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Government Deficits and Interest Rates: A Keynesian View

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ABSTRACT

We test the neoclassical loanable funds model which postulates that, ceteris paribus, government borrowing increases the long-term rate of interest. The empirical literature exploring such a connection remains largely mixed. We clarify the conflicting results by deploying an ARDL model to decompose the relationship in the United States into long and short-run effects across multiple measures of the government deficit and long-term interest rate. We find a tendency for changes in the deficit to increase long-term interest rates in the short run but the effect is reversed in the long run. We argue that these results are consistent with John Maynard Keynes' view of the long-term rate as being heavily influenced by monetary policy, central bank credibility and market convention.

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Introduction

Neoclassical theory adheres to the loanable funds theorem in which households forego consumption and save a portion of their income. These funds are deposited with a bank who then lends them to businesses looking to invest. An increase in government spending reduces national saving and the supply of loanable funds.[1] A decrease in the supply of loanable funds increases interest rates which makes it more expensive to borrow. The loanable funds model is embedded in the assumptions of the famous IS-LM model, the workhorse of macroeconomic models and is often taken for granted in policy analysis.

This increase in government borrowing, which leads to a "crowding out" of the private sector is also said to have an impact on a country's international trade position. With higher domestic interest rates, the currency appreciates, making local goods and services more expensive for foreigners, resulting in a current account deficit. Mirroring a current account deficit is a balance of payments surplus, increasing foreign ownership of domestic production. Income instead flows to foreigners, reducing current and future domestic income (Elmendorf and Mankiw 1999). Taken together, these theories lead economists to caution against excessive government borrowing as it is thought to be highly disruptive, not just to domestic capital accumulation but also to a country's balance of payments.

There are two ways to mitigate the effects of deficits on interest rates. According to Barro (1974), forward-looking households would interpret a budget deficit as a postponed tax liability and would increase their saving in response. In a small open economy model, capital inflows from abroad would offset the decline in national saving. In both cases, the increase in interest rates is completely offset. However, the more widely accepted view is that capital inflows would partially offset the increase in interest rates but not enough to mitigate the decrease in domestic investment (Gale and Orszag 2004).[2] The result is an increase in foreign ownership of domestic assets and a reduction in investment. It is acknowledged, however, that budget deficits can have a positive impact in the short run (Bernheim 1989). If the economy is running below capacity, a budget deficit can increase domestic income and saving by putting idle resources to work resulting in no impact on interest rates. This is in contrast to the long run, where the economy is assumed to converge to full employment and capital utilization. At which point, a government deficit simply results in a reduction in national saving and an increase in interest rates.

In contrast, heterodox schools of thought reject the loanable funds theorem and the impact of budget deficits on interest rates, growth and trade. One objection is based on different interpretations of accounting identities and an appreciation that national accounting relationships are primarily monetary relationships and can only be interpreted as real economic relationships secondarily. By definition, one sector's deficit is another's surplus. In a closed economy, the net financial saving of the private sector is exactly equal to the government's deficit, and vice versa

[1] Since we live in a monetary economy, we address the financial representation of the loanable funds theory as opposed to the view that abstracts away from money and relies on barter.

[2] This is, in fact, no different from what we would expect from a standard Mundell-Fleming model with high capital mobility. This model, based on the IS-LM and hence with a loanable funds core, predicts that domestic interest rates cannot deviate much from international rates without balance of payments problems occurring. (Darity Jr. & Young 2004).

(Godley 1999). Godley emphasized this national accounting perspective to raise questions about causality. As we have seen, neoclassical theory implies that government borrowing will result in higher interest rates that then cause a deterioration in the balance of payments. This is often referred to as the "twin deficits hypothesis" (Miller & Russek 1989). Godley, by contrast, follows Kaldor (Thirlwall 2013) and raises the possibility that balance of payments deficits may be due to structural issues with the economy – say, a decline in manufacturing as a percentage of output (Coutts & Rowthorn 2004) – and that the government deficit that results is a residual. In effect, the government deficit opens passively as both the domestic private sector and the foreign sector seek to increase their saving. Naturally, for this reason, a neoclassical would have a very different policy prescription for "twin deficits" as a heterodox economist following Godley's work.

