present value of surplus has no significant effect on the nominal short rate. Columns 1 through 5 show that the estimated effects are near zero and remain statistically insignificant, whether assessing the immediate impact or when cumulating changes in the nominal short rate across subsequent months.

Default risk. To assess the significance of the default loss channel, $\gamma_t \delta_{t+1}$, we use CDS rates on U.S. Treasuries. A CDS rate represents the annual insurance premium, expressed as a percentage of the face value, paid to hedge against defaults or debt restructurings on U.S. Treasuries. Our dataset spans from December 2007 to December 2022 and encompasses six distinct tenors: 1, 2, 3, 5, 7, and 10 years. By analyzing CDS rates across these varying tenors, we can deduce the perceived default risk at specific maturities.

Table A.2 in the Appendix shows the results. We find that a decline in the present value of surplus (indicating greater anticipated deficits) is associated with an increase in CDS rates across the six maturities we examined. However, these effects are not statistically significant, with the t-statistics falling below -1.65. Moreover, accumulating the changes in CDS rates over subsequent months does not increase the magnitude of the effects.

3.6 Inflation expectations

This section examines how expected inflation responds to news about the federal budget. As a measure of inflation expectations, we utilize zero-coupon inflation swaps, which are widely traded financial instruments that act as hedges against a rise in inflation. In these swaps, executed between two counterparties at a predetermined time, one party agrees to exchange fixed payments for floating ones. The floating payment is tied to the cumulative inflation realized over the duration of the contract, using the consumer price index as the benchmark. Consequently, when risk premia are negligible, the fixed-rate payment can serve as a good market-based proxy of inflation expectations over the contract's term.

Table 5. **Surpluses and Changes in Inflation Expectations**

	Maturity of the inflation swap contracts				
	1 year	3 year	5 year	10 years	20 years
Coefficient	(1)	(2)	(3)	(4)	(5)
$\texttt{pv}_{it}$	-0.25	-0.31	-0.23	-0.43	-0.41
	[-0.86]	[-1.82]	[-1.74]	[-2.22]	[-2.62]
R^2 in %	4.26	5.14	2.49	3.01	3.56
Observations	2,418	2,395	2,395	2,419	2,392

Notes: This table presents regression results for the equation:

$$\Delta InflationSwaps_t^j = b \cdot \texttt{pv}_{it} + controls + c_t + \epsilon_t,$$

where $\Delta InflationSwap_t^j$ is the daily change in inflation swaps for contract maturity j years. $\texttt{pv}_{it}$ denotes the change in surplus by bill i on day t scaled by the nominal output for the previous year. We use news announcements of the top 50 macroeconomic indicators as contemporaneous controls. We also control for lagged daily returns from $t-6$ to $t-1$, and the following lagged macro variables available at the daily frequency: CBOE Volatility Index, 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity, Federal Funds Effective Rate, 5-Year Breakeven Inflation Rate, Term Premium on a 10 Year Zero Coupon Bond. The daily variable $\Delta InflationSwap_t^j$ is in basis points, while $\texttt{pv}_{it}$ is in percent (as a percentage of GDP). t-statistics are in squared brackets.

Table 5 presents the results. We regress daily changes in the swap's fixed rate against the present value of surpluses, incorporating the control variables outlined in Section 2.4. Each column of the table measures the effect on different tenors: 1 year, 3 years, 5 years, 10 years, and 20 years. The estimated coefficient is consistently negative across columns, suggesting that news of lower future surpluses (or increased deficits) leads to an increase in inflation expectations. The estimated effect is negative, but small and statistically insignificant for contracts maturing within the 1 to 3 year range. However, the effect becomes more pronounced for inflation expectations beyond 5 years. For example, the estimated coefficient for a 1-year maturity swap is -0.25 (t-statistic = -0.86), but it increases to -0.41 for a swap maturing in 10 years (t-statistic = -2.22).

Next, we show that the estimated effects on inflation expectations are persistent and grow in magnitude when aggregated over the following months. Specifically, we regress the cumulative H step-ahead change in 10-year inflation expectations against the present value of the surplus. Table 6 presents the results. In line with our prior results, the coefficient for $\texttt{pv}_{it}$ increases as changes in inflation expectations accumulate over time. For example, a 1% increase in $\texttt{pv}_{it}$ leads to a decrease of -1.25 basis points in inflation

Table 6. **Surpluses and Changes in Inflation Expectations: Persistence of the effects**

Coefficient	Current (1)	Future inflation: $\sum_{j=1}^{H} \Delta InflationSwaps_{t+j}^{10y}$ 30 days (2)	60 days (3)	90 days (4)	120 days (5)
$\texttt{pv}_{it}$	-0.43	-1.25	-0.78	-1.94	-2.24
	[-2.22]	[-2.49]	[-1.46]	[-2.43]	[-2.61]
R^2 in %	3.01	5.80	14.08	23.68	27.88
Observations	2,419	2,419	2,419	2,419	2,419

Notes: This table presents regression results for the equation:

$$\sum_{t}^{H} \Delta InflationSwaps_t^{10y} = b \cdot \texttt{pv}_{it} + controls + c_t + \epsilon_t,$$

where $\Delta InflationSwaps_t^{10y}$ is the daily change in inflation swaps for a contract maturity of 10 years. $\texttt{pv}_{it}$ denotes the change in surplus by bill i on day t scaled by the nominal output for the previous year. We use news announcements of the top 50 macroeconomic indicators as contemporaneous controls. We also control for lagged daily returns from $t-6$ to $t-1$, and the following lagged macro variables available at the daily frequency: CBOE Volatility Index, 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity, Federal Funds Effective Rate, 5-Year Breakeven Inflation Rate, Term Premium on a 10 Year Zero Coupon Bond. The daily variable $\Delta InflationSwap_t^{10y}$ is in basis points, while $\texttt{pv}_{it}$ is in percent (as a percentage of GDP). t-statistics are in squared brackets.

expectations (t-statistic = -2.49) over a one-month period, and this effect increases to -2.24 basis points within a 4-month timeframe (t-statistic = -2.61).

The appendix presents additional results. Figure A.4 presents the event study plot, showing the differential effect on inflation expectations due to expected increases in future deficits versus surpluses. Figure A.7 underscores the economic significance by cumulating the changes in inflation expectations on days with CBO projections that increased deficits. Finally, Tables A.4 and A.5 report robustness results using the breakeven yield, that is the difference between nominal and real yields, as the measure of inflation expectations.

3.7 Long-term bond yields

This section examines how long-term yields respond to news about the federal budget. Panel A of Table 7 shows the effect of the present value of surplus on the 10-year U.S. Treasury zero-coupon yield, utilizing yield data sourced from Gürkaynak et al. (2007). We find that news of lower future surpluses extracted from bills increases long-term yields. Specifically, Column 1 shows an immediate effect of -0.30, with a t-statistic of

Table 7. **Surpluses and Nominal Yields**

A. Nominal 10 years		10-Year Nominal Yield: $\sum_{j=1}^{H} y_{t+j}^{n}$			
	Current	30 days	60 days	90 days	120 days
Coefficient	(1)	(2)	(3)	(4)	(5)
$\texttt{pv}_{it}$	-0.30	-1.16	-2.28	-3.01	-3.35
	[-1.89]	[-1.37]	[-2.03]	[-2.57]	[-2.59]
R^2 in %	1.43	3.07	7.98	11.21	13.01
Observations	2,972	2,972	2,972	2,972	2,972

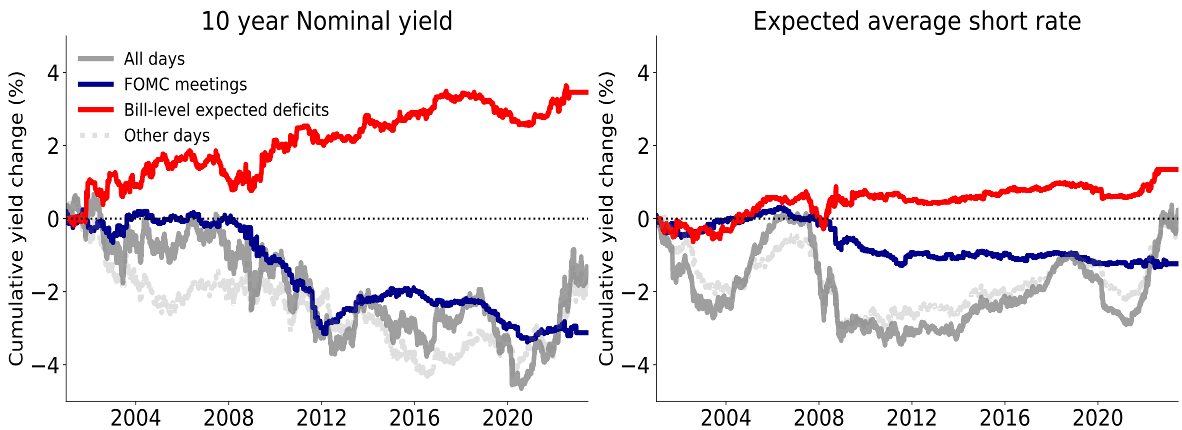
B. Average expected nominal short-term interest rate		Expected short rate: $\sum_{j=1}^{H} rx_{t+j}$			
	Current	30 days	60 days	90 days	120 days
Coefficient	(1)	(2)	(3)	(4)	(5)
$\texttt{pv}_{it}$	-0.05	-0.52	-0.35	-0.53	-0.68
	[-0.51]	[-1.19]	[-0.66]	[-0.72]	[-0.84]
R^2 in %	3.24	14.44	18.16	20.31	25.85
Observations	2,972	2,972	2,972	2,972	2,972

Notes: This table presents regression results for the equation: $\sum_{t}^{H} \Delta x_t = a \cdot \texttt{pv}_{it} + controls + c_t + \epsilon_t$, where Δx_t is the daily change in term premia, convenience yields and nominal short rate. $\texttt{pv}_{it}$ denotes the change in surplus by bill i on day t scaled by the nominal output for the previous year. In columns (2) through (6), we use news announcements of the top 50 macroeconomic indicators as contemporaneous controls. We also control for lagged daily returns from $t-6$ to $t-1$, and the following lagged macro variables available at the daily frequency: CBOE Volatility Index, 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity, Federal Funds Effective Rate, 5-Year Breakeven Inflation Rate, Term Premium on a 10 Year Zero Coupon Bond. The daily return r_t is in basis points, while $\texttt{pv}_{it}$ is in percent (as a percentage of GDP). t-statistics are in squared brackets.

-1.89. Moreover, columns 2 to 5, show that the effect amplifies as the effects accumulate over subsequent months. By the fourth month, a 1% rise in the present value of surplus corresponds to a cumulative yield increment of -3.35 basis points (t-statistic of -2.59).

To quantify the impact of lower future surplus on long-term yields, the red line in the left panel of Figure 7 traces the cumulative changes in long-term yields on days marked by increases in the present value of deficits. During our sample period, the 10-year nominal yield increased by approximately 3.45% on those specific days. For comparison, on FOMC meeting days, long-term yields have decreased by about -3.12%, as previously documented in Hillenbrand (2021). On other days, the yields decrease approximately by -1.75%. Notably, the changes observed on FOMC meeting days and the other days counterbalance the yield hikes due to deficits, resulting in an overall decrease of roughly -1.25%. Table A.6 in the Appendix provides a breakdown of the average daily yield

Fig. 7. **Long-term Yields and Expected Average Short Rates around Deficit Projections**



Notes: The dark gray line shows the cumulative change in nominal yields (left plot) and expected average short rates (right plot). The blue line shows the cumulative yield change around a 3-day window around FOMC meetings. The red line shows the cumulative yield change surrounding CBO cost estimates below median values (but not FOMC days). The light gray denotes the cumulative yield changes around other days.

changes observed on these distinct events days.

Next, we look at the effect on average expected short-term nominal rates. The motivation for looking at this variable is that it represents the difference between an n-maturity yield and the bond's term premium:

$$\underbrace{\frac{1}{n}\sum_{i=1}^{n} E_t\left(y^{(1)}_{t+i-1}\right)}_{\text{Average nominal short rate}} = y^{(n)}_t - \underbrace{\frac{1}{n}\sum_{i=1}^{n} E_t\left(rx^{(n-i+1)}_{t+i}\right)}_{\text{Term premium}}, \tag{9}$$

where $rx^{(n)}_{t+1}$ denotes the excess log return on buying an n-period bond at time t and selling it at time $t+1$ as an $n-1$ period bond (i.e., $rx^{(n)}_{t+1} = ny^{(n)}_t - (n-1)y^{(n-1)}_{t+1} - y^{(1)}_t$). The bond's term premium is the second summation on the right. By focusing on expected short-term nominal rates, we can test whether fluctuations in nominal yields are primarily driven by the term premium channel.

Panel B of Table 7 presents the results. In columns 1 through 5, the estimated coefficient for $\texttt{pv}_{it}$ is negative, though it is statistically insignificant. This finding indicates that a significant portion of the response to bond yield is likely driven by changes in the term premium. However, the right panel of Figure 7, reveals a pronounced increase of approximately 1.34%, as denoted by the red line, when aggregating changes in the average nominal short rate on days with increasing deficits. However, this increase is almost counterbalanced by the -1.24% reduction observed on the days of the FOMC meeting.

In the appendix, we present findings related to the 10-year real yield. As shown in Table A.7, when using the continuous measure $\texttt{pv}_{it}$, the estimated effects are near zero and lack statistical significance. However, Figure A.8 reveals that by aggregating the changes in real yields on days characterized by escalating deficits, there is a substantial increase of approximately 2.41%. On the contrary, on days of FOMC meetings, the real yield sees a decline of roughly -3.52%.

4 Learning about Future Surpluses

This section builds a present value framework with parameter learning to interpret the informational content of the government cost projections. Bayesian investors use new data to update their beliefs about the government budget process in the long run. We derive a present value framework using a linearized government budget identity that decomposes surplus news into unobserved components linked to *enacted* and *future bills*. We show that this model can explain the bond price responses to cost projections, including the price drifts, documented in Section 3.

We start by outlining the present value model. We show how surplus news can be decomposed into the contributions from enacted and future bills separately. Then, we specify the unobserved components governing surpluses and discount rates that investors learn about. Finally, we describe how investors update their beliefs and the implications for bond valuations.

4.1 Present value framework

We start with the one-period government budget identity at time t:

$$B_t + S_t = (1 + \tilde{r}_t)B_{t-1} \tag{10}$$

where B_t is the nominal market value of government debt held by the public, S_t is nominal primary surpluses, and $\tilde{r}_t$ is the nominal portfolio return on government debt and can include partial default. We next rewrite the budget identity by normalizing the variables by nominal GDP to obtain:

$$\hat{B}_t + \hat{S}_t = \frac{1 + \tilde{r}_t}{\Pi_t \Delta Y_t} \hat{B}_{t-1}, \tag{11}$$

where $\hat{B}_t \equiv B_t/(P_t Y_t)$, $\hat{S}_t \equiv S_t/(P_t Y_t)$, $\Pi_t \equiv P_t/P_{t-1}$, and $\Delta Y_t \equiv Y_t/Y_{t-1}$.

Take logs of equation (11) at $t+1$, we have:

$$\log\left(e^{b_{t+1}} + \hat{S}_{t+1}\right) = \hat{r}_{t+1} + b_t, \tag{12}$$

where $\hat{r}_{t+1} \equiv \tilde{r}_{gt+1} - \pi_{t+1} - \Delta y_{t+1}$ is the log inflation and growth-adjusted portfolio return, $\pi_t \equiv \log(\Pi_t)$, and $\Delta y_t \equiv \log(\Delta Y_t)$. We linearize equation (11) to obtain tractability in our present value framework. As surpluses can take on negative values, we linearize the level of surpluses as in Jiang et al. (2021) and Cochrane (2022). We take a Taylor expansion of the first term in equation (11) around the steady state:

$$\log\left(e^{b_{t+1}} + \hat{S}_{t+1}\right) \approx \alpha + \nu b_{t+1} + \gamma \hat{S}_{t+1}, \tag{13}$$

where α, ν, and γ are constants of the linearization. Details of the approximation and the expressions for the constants are presented in the Appendix.

Plug the approximation into equation (12) to get the linearized government budget equation:

$$\alpha + \nu b_{t+1} + \gamma \hat{S}_{t+1} = \hat{r}_{t+1} + b_t. \tag{14}$$

We can iterate equation (14) forward T years to get:

$$b_t = \alpha^\star + \sum_{j=1}^{T} \nu^{j-1} \gamma \hat{S}_{t+j} - \sum_{j=1}^{T} \nu^{j-1} \hat{r}_{t+j} + \nu^T b_{t+T}, \tag{15}$$

where $\alpha^\star \equiv \alpha/(1-\nu)$. This identity holds ex post, but also holds ex ante with rational or any subjective expectations operator that respects the identity:

$$b_t = \alpha^\star + \mathbb{E}_t \sum_{j=1}^{T} \nu^{j-1} \gamma \hat{S}_{t+j} - \mathbb{E}_t \sum_{j=1}^{T} \nu^{j-1} \hat{r}_{t+j} + \mathbb{E}_t \nu^T b_{t+T}, \tag{16}$$

This relation links the debt-to-GDP ratio to surplus-to-GDP news, government discount rate news, and future values of the debt-to-GDP ratio.

4.2 Decomposing surplus news

The CBO forecasts cash flows from enacted legislation but not from future legislation. Therefore, the CBO releases of cost projections provide direct updates on the surplus contributions from enacted laws but may also provide signals about future policy actions. We decompose surplus news into the contributions from enacted bills and from future bills in our present value framework to disentangle the informational content of the CBO cost projections.

The expected aggregate surplus at $t+j$ is the sum of the cash flows from the individual bills affecting the cash flows of the government:

$$\mathbb{E}_t \hat{S}_{t+j} = \underbrace{\mathbb{E}_t \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)}}_{\substack{\text{surplus from} \\ \text{enacted bills}}} + \underbrace{\mathbb{E}_t \sum_{l=1}^{n_{>t}^{t+j}} \hat{S}_{t+j}^{(l)}}_{\substack{\text{surplus from} \\ \text{future bills}}}, \tag{17}$$

where n_t^{t+j} is the number of bills enacted before or at t that have a cash flow affecting the aggregate surplus at time $t+j$, $n_{>t}^{t+j}$ is the number of bills expected to be enacted after t that have a cash flow expected to affect the aggregate surplus at time $t+j$, $\hat{S}_{t+j}^{(k)} \equiv S_{t+j}^{(k)}/(P_t Y_t)$ is the expected cash flow contribution of bill k at time $t+j$ normalized by nominal GDP.

We can plug the surplus decomposition into equation (16) to separate surplus news into the contributions of current enacted bills and future bills to the present value of surpluses:

$$b_t = \alpha^\star + \underbrace{\mathbb{E}_t \sum_{j=1}^{T} \nu^{j-1} \gamma \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)}}_{\substack{\text{surplus news from}\\ \text{enacted bills}\\ (\texttt{cbo})}} + \underbrace{\mathbb{E}_t \sum_{j=1}^{T} \nu^{j-1} \gamma \sum_{l=1}^{n_{>t}^{t+j}} \hat{S}_{t+j}^{(l)}}_{\substack{\text{surplus news from}\\ \text{future bills}}} - \underbrace{\mathbb{E}_t \sum_{j=1}^{T} \nu^{j-1} \hat{r}_{t+j}}_{\text{discount rates}} + \underbrace{\mathbb{E}_t \nu^T b_{t+T}}_{\substack{\text{long-run}\\ \text{debt projection}\\ (\texttt{cbo})}}. \tag{18}$$

The CBO provides direct updates on two of the components in equation (18) highlighted underneath with (cbo). The first of these two CBO terms specifically represents the cost projections of enacted bills and for other factors affecting the cash flows of enacted bills (e.g., including changes in the forecast of economic conditions) up to the horizon $T = 10$ years. The second CBO term represents the 10-year debt-to-GDP projections.

The CBO does not provide cash flow projections of future enacted bills, expected amendments to existing bills beyond T, nor the impact of other economic factors beyond T. We represent the cash flow effects up to horizon T not explicitly included in the CBO with the term labeled surplus news from future bills. The CBO also does not provide direct projections of government discount rates, which is represented by the term discount rate news that incorporates the effects up to horizon T. The CBO projections of cash flows from enacted bills and future debt can still provide indirect but valuable news about future policy actions and discount rates.

We aim to use bond prices, the releases of CBO cost and debt projections, and the restrictions imposed by the present value framework to learn about investor beliefs about the path of future surpluses and discount rates from current enacted bills and from future enacted bills. We formalize the learning of the bond investors in the next section by specifying the processes governing the cash flow and discount rate processes along with the information set of the investors.

4.3 Unobserved components of surpluses

We assume that bond investors use the present value framework along with time series models for surpluses, distinguishing between surpluses from *enacted* legislation and *future* legislation. We model the contribution of enacted bills to the aggregate surplus at time t (scaled by GDP) as:

$$\begin{aligned} \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} &= \mu_\psi^{(j)} + \psi_{t+j-1} + \sigma_e \epsilon_{et+j}, \\ \psi_{t+j} &= \rho_\psi \psi_{t+j-1} + \sigma_\psi \epsilon_{\psi t+j}, \\ & \epsilon_{et+j}, \epsilon_{\psi t+j} \sim i.i.d.\ N(0,1) \end{aligned} \tag{19}$$

where this specification decomposes $\sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)}$ into a persistent component (ψ_t), a transitory component ($\sigma_e \epsilon_{et+1}$), and a deterministic horizon j-dependent component ($\mu_\psi^{(j)}$). The persistent component follows an AR(1) process, characterized by a zero mean and a persistence determined by the parameter ρ_ψ. The deterministic component is given by $\mu_\psi^{(j)} = \delta^{(j)} \mu_0$ where $\delta^{(j)} \in (0,1)$ is the average share of the aggregate surplus at horizon j accounted for by enacted bills for $j = 1, ..., 10$. The deterministic component captures a linear time trend in the data, attributing to the fact that enacted bills today contribute to a declining share of the total aggregate surplus as we increase the forecast horizon due to cash flows from current bills terminating and cash flows from future bills starting.

We assume that surplus to GDP attributed to future bills evolves as:

$$\begin{aligned} \sum_{l=1}^{n_{>t}^{t+j}} \hat{S}_{t+j}^{(l)} &= \mu_\chi^{(j)} + \chi_{t+j-1} + \sigma_f \epsilon_{ft+j}, \\ \chi_{t+j} &= \rho_\chi \chi_{t+j-1} + \sigma_\chi \epsilon_{\chi t+j}, \\ & \epsilon_{ft+j}, \epsilon_{\chi t+j} \sim i.i.d.\ N(0,1), \end{aligned} \tag{20}$$

where χ_t denotes the persistent component with mean zero and persistence ρ_χ, the term $\sigma_s \epsilon_{st+1}$ is the transitory component, and μ_χ^j is the time-j deterministic component given by $\mu_\chi^{(j)} = (1 - \delta^{(j)}) \mu_0$.

We assume that the growth and inflation-adjusted government bond portfolio return follows:

$$\begin{aligned}\hat{r}_{t+1} &= \mu_r + h_{t-1} + \sigma_r \epsilon_{rt+1}, \\ h_t &= \rho_h h_{t-1} + \sigma_h \epsilon_{ht+1}, \\ & \quad \epsilon_{rt+1}, \epsilon_{ht+1} \sim i.i.d.\ N(0,1),\end{aligned} \tag{21}$$

where h_t is the persistent component with mean zero and persistence ρ_h, $\sigma_r \epsilon_{rt+1}$ is the transitory component, and μ_r is the unconditional mean.

4.4 Biases in CBO expectations

We assume that the CBO projection of the surpluses of horizon j from enacted bills may deviate from the rational expectations counterpart by an additive wedge:

$$\mathbb{E}_t^* \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} = \mathbb{E}_t \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} + \texttt{bias}_s^{(j)}, \tag{22}$$

where $E_t^*[\cdot]$ denotes the CBO expectations and $E_t[\cdot]$ denotes the rational expectations.

Let $\epsilon_{st}^{(j)} \equiv \hat{S}_{t+j} - E_t[\hat{S}_{t+j}]$ denote the surplus innovation of horizon j under rational expectations. Using the definition of the surplus innovation with equation (22) implies:

$$\hat{S}_{t+j} - \mathbb{E}_t^* \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} - \mathbb{E}_t \sum_{l=1}^{n_{>t}^{t+j}} \hat{S}_{t+j}^{(l)} = \epsilon_{st}^{(j)} - \texttt{bias}_s^{(j)} \tag{23}$$

Similarly, we assume that the CBO projection of the debt to GDP ratio of horizon T can deviate from rational expectations by an additive wedge:

$$\mathbb{E}_t^* b_{t+T} = \mathbb{E}_t b_{t+T} + \texttt{bias}_b \tag{24}$$

where the term $\texttt{bias}_b$ captures the CBO's bias in forecasting debt to GDP from rational expectations. Let $\epsilon_{bt} \equiv b_{t+T} - \mathbb{E}_t b_{t+T}$ denote the debt innovation under rational expectations. Using the definition of the debt innovation with equation (24) implies:

$$b_{t+T} - \mathbb{E}_t^* b_{t+T} = \epsilon_{bt} - \texttt{bias}_b. \tag{25}$$

Hence, we can use realized and cbo forecasted data to infer the bias parameters for surplus and debt.

4.5 Bayesian learning

Forecasting the aggregate surplus, $E_t \hat{S}_{t+j}$, is challenging as investors do not directly observe the latent states, z_t, the parameter vector, Θ_p, and the CBO bias terms, Θ_b, defined as:

$$z_t = [\psi_t, \chi_t, h_t], \qquad \Theta_p = \left[\mu_0, \rho_\psi, \sigma_\psi^2, \rho_\chi, \sigma_\chi^2, \rho_h, \sigma_h^2, \sigma_r^2\right]', \qquad \Theta_b = \left[\texttt{bias}_s^j, \texttt{bias}_b\right]'.$$

However, we endow investors with initial beliefs about these unknown states and parameters, and each period they observe the vector:

$$y_t = [\hat{S}_{t+j},\ \mathbb{E}_t^* \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)},\ b_t,\ \mathbb{E}_t^* b_{t+T},\ \hat{r}_t],$$

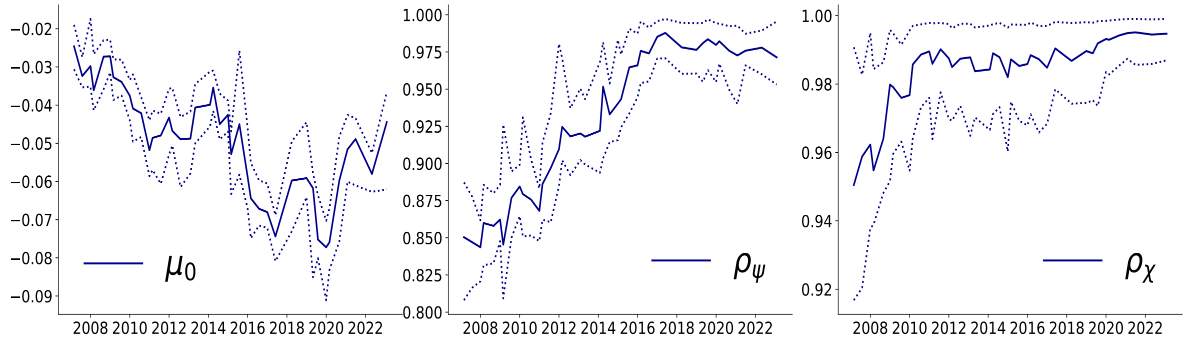
which consists of realized surplus, expected surplus for year $t+j$, realized debt-to-GDP ratio, expected debt-to-GDP ratio, and the growth and inflation-adjusted return on the government bond portfolio.

Investors utilize the incoming data along with Bayes' Law to iteratively update their beliefs concerning the states and parameters. To do so, it is useful to express the vector of observables as a function of the states. The link between these observables and states, along with bias terms, is delineated in Sections 4.3 and 4.4 and can be expressed as follows:

$$y_t \;=\; D + Z z_t + \Sigma^u u_t, \quad u_t \sim N(0, I), \tag{26}$$

where D and Z is a function of the parameter vectors Θ_p and Θ_b, and z_t is the vector of

Fig. 8. **Evolution of the parameter estimates**



Notes: Each panel plots the evolution of beliefs about the model parameters: μ_0, ρ_ψ, and ρ_χ. The blue solid lines are the posterior median estimates, and the dotted blue lines are the 5th and 95th percentiles of the posterior distribution.

states.

The state variables themselves follow a vector autoregressive process of the form:

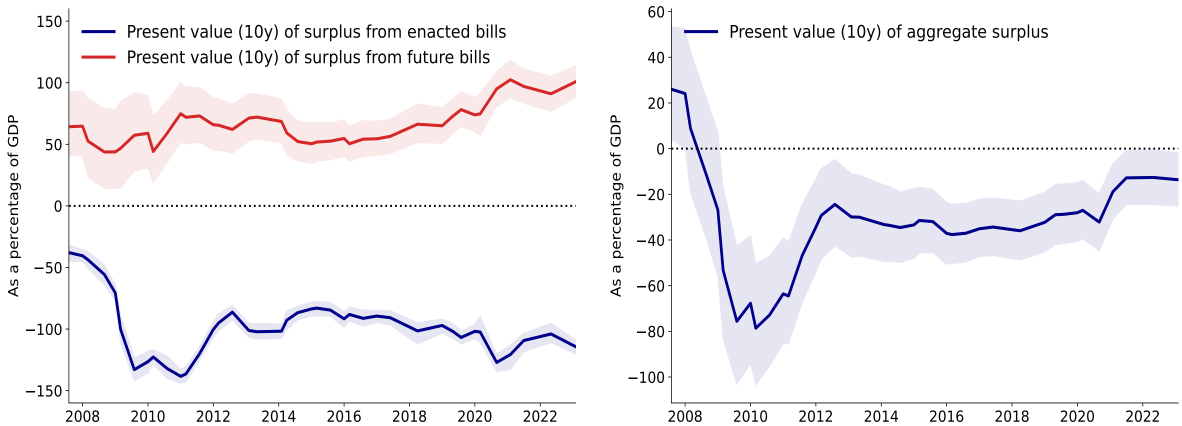
$$z_t = \Phi z_{t-1} + \Sigma^\omega \omega_t, \quad \omega_t \sim N(0, I), \tag{27}$$

where the state vector contains the hidden states ψ_t, χ_t, and h_t, as well as their respective lags and innovations. The appendix provides the details about the state-space system.

We initiate investors with initial beliefs in 1999Q4. Employing data spanning from 1999Q4 to 2007Q1, the investors perform posterior inference and sample from the posterior distribution of hidden states and parameters, producing forecasts for varying horizons of the aggregate surplus. Subsequently, when a new CBO projection becomes available (typically three times annually), investors use the newly released projections to update their beliefs and issue a new forecast. Investors continue this recursive process up to 2022Q4. We use a Metropolis-within-Gibbs algorithm for Bayesian inference. We describe this algorithm and the assumed distribution of initial beliefs in the Appendix.

Figure 8 plots the evolution of the posterior median estimates of the model parameters μ_0, ρ_ψ, and ρ_χ, along with the 90% credible intervals between 2007Q1 to 2022Q4. Figure B.9 in the Appendix presents the values for the rest of the model parameters. The figure displays notable shifts in investors' beliefs regarding the parameters that dictate the process of expected surpluses from enacted bills. Specifically, the unconditional mean

Fig. 9. **Model-implied present value of surplus or deficits [-] as a percentage of GDP**



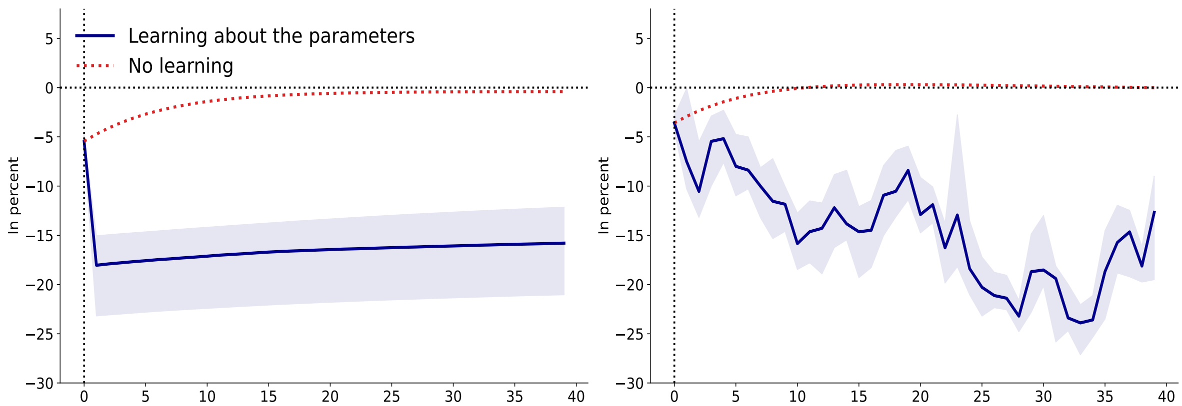
Notes: The left panel presents the present value of surplus coming from enacted (blue line) and future bills (red line) using a 10 year horizon. The right panel shows the present value of all bills using a 10 year horizon. Red and blue shades denote the 5th and 95th percentiles of the posterior distribution. To compute these estimates, we use the entire sample for posterior inference.

estimate, μ_0, exhibits a gradual decline over time. Meanwhile, the persistence parameter, ρ_ψ, experiences a gradual increase, starting at approximately 0.85 in the early sample period and reaching around 0.97 toward the end of the sample. The gradual increase in the persistence parameters and decline in the mean reflects the investor learning about the deepening deficits over the past two decades.

The left panel of figure 9 plots the decomposition of the investor's best estimates of the 10-year present value contributions from enacted legislation (blue line) and future legislation (red line) as a percentage of GDP with the 5th and 95th percentiles of the posterior distribution denoted by the shaded areas. Both lines exhibit a drop at the start, with a more pronounced decline in the contributions from enacted bills, capturing the deep deficits unfolding during this period. The present value of future legislation is positive and exhibits some reversals at the end of the sample, potentially reflecting beliefs of increasing measures toward fiscal consolidations in the subsequent decade.

The right panel plots the investor's forecasts of the 10-year present value of primary surpluses, which is the sum of the two series in the left panel. The aggregate series illustrates how investors expect the deficits will continue to persist through the next decade, although decreasing in magnitude due to expectations of possible fiscal consolidations from future policy actions.

Fig. 10. **Impulse response to news of rising deficits**



Notes: The left panel shows the impulse response of the log debt to the log debt-to-GDP ratio following an unexpected decrease in expected surplus coming from enacted bills $(-\sigma_{\psi}\epsilon_{\psi,t})$ and an increase in expected surplus coming from future bills $(\sigma_{\chi}\epsilon_{\chi,t})$. The red dotted line assumes constant parameters, while the blue line incorporates parameter updates in the second period based on investors' revised beliefs. The first scenario uses posterior median estimates from 1999-2007, and the second from 2008-2022. In the left panel, we compute the impulse response using the entire sequence of parameter changes observed from 2007 to 2022.

Bond price responses. Learning about the parameters underlying the data-generating process can induce drifts in bond valuations. To illustrate this, the left panel in Figure 10 depicts the impulse response of the log debt-to-GDP ratio following an unexpected decrease in the expected surplus of enacted bills by one standard deviation (i.e., $\frac{\partial b_t}{\partial \epsilon_{\psi,t}} < 0$). We present two impulse responses. The red dotted line assumes constant parameters, while the blue line incorporates parameter updates in the second period based on investors' revised beliefs. The first scenario uses posterior median estimates from 1999-2007, and the second from 2008-2022.

The figure shows that during the first period, the value of debt decreased with news of rising deficits. Without parameter changes, as depicted by the red dotted line, the value of debt converges towards its unconditional mean. However, the blue line shows that, with parameter changes in the subsequent period, the value of debt decreases again as the investors update their beliefs about the persistence of the expected surplus from enacted bills. Subsequently, without further parameter changes, the market value of debt gradually converges to its new unconditional mean.

In the right panel of Figure 10, we feed the entire sequence of parameter changes observed from 2007 to 2022. The blue line shows that the value of debt decreases constantly as investors update their beliefs about the data-generating process, even in the absence of new shocks. Consequently, an econometrician looking at the data ex-post would find predictable price drifts as investors use Bayes Law to incorporate new information to update their beliefs optimally.

5 Conclusion

We document that daily CBO cost projections about individual enacted legislation contain valuable news about the path of future surpluses to bond investors. We document that cost releases of bills increasing deficits significantly lower the market value of public debt in daily event windows. The effects grow as we expand the event window from days to months and are concentrated on news about deficits, suggesting that investors are learning about the deepening deficits unfolding over our sample. We find that the cost projections generate significant discount rate effects: News about higher deficits lowers convenience yields and raises nominal term premia persistently. Inflation expectations and long-term nominal yields increase persistently to deficit news, consistent with the adjustment mechanisms in the fiscal theory.

We interpret our results in a present value framework with Bayesian investors who learn about unobserved components of the budget process with incoming data from bond markets and cost releases. We find that the investor updates the persistence parameter upwards and the unconditional mean parameter downwards in the surplus process, reflecting the revision in beliefs about the duration and severity of deficits over the past two decades. The investor's forecast about the present value of surpluses over a 10-year horizon implies long-lasting deficits. However, in our surplus decomposition, the investor expects reversals in the present value contributions from future legislation at the end of the sample, suggesting beliefs of fiscal consolidations over the next decade. The gradual revisions in parameters governing the surplus process generate bond price drifts in line with our regression evidence.

References

Adrian, T., Crump, R. K., Moench, E., 2013. Pricing the term structure with linear regressions. Journal of Financial Economics 110, 110–138.

Alesina, A., Favero, C., Giavazzi, F., 2019. Effects of austerity: Expenditure-and tax-based approaches. Journal of Economic Perspectives 33, 141–162.

Berndt, A., Lustig, H., Yeltekin, Ş., 2012. How does the us government finance fiscal shocks? American Economic Journal: Macroeconomics 4, 69–104.

Bianchi, F., Gomez-Cram, R., Kung, H., 2021. Using social media to identify the effects of congressional partisanship on asset prices. Tech. rep., National Bureau of Economic Research.

Bianchi, F., Lettau, M., Ludvigson, S. C., 2022. Monetary policy and asset valuation. The Journal of Finance 77, 967–1017.

Campbell, J. Y., Gao, C., Martin, I. W., 2023. Debt and deficits: Fiscal analysis with stationary ratios. Tech. rep., National Bureau of Economic Research.

Cochrane, J. H., 2001. Long-term debt and optimal policy in the fiscal theory of the price level. Econometrica 69, 69–116.

Cochrane, J. H., 2022. The fiscal roots of inflation. Review of Economic Dynamics 45, 22–40.

Collin-Dufresne, P., Hugonnier, J., Perazzi, E., 2023. Admissible surplus dynamics and the government debt puzzle. Swiss Finance Institute Research Paper .

Collin-Dufresne, P., Johannes, M., Lochstoer, L. A., 2016. Parameter learning in general equilibrium: The asset pricing implications. American Economic Review 106, 664–698.

Corhay, A., Kind, T., Kung, H., Morales, G., 2023. Discount rates, debt maturity, and the fiscal theory. Journal of Finance, forthcoming .

Croce, M. M., Lettau, M., Ludvigson, S. C., 2015. Investor information, long-run risk, and the term structure of equity. The Review of Financial Studies 28, 706–742.

Drautzburg, T., 2020. A narrative approach to a fiscal dsge model. Quantitative Economics 11, 801–837.

Farmer, L., Nakamura, E., Steinsson, J., 2021. Learning about the long run. Tech. rep., National Bureau of Economic Research.

Guajardo, J., Leigh, D., Pescatori, A., 2014. Expansionary austerity? international evidence. Journal of the European Economic Association 12, 949–968.

Gürkaynak, R. S., Sack, B., Wright, J. H., 2007. The us treasury yield curve: 1961 to the present. Journal of monetary Economics 54, 2291–2304.

Hall, G. J., Sargent, T. J., 2011. Interest rate risk and other determinants of post-wwii us government debt/gdp dynamics. American Economic Journal: Macroeconomics 3, 192–214.

Hall, G. J., Sargent, T. J., 2022. Three world wars: Fiscal–monetary consequences. Proceedings of the National Academy of Sciences 119, e2200349119.

Hanson, S. G., Stein, J. C., 2015. Monetary policy and long-term real rates. Journal of Financial Economics 115, 429–448.

Hillenbrand, S., 2021. The fed and the secular decline in interest rates. Available at SSRN 3550593 .

Hilscher, J., Raviv, A., Reis, R., 2022. Inflating away the public debt? an empirical assessment. The Review of Financial Studies 35, 1553–1595.

Holston, K., Laubach, T., Williams, J. C., 2017. Measuring the natural rate of interest: International trends and determinants. Journal of International Economics 108, S59–S75.

Jiang, Z., Lustig, H., Van Nieuwerburgh, S., Xiaolan, M. Z., 2019. The us public debt valuation puzzle. Tech. rep., National Bureau of Economic Research.

Jiang, Z., Lustig, H., Van Nieuwerburgh, S., Xiaolan, M. Z., 2021. What drives variation in the us debt/output ratio? the dogs that didn't bark. Tech. rep., National Bureau of Economic Research.

Kozlowski, J., Veldkamp, L., Venkateswaran, V., 2020. The tail that wags the economy: Beliefs and persistent stagnation. Journal of Political Economy 128, 2839–2879.

Krishnamurthy, A., Vissing-Jorgensen, A., 2012. The aggregate demand for treasury debt. Journal of Political Economy 120, 233–267.

Laubach, T., Williams, J. C., 2003. Measuring the natural rate of interest. Review of Economics and Statistics 85, 1063–1070.

Liu, Y., Wu, J. C., 2021. Reconstructing the yield curve. Journal of Financial Economics 142, 1395–1425.

Mertens, K., Ravn, M. O., 2012. Empirical evidence on the aggregate effects of anticipated and unanticipated us tax policy shocks. American Economic Journal: Economic Policy 4, 145–181.

Ramey, V. A., 2011. Identifying government spending shocks: It's all in the timing. The Quarterly Journal of Economics 126, 1–50.

Romer, C. D., Romer, D. H., 2010. The macroeconomic effects of tax changes: estimates based on a new measure of fiscal shocks. American Economic Review 100, 763–801.

Saturno, J. V., 2023. Introduction to the federal budget process. Washington, DC: Congressional Research Service .

Vissing-Jorgensen, A., Krishnamurthy, A., 2011. The effects of quantitative easing on interest rates: Channels and implications for policy. Brookings Papers on Economic Activity 43, 215–287.

Appendix

Learning about the federal budget process

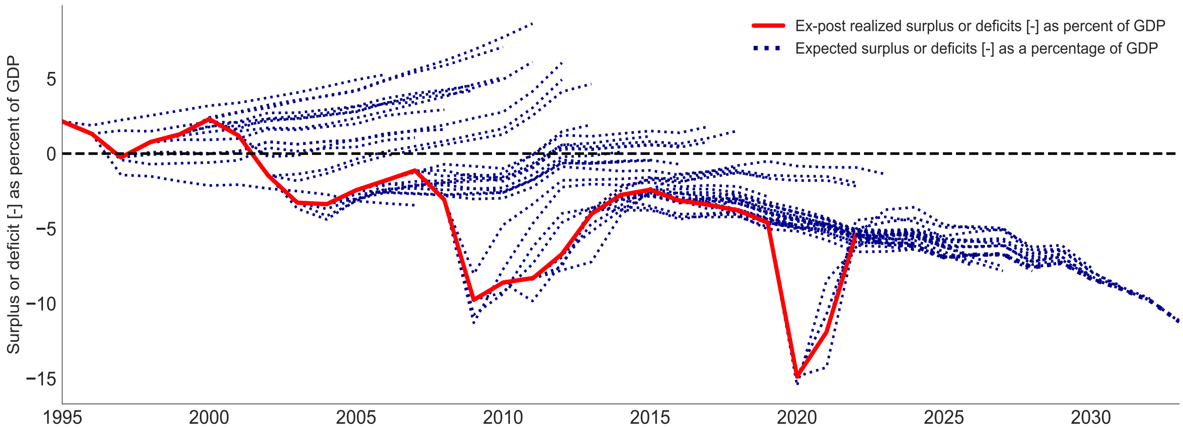
Roberto Gómez-Cram Howard Kung Hanno Lustig

July 2023

Appendix Table of Contents

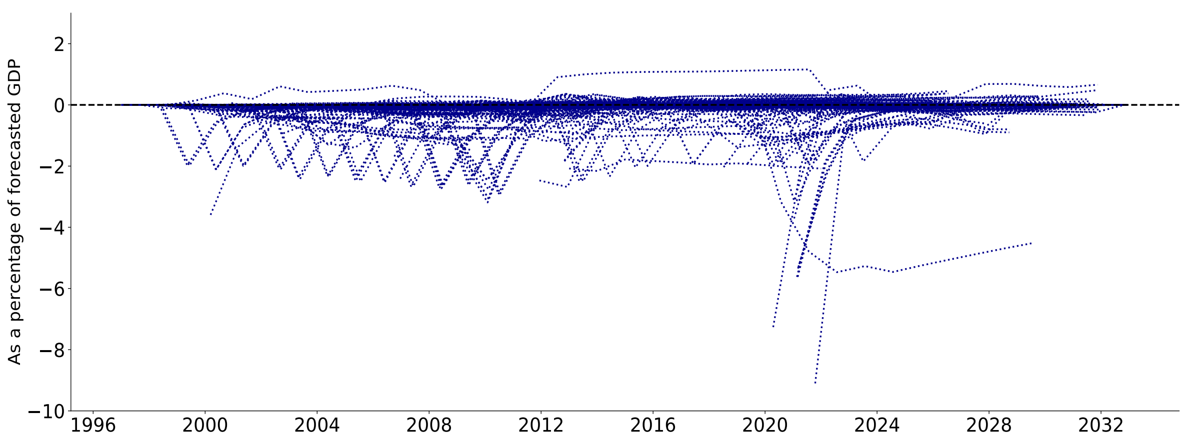
Appendix A - Additional Tables and Figures

Fig. A.1. **Realized versus expected surplus or deficits [-] as a percentage of GDP**



Notes: The figure displays the realized surplus or deficit (-) as a percentage of GDP in red. The blue dotted lines represent the CBO's 10-year projected surplus as a percentage of GDP.

Fig. A.2. **Bill-level expected net effect of surplus or deficit [-] as percentage of GDP**



Notes: The figure shows the expected net increase or decrease (indicated by [-]) in the deficit scaled by GDP. Each dotted line corresponds to a cost estimate for a specific bill, covering the current year and the subsequent decade. In total, we show 15,533 unique cost estimates spanning the 105th Congress (1997-1998) to the 117th Congress (2021-2022).

Table A.1. **Surpluses and Government Bond Returns**

	Current returns		Future returns: $\sum_{j=1}^{H} r_{t+j}$ horizon in days			
			30	60	90	120
Coefficient	(1)	(2)	(3)	(4)	(5)	(6)
$\texttt{pv}_{it}$	0.28	0.29	1.45	2.29	2.79	3.36
	[1.94]	[1.94]	[1.84]	[1.60]	[1.89]	[2.40]
R^2 in %	0.09	4.92	4.82	10.52	13.62	15.20
Observations	2,989	2,988	2,988	2,988	2,983	2,964
Controls	No	Yes	Yes	Yes	Yes	Yes

Notes: This table presents regression results for the equation:

$$\sum_{t}^{H} r_t = b \cdot \texttt{pv}_{it} + controls_t + c_t + \epsilon_t,$$

where r_t is the daily nominal return on the government debt portfolio computed using procedures similar to Hall and Sargent (2011). $\texttt{pv}_{it}$ denotes the change in surplus by bill i on day t scaled by *market value of debt*. In columns (2) through (6), we use various controls. We use news announcements of the top 50 macroeconomic indicators as contemporaneous controls. We also control for lagged daily returns from $t-6$ to $t-1$, and the following lagged macro variables available at the daily frequency: CBOE Volatility Index, 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity, Federal Funds Effective Rate, 10-Year Breakeven Inflation Rate, Term Premium on a 10 Year Zero Coupon Bond. The daily return r_t is in basis points, while $\texttt{pv}_{it}$ is in percent (as a percentage of market value of debt). t-statistics are in squared brackets.

Table A.2. **Changes in credit default swaps**

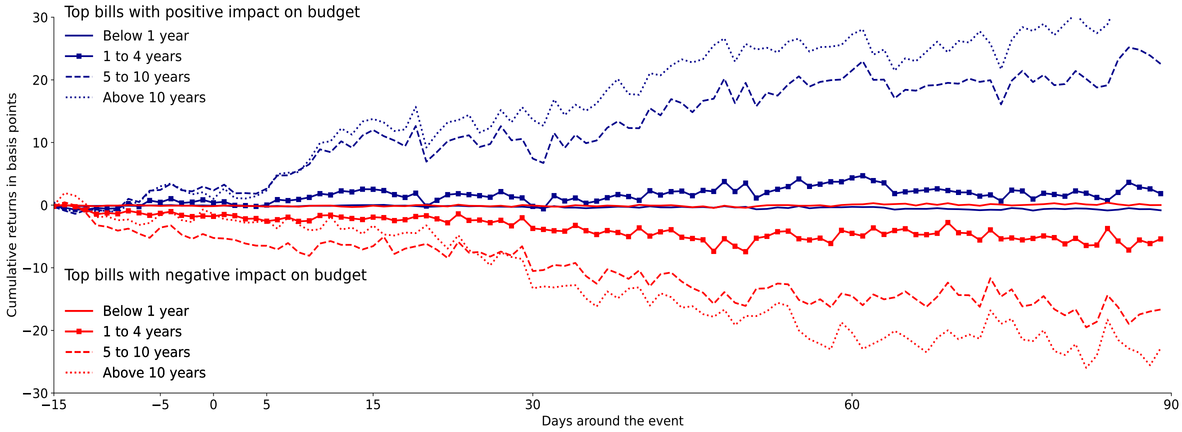
	Maturity of the CDS contract					
	1 year	2 year	3 year	5 years	7 years	10 years
Coefficient	(1)	(2)	(3)	(4)	(5)	(6)
$\texttt{pv}_{it}$	-0.25	-0.25	-0.21	-0.16	-0.11	-0.08
	[-1.64]	[-1.58]	[-1.38]	[-1.22]	[-1.12]	[-0.84]
R^2 in %	9.72	9.61	6.54	4.19	4.27	4.40
Observations	1,866	1,866	1,866	1,866	1,866	1,866
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents regression results for the equation:

$$\Delta CDS_t^j = b \cdot \texttt{pv}_{it} + controls_t + c_t + \epsilon_t,$$

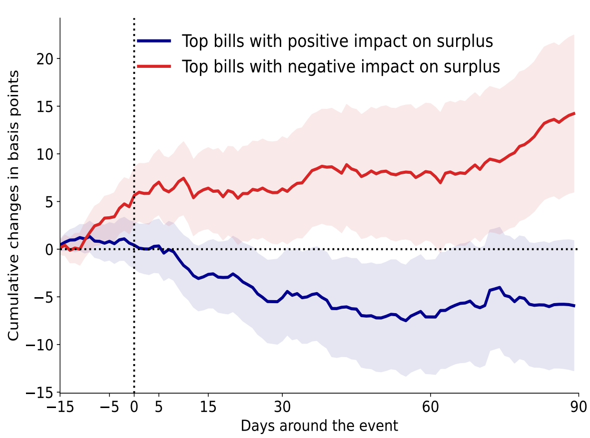
where ΔCDS_t^j is the daily change in the credit default swap of a contract with maturity j years. $\texttt{pv}_{it}$ denotes the change in surplus by bill i on day t scaled by the nominal output for the previous year. We use news announcements of the top 50 macroeconomic indicators as contemporaneous controls. We also control for lagged daily returns from $t-6$ to $t-1$, and the following lagged macro variables available at the daily frequency: CBOE Volatility Index, 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity, Federal Funds Effective Rate, 5-Year Breakeven Inflation Rate, Term Premium on a 10 Year Zero Coupon Bond. The daily variable ΔCDS_t^j is in basis points, while Δs_t is in percent (as a percentage of GDP). t-statistics are in squared brackets.

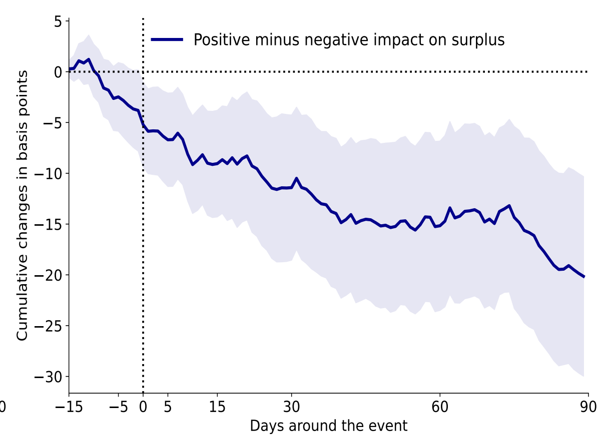
Fig. A.3. **Event-study plot: Decomposition of the Nominal returns by Maturity of Obligation**



Notes: This figure displays the impact of surplus news on government bond portfolio returns for various event windows and for different bond maturity. Firstly, we sort bills into 10 deciles based on their effect on the government surplus. Then, for each decile, we calculate the cumulative bond return from 15 business days before the legislative events to 90 business days afterward. The blue and red shades represent the 95% error bands. The CBO Cost Estimates were published on day 0. The line label "Below 1 year" is $\sum_{j=1}^{12} r^j_{t,t+1} B^j_t / \tilde{B}_t$; line label "1 to 4 years" is $\sum_{j=13}^{48} r^j_{t,t+1} B^j_t / \tilde{B}_t$; line label "5 to 10 years" is $\sum_{j=1}^{12} r^j_{t,t+1} B^j_t / \tilde{B}_t$ $\sum_{j=49}^{120} r^j_{t,t+1} B^j_t / \tilde{B}_t$; line label "Above 10 years" is $\sum_{j=121}^{360} r^j_{t,t+1} B^j_t / \tilde{B}_t$. where $\tilde{B}_t = \sum_{j=1}^{n} B^j_t$ is the total market value of debt hold by the public (n is in months).

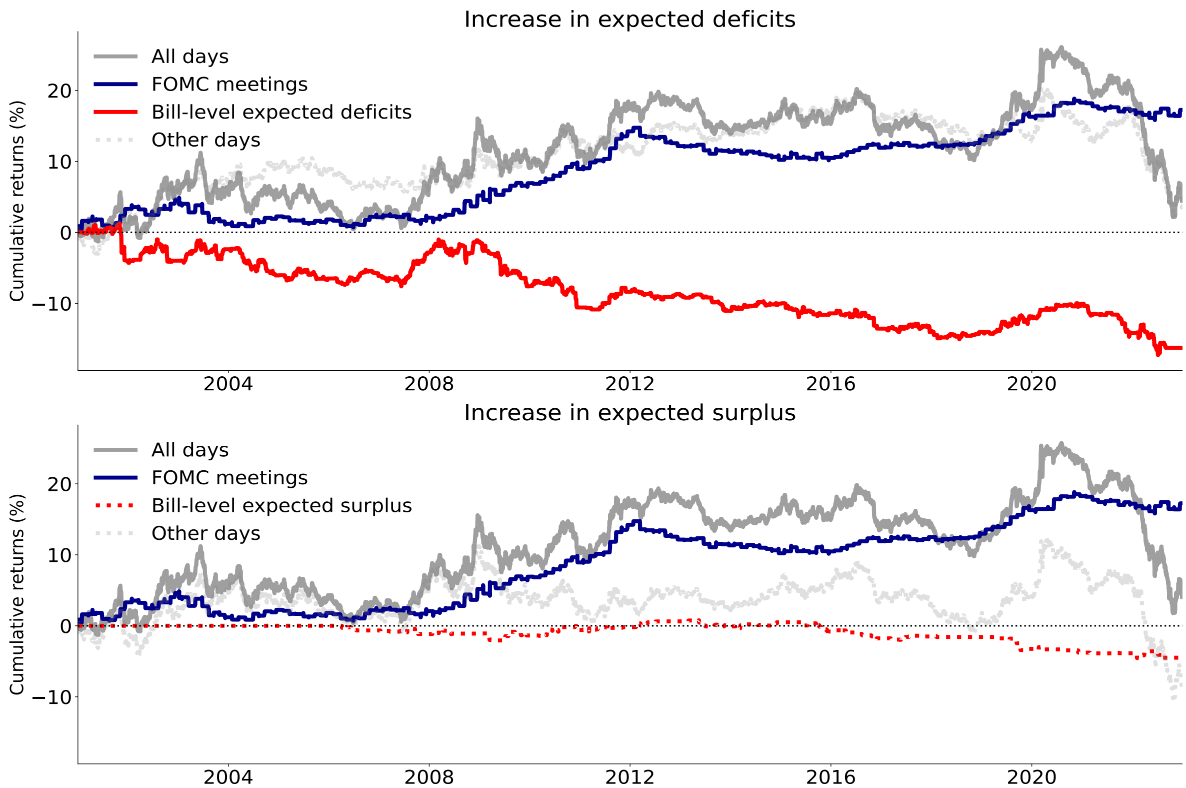
Fig. A.4. **Event-study plot: Days around the CBO publication date and inflation swaps**





Notes: This figure displays the impact of surplus news on changes in 10-year inflation swaps. Firstly, we sort bills into 20 bins based on their effect on the government surplus. Then, for the first and last bins, we calculate the cumulative change in inflation swaps from 15 business days before the legislative events to 90 business days afterward. The blue and red shades represent the 90% error bands. The CBO Cost Estimates were published on day 0.

Fig. A.5. **Bond Returns around Deficit and Surplus Projections Considering FOMC days**



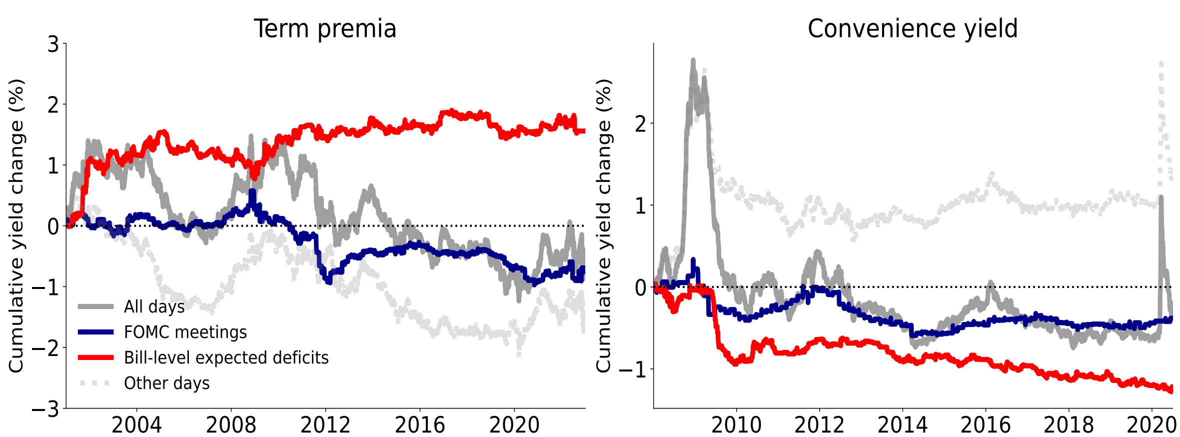
Notes: This figure shows cumulative returns on the government debt portfolio using four different sets of days. In both panels, the dark gray line displays the cumulative return using all trading days, while the dark blue line computes cumulative returns using a 3-day window centered on the FOMC meeting days. In the top panel, the red line computes cumulative returns using CBO cost release dates where the bill is expected to increase the present value of deficits above median values, and these dates do not coincide with FOMC meeting days. In the bottom panel, the red dotted line computes cumulative returns using CBO cost release dates where the bill is expected to increase the present value of surplus above median values, and these dates do not coincide with FOMC meeting days. Lastly, in both panels, the light gray lines compute cumulative returns using all remaining trading days. The sample period runs from January 2000 to December 2022.

Table A.3. **Return and Yield Changes around Bill-level Expected Deficits Considering FOMC days**

	All days	FOMC meetings	Bill-level expected deficits	Other days
	(1)	(2)	(3)	(4)
A. Nominal return on the government debt portfolio				
Mean in bps	0.08	3.09	-1.39	0.09
	[0.21]	[3.15]	[-2.16]	[0.23]
Observations	5,499	530	1,123	3,846
B. Bond risk premium on the government debt portfolio				
	(1)	(2)	(3)	(4)
Mean in bps	-0.01	-0.14	0.11	-0.04
	[-0.28]	[-1.47]	[1.17]	[-0.86]
Observations	5,495	532	1,338	3,625
C. Convenience yield on the government debt portfolio				
	(1)	(2)	(3)	(4)
Mean in bps	-0.01	-0.13	-0.21	0.08
	[-0.10]	[-1.16]	[-3.38]	[0.78]
Observations	3,056	288	716	2,052

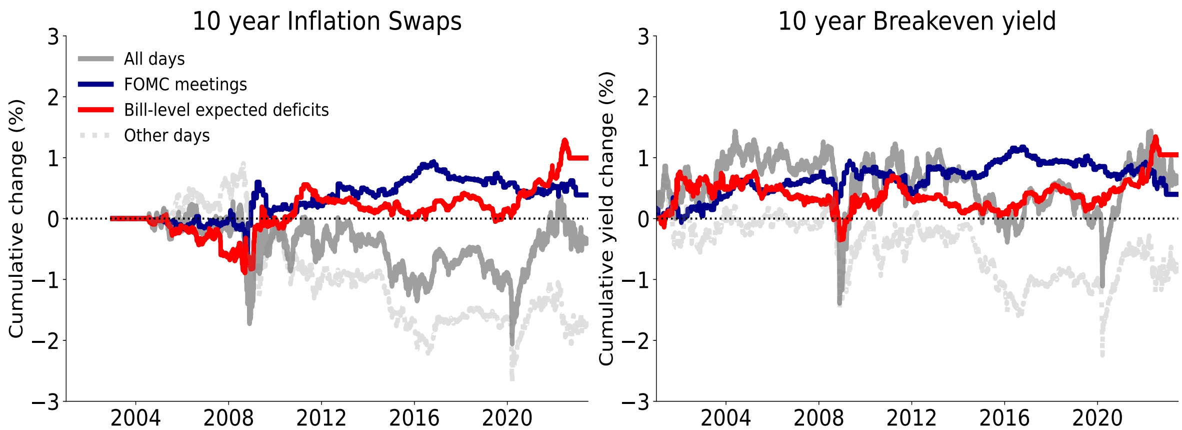
Notes: Panel A shows the average daily return on the government debt portfolio over four distinct day sets. Column 1 covers all trading days, while Column 2 incorporates a 3-day window centered on FOMC meeting days. Column 3 considers the CBO cost release dates where the bill is expected to increase the present value of deficits above the median values, and these dates do not coincide with FOMC meeting days. Column 4 includes all other trading days. Panels B and C use the same-day classifications, but compute the average term premia and convenience yields of the government debt portfolio, respectively.

Fig. A.6. **Term Premia and Convenience Yields around Deficit Projections Considering FOMC days**



Notes: The dark gray line shows the cumulative change in term premia (left plot) and convenience yields (right plot). The blue line shows the cumulative change around a 3-day window around FOMC meetings. The red line shows the cumulative change surrounding CBO cost estimates below median values (but not FOMC days). The light gray denotes the cumulative changes around other days.

Fig. A.7. **Inflation Expectations around Deficit Projections**



Notes: The dark gray line shows the cumulative change in inflation swaps (left plot) and breakeven yields (right plot). The blue line shows the cumulative change around a 3-day window around FOMC meetings. The red line shows the cumulative change surrounding CBO cost estimates below median values (but not FOMC days). The light gray denotes the cumulative changes around other days.

Table A.4. **Changes in break even inflation**

		by Maturity of Obligation		
		5 y	10y	30 y
Coefficient	Variable	(1)	(2)	(3)
a	$\texttt{pv}_{it}$	-0.22	-0.11	-0.04
		[-3.82]	[-2.73]	[-1.75]
R^2 in %		5.06	4.17	1.66
Controls		Yes	Yes	Yes

Notes: This table presents regression results for the equation:

$$\sum_{t}^{H} \Delta BreakEven_t^j = a \cdot \texttt{pv}_{it} + controls + c_t + \epsilon_t,$$

where $\Delta BreakEven_t^j$ is the daily change in the j-year break even inflation measure. $\texttt{pv}_{it}$ denotes the change in surplus by bill i on day t scaled by the nominal output for the previous year. In columns (2) through (6), we use news announcements of the top 50 macroeconomic indicators as contemporaneous controls. We also control for lagged daily returns from $t-6$ to $t-1$, and the following lagged macro variables available at the daily frequency: CBOE Volatility Index, 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity, Federal Funds Effective Rate, 5-Year Breakeven Inflation Rate, Term Premium on a 10 Year Zero Coupon Bond. The daily variable $\Delta BreakEven_t^j$ is in basis points, while $\texttt{pv}_{it}$ is in percent (as a percentage of GDP). t-statistics are in squared brackets.

Table A.5. **Surpluses and Inflation Expectations: Break-even inflation**

Break Even 10 years					
		Future inflation: $\sum_{j=1}^{H} \Delta InflationBE_{t+j}^{10y}$			
	Current	30 days	60 days	90 days	120 days
Coefficient	(1)	(3)	(4)	(5)	(6)
$\texttt{pv}_{it}$	-0.38	-1.15	-2.12	-3.51	-3.57
	[-2.70]	[-2.56]	[-2.86]	[-3.06]	[-2.68]
R^2 in %	1.84	7.37	14.32	23.75	28.47
Observations	2,967	2,967	2,967	2,967	2,967

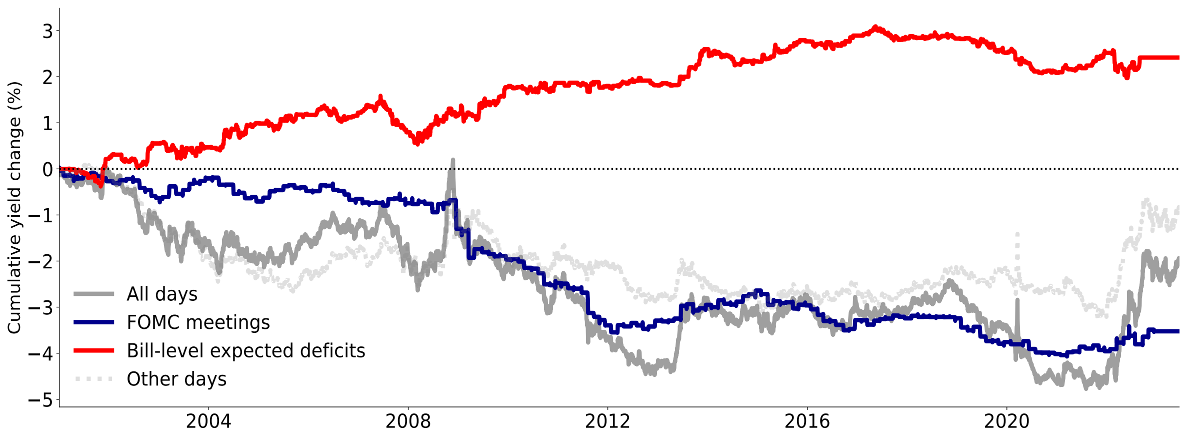
Notes: This table presents regression results for the equation: $\sum_{t}^{H} \Delta InflationBE_t^{10y} = a \cdot \texttt{pv}_{it} + controls + c_t + \epsilon_t$, where $\Delta InflationBE_t^{10y}$ is the daily change in the break-even inflation yield with maturity of 10 years. $\texttt{pv}_{it}$ denotes the change in surplus by bill i on day t scaled by the nominal output for the previous year. We use news announcements of the top 50 macroeconomic indicators as contemporaneous controls. We also control for lagged daily returns from $t-6$ to $t-1$, and the following lagged macro variables available at the daily frequency: CBOE Volatility Index, 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity, Federal Funds Effective Rate, 5-Year Breakeven Inflation Rate, Term Premium on a 10 Year Zero Coupon Bond. The daily variable $\Delta InflationBE_t^{10y}$ is in basis points, while $\texttt{pv}_{it}$ is in percent (as a percentage of GDP). t-statistics are in squared brackets.

Table A.6. **Return and Yield changes around bill-level expected deficits**

A. 10-Year Nominal Yield				
	All days (1)	FOMC meetings (2)	Bill-level expected deficits (3)	Other days (4)
Mean in bps	-0.03	-0.59	0.31	-0.04
	[-0.36]	[-2.26]	[2.29]	[-0.62]
Observations	5,618	5,34	1,119	3,965
B. Average expected nominal short-term interest rate				
	All days (1)	FOMC meetings (2)	Bill-level expected deficits (3)	Other days (4)
Mean in bps	0.00	-0.23	0.12	0.00
	[0.06]	[-1.71]	[1.32]	[0.03]
Observations	5,618	5,34	1,119	3,965
C. 10-Year Real Yield				
	All days (1)	FOMC meetings (2)	Bill-level expected deficits (3)	Other days (4)
Mean in bps	-0.04	-0.66	0.22	-0.02
	[-0.56]	[-2.42]	[1.78]	[-0.32]
Observations	5618	534	1119	3965

Notes: Panel A shows the average daily change in the 10-year nominal yield over four distinct day sets. Column 1 covers all trading days, while Column 2 incorporates a 3-day window centered on FOMC meeting days. Column 3 considers the CBO cost release dates where the bill is expected to increase the present value of deficits above the median values, and these dates do not coincide with FOMC meeting days. Column 4 includes all other trading days. Panels B and C use the same-day classifications, but compute the average chane in the average expected nominal short-term rate and the 10-year real yield, respectively.

Fig. A.8. **Real yields around Deficit Projections**



Notes: The dark gray line shows the cumulative change in the 10-year real yield. The blue line shows the cumulative change around a 3-day window around FOMC meetings. The red line shows the cumulative change surrounding CBO cost estimates below median values (but not FOMC days). The light gray denotes the cumulative changes around other days.

Table A.7. **Surpluses and Real Yields**

TIPS 10 years					
		10-Year Real Yield: $\sum_{j=1}^{H} TIPS_{t+j}$			
	Current	30 days	60 days	90 days	120 days
Coefficient	(1)	(3)	(4)	(5)	(6)
$\texttt{pv}_{it}$	0.05	0.01	-0.17	0.13	-0.19
	[0.34]	[0.01]	[-0.20]	[0.14]	[-0.20]
R^2 in %	2.89	5.39	14.98	22.00	23.31
Observations	2,967	2,967	2,967	2,967	2,967

Notes: This table presents regression results for the equation: $\sum_t^H \Delta x_t = a \cdot \texttt{pv}_{it} + controls + c_t + \epsilon_t$, where Δx_t is the daily change in the 10-year real yield. $\texttt{pv}_{it}$ denotes the change in surplus by bill i on day t scaled by the nominal output for the previous year. In columns (1) through (5), we use news announcements of the top 50 macroeconomic indicators as contemporaneous controls. We also control for lagged daily returns from $t-6$ to $t-1$, and the following lagged macro variables available at the daily frequency: CBOE Volatility Index, 10-year Treasury Constant Maturity Minus 2-year Treasury Constant Maturity, Federal Funds Effective Rate, 5-year Breakeven Inflation Rate, Term Premium on a 10-year zero coupon bond. The daily real yield change is in basis points, while $\texttt{pv}_{it}$ is in percent (as a percentage of GDP). t-statistics are in squared brackets.

Appendix B - Learning about Future Surpluses

Section B.1 describes the state-space representation for the learning model. Section B.2 presents the assumed distribution of initial beliefs and describes the algorithm used for posterior inference.

B.1 State-space representation of the learning model

Below we describe the state-space representation for the learning model. To do so, we first need to express the vector of observables, y_t, as a function of the latent states.

The vector of observables is given by:

$$y_t = [\hat{S}_{t+j},\ \mathbb{E}_t^* \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)},\ b_t,\ \mathbb{E}_t^* b_{t+T},\ \hat{r}_t],$$

where $\hat{S}_{t+j}$ denotes the realized surplus, $\mathbb{E}_t^* \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)}$ is the expected surplus for year $t+j$, b_t is the realized debt-to-GDP ratio, $\mathbb{E}_t^* b_{t+T}$ is the expected debt-to-GDP ratio for year $t+T$, and $\hat{r}_t$ is the return on the government bond portfolio, adjusted for both growth and inflation.

- *Realized surplus.* We assume that the CBO projection of the surpluses of horizon j from enacted bills may deviate from the rational expectations counterpart by an additive wedge:

$$\mathbb{E}_t^* \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} = \mathbb{E}_t \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} + \texttt{bias}_s^{(j)}, \tag{B.1}$$

  where $\texttt{bias}_s^{(j)}$ captures the CBO's bias in forecasting surplus to GDP from rational expectations.

  Let $\epsilon_{st}^{(j)} \equiv \hat{S}_{t+j} - E_t[\hat{S}_{t+j}]$ denote the surplus innovation of horizon j under rational expectations. Using the definition of the surplus innovation with equation (B.1) implies:

$$\hat{S}_{t+j} - \mathbb{E}_t^* \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} - \mathbb{E}_t \sum_{l=1}^{n_{>t}^{t+j}} \hat{S}_{t+j}^{(l)} = \epsilon_{st}^{(j)} - \texttt{bias}_s^{(j)}. \tag{B.2}$$

We can observe $\hat{S}_{t+j}$ and $\mathbb{E}_t^* \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)}$. Moreover, from equation (20) in the main text we have: $\mathbb{E}_t \sum_{l=1}^{n_{>t}^{t+j}} \hat{S}_{t+j}^{(l)} = \mu_\chi^{(j)} + \rho_\chi \chi_t$. Hence,

$$\hat{S}_{t+j} - \mathbb{E}_t^* \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} = -\texttt{bias}_s^{(j)} + \mu_\chi^{(j)} + \rho_\chi \chi_t + \sigma_s^{(j)} \epsilon_{st}^{(j)}. \tag{B.3}$$

- *Expected surplus from CBO.* The CBO issues surplus projections for the next year and the following decade. Given the constants of linearization ν and γ, we can express the present value of surplus from enacted bills as follows:

$$\sum_{j=1}^{T} \nu^{j-1} \gamma \mathbb{E}_t^* \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} = \sum_{j=1}^{T} \nu^{j-1} \gamma \mathbb{E}_t \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} + \sum_{j=1}^{T} \nu^{j-1} \gamma \texttt{bias}_s^{(j)} \tag{B.4}$$

We observe the term on the left and from equation (19) in the main text we have that

$$\sum_{j=1}^{T} \nu^{j-1} \gamma \mathbb{E}_t \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} = A_{0,\psi} + A_{1,\psi} \psi_t \tag{B.5}$$

where $A_{0,\psi}$ and $A_{1,\psi}$ are a function of the model parameters and given by $A_{0,\psi} = \gamma \mu_0 \sum_{j=1}^{T} \nu^{j-1} \delta^{(j)}$ and $A_{1,\psi} = \gamma \dfrac{1 - (\nu \rho_\psi)^T}{1 - \nu \rho_\psi}$. Hence, from equations (B.6) and (B.5) we have:

$$\sum_{j=1}^{T} \nu^{j-1} \gamma \mathbb{E}_t^* \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} = A_{0,\psi} + A_{1,\psi} \psi_t + \sum_{j=1}^{T} \nu^{j-1} \gamma \texttt{bias}_s^{(j)}. \tag{B.6}$$

- *Future debt-to-GDP ratio* We assume that the CBO projection of the debt-to-GDP ratio of horizon T can deviate from rational expectations by an additive wedge:

$$\mathbb{E}_t^* b_{t+T} = \mathbb{E}_t b_{t+T} + \texttt{bias}_b \tag{B.7}$$

where the term $\texttt{bias}_b$ captures the CBO's bias in forecasting debt to GDP from rational expectations. Let $\epsilon_{bt} \equiv b_{t+T} - \mathbb{E}_t b_{t+T}$ denote the debt innovation under rational expectations. Using the definition of the debt innovation with equation (B.7) implies:

$$b_{t+T} - \mathbb{E}_t^* b_{t+T} = -\texttt{bias}_b + \sigma_b \epsilon_{bt}. \tag{B.8}$$

- *Realized return on the government bond portfolio.* From equation (21) in the main text it follows that:

$$\hat{r}_t = \mu_r + h_{t-1} + \sigma_r \epsilon_{rt+1}. \tag{B.9}$$

- *Contemporaneous debt-to-GDP ratio.* From equation (18) in the main text we have:

$$b_t = \alpha^\star + \mathbb{E}_t \sum_{j=1}^{T} \nu^{j-1} \gamma \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} + \mathbb{E}_t \sum_{j=1}^{T} \nu^{j-1} \gamma \sum_{l=1}^{n_{>t}^{t+j}} \hat{S}_{t+j}^{(l)} - \mathbb{E}_t \sum_{j=1}^{T} \nu^{j-1} \hat{r}_{t+j} + \mathbb{E}_t \nu^T b_{t+T}$$

We can incorporate information on projected surplus and debt-to-GDP ratio as follows:

$$\begin{aligned} b_t \;=\; & \alpha^\star + \left(\mathbb{E}_t^* \sum_{j=1}^{T} \nu^{j-1} \gamma \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} - \sum_{j=1}^{T} \nu^{j-1} \gamma \texttt{bias}_s^{(j)} \right) \\ & + \; \mathbb{E}_t \sum_{j=1}^{T} \nu^{j-1} \gamma \sum_{l=1}^{n_{>t}^{t+j}} \hat{S}_{t+j}^{(l)} - \mathbb{E}_t \sum_{j=1}^{T} \nu^{j-1} \hat{r}_{t+j} \\ & + \left(\nu^T \mathbb{E}_t^* b_{t+T} - \nu^T \texttt{bias}_b \right). \end{aligned}$$

Using equation (20) in the main text we can express

$$\mathbb{E}_t \sum_{j=1}^{T} \nu^{j-1} \gamma \sum_{l=1}^{n_{>t}^{t+j}} \hat{S}_{t+j}^{(l)} = A_{0,\chi} + A_{1,\chi}\chi_t$$

where $A_{0,\chi} = \gamma\mu_0 \sum_{j=1}^{T} \nu^{j-1}(1-\delta^{(j)})$ and $A_{1,\chi} = \gamma\frac{1-(\nu\rho_\chi)^T}{1-\nu\rho_\chi}$.

Using equation (21) in the main text we can express

$$-\mathbb{E}_t \sum_{j=1}^{T} \nu^{j-1} \hat{r}_{t+j} = A_{0,h} + A_{1,h}h_t$$

where $A_{0,h} = \mu_r \frac{1-\nu^T}{1-\nu}$ and $A_{1,h} = \frac{1-(\nu\rho_h)^T}{1-\nu\rho_h}$.

Hence, we have that

$$\begin{aligned} b_t &= \alpha^\star + \left(\mathbb{E}_t^* \sum_{j=1}^{T} \nu^{j-1}\gamma \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} - \sum_{j=1}^{T} \nu^{j-1}\gamma \texttt{bias}_s^{(j)} \right) + \left(\nu^T \mathbb{E}_t^* b_{t+T} - \nu^T \texttt{bias}_b\right) \\ &+ A_{0,\chi} + A_{1,\chi}\chi_t - A_{0,h} - A_{1,h}h_t. \end{aligned} \quad \text{(B.10)}$$

Measurement Equations. It is convenient to break down the system into two terms. First, conditional on the bias parameters $\texttt{bias}_s^{(j)}$ and $\texttt{bias}_b$, we can specify $\tilde{y}_t$ as:

$$\tilde{y}_t = \left[\mathbb{E}_t^* \sum_{j=1}^{T} \nu^{j-1}\gamma \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)}, \quad b_t - \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} - \nu^T \mathbb{E}_t^* b_{t+T}, \quad \hat{r}_t \right]_{3\times 1}^{\prime}$$

We can then write the measurement equation as follows:

$$\tilde{y}_t = D + Zz_t + \Sigma^u u_t, \quad u_t \sim N(0, I). \quad \text{(B.11)}$$

If we define the vector of states as

$$z_t = \begin{bmatrix} \psi_t & \psi_{t-1} & \chi_t & \chi_{t-1} & h_t & h_{t-1} & \sigma_\psi\epsilon_{\psi,t} & \sigma_\chi\epsilon_{\chi,t} & \sigma_h\epsilon_{h,t} & \sigma_r\epsilon_{r,t} \end{bmatrix}_{10\times 1}^{\prime} \quad \text{(B.12)}$$

Then, the coefficient matrices D, Z, and Σ_u are given by:

$$D = \begin{bmatrix} A_{0,\psi} + \sum_{j=1}^{T} \nu^{j-1}\gamma\texttt{bias}_s^{(j)} \\ \alpha^* - \sum_{j=1}^{T} \nu^{j-1}\gamma\texttt{bias}_s^{(j)} - \nu^T\texttt{bias}_b + A_{0,\chi} - A_{0,h} \\ \mu_r \end{bmatrix}_{3\times1}, \qquad \Sigma^u = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}_{3\times3}.$$

$$Z = \begin{bmatrix} 0 & \rho_\psi A_{1,\psi} & 0 & 0 & 0 & 0 & A_{1,\psi} & 0 & 0 & 0 \\ 0 & 0 & 0 & \rho_\chi A_{1,\chi} & 0 & \rho_h A_{1,h} & 0 & A_{1,\chi} & A_{1,h} & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \end{bmatrix}_{3\times10}.$$

State-transition equation. Given the state vector z_t in equation (B.12), we write the state-transition equation as

$$z_t = \Phi z_{t-1} + \Sigma^\omega \omega_t, \quad \omega_t \sim N(0, I). \tag{B.13}$$

and the matrices Φ are given by Σ^ω :

$$\Phi = \begin{bmatrix} \rho_\psi & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \rho_\chi & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \rho_h & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}_{10\times10} \qquad \Sigma^\omega = \begin{bmatrix} \sigma_\psi & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \sigma_\chi & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \sigma_h & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \sigma_\psi & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \sigma_\chi & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \sigma_h & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \sigma_r \end{bmatrix}_{10\times10}.$$

Second, conditional on the state vector z_t we have:

$$
\begin{aligned}
b_{t+T} - \mathbb{E}_t^* b_{t+T} &= -\texttt{bias}_b + \sigma_b \epsilon_{bt} \\
\hat{S}_{t+j} - \mathbb{E}_t^* \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)} - \mu_\chi^{(j)} - \rho_\chi \chi_t &= -\texttt{bias}_s^{(j)} + \sigma_s^{(j)} \epsilon_{st}^{(j)}.
\end{aligned}
$$

where $-\texttt{bias}_b$ and $-\texttt{bias}_s^{(j)}$ denote the constant parameters.

B.2 Prior Distribution and posterior inference

Define the parameter vector, Θ_p, and the CBO bias terms, Θ_b as:

$$
\Theta_p = \left[\mu_0, \rho_\psi, \sigma_\psi^2, \rho_\chi, \sigma_\chi^2, \rho_h, \sigma_h^2, \sigma_r^2\right]', \qquad \Theta_b = \left[\texttt{bias}_s^j, \texttt{bias}_b, \sigma_s^{2(j)}, \sigma_b^2\right]'.
$$

Let $p(\Theta_p, \Theta_b)$ denote the joint prior distribution on the parameter vectors Θ_p and Θ_b, and let $p(y|\Theta_p, \Theta_b)$ denote the likelihood function of the data given the parameter vectors. Our goal is to sample from the posterior distribution of the parameters given the data y, where Bayes' theorem provides the link:

$$
p(\Theta_p, \Theta_b|y) = \frac{p(y|\Theta_p, \Theta_b)p(\Theta_p, \Theta_b)}{p(y)}.
$$

B.2.1 Prior Distribution

We assume the following distribution for the priors:

$$
\begin{aligned}
\Theta_i &\sim \mathcal{N}(\mu_{\Theta_i}, \sigma_{\Theta_i}^2) \quad \text{for} \quad \Theta_i \in \{\mu_0, \texttt{bias}_s^j, \texttt{bias}_b\}, \\
\Theta_i &\sim \mathcal{N}^{\mathcal{T}}(\mu_{\Theta_i}, \sigma_{\Theta_i}^2) \quad \text{for} \quad \Theta_i \in \{\rho_\psi, , \rho_\chi, \rho_h\}, \\
\Theta_i &\sim \mathcal{IG}(\alpha_{\Theta_i}, \beta_{\Theta_i}) \quad \text{for} \quad \Theta_i \in \{\sigma_\psi^2, \sigma_\chi^2, \sigma_h^2, \sigma_r^2, \sigma_s^{2(j)}, \sigma_b^2\},
\end{aligned}
$$

where $\mathcal{N}$ denotes the normal distribution, $\mathcal{N}^{\mathcal{T}}$ is the truncated (outside of the interval $(-1, 1)$) normal distribution, and $\mathcal{IG}$ is the inverse gamma distribution. We start the initial beliefs at the posterior median estimates using data from September 1997 to March 2007 and noninformative priors.

B.2.2 Posterior inference

We now describe the Metropolis-within-Gibbs algorithm that we use for Bayesian inference. We use a We start with an initial guess of the parameters $\Theta_p^{(0)} = \left[\mu_0^{(0)}, \rho_\psi^{(0)}, \sigma_\psi^{2(0)}, \rho_\chi^{(0)}, \sigma_\chi^{2(0)}, \rho_h^{(0)}, \sigma_h^{2(0)}, \sigma_r^{2(0)}\right]'$, $\Theta_b^{(0)} = \left[\texttt{bias}_s^{(j)(0)}, \texttt{bias}_b^{(0)}, \sigma_s^{2(j)(0)}, \sigma_b^{2(0)}\right]'$ and states $\psi_{1:T}^{(0)}$, $\chi_{1:T}^{(0)}$, and $h_{1:T}^{(0)}$, where the subscript $\{1:T\}$ denotes the sequence of latent states from time 1 to time T.

Given a draw $\Theta_p^{(k)}$, $\Theta_b^{(k)}$, $\psi_{1:T}^{(k)}$, $\chi_{1:T}^{(k)}$, and $h_{1:T}^{(k)}$, we generate the next draw $k+1$ as follows:

1. Draw $\Theta_b^{(k+1)}$ using a Gibbs sampling step

   - Draw $\texttt{bias}_b^{(k+1)} \mid \sigma_b^{2(k)}, y_{1:T}$ using the following conditional sampling density:

     $$-\texttt{bias}_b^{(k+1)} \mid \sigma_b^{2(k)}, y_{1:T} \sim \mathcal{N}\left(\tilde{\Theta}_i, \tilde{\sigma}^2_{\Theta_i}\right)$$

     with

     $$\tilde{\sigma}^2_{\Theta_i} \equiv \left[\frac{1}{\sigma^2_{\Theta_i}} + \frac{1}{\sigma_b^{2(k)}}T\right]^{-1}, \qquad \tilde{\Theta}_i \equiv \tilde{\sigma}^2_{\Theta_i}\left[\frac{\Theta_i}{\sigma^2_{\Theta_i}} + \frac{1}{\sigma_b^{2(k)}}\sum_{t=1}^{T}\left(b_{t+T} - E_t^* b_{t+T}\right)\right].$$

   - Draw $\sigma_b^{2(k+1)} \mid \texttt{bias}_b^{(k+1)}, y_{1:T}$ using the following conditional sampling density:

     $$\sigma_b^{2(k+1)} \mid \texttt{bias}_b^{(k+1)}, y_{1:T} \sim \mathcal{IG}(\tilde{\alpha}_{\Theta_i}, \tilde{\beta}_{\Theta_i})$$

     with

     $$\tilde{\alpha}_{\Theta_i} \equiv \alpha_{\Theta_i} + T/2, \qquad \tilde{\beta}_{\Theta_i} \equiv \beta_{\Theta_i} + \frac{1}{2}\sum_{t=1}^{T}\left(b_{t+T} - E_t^* b_{t+T} + \texttt{bias}_b^{(k+1)}\right)^2$$

   - Draw $\texttt{bias}_s^{(j)(k+1)} \mid \sigma_s^{2(j)(k)}, \mu_0^{(k)}, \rho_\chi^{(k)}, \chi_{1:T}^{(k)}, y_{1:T}$ using the following conditional sampling density:

     $$-\texttt{bias}_s^{(j)(k+1)} \mid \sigma_s^{2(j)(k)}, \mu_0^{(k)}, \rho_\chi^{(k)}, \chi_{1:T}^{(k)}, y_{1:T} \sim \mathcal{N}\left(\tilde{\Theta}_i, \tilde{\sigma}^2_{\Theta_i}\right)$$

     with

     $$\tilde{\sigma}^2_{\Theta_i} \equiv \left[\frac{1}{\sigma^2_{\Theta_i}} + \frac{1}{\sigma_s^{2(j)(k)}}T\right]^{-1}, \tilde{\Theta}_i \equiv \tilde{\sigma}^2_{\Theta_i}\left[\frac{\Theta_i}{\sigma^2_{\Theta_i}} + \frac{1}{\sigma_s^{2(j)(k)}}\sum_{t=1}^{T}\left(S_{t+j} - E_j^* S_{t+j} - \mu_\chi^{j(k)} - \rho_\chi^{(k)}\chi_t^{(k)}\right)\right].$$

- Draw $\sigma_s^{2(j)(k+1)} \mid \texttt{bias}_s^{(j)(k+1)}, \mu_0^{(k)}, \rho_\chi^{(k)}, \chi_{1:T}^{(k)}, y_{1:T}$ using the following conditional sampling density:

$$\sigma_s^{2(j)(k+1)} \mid \texttt{bias}_s^{(j)(k+1)}, \mu_0^{(k)}, \rho_\chi^{(k)}, \chi_{1:T}^{(k)}, y_{1:T} \sim \mathcal{IG}(\tilde{\alpha}_{\Theta_i}, \tilde{\beta}_{\Theta_i})$$

  with

$$\tilde{\alpha}_{\Theta_i} \equiv \alpha_{\Theta_i} + T/2, \qquad \tilde{\beta}_{\Theta_i} \equiv \beta_{\Theta_i} + \frac{1}{2}\sum_{t=1}^{T}\left(S_{t+j} - E_j^* S_{t+j} - \mu_\chi^{j(k)} - \rho_\chi^{(k)}\chi_t^{(k)} + \texttt{bias}_s^{(j)(k+1)}\right)^2$$

  where we do this for $j = 1, \dots, 10$.

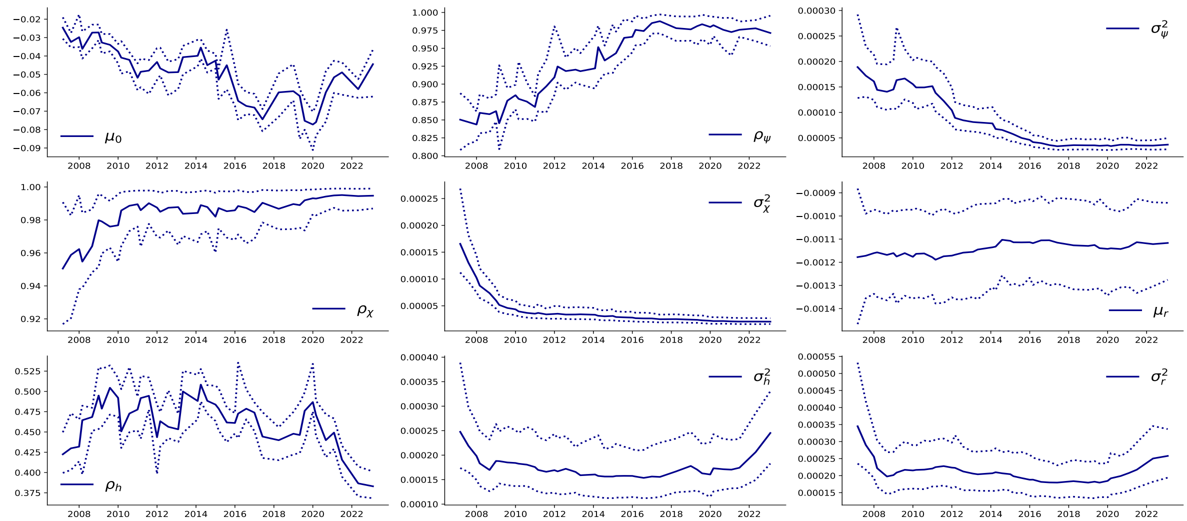
2. Draw $\Theta_p^{(k+1)} \mid \Theta_b^{(k+1)}, \psi_{1:T}^{(k)}, \chi_{1:T}^{(k)}, h_{1:T}^{(k)}, y_{1:T}$. Since there is no close form expression for the posterior of $\Theta_p^{(k+1)}$, we use a standard random-walk Metropolis–Hastings algorithm, where we targer a 30% acceptance rate over the burn-in period.

3. Given $\Theta_p^{(k+1)}, \Theta_b^{(k+1)}, y_{1:T}$ obtain $\psi_{1:T}^{(k)}, \chi_{1:T}^{(k)}, h_{1:T}^{(k)}$ via the Kalman filter using the state-space representation described in Section B.1.

We iterate over these steps to generate 10,000 draws from the posterior distribution of the parameters and states at each time T.

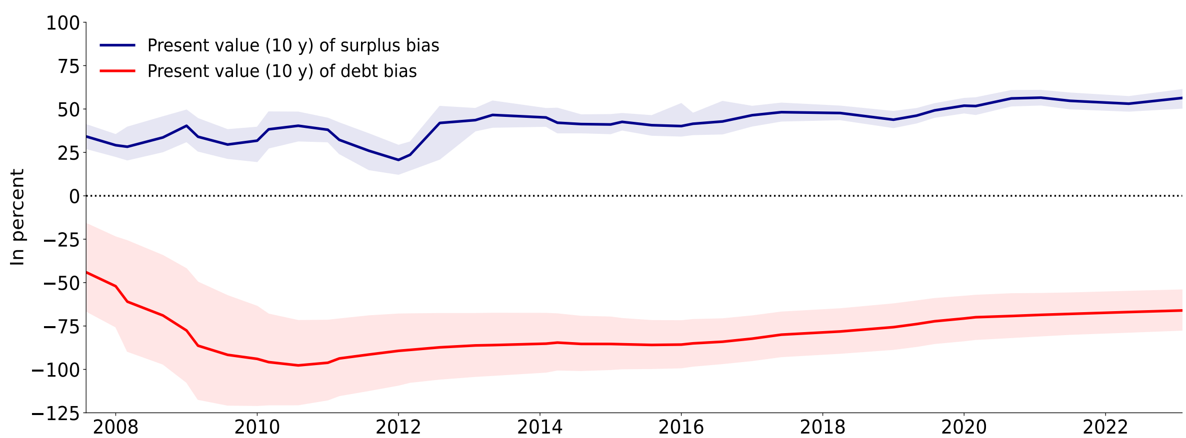
B.2.3 Additional Tables and Figures

Fig. B.9. **Evolution of the parameter estimates**



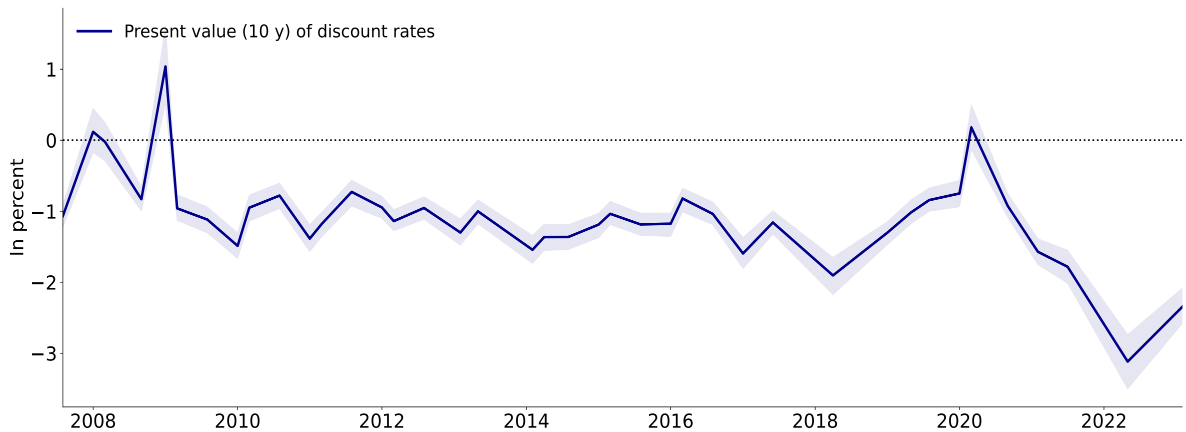
Notes: Each panel plots the evolution of beliefs about the model parameters: μ_0, ρ_ψ, σ^2_ψ, ρ_χ,σ^2_χ, ρ_h, σ^2_h, σ^2_r. The blue solid lines are the posterior median estimates, and the dotted blue lines are the 5th and 95th percentiles of the posterior distribution.

Fig. B.10. **Present value of surplus and debt bias**



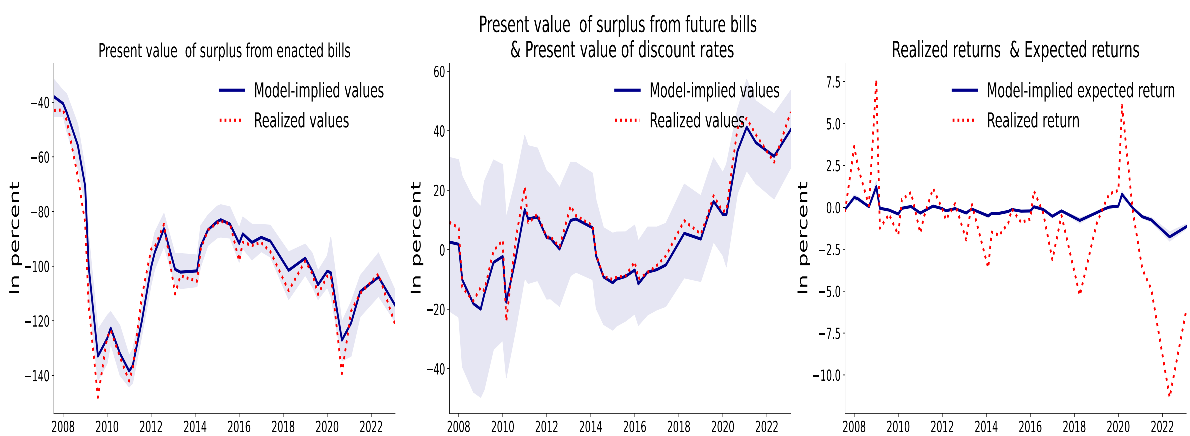
Notes: The figure presents changes in the present value of surplus bias, $\sum_{j=1}^{T} \nu^{j-1}\gamma \texttt{bias}_s^{(j)}$, and debt bias, $\nu^T \texttt{bias}_b$. The red and blue shades denote the 5th and 95th percentiles of the posterior distribution.

Fig. B.11. **Present value of discount rates**



Notes: The figure presents the present value of discount rates. The blue shades denote the 5th and 95th percentiles of the posterior distribution.

Fig. B.12. **Model-implied values versus realized values**



Notes: The left panel presents the present value of surplus from enacted bills. The blue line corresponds to model-implied values, while the red line denotes realized values from the CBO. The panel in the middle presents the present value of discount rates plus the present value from future bills. We also plot the realized value of $b_t - \nu^T E^* b_{t+T} - \mathbb{E}_t^* \sum_{k=1}^{n_t^{t+j}} \hat{S}_{t+j}^{(k)}$ in red. The right panel shows the expected return series in blue and the realized return series in red. The blue shades denote the 5th and 95th percentiles of the posterior distribution.