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Debt, Deficits, and Interest Rates

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This paper identifies how a rise in the deficit/debt impacts interest rates by looking at the high-frequency response of interest rates to fiscal surprises. The fiscal surprises are the unexpected components of deficit releases and the changes in official forecasts by the Congressional Budget Office and by the Office of Management and Budget. The paper estimates that a rise in the deficit-to-GDP ratio of 1 percentage point raises the 10-year nominal rate by 8.1 basis points. This is quantitatively similar for other Treasury maturities and for corporate debt interest rates. The paper also investigates which of the theoretical channels is driving this relationship and whether surprises are affecting interest rate expectations or the term premium. These results are used to estimate how recent spending proposals may affect interest rates.

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1 Introduction

A key question in economics is how a change in government borrowing affects interest rates. Barro (1974) famously proposed the theory of Ricardian Equivalence: that whether a government funds itself through taxation or borrowing should, all else being equal, have no impact on interest rates. Empirically, the evidence is much less clear.[1] Such a relationship has important implications for fiscal/monetary policy, because if an increase in government borrowing raises interest rates, it will be more expensive for the government to borrow, asset prices will fall, and a rise in the natural real rate implies that monetary policy is more stimulative, all else being equal. Therefore, it is important to understand how a change in deficits/debt affects interest rates, especially given the current policy environment.

In this paper, I study the empirical relationship between deficits, debt, and interest rates. I identify how a rise in the deficit/debt impacts interest rates by analyzing the high-frequency response of interest rates to fiscal surprises. The first fiscal surprise I consider is the deficit release surprise. This is the difference between the Treasury's release of the preceding month's deficit and the Informa forecast of the preceding month's deficit, which is issued on the Friday before the Treasury's release. The second fiscal surprise I consider is the deficit/debt forecast surprise. This is the change in the deficit/debt from the previous to the current release in the Congressional Budget Office (CBO)/Office of Management and Budget (OMB) forecasts for the current year. The assumptions here are that these fiscal surprises do come as a surprise to financial markets and that high-frequency changes in financial markets around these surprises can be attributed to the fiscal surprises.

I find three main results. First, I find that an increase in the deficit-to-GDP ratio of 1 percentage point raises the 10-year nominal rate by 8.1 basis points. This is estimated using the deficit release surprise. I find quantitatively similar results across other maturities. I estimate that an increase in the deficit-to-GDP ratio of 1 percentage point raises the 2-, 5-, and 30-year nominal rates by 4.9, 8.0, and 6.8 basis points, respectively. I also find that an increase in the deficit-to-GDP ratio of 1 percentage point raises the corporate 10-to-15-year interest rate by a significant 7.1 basis points, so the effects on government debt interest rates spill over into other debt markets. I verify the baseline result using my second fiscal surprise measure. I also find that the CBO deficit fiscal surprise raises the 10-year nominal rate by 3.8 basis points. This is a significant but smaller effect than that of the deficit release surprise. This estimate may be smaller because the CBO fiscal releases may contain information that is already known by financial markets and therefore not a surprise. I then look at the relationship between the debt-

[1] See Elmendorf and Mankiw (1999) and Engen and Hubbard (2004) for literature summaries.

to-GDP ratio and interest rates. Using the baseline deficit release surprise measure, I estimate that an increase in the debt-to-GDP ratio of 1 percentage point raises the 10-year nominal rate by 4.3 basis points. This fits with the literature review, back of the envelope calculation, and analysis of Engen and Hubbard (2004), who estimate that an increase in the debt-to-GDP ratio of 1 percentage point raises the 10-year nominal rate by 3 to 5 basis points.[2]

Second, I investigate which channels drive the relationship between deficits, debt, and interest rates. I compare the strength of different channels by comparing how deficit surprises differentially affect nominal and real rates, and how their impact varies depending on the size of government spending changes. I find that deficit surprises appear to affect interest rates primarily through the need for rates to rise to motivate consumers to hold more debt (the crowding-out channel) and through beliefs that monetary policy may allow more inflation.[3] I also show that the resulting change in inflation expectations happens relatively far in the future. One explanation for this is that financial markets have concerns that as debts rise, there could be greater desire to allow higher inflation in the long term by policymakers. These effects arise through both the term premium and the expectations channel.

Third, I apply these estimates to the current policy environment to estimate how recently enacted and proposed fiscal packages that may raise debt could affect interest rates. The American Rescue Plan (ARP) Act of 2021 was signed into law on March 11, 2021, and is estimated to raise cumulative deficits over 10 years by $1.86 trillion. The American Jobs Plan (AJP) was proposed in the same month and is estimated to raise cumulative deficits over 10 years by $0.90 trillion. Applying my estimates of how a rise in debt affects interest rates, I find that the ARP and the AJP would raise the 10-year nominal rate by 34.2 and 17.6 basis points, respectively, and by 51.8 basis points in total. This is a highly speculative exercise because it is unclear exactly how the AJP will be written if it is passed, and it is uncertain how much additional revenue may be raised to pay for these spending plans in the long term.

I contribute to several strands of the literature. First, I contribute to the literature looking at the relationship between deficits/debt and interest rates. Many papers have been written about the relationship between deficits, debt, and interest rates, but the topic has been relatively little researched since the mid-2000s. Examples of such papers include Cebula and Koch (1989), Barro and Sala-i Martin (1990), Cohen and Garnier (1991), Elmendorf (1993), Kitchen (2002), Laubach (2003), and Engen and Hubbard (2004).[4] Most of the literature relies on structural approaches and/or wide regression periods. Structural approaches, such as those

[2]The analysis in Engen and Hubbard (2004) is largely conducted through structural regressions or with long time periods, rather than the high-frequency approach used in this paper.

[3]See more details about potential channels in the related literature section.

[4]See Elmendorf and Mankiw (1999) and Engen and Hubbard (2004) for literature summaries.

involving vector autoregressions (VAR), rely on a strict formulation of the relationship between deficits/debt and interest rates, which may not be empirically accurate. Running regressions over wide time periods, such as by quarter or year, risks the possibility that confounding factors will drive the results. This is a notable concern because interest rates do show strong trends over time.[5] In this paper, I offer a comprehensive high-frequency identification approach, which is not subject to these critiques.

Second, I contribute to the limited literature utilizing a high-frequency approach to identify the relationship between deficits, debt, and interest rates. Only a limited number of papers take a high-frequency approach to examining how changes in deficits/debt affect interest rates. Kliesen and Schmid (2004) look at whether a range of economic release surprises affect interest rates; they define deficit surprises by comparing the Treasury release with the Informa forecast from the preceding week. As in this paper, one of the economic release surprises is the deficit. They find that deficit surprises do not have a significant effect on interest rates, but they consider only the 1997–2003 period. I focus on the deficit release surprises and consider the period of 1980 through 2019, in which I do find a positive relationship between deficit release surprises and interest rates. Wachtel and Young (1987) compute CBO/OMB deficit surprises for 1979 through 1986 using the current CBO/OMB deficit forecast for the current year minus the previous forecast for the current year. They find that a 1 percent increase in the CBO deficit-to-GDP ratio significantly raises interest rates by about 9 basis points, but they find no effect for OMB forecasts.[6] This is qualitatively similar to what I find; it is also quantitatively similar to my deficit release surprise measure but smaller than my equivalent CBO deficit forecast surprise measure. Thorbecke (1993) extends the results to 1990 and finds similar results. I extend the research in these papers by considering a much wider sample and a range of different outcomes and by considering multiple deficit surprises together.

Third, I contribute to the literature trying to determine which theory best explains why there might be a relationship between deficits/debt and interest rates. There are three commonly noted theories for such a relationship. (1) Debt may crowd out capital. If a government cuts taxes and borrows to fund the same level of government spending, then other agents have to hold the resulting debt. Ricardian Equivalence (Barro, 1974) suggests that an increase in the supply of debt will be met by an equivalent increase in the demand for debt by households in this case.[7] However, Ricardian Equivalence holds only under certain strong assumptions,

[5]The relationship between debt and interest rates is shown in figure 3.

[6]They report that a $1 billion rise in the projected deficit raises interest rates by 0.3 basis point, and nominal GDP was about $3 trillion in the early 1980s.

[7]The idea here is that households realize that lower taxes now dictate that they will have to pay more in taxes later. Therefore, the increase in the supply of debt is matched by the increase in the demand for debt, so there is no change in the real interest rate.

notably that the agent whose taxes are cut is the one who will pay the resulting debt and that the agent rationally realizes that a cut in taxes will need to be paid back in the future. Without these strong assumptions, agents will need an additional incentive to hold the increase in the supply of debt, so the real interest rate on the debt must rise.[8] (2) Government spending may raise interest rates regardless of how it is financed. The key mechanism for this effect is that government spending can change the consumption path of savers, which adjusts the real interest rate.[9] (3) Higher government debt may change how monetary policy treats inflation. With higher debt, there is greater incentive for governments to allow higher inflation and reduce the real burden of the debt they face.[10] Thorbecke (1993) uses an approach similar to that of Wachtel and Young (1987) to estimate which of the potential theories best explains the relationship between deficits/debt and interest rates. He finds that the crowding-out effect best explains the relationship. I also find the crowding-out effect is strongest, but that increased inflation expectations may also play a role.

Fourth, I contribute to the literature looking at whether a rise in deficits/debt may affect interest rates primarily through interest rate expectations or the term premium. Greenwood and Vayanos (2014) show that a lengthening of the maturity of Treasuries raises the term premium, so it could be expected that if the increase in debt manifests through the issuance of long-term Treasuries then the term premium will rise. Krishnamurthy and Vissing-Jorgensen (2012) argue that there is a Treasury bond liquidity/safety benefit that explains why Treasuries offer lower returns than other similar assets, but that this benefit decreases as the supply of safe Treasury bonds increases. Assuming this effect is stronger for long-term Treasuries, this would imply that an increase in the supply raises the term premium. I show empirically that the rise in deficits/debt appears to affect interest rates both through the expectations and term premia of both real interest rates and inflation.

The rest of the paper proceeds as follows. In section 2, I present the empirical strategy. In section 3, I present the results. In section 4, I apply the results to the current policy environment. In section 5, I conclude.

[8] A higher real interest rate on bonds implies that other assets will also need to pay higher returns to attract funds. As a result, the cost of borrowing/renting capital rises, and so capital is "crowded out."

[9] A simple example of this mechanism is when the government spends more now on non-savers and funds this spending through taxation on savers. If the tax is applied now (so that the spending is tax financed), the consumption of savers falls now relative to the future, which causes savers to want to save less and spend now, raising the real interest rate. And if this spending is financed by debt, which will also be paid off by savers but in the future, the savers need to cut their consumption now to issue more debt, while their consumption will be unchanged in the future since the higher taxes they face will be paid by the extra assets they hold. So again, the real interest rate rises.

[10] Extreme examples of governments monetizing debt, which seem very unlikely to be relevant to the case of the United States, are the hyperinflations in Germany in 1923 and in Latin America in the 1980s. A more prosaic example would be a higher debt burden motivating policymakers to set a mildly higher inflation target.

2 Empirical Strategy

This paper uses a high-frequency identification approach. Changes in deficits and debt could correlate with other factors that impact interest rates. Therefore, to identify only the impact of deficit and debt releases, I look at how interest rates change in a high-frequency window around releases. I typically use a 24-hour window. This approach is similar to those of Kuttner (2001), Gürkaynak et al. (2004), and Gürkaynak et al. (2005).

The default regression is shown in equation 1. It is an OLS regression of each weekday from 1980 through 2019. The dependent variable is some measure of the daily change in the interest rate. The independent variables are five deficit/debt surprises and dummy variables for each weekday. The main measure is based on deficit release surprises using Treasury and Informa data. I also construct four Congressional Budget Office (CBO)/Office of Management and Budget (OMB) deficit/debt forecast surprises. Note that a surprise is set as 0 on days when there is no release that day.

$$\begin{aligned}\Delta InterestRate_t = {} & DeficitReleaseSurprise_t \\ & + CBODeficitForecastSurprise_t + CBODebtForecastSurprise_t \\ & + OMBDeficitForecastSurprise_t + OMBDebtForecastSurprise_t + WeekdayDummy_t + u_t\end{aligned} \tag{1}$$

The primary fiscal surprise measure is the deficit release surprise, and it is constructed using Treasury and Informa data. The Treasury releases the government's fiscal statement including the deficit once a month. However, financial markets may anticipate some of the changes in the deficit from one month to the next, so looking at the change in the deficit will not accurately capture the response of financial markets to deficit surprises. To get around this problem, I use Informa forecasts. Each Friday, Informa surveys financial market participants to determine their expectations for economic releases in the subsequent week.[11] Therefore, to obtain a measure of the fiscal surprise, I compare the deficit release with the forecast from the preceding Friday. I also divide these deficit measures by GDP, so the sizes of the surprises are comparable over time. The formula is shown in equation 2. This approach is similar to that of Kliesen and Schmid (2004).[12] Informa began surveying expectations of deficit releases in 1988, and I am

[11] Note that deficit releases are revised over time, so I compare the Informa forecast with the initial release of the deficit from the Treasury, which is also recorded by Informa.

[12] I downloaded the Treasury releases for the deficit along with the Informa forecasts from Haver. The initial releases are revised but typically do not differ much from the current releases for the same months available now on the Treasury website. On this basis, I adjusted the releases for 1988M3, 1990M5, and 1993M4, which seem to be mischaracterized as surpluses rather than deficits.

able to construct 363 deficit release surprises.

$$InformaDeficitShock_t = \left(\frac{Deficit}{GDP}\right)_t - \mathbb{E}_{L.Fri}\left[\left(\frac{Deficit}{GDP}\right)_t\right] \tag{2}$$

I produce additional surprise measures using CBO and OMB forecast releases. The CBO and OMB both release fiscal forecasts, typically once or twice a year.[13] These nearly always include forecasts of the deficit, government spending, debt held by the public, and GDP in the current year and subsequent year. To construct the CBO deficit surprise, I compare the deficit forecast made for the current year in the current release with the deficit forecast made for the current year in the previous release.[14] The deficits are adjusted by the CBO's forecast for GDP. Equation 3 shows this formulaically. CBO debt surprises and OMB deficit/debt surprises are constructed similarly. CBO and OMB data start in 1980 and 1982, respectively.[15] There are 60 and 53 CBO deficit/debt surprises and 61 and 51 OMB deficit/debt surprises, respectively.[16] This approach is similar to those of Wachtel and Young (1987) and Thorbecke (1993).

$$CBODeficitForecastSurprise_t = \mathbb{E}_t\left[\left(\frac{Deficit}{GDP}\right)_{Year(t)}\right] - \mathbb{E}_{prev.release}\left[\left(\frac{Deficit}{GDP}\right)_{Year(t)}\right] \tag{3}$$

Of the two surprise approaches, I believe the deficit release surprise may be more reliable than the deficit/debt forecast surprises. A key property of my high-frequency identification approach is that the surprise should be information not already known by financial markets. This criterion appears to be satisfied well by the deficit release surprises, since the Treasury releases are made only several days after the Informa forecasts. This may not always be true with the forecast surprises, since the new forecast is compared with a forecast made multiple months ago. As a result, financial markets are more likely to have already incorporated information in the new forecast of the CBO/OMB, in which case the new forecast will not be informative. I therefore

[13] All CBO fiscal reports are listed at `https://www.cbo.gov/publication/most-recent/reports`. The website gives dates for the reports, but they are not always accurate (many list the first of the month as a placeholder). I use the date given if it is not the first of the month or if it is after 2010. Otherwise, when available, I use the date given in the URL, the date given on the report's first page, or the date given in Wachtel and Young (1987) and Thorbecke (1993). However, this still means I am missing some CBO release dates, especially in the 1990s. All OMB reports (with dates) back to 1995 are listed at `https://www.govinfo.gov/app/collection/budget`. All annual, not midyear, OMB fiscal reports (with dates) are listed at `https://fraser.stlouisfed.org/title/budget-united-states-government-54?browse=1920s`. When they are available, I make use of Haver data. Otherwise, I take data from the reports directly.

[14] Note that if the previous release was in the current or previous year, then the forecast for the current-year deficit will be made in the current or previous year, respectively.

[15] I follow Wachtel and Young (1987) and include only CBO reports from 1982, when the CBO started using a total budget deficit measure.

[16] I do not have surprises for every CBO/OMB release due to missing release dates for the CBO, particularly in the 1990s, and the fact that in some earlier releases, the CBO/OMB did not forecast debt.

expect that the degree to which CBO/OMB forecast surprises manifest a positive relationship between deficit/debt and interest rates may be biased downward, since not all of the information in the forecast surprise measures will be new.

I look at how the fiscal surprises affect several different dependent variables. I obtain nominal interest rates on Treasury notes/bonds and interest rates on Treasury Inflation-Protected Securities (TIPS) from the Treasury. I obtain the Gürkaynak et al. (2010) forward decomposition and the d'Amico et al. (2016) expectations/term premium decomposition from the Federal Reserve Board. I gather data on corporate bonds and mortgage rates from Intercontinental Exchange (ICE), data on the SP500 from S&P, and data on exchange rates from *The Wall Street Journal*. The dependent variable measures I use were all measured at or near the end of the business day. All of the deficit surprises were released in the early afternoon, while some of the CBO/OMB surprises were released late in the day or on weekends, in which case I treat them as having been released on the next weekday.

3 Results

3.1 Basic Results

Table 1 reports the baseline results. A 1 percentage point rise in the deficit release surprise is associated with a rise of 8.1 basis points in the 10-year nominal interest rate. Assuming the high-frequency identification strategy works, this implies that a 1 percentage point rise in the deficit-to-GDP ratio raises the 10-year nominal rate by 8.1 basis points. A 1 percentage point Congressional Budget Office (CBO) deficit forecast surprise is associated with a rise of 3.8 basis points in the 10-year nominal interest rate. Both of these deficit surprises are significant at the 5 percent level. This fits with the theories that suggest a positive relationship between increasing debt and a rise in interest rates. The CBO debt forecast surprise and both of the Office of Management and Budget (OMB) forecast surprises are not significant. The fact that the deficit forecast surprise has a positive impact on interest rates for the CBO but not the OMB fits with results from Wachtel and Young (1987).

Table 1: Baselines Results

Δ Treas. 10 Year Rate (%)	(1)
Informa Def./GDP % Shock	0.081*
	(0.038)
CBO Def./GDP % Shock	0.038*
	(0.016)
CBO Debt/GDP % Shock	-0.019
	(0.010)
OMB Def./GDP % Shock	0.003
	(0.006)
OMB Debt/GDP % Shock	-0.002
	(0.005)
N	9566
Timeframe	1980-2019

Sources: CBO, Informa, OMB, Treasury. Time period: 1980–2019 weekdays. Dependent variable: the change in the 10-year Treasury rate from the previous weekday measured near the close of the business day. Independent variables: five surprise measures plus dummy variables for each weekday. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

One potential reason why the CBO deficit forecast surprise is significantly positive but the OMB deficit forecast surprise is not is that the CBO may be perceived as offering more accurate forecasts than the OMB. The CBO was founded in 1974 to provide independent budget analysis, while the OMB is controlled by the executive branch. Given the executive branch's control over the OMB, it seems possible that the OMB forecasts could be influenced by political motives. Joyce et al. (2015) argue that the CBO's independence is why it has become the authoritative source for budget forecasts. Indeed, a 2017 survey of economists by Chicago Booth found that no prominent economist disagreed with the statement that "the CBO has historically issued credible forecasts of the effects of both Democratic and Republican legislative proposals."[17]

The CBO deficit forecast surprises may have a weaker effect on interest rates than the deficit release surprise because they contain information that financial markets already have internalized. A CBO deficit forecast surprise is the change in the deficit-to-GDP-ratio forecast from the previous CBO release. These releases take place typically no more than twice a year. Therefore, if there is a change in policy between these forecasts that affects the deficit, there is plenty of time for financial markets to internalize this change before the CBO issues its next forecast. I test this hypothesis in table 9, where I look at whether earlier or later CBO surprises affect interest rates more. To do this, I include a dummy variable for whether the previous forecast was issued within the preceding 180 days and interact this dummy with each of the CBO/OMB

[17]See Chicago Booth Initiative on Global Markets Forum, "The CBO," March 21, 2017, https://www.igmchicago.org/surveys/the-cbo/.

deficit forecast surprises. This interaction reveals that the CBO deficit forecast surprise is associated with a rise of 6.3 percentage points when the previous forecast was released within the last 180 days, and a rise of 0.1 percentage point when the previous forecast was released more than 180 days earlier. Therefore, there does appear to be evidence that a CBO deficit forecast surprise has less of an impact when the previous forecast was issued longer ago and the information in older surprises is more likely to have been internalized by financial markets. This may explain why the coefficient is lower for the CBO deficit forecast surprise than for the deficit release surprise.

Despite showing significantly positive results for deficit surprises, table 1 does not show significant results for the debt surprises. One potential reason for this may be that changes in the deficit are more likely to capture sustained fiscal changes. I believe that an explanation for why the coefficient on the debt-to-GDP ratio could be biased downward is that if the deficit-to-GDP ratio has risen since the release of the last forecast, the debt-to-GDP ratio will probably have risen more if the last forecast was issued longer ago. However, as can be seen in table 9, if the last forecast was issued longer ago, markets are more likely to have internalized the change in the deficit-to-GDP ratio, so markets will respond less to the CBO's forecast surprise, since it's less of a surprise. Therefore, the coefficient on the debt-to-GDP-ratio proxy may be biased downward since it ends up serving as a proxy for how long ago the previous forecast occurred, which makes the forecast less accurate.

I conduct several tests to verify the robustness of the results. In table 10, I check how well the results hold across each decade from the 1980s through the 2010s. The results broadly show a decline in the strength of the relationship over time, and the decline is steeper for the Informa data. I can think of two possible explanations for why this is so. First, there has been less of a focus on deficits in recent years than in the past. Second, alternative monetary policy tools, notably forward guidance and quantitative easing, may have reduced the degree to which long-term nominal interest rates move in response to surprises, because financial markets already have a sense of the path that monetary policy and thus long-term interest rates will follow. There are only four CBO deficit forecast surprises in the 1990s due to data limitations, which may explain why that coefficient seems very different from the others. In table 11, I look at how the results are altered if I use a wider window for the change in interest rates, from the day before a surprise to a week after it. I find that the coefficient for the deficit release surprise rises (but is no longer significant), which provides limited evidence of the sustained impact of deficit surprises on interest rates. In table 12, I show that changing the deficit release surprise so that it is measured against potential GDP rather than actual GDP does not alter the results.

I examine whether including other economic surprises in the analysis affects the results. I

consider the impact of surprises (measured similarly to the deficit release surprise) to CPI inflation, CPI core inflation, employment growth, real GDP growth, and unemployment. Only 36 deficit release surprises (out of 366 total) coincide with one of these other economic releases. I exclude these 36 surprises in table 13 and find very similar results. In table 14, I conduct the analysis while including the 36 surprises but controlling for the additional economic surprises and again obtain results that are very similar to the baseline. Table 14 also gives the full set of coefficients for table 1.

I conduct a graphical and outlier analysis. Figure 4 shows the main deficit surprises plotted against the change in the 10-year nominal interest rate. Subfigures (a) and (b) show the deficit release surprises and the CBO deficit forecast surprises, respectively. Both graphs show a clear positive slope for the line of best fit. Some of the deficit-to-GDP-ratio surprises could be considered outliers, though none is an extreme outlier. To verify these points are not driving the results, I winsorize the data; that is, I remove the bottom 5 percent and the top 5 percent of each Informa surprise and CBO deficit surprise. Regressions using the winsorized surprises are shown in table 15. The coefficients remain very similar, and the CBO deficit surprises remain significant, though the Informa surprises are no longer significant at a 5 percent level. Plots of the winsorized data are presented in figure 5.

I also verify whether changing the year that is forecast in the deficit forecast surprises affects the results. In the baseline analysis, I follow Wachtel and Young (1987) and Thorbecke (1993) by looking at how changes to the forecast for the deficit/debt for the current year affect interest rates. An alternative is to look at how changes to forecasts for future years affect interest rates. Table 16 shows that CBO deficit-to-GDP-ratio surprises continue to have a positive effect on interest rates for future-year forecasts, though the effects are not quite as large as those for the current-year forecasts, and they are not significant. This suggests that financial markets pay the most attention to the forecast for the deficit for the current year.

I also estimate how much a 1 percentage point rise in the debt-to-GDP ratio affects interest rates. To do this, I first estimate how much a 1 percentage point rise in the deficit-to-GDP ratio affects the debt-to-GDP ratio. Table 2 presents a regression of the monthly deficit-to-GDP ratio on the lag of itself. This implies that a 1 percentage point rise in the deficit-to-GDP ratio is associated with a 1 percentage point increase in the debt-to-GDP ratio in the current month, a 0.47 percentage point increase in the debt-to-GDP ratio in the subsequent month, a 0.47^2 percentage point increase in the deficit-to-GDP ratio in two months, and so on. Overall, this implies that a 1 percentage point rise in the deficit-to-GDP ratio is associated with a long-term 1.87 percentage point rise in the debt-to-GDP ratio.[18] Since the baseline results imply that a 1

[18]The computation here is: $1 + 0.47 + 0.47^2 + \ldots = \frac{1}{1-0.47} = 1.87$.

percentage point rise in the deficit-to-GDP ratio is associated with an 8.1 basis point rise in the 10-year nominal interest rate, this suggests that a 1 percentage point rise in the debt-to-GDP ratio is associated with a 4.3 basis point rise in the 10-year nominal interest rate.

Table 2: Persistence of Deficits

Def./GDP (SA)	(1)
L.Def./GDP (SA)	0.466***
	(0.041)
N	479
Timeframe	1980-2019

Sources: BEA, Treasury. Time period: months from 1980 through 2019. Dependent variable: the deficit-to-GDP ratio for a given month. Independent variables: lag of the deficit-to-GDP ratio. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

3.2 Impact on Other Interest Rates and Asset Prices

Table 3 shows the impact of the two main fiscal surprise measures on different maturities of US government debt. Both surprises are significant and positive for 5-, 10-, and 30-year maturity debt. The effects seem to be strongest on 5- and 10-year maturity debt. Therefore, deficit surprises appear to have a broad impact on different maturities of Treasury interest rates.

Table 3: Impact across Treasury Maturities

	2 Year	5 Year	10 Year	30 Year
Informa Def./GDP % Shock	0.049	0.080*	0.081*	0.068*
	(0.042)	(0.041)	(0.038)	(0.035)
CBO Def./GDP % Shock	0.035	0.043*	0.038*	0.040**
	(0.018)	(0.017)	(0.016)	(0.015)
N	9566	9566	9566	9566
Timeframe	1980-2019	1980-2019	1980-2019	1980-2019

Sources: CBO, Informa, OMB, Treasury. Time period: 1980–2019 weekdays. Dependent variable: the change in the interest rate from the previous weekday of different maturities of Treasury notes/bonds measured near the close of the business day. Independent variables: five surprise measures plus dummy variables for each weekday. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

Table 4 shows how corporate interest rates at different maturities respond to deficit surprises. Deficit release surprises and CBO deficit forecast surprises have a significantly positive effect on the interest rates of corporate bonds with maturities longer than 7 and 10 years, respectively. A 1 percentage point deficit release surprise and a 1 percentage point CBO deficit forecast surprise raise the 10-to-15-year corporate bond rate by 7.1 and 2.9 basis points, respectively, which is

comparable to the 8.1 and 3.8 basis points I find with the Treasury 10-year nominal rate. This implies that a rise in deficits affects borrowing costs not only for the government but also for the wider business world. The effect seems to be focused on long-term-maturity corporate debt. The rise in corporate interest rates is likely to make corporate borrowing harder and could therefore be contractionary, but this effect may be dominated by the increased spending from running a larger government deficit. Table 17 considers how the relationship varies by the credit rating of corporate bonds. It demonstrates that an increase in the deficit raises interest rates for investment-grade corporate debt but has less of an effect on junk bonds. This may make sense, since safe corporate debt is likely to be viewed as an asset class that is closer to safe government bonds, so their returns are likely to be more closely linked.

Table 4: Impact on Corporate Bond Interest Rates by Maturity

	Corp 1-3y	Corp 3-5y	Corp 5-7y	Corp 7-10y	Corp 10-15y	Corp 15+y
Informa Def./GDP % Shock	-0.005	0.036	0.049	0.048	0.071**	0.054*
	(0.027)	(0.028)	(0.028)	(0.029)	(0.025)	(0.023)
CBO Def./GDP % Shock	0.018	0.024	0.024	0.029*	0.029*	0.027*
	(0.013)	(0.014)	(0.014)	(0.014)	(0.012)	(0.011)
N	8335	8340	7522	6956	8340	8335
Timeframe	1986-2019	1986-2019	1990-2019	1992-2019	1986-2019	1986-2019

Sources: CBO, ICE, Informa, OMB. Time period: weekdays over various years. Dependent variable: the change in the interest rate from the previous weekday of different maturities of corporate bonds measured at the close of the business day. Independent variables: five surprise measures plus dummy variables for each weekday. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

I also look at how other asset classes respond to deficit surprises. Table 18 shows that both deficit surprises have a positive but insignificant effect on 15- and 30-year mortgage rates. A rise in long-term interest rates implies a higher discount factor and thus lower assets prices; it also implies higher returns on investments relative to other countries and thus a higher exchange rate. Table 19 demonstrates that, as expected, both deficit surprises lower the SP500 and raise the exchange rate relative to the Japanese yen, but that these coefficients are not significant.

3.3 Decomposition into Potential Channels

Table 5 presents a comparison of the differences between the effects of deficit surprises on Treasury Inflation-Protected Securities (TIPS) and nominal bonds. The deficit surprises have a stronger effect on nominal interest rates (6.8 basis points for a 1 percentage point Informa surprise) than on TIPS (3.7 basis points). However, TIPS always respond positively to deficit surprises, and those responses are significant for CBO surprises. Note that TIPS are relatively new, so I consider the data only from 1999 onward. Also, the TIPS market became very illiquid

during the Great Recession, so I present results excluding the Great Recession, which show similar effects.

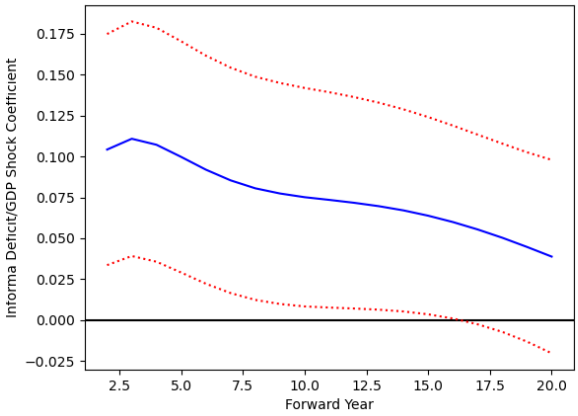
Table 5: Impact on TIPS

Timeframe	1999-2019		1999-2019 ex. GR	
Δ 10 Year	Nom.	TIPS	Nom.	TIPS
Informa Def./GDP % Shock	0.068*	0.037	0.087**	0.052*
	(0.032)	(0.026)	(0.031)	(0.023)
CBO Def./GDP % Shock	0.028	0.024*	0.028	0.017
	(0.015)	(0.012)	(0.015)	(0.011)
N	5022	5013	4543	4532

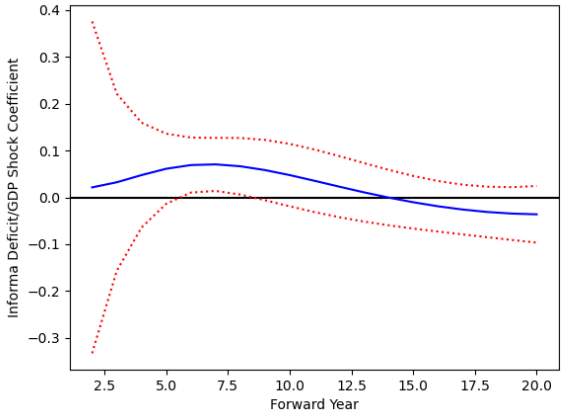
Sources: CBO, Informa, OMB, Treasury. Time period: weekdays over various years. Dependent variable: the growth in interest rates on TIPS and nominal debt from the previous weekday to the current weekday. Independent variables: five surprise measures plus dummy variables for each weekday. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

In Figure 1, I assess the degree to which deficit release surprises affect interest rates across the maturity spectrum. I do so by regressing the forward interest rate at each year for 2 through 20 years on the standard surprises and plot the coefficient for the deficit release surprise. I do this for three dependent variables: the nominal rate, the TIPS rate, and the inflation breakeven rate (the difference between the nominal rate and the TIPS rate). The first plot shows a gentle decline in the degree to which deficit surprises affect the nominal rate. The second plot shows a hump-shaped response of TIPS rates to deficit surprises. This could be interpreted as aligning with the idea that an initial rise in the deficit is likely to be associated with an accumulation of debt, leading to a rise in interest rates until the government begins to repay the debt and interest rates fall. Breakeven inflation, on the other hand, is significant at longer-term maturities. This could be interpreted as supporting the concern that higher debt could lead to higher inflation in the long term.

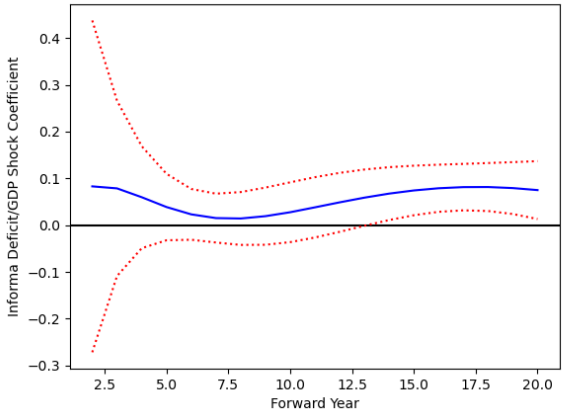
Figure 1: Forward Interest Rates Decomposition



(a) Nominal Interest Rates



(b) TIPS Interest Rates



(c) Inflation Breakeven Rates

Sources: FRB, Informa. Each graph is created by running a regression of the forward interest rate at different maturities on the five surprise measures plus dummy variables for each weekday. The forward interest rate is measured at each year from 2 through 20 years and is computed using the measure by Gürkaynak et al. (2010). The coefficient on Informa is then plotted as the unbroken line in the graph where the dashed line represents 5 percent standard errors. The dependent variable is the nominal rate, the TIPS rate, and the inflation breakeven rate. The time period for the regressions is 1999 through 2019 weekdays.

In table 6, I examine whether government spending affects interest rates more than an equivalent cut in taxes, which is needed for the government spending channel to explain the relationship between deficits and interest rates. To do this, I control for government spending. For the deficit release surprise, I incorporate the change in government spending that is released at the same time as the monthly deficit release.[19] For the CBO/OMB deficit forecast surprises, I

[19]Note that this is not a perfect measure of the government spending surprise because, unlike with the deficit surprise, Informa does not release a forecast of what government spending will be. Therefore, I am looking at

incorporate the change in the forecast of government spending. The coefficient on the deficit surprises then should represent the impact of a 1 percentage point rise in the deficit-to-GDP ratio as a result of tax cuts, and the government spending coefficient represents the different impact on interest rates of a rise in government spending relative to a tax cut. The coefficient on government spending is very low, which suggests the government spending channel is not an important driver of the relationship. This is similar to what Thorbecke (1993) finds. I can also use table 6 to decompose the importance of the potential channels.[20] The deficit release (forecast) surprise implies 54 percent (79 percent) of the relationship is driven by the crowding out of capital, 6 percent (4 percent) by government spending, and 40 percent (17 percent) by inflation risk.

Table 6: Impact of Deficits from Higher Government Spending Relative to Deficits from Tax Cuts

Δ 10 Year	Nom.	Nom.	TIPS
Informa Def./GDP % Shock	0.067*	0.063	0.036
	(0.032)	(0.034)	(0.027)
CBO Def./GDP % Shock	0.028	0.027	0.022
	(0.014)	(0.015)	(0.012)
Gov./GDP % Change		0.004	0.001
		(0.012)	(0.009)
CBO Gov./GDP % Shock		0.005	0.008
		(0.020)	(0.016)
N	5029	5029	5013
Timeframe	1999-2019	1999-2019	1999-2019

Sources: CBO, Informa, OMB, Treasury. Time period: weekdays from 1999 through 2019. Dependent variable: the change in interest rates on TIPS and nominal debt from the previous weekday to the current weekday. I use the Gurkaynak Sack Wright derived 10-year nominal rates rather than the Treasury rates, which is why the numbers in column (1) differ very slightly from table 5. Independent variables: five surprise measures plus dummy variables for each weekday; additionally (when shown) the change in government spending/GDP (in percent) announced on the same day as the deficit, and the change in the CBO government spending/GDP (in percent) forecast from the previous forecast. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

Table 7 decomposes the impact of the deficit surprises into four factors associated respectively with the real expectations channel, the inflation expectations channel, the real term premium,

just the change in government spending from the previous month, rather than the difference between the release of government spending and the forecast.

[20]To do this, I assume that adding government spending surprises removes the government spending channel, and then regressing on TIPS rather than the nominal rate removes the monetary policy channel. The idea behind the monetary policy channel part of the decomposition is that higher risk of inflation manifests through higher breakeven inflation. This would lead to a rise in interest rates on long-term nominal debt relative to TIPS debt. However, it is possible that concerns about the risk of higher inflation could cause central banks to pursue contractionary monetary policy with higher real interest rates to reduce inflation expectations. In this alternative case, the monetary policy channel could also manifest in higher TIPS rates.

and the inflation term premium. It does this by regressing the surprises on each of these four factors using a decomposition by d'Amico et al. (2016). This decomposition implies that 71 percent (50 percent) of the impact of deficit release (forecast) surprises on interest rates comes through the term premium, and 29 percent (50 percent) comes through the expectations channel. One explanation for why CBO surprises would have a larger effect through the expectations channel than the term premium is that CBO forecasts may contain more definitive information about the future, whereas monthly deficit surprises are likely to be fairly noisy and so more likely to indicate risk. Deficit changes ultimately appear to raise both expectations and term premia of both real interest rates and inflation.

Table 7: Impact on Different Components of Interest Rates

	E[Real]	E[Infl.]	Real T.P.	Infl. T.P.
Informa Def./GDP % Shock	0.012	0.012	0.032**	0.017**
	(0.007)	(0.006)	(0.012)	(0.006)
CBO Def./GDP % Shock	0.007*	0.006*	0.009	0.004
	(0.003)	(0.003)	(0.006)	(0.003)
N	8816	8816	8816	8816
Timeframe	1983-2019	1983-2019	1983-2019	1983-2019

Sources: CBO, FRB, Informa, OMB. Time period: weekdays from 1983 through 2019. Dependent variable: the change in different components of the interest rate on 10-year nominal debt from the previous weekday to the current weekday; the different components are from a decomposition by d'Amico et al. (2016). Independent variables: five surprise measures plus dummy variables for each weekday. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

4 Policy Implications

This section examines the degree to which recent and proposed increases in spending could affect the interest rate on long-term Treasury debt.

In March 2021, a large stimulus bill was enacted and a large infrastructure plan was proposed. The American Rescue Plan (ARP) Act of 2021 is a stimulus package that was signed into law on March 11, 2021. The Congressional Budget Office (2021) estimates that the sum of the increases in the deficit from 2021 through 2030 as a result of the bill will be $1.86 trillion. Later that month, the Biden administration proposed the American Jobs Plan (AJP). The bipartisan organization Committee for a Responsible Federal Budget (2021) estimated that this plan would lead to $2.65 trillion in additional spending and $1.75 trillion in additional receipts over the next 10 years, thus raising total deficits by $0.90 trillion. Taking these estimates as given, the ARP and the AJP would therefore raise the debt-to-GDP ratio by 7.95 and 4.09 percentage points,

respectively.[21] [22] Section 3 estimates that a 1 percentage point rise in the debt-to-GDP ratio raises 10-year nominal interest rates by 4.3 basis points.[23] Therefore, I estimate that the ARP and the AJP would raise the 10-year nominal rate by 34.2 and 17.6 basis points, respectively, and 51.8 basis points in total.

These estimates are approximate, and there are various reasons why the impact on interest rates could be different. It's unclear how tax receipts will change in response to the proposed policies. For example, the Committee for a Responsible Federal Budget (2021) found the initial proposal for the AJP to be revenue neutral over a 15-year period as opposed to a 10-year period, for which cumulative deficits would be $0.90 trillion. However, this assumes that the revenue-raising plans would not be changed. If they were reduced, the cumulative deficits could instead be higher. Additionally, the final structure of the AJP remains highly uncertain and could involve much more or much less spending, or not be passed at all.

Recent developments align with the possibility that recent spending plans and proposals may increase deficits and debt and therefore prompt higher interest rates, but higher interest rates could also be due to other factors. Figure 2 shows that the 10-year nominal rate rose by about 1 percentage point from August 2020 through March 2021. This fits with the idea that financial markets expect higher debt/deficits and thus higher interest rates. However, this could instead be due to a broader recovery in the economy. Table 8 shows measured increases in expectations of both headline inflation and core inflation. It shows that in February 2021, forecasters were expecting very mild overshooting of the 2 percent inflation target, in contrast to previous expectations of some undershooting. This fits with the idea that part of the way that higher deficits and debt raise interest rates is through higher inflation expectations. However, higher interest rates again could instead be due to the economic recovery or the newly stated aim of the Federal Reserve to allow inflation to temporarily overshoot its target.

[21] In its March 2021 Budget Outlook, the CBO forecast that the 2021 GDP will be $22.0 trillion.

[22] The estimates from the Congressional Budget Office and the Committee for a Responsible Federal Budget do not take into account the additional debt-servicing costs, but these would presumably not be very large if interest rates remain low.

[23] One alternative approach for estimating the impact of the rise in the deficit on interest rates would be to look directly at how the deficit will change in response to the current spending bills. However, this deficit approach would imply that there are no long-term effects of a temporary deficit; that is, if the government raises the deficit at $t = 1$ and then lowers it back to the same level in $t = 2$ as in $t = 0$, interest rates would be unchanged even though debt has increased, which I do not think makes sense. Therefore, I prefer the approach of computing the relationship between debt and interest rates using the empirical relationships between deficits and interest rates, and deficits and debt.

Figure 2: 10-Year Nominal Rate over the Past Year

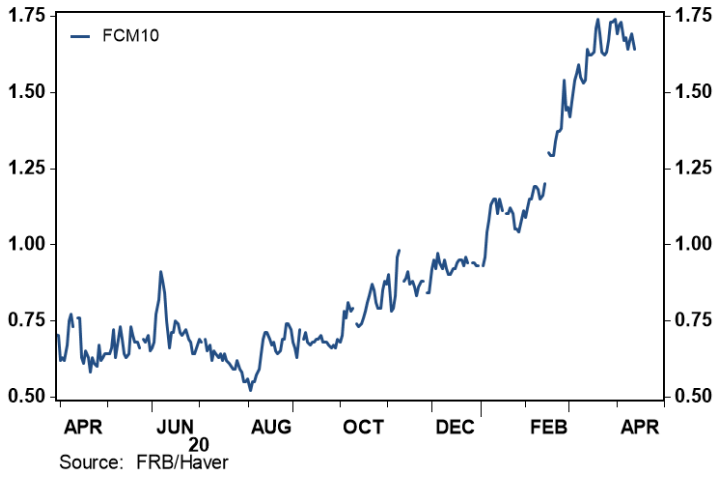


Table 8: Inflation Expectations in Recent Months

	Headline			Core		
	2020M8	2020M11	2021M2	2020M8	2020M11	2021M2
2020Q4	1.6	2.0	n/a	1.5	2.1	n/a
2021Q1	1.8	2.0	2.5	1.6	1.8	2.1
2021Q2	1.6	2.0	2.1	1.8	2.0	2.1
2021Q3	2.1	2.1	2.1	1.8	1.9	2.1
2021Q4	n/a	2.2	2.2	n/a	1.9	2.1

Source: Survey of Professional Forecasters.

5 Conclusion

In this paper, I hope to have provided a comprehensive account of the evidence of the relationship between deficits, debt, and interest rates using a high-frequency identification approach. This high-frequency identification approach offers several advantages over structural and long-term approaches, which may require specific modeling assumptions and may be subject to confounding factors. With this approach, I show that a rise in deficits/debt is likely to lead to a rise in interest rates. These results hold across a range of assets, and they affect both the real and inflation components of interest rates through both the expectations channel and term premium. However, it should be noted that my results do vary somewhat depending on which

high-frequency surprise is used and, even with the same methodology, they are not identical over time. So, while this work implies an effect of deficits/debt on interest rates, the policy estimates I draw from my results lack some precision. This stems from the fact that there are only so many fiscal releases from which I can draw the high-frequency surprises used in my paper. Ultimately, it is difficult to identify the relationship between debt, deficits, and interest rates when so many ingredients affect these variables and when changes in fiscal plans are often motivated by other factors that are themselves likely to impact interest rates.

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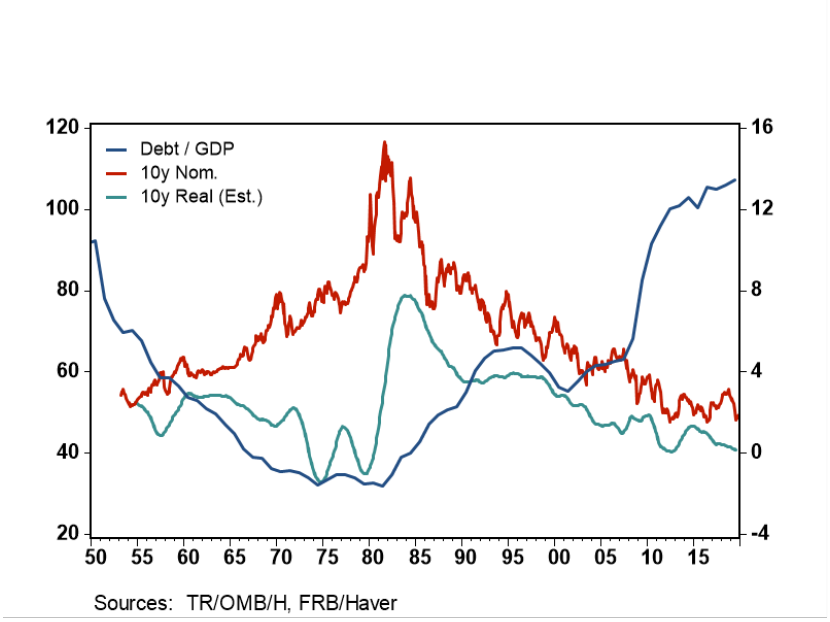
A Historical Relationship between Debt and Interest Rates

Figure 3 presents the historical relationship between nominal interest rates (in red), an approximate measure of the real interest rate (in turquoise), and debt/GDP (in blue). The graph shows that as interest rates rose from the 1950s to the early 1980s, the debt-to-GDP ratio decreased, and as interest rates have fallen back down, the debt-to-GDP ratio has grown. This is the opposite of what theory would suggest. However, many confounding factors could have driven these results. For example, it seems likely that trend inflation was higher in the 1980s than it has been in recent years for reasons other than fiscal policy.

Figure 3: Historical Relationship



The 10-year real rate is approximated here by the three-year moving average of the nominal interest rate minus the three-year moving average of core inflation.

B Additional Results and Checks

B.1 CBO/OMB Freshness of Forecast

Table 9: CBO/OMB Freshness of Forecast

Δ Treas. 10 Year Rate (%)	(1)	(2)
Informa Def./GDP % Shock	0.081*	0.081*
	(0.038)	(0.038)
CBO Def./GDP % Shock	0.038*	0.001
	(0.016)	(0.025)
CBO Debt/GDP % Shock	-0.019	-0.008
	(0.010)	(0.018)
OMB Def./GDP % Shock	0.003	0.001
	(0.006)	(0.006)
OMB Debt/GDP % Shock	-0.002	-0.001
	(0.005)	(0.005)
Recent Dummy * CBO Def./GDP % Shock		0.062
		(0.033)
Recent Dummy * CBO Debt/GDP % Shock		-0.025
		(0.022)
Recent Dummy * OMB Def./GDP % Shock		0.009
		(0.020)
Recent Dummy * OMB Debt/GDP % Shock		-0.010
		(0.013)
N	9566	9566
Timeframe	1980-2019	1980-2019

Sources: CBO, Informa, OMB, Treasury. Time period: weekdays from 1980 through 2019. Dependent variable: the change in the 10-year Treasury nominal interest rate from the previous weekday to the current weekday. Independent variables: five surprise measures plus dummy variables for each weekday; plus CBO/OMB recent surprises that equal the surprise they correspond to when the previous forecast was released <= 180 days prior and 0 when the previous forecast was released > 180 days ago or when there was no forecast. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

B.2 By Decade

Table 10: Results by Decade

Timeframe	1980s	1990s	2000s	2010s
Δ Treas. 10 Year Rate (%)	(1)	(2)	(3)	(4)
Informa Def./GDP % Shock	0.242	0.157	0.092	0.033
	(0.370)	(0.085)	(0.048)	(0.041)
CBO Def./GDP % Shock	0.055	-0.259	0.033	0.024
	(0.052)	(0.341)	(0.023)	(0.018)
CBO Debt/GDP % Shock	0.018	0.207	-0.016	-0.016
	(0.061)	(0.237)	(0.014)	(0.012)
OMB Def./GDP % Shock	-0.010	0.021	0.005	0.002
	(0.021)	(0.039)	(0.007)	(0.007)
OMB Debt/GDP % Shock	0.020	-0.010	-0.016*	-0.006
	(0.018)	(0.021)	(0.008)	(0.006)
N	2382	2396	2394	2394

Sources: CBO, Informa, OMB, Treasury. Time period: weekdays from 1980 through 2019. Dependent variable: the change in the 10-year Treasury nominal interest rate from the previous weekday to the current weekday. Independent variables: five surprise measures plus dummy variables for each weekday. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

B.3 Broader Window for Shocks

Table 11: Broader Window for Shocks

	Daily diff	7 day diff
Informa Def./GDP % Shock	0.081*	0.182
	(0.038)	(0.112)
CBO Def./GDP % Shock	0.038*	-0.003
	(0.016)	(0.044)
N	9566	9570
Timeframe	1980-2019	1980-2019

Sources: CBO, Informa, OMB, Treasury. Time period: weekdays from 1980 through 2019. Dependent variable: the change in the 10-year Treasury nominal interest rate from the previous weekday to the current weekday or from the previous weekday to the current weekday one week in advance. Independent variables: five surprise measures plus dummy variables for each weekday. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

B.4 Alternative GDP Ratio

Table 12: Alternative GDP Ratio

Δ Treas. 10 Year Rate (%)	Basic GDP	Potential GDP
Informa Def./GDP % Shock	0.081*	
	(0.038)	
CBO Def./GDP % Shock	0.038*	0.038*
	(0.016)	(0.016)
Def./Pot.GDP % Shock		0.082*
		(0.039)
N	9566	9566
Timeframe	1980-2019	1980-2019

Sources: CBO, Informa, OMB, Treasury. Time period: weekdays from 1980 through 2019. Dependent variable: the change in the 10-year Treasury nominal interest rate from the previous weekday to the current weekday. Independent variables: five surprise measures plus dummy variables for each weekday; also varying the Informa surprise measure by dividing by potential GDP rather than actual GDP. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

B.5 Other Release Shocks

Table 13: Alternative GDP Ratio

Δ Treas. 10 Year Rate (%)	All	Excluding Multiple Days
Informa Def./GDP % Shock	0.081*	0.083*
	(0.038)	(0.038)
CBO Def./GDP % Shock	0.038*	0.037*
	(0.016)	(0.017)
N	9566	8614
Timeframe	1980-2019	1980-2019

Sources: CBO, Informa, OMB, Treasury. Time period: weekdays from 1980 through 2019. Dependent variable: the change in the 10-year Treasury nominal interest rate from the previous weekday to the current weekday. Independent variables: five surprise measures plus dummy variables for each weekday. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

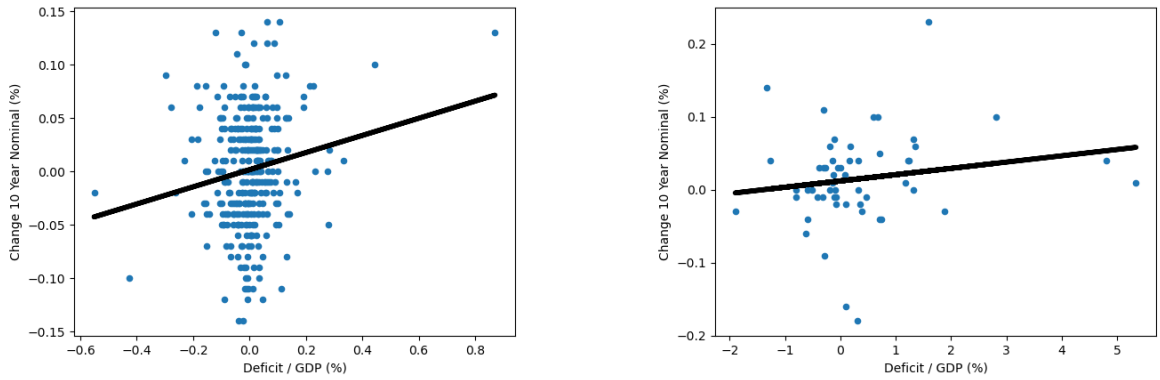
Table 14: Alternative GDP Ratio

Δ Treas. 10 Year Rate (%)	(1)	(2)
Intercept	0.004*	0.004*
	(0.002)	(0.002)
C(dayofweek)[T.1]	-0.010***	-0.010***
	(0.002)	(0.002)
C(dayofweek)[T.2]	-0.003	-0.003
	(0.002)	(0.002)
C(dayofweek)[T.3]	-0.006*	-0.006*
	(0.002)	(0.002)
C(dayofweek)[T.4]	-0.008***	-0.008***
	(0.002)	(0.002)
Informa Def./GDP % Shock	0.081*	0.082*
	(0.038)	(0.038)
CBO Def./GDP % Shock	0.038*	0.037*
	(0.016)	(0.016)
CBO Debt/GDP % Shock	-0.019	-0.019
	(0.010)	(0.010)
OMB Def./GDP % Shock	0.003	0.002
	(0.006)	(0.005)
OMB Debt/GDP % Shock	-0.002	-0.002
	(0.005)	(0.005)
CPI % Shock		0.060*
		(0.025)
Core CPI % Shock		0.102**
		(0.040)
Employ Gr. % Shock		0.041***
		(0.004)
Real GDP Gr. % Shock		0.011
		(0.010)
Unemp. % Shock		-0.062**
		(0.021)
N	9566	9566
Timeframe	1980-2019	1980-2019

Sources: CBO, Informa, OMB, Treasury. Time period: weekdays from 1980 through 2019. Dependent variable: the change in the 10-year Treasury nominal interest rate from the previous weekday to the current weekday. Independent variables: five surprise measures plus dummy variables for each weekday. Also including additional surprises where specified: CPI inflation (1980+), CPI core inflation (1989+), employment growth (1985+), GDP growth (1990+), unemployment (1980+). These additional surprises are defined similarly to the standard deficit release surprise measure; for example, the CPI inflation surprise equals the actual release of CPI inflation minus the Informa forecast of CPI inflation the preceding Friday. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

B.6 Surprise Plots

Figure 4: Plots of Shocks and Change in 10-Year Nominal Rate



(a) Informa Deficit/GDP Shock (b) CBO Deficit/GDP Shock

Sources: CBO, Informa, OMB, Treasury. Time period: weekdays from 1980 through 2019. Shows only periods when the given surprises are non-zero.

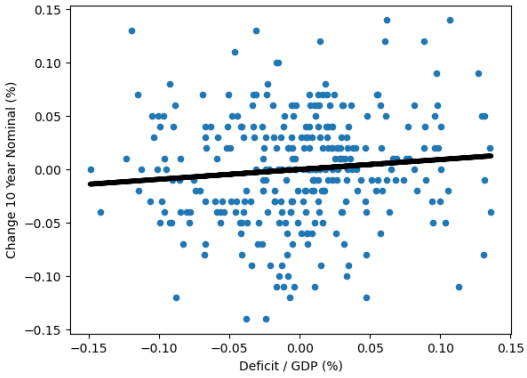
B.7 Outliers

Table 15: Alternative GDP Ratio

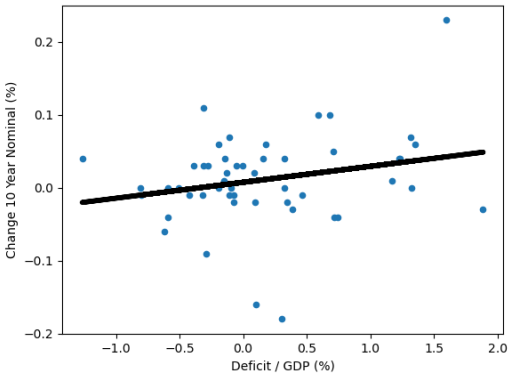
Δ Treas. 10 Year Rate (%)	Full	Windsor
Informa Def./GDP % Shock	0.081*	0.095
	(0.038)	(0.075)
CBO Def./GDP % Shock	0.038*	0.038*
	(0.016)	(0.018)
CBO Debt/GDP % Shock	-0.019	-0.019
	(0.010)	(0.014)
OMB Def./GDP % Shock	0.003	0.014
	(0.006)	(0.013)
OMB Debt/GDP % Shock	-0.002	-0.009
	(0.005)	(0.008)
N	9566	9524
Timeframe	1980-2019	1980-2019

Sources: CBO, Informa, OMB, Treasury. Time period: weekdays from 1980 through 2019. Dependent variable: the change in the 10-year Treasury nominal interest rate from the previous weekday to the current weekday. Independent variables: five surprise measures plus dummy variables for each weekday. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively. Winsorize by removing the 5 percent smallest and largest deficit surprises for both CBO and Informa.

Figure 5: Plots of Shocks and Change in 10-Year Nominal Rate



(a) Informa Deficit/GDP Shock



(b) CBO Deficit/GDP Shock

Sources: CBO, Informa, OMB, Treasury. Time period: weekdays from 1980 through 2019. Shows only periods when the given surprises are non-zero. Winsorize by removing the 5 percent smallest and largest deficit surprises for both CBO and Informa.

B.8 CBO/OMB Varying Shock Forecast Year

Table 16: CBO/OMB Varying Shock Forecast Year

treas__int_y10__di	(1)	(2)	(3)	(4)
MMS Def./GDP % Shock	0.081*	0.081*	0.081*	0.081*
	(0.038)	(0.038)	(0.038)	(0.038)
CBO Def./GDP % Shock Year 0	0.038*			
	(0.016)			
CBO Def./GDP % Shock Year 0	-0.019			
	(0.010)			
OMB Def./GDP % Shock Year 0	0.003			
	(0.006)			
OMB Def./GDP % Shock Year 0	-0.002			
	(0.005)			
CBO Def./GDP % Shock Year 1		0.015		
		(0.015)		
CBO Def./GDP % Shock Year 1		-0.002		
		(0.006)		
OMB Def./GDP % Shock Year 1		0.012		
		(0.007)		
OMB Def./GDP % Shock Year 1		-0.008		
		(0.004)		
CBO Def./GDP % Shock Year 2			0.024	
			(0.017)	
CBO Def./GDP % Shock Year 2			-0.002	
			(0.004)	
OMB Def./GDP % Shock Year 2			0.016*	
			(0.008)	
OMB Def./GDP % Shock Year 2			-0.007*	
			(0.003)	
CBO Def./GDP % Shock Year 3				0.026
				(0.018)
CBO Def./GDP % Shock Year 3				-0.002
				(0.004)
OMB Def./GDP % Shock Year 3				0.006
				(0.010)
OMB Def./GDP % Shock Year 3				-0.004
				(0.003)
N	9566	9566	9566	9566
Timeframe	1980-2019	1980-2019	1980-2019	1980-2019

Sources: CBO, Informa, OMB, Treasury. Time period: weekdays from 1980 through 2019. Dependent variable: the change in the 10-year Treasury nominal interest rate from the previous weekday to the current weekday. Independent variables: five surprise measures plus dummy variables for each weekday; the forecast year used to construct the CBO/OMB fiscal surprises is also varied across regressions; for example, CBO deficit/GDP surprise year one compares the current forecast for one year ahead with the previous forecast for the year that is currently one year ahead. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

B.9 Other Assets

Table 17: Impact on Corporate Bond Interest Rates by Credit Rating

	Investment Grade				Junk Grade	
	Corp AAA	Corp AA	Corp A	Corp BBB	Corp BB	Corp B
Informa Def./GDP % Shock	0.039	0.031	0.031	0.049*	0.014	0.020
	(0.028)	(0.025)	(0.025)	(0.024)	(0.030)	(0.041)
CBO Def./GDP % Shock	0.019	0.024	0.025*	0.024*	0.014	0.001
	(0.014)	(0.012)	(0.012)	(0.012)	(0.015)	(0.020)
N	7815	7817	7817	7815	7794	7810
Timeframe	1988-2019	1988-2019	1988-2019	1988-2019	1988-2019	1988-2019

Sources: CBO, ICE, Informa, OMB. Time period: weekdays over various years. Dependent variable: the change in the interest rate from the previous weekday of corporate bonds divided into different credit ratings where the interest rate is measured at the close of the business day. Independent variables: five surprise measures plus dummy variables for each weekday. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

Table 18: Impact on Mortgage Rates

	Mort 15	Mort 30
Informa Def./GDP % Shock	0.033	0.036
	(0.035)	(0.042)
CBO Def./GDP % Shock	0.016	0.014
	(0.017)	(0.021)
N	6972	7924
Timeframe	1988-2019	1992-2019

Sources: CBO, ICE, Informa, OMB. Time period: weekdays over various years. Dependent variable: the change in the interest rate from the previous weekday of fixed rate mortgages by maturity. Independent variables: five surprise measures plus dummy variables for each weekday. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.

Table 19: Impact on Other Asset Prices

	SP500 gr.	JPY/USD gr.
Informa Def./GDP % Shock	-0.163	0.149
	(0.560)	(0.332)
CBO Def./GDP % Shock	-0.018	0.205
	(0.242)	(0.167)
N	9745	7942
Timeframe	1980-2019	1989-2019

Sources: CBO, Informa, OMB, S&P, *WSJ*. Time period: weekdays over various years. Dependent variable: the growth in the SP500 or the exchange rate of JPY/USD from the previous weekday to the current weekday. Independent variables: five surprise measures plus dummy variables for each weekday. *, **, and *** represent < 0.05, < 0.01, and < 0.001 significance, respectively.