Another objection can be found in Lindner (2015). He shows that economists have misinterpreted the saving and investment identity because of its roots abstracting away from a monetary economy. Using a rigorous accounting framework, he shows that it is not possible for saving to finance investment and that economists have confused saving with the availability of credit. He also remarks that any policy that discourages consumption suffers from the fallacy of composition (Keynes 1936). If any sector decides to save financially by reducing their spending, it reduces the income of others, specifically the business sector. Not only does saving not increase the supply of credit, but it would lead to an excess of goods and services in the economy prompting a decrease in production which, in turn, may be followed by a decline in investment and thus national saving - the opposite of what neoclassical authors assume. A similar argument was also put forward by Vickrey (1998).

An additional objection is regarding the function of banks as financial intermediaries and their ability to extend credit. Banks do not increase their capacity to lend by obtaining deposits from savers or having excess reserves on hand as is typically portrayed in economics textbooks in the so-called "money multiplier" model of bank lending (Mankiw 2009). Instead, banks extend credit and thus create new purchasing power, ex-nihilo, as a series of bookkeeping entries. This has been known since at least the mid-nineteenth century when the so-called Banking School economists arrived at this conclusion through a study of some of the first systematic banking statistics ever created. This perspective was also integrated into neoclassical theory by Knut Wicksell from the very beginning and forms the basis for modern central bank interest rate theory (Arnon 2011). The present authors are unsure why neoclassicals equivocate between loanable funds and endogenous money views. We can only attribute it to siloization within the discipline. Meanwhile, this view of credit creation has been adopted by major central banks around the world (Jakab and Kumhof 2015; Deutsche Bundesbank 2017).

Our framework revolves around Keynes' belief that market convention and the actions of the central bank have a sizable influence on long-term interest rate formation. Through control of the short-term interest rate and management of expectations, the central bank can tame the long-term rate of interest if monetary policy is communicated and executed with sufficient credibility. It is thus said that the interest rate is "conventional" in the sense that the current yield reflects the market's expectation of future yields. Since the long rate is a function of the short rate and a forward rate, it can be expressed as an average of current and expected future short rates. The market, then, must draw inferences from central bank communications, open market operations and short-term interest rate setting to determine the path of monetary policy. In addition, investors consider their liquidity-preference function to determine a premium for parting with liquidity, also known as a term premium. It is important to differentiate this framework from the neoclassical vision where saving and investment decisions in the market for loanable funds determine the long-term interest rate. Thus, government deficits do not raise interest rates through the channels surmised by the loanable funds theory. If budget deficits were to raise the long-term rate of interest it would be through convention. Facing an uncertain future, individuals look to the opinions of others to assess the current and future state of affairs. According to Keynes (1936), "[i]n practice, we have tacitly agreed, as a rule, to fall back on what is, in truth, a convention… We are assuming, in effect, that the existing market valuation, however arrived at, is uniquely correct in relation to our existing knowledge of the facts" (p. 152). A consequence of this logic is that market participants "devote [their] intelligences to anticipating what average opinion expects the average opinion to be" (p. 156). These opinions need not be rooted in objective reality "so long as we can rely on the maintenance of the convention" (p. 152). The problem is that conventions are fragile as markets are "liable to change violently as the result of a sudden fluctuation of opinion" (p. 154). However, the central bank has the power to influence convention if it is "rooted in strong conviction, and promoted by an authority unlikely to be superseded" (p. 203).[3] We thus postulate that in the United States any effect of budget deficits on interest rates, should there be a significant effect at all, would be fleeting.

1 Theoretical Framework

The institutional structure governing the economy is of critical importance. We assume that the country is monetarily sovereign as defined by Wray (2012). The country issues its own nonconvertible free-floating currency, has the capacity to impose and enforce tax liabilities payable in its own currency and issues debts denominated in that currency. The central bank sets the short rate and follows a simple Taylor Rule (Taylor 1993):

$$r_{1,t} = r^* + \pi_t + \theta_\pi \lambda_t + \theta_\gamma \gamma_t \tag{1}$$

where $r_{1,t}$ is the short rate at time t, r^* is the neutral rate, π_t is the rate of inflation, λ_t is the difference between the rate of inflation and its target and γ_t is the output gap.[4] We then proceed to the expectations hypothesis where the yield on an n period bond is equal to the average of current and future short rates[5]:

$$r_{n,t} = \frac{1}{n}\sum_{i=0}^{n-1} E\left[r_{1,t+i}\right] \tag{2}$$

Expressed in terms of the central bank's reaction function:

$$r_{n,t} = r^* + \frac{1}{n}\sum_{i=0}^{n-1} E[\pi_{t+i}] + \theta_\pi \frac{1}{n}\sum_{i=0}^{n-1} E[\lambda_{t+i}] + \theta_\gamma \frac{1}{n}\sum_{i=0}^{n-1} E[\gamma_{t+i}] \tag{3}$$

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[3] For a similar view to our own see: (Lavoie & Seccareccia 2004).
[4] Whether or not there exists a unique neutral, or "natural", rate, which Keynes rejected, is unimportant. The purpose is to use a reaction function that reasonably represents "convention," or how the market believes the central bank sets the short-term interest rate.
[5] We show arithmetic averages for ease of exposition.

The central bank has three primary mechanisms to induce changes in current and expected future short rates:

$$r_{1,t}, E\left[r_{1,t}\right] = f(S, O, R) \tag{4}$$

where S is signaling, O is open market operations and R is setting the short rate explicitly via changes in the overnight rate. Additionally, investors require a term premium on longer maturity bonds but, given the safety and liquidity of U.S. Treasuries, are willing to pay a premium as well. Therefore, the equation becomes:

$$r_{n,t} = \frac{1}{n}\sum_{i=0}^{n-1} E\left[r_{1,t+i}\right] + \phi_t + \theta_\sigma \sigma_t \tag{5}$$

where ϕ_t is a term premium and θ_σ is the sensitivity to changes in risk aversion. The term premium measures the expected excess return investors require to hold a long-maturity bond versus rolling over a series of short-maturity bonds.

2 Literature Review

In a survey of 59 papers, Gale and Orszag (2003) conclude that a projected budget deficit of 1% of GDP increases long-term interest rates by between 50 and 100 basis points. In total, 19 of the studies show an insignificant relationship, 29 are significant and 11 are mixed. However, there is dispersion within the results based on how deficits and debt are measured.

Here caution must be exercised. Debt-to-GDP ratios are often used by ratings agencies to determine the creditworthiness of various countries, especially small countries, developing countries and countries operating a fixed exchange rate. These ratings are then used by bond market analysts to set bond prices and hence yields. Often this is not even voluntary. Portfolio constraints only allow bond market investors to hold a certain portion of their portfolio in bonds with low ratings. So, even if a bond investor thinks a credit downgrade is arbitrary, they may be constrained in what they can do by regulations. The ratings agencies are thus the most perfect example of what we would call, following Keynes, interest rate setting by “convention.” When economists undertake empirical studies on interest rates and use both stock (debt-to-GDP) and flow (deficit-to-GDP) they are mixing apples and oranges.[6] They also risk simply detecting the influence of the impact that ratings agencies are having on market convention.

Of the studies using expected deficits, 12 of 17 found a significant link to higher interest rates, a vector autoregression approach yielded 2 of 10 and current deficits 14 of 31. It is argued that since interest rates are forward-looking, the most relevant variable for consideration is expected future deficits (Feldstein 1986). An innovation, to remove the effects of the business cycle, was to use forward rates. A study by Laubach (2003), using OMB and CBO forecasts, determines that a 1% increase in the deficit as a percent of GDP increases five-year-ahead ten-year Treasury yields by 23 basis points. Engen and Hubbard (2004) find that an increase in projected debt relative to GDP increases forward long-term rates by about 3 basis points and 18 basis points for the projected deficit. Though, they conclude that theory would dictate debt, not deficits, is consistent with a

[6] This reminds us of Michal Kalecki’s famous quip that economics is “the science of confusing stocks and flows.”

model of crowding out. Elmendorf and Mankiw (1999) suggest that this can be reconciled assuming different models of consumer behavior.

Concerning private rates, an approach by Auerbach, Gorodnichenko and Murphy (2020) observe local economies and the effects of federal government defense contracts on credit conditions. They find that not only do the economies experience greater growth, but that interest rates on consumer loans decrease. They conclude that it raises incomes and reduces risk premiums. This is consistent with the Levy-Kalecki theory of profits which is instead applied to the corporate sector (Levy 2000). Government deficits are a source of business profits at the economy-wide level which reduces the risk of lending to corporations. Boons and Valkanov (2021) also find support for this premise.

There is also a large body of literature supporting the influence of central bank actions on long-term rates. Akram and Li (2020), also operating within a Keynesian framework, determine that the short rate has a decisive impact on the 10-year Treasury yield. Borio et. al (2017), considering a cross-section of 19 countries, find that monetary policy has significant explanatory power for the secular decline in real interest rates since the 1980s and that non-monetary factors, such as saving and investment, do not. Hillenbrand (2020) finds that the entire decline in long-term Treasury yields since 1980 occurred around a 3-day window surrounding FOMC meetings and two-thirds of the change was due to lower expectations about future short rates. Similarly, Hanson and Stein (2015) show that decreases in nominal short rates on the day of a central bank announcement are associated with a reduction in the long-term forward real rates. Gagnon et al. (2010) find that central bank purchases significantly lower the yields on long-term securities. Krishnamurthy and Vissing-Jorgensen (2011) also determine that central bank announcements of purchases, and the purchases themselves, significantly lower the yields on long-term Treasuries.

3 Data

We take a holistic approach to examining the impact of deficits on interest rates. To do so, we use multiple measures across both categories. For interest rates, we use the current 10-year Treasury rate (*10Y*) and the 10-year Treasury rate 5 years forward (*5Y10Y*).[7] For the latter, following Laubach (2013), we take the average of one-year forward rates from 5 to 14 years ahead as implied by the zero-coupon curve supplied by the Federal Reserve.[8] We choose longer-term rates since if there is an effect it is expected to be magnified in higher duration bonds as shorter durations have an increasingly greater relationship with the current stance of monetary policy (Blanchard 1984). The use of forward rates further mitigates the influence of recent macroeconomic conditions. We also use three different measures of deficits: the projected deficit as a percent of GDP five years

[7] All data is quarterly.

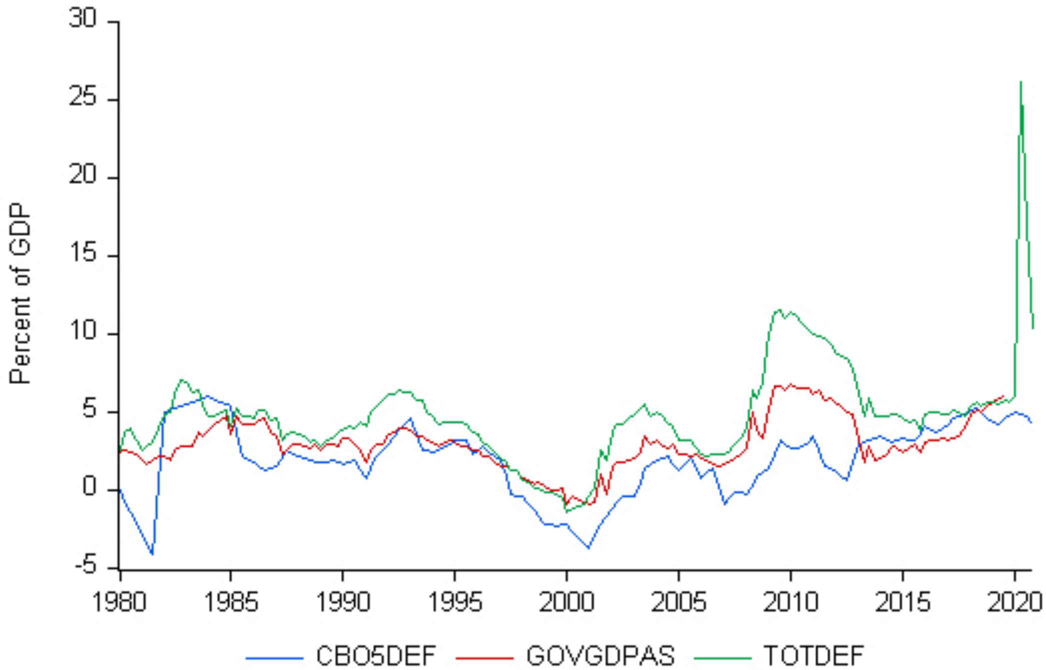
[8] We derive one-year forward rates as:

$$f_{n,1} = i_{n+1}(n+1) - i_n n$$

where $f_{n,1}$ is the one-year rate n years forward and i_n is the n-year continuously-compounded zero-coupon rate. After averaging one-year forward rates, the resulting 10-year rate 5 years forward is also in continuously-compounded form. Our results are quantitatively unchanged when converted to coupon-equivalent yields.

in the future provided by the CBO (*CBO5DEF*), the total deficit as a percent of GDP (*TOTDEF*) and the structural deficit as a percent of GDP (*GOVGDPAS*).[9]

Figure 1: Measures of the government deficit relative to GDP (inverted)



To round out our theoretical model, we must include measures that capture the central bank reaction function and risk aversion. Inflation expectations (*INF*) are taken from the FRB/US model which is derived using the forecasted average inflation rate over the next 10 years from the Survey of Professional Forecasters. For the evolution of the output gap, we use the average expected output gap over the next ten years from the FRB/US model (*GAP*). We include the level of Federal Reserve holdings of federal debt as a percent of GDP (*HOLD*). As in Hillenbrand (2020), we use the quarterly sum of yield changes from the day before to the day after an FOMC announcement (*FOMC*).[10] To proxy for risk aversion, we use the VIX index, a binary recession indicator from the NBER (*USREC*) and flight-to-safety episodes (*FTS*) from Baele et al. (2020). The latter two are incorporated into the model as fixed regressors.

[9] Projections are from Gamber and Seliski (2019) before July 2017 and the CBO thereafter. The structural deficit is the total deficit minus estimates of automatic stabilizers from the CBO ending in the third quarter of 2019. Data is linearly interpolated to a quarterly frequency.

[10] Calculated individually for both forward and current long-term interest rates.

4 Empirical Approach

We build an ARDL model as specified by Pesaran, Shin and Smith (2001). There are numerous advantages to employing an ARDL model. First, it allows us to discern the long and short-run effects of the given variables. Second, we can use regressors of mixed orders of integration as opposed to other cointegration techniques which require all variables to be of the same order of integration. Third, it is a more efficient estimator for small sample sizes. Finally, it avoids the problems of endogeneity and autocorrelation since each variable can have its own lag parameter (Pesaran and Shin 1999). The unrestricted error-correction representation of an ARDL(p, q) model is expressed as:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{p} \varphi_i \Delta y_{t-i} + \sum_{j=0}^{q} \omega_j \Delta x_{t-j} + \sum_{m=1}^{n} \lambda_m z_m + \beta_0 y_{t-1} + \beta_1 x_{t-1} + \epsilon_t \tag{6}$$

where y_t is the dependent variable, x_t is the independent variable and z_m is a fixed regressor; φ_i and ω_j are the short-run dynamic coefficients while β_0 *and* β_1 are the long-run coefficients; α_0 is a constant and ϵ_t is the error term. The number of lags p and q are chosen to minimize the Akaike Information Criterion (AIC) of the overall model. Since we are using quarterly data, we set the maximum allowable number of lags to four. We then determine the existence of a cointegrating relationship by testing if the constant and long-run coefficients are jointly zero:

$$H_0: \alpha_0 = \beta_0 = \beta_1 = 0$$

$$H_1: \alpha_0 \neq \beta_0 \neq \beta_1 \neq 0$$

where H_0 is the null of no cointegration against the alternative H_1 of cointegration. We compare the computed F-statistic to the critical values provided by Pesaran et al. (2001). The null hypothesis is rejected if the F-statistic is greater than the upper bound. If the F-statistic is below the lower bound, the null hypothesis cannot be rejected. Lastly, the result is inconclusive if it is between the lower and the upper bound. In the presence of cointegration, we can proceed to estimating the long-run equilibrium relationship:

$$y_t = \theta_0 + \theta_1 x_t + \epsilon_t \tag{7}$$

where θ_0 and θ_1 correspond to $\frac{\alpha_0}{-\beta_0}$ and $\frac{\beta_1}{-\beta_0}$ from Equation 6 which can be reformulated to include an error correction term:

$$\Delta y_t = \sum_{i=1}^{p} \varphi_i \Delta y_{t-i} + \sum_{j=0}^{q} \omega_j \Delta x_{t-j} + \sum_{m=1}^{n} \lambda_m z_m + \beta_0 EC_{t-1} + \epsilon_t \tag{8}$$

where β_0 is now the coefficient that restores long-run equilibrium and the error-correction term EC_{t-1} represents the residuals from the long-run equation. A significantly negative error correction parameter would indicate the model indeed reverts to a long-run equilibrium. Pesaran et al. (2001) identify five deterministic specifications for the bounds test: no constant and no trend; restricted constant and no trend; unrestricted constant and no trend; unrestricted constant and restricted trend; and unrestricted constant and unrestricted trend. For brevity, we proceed with a restricted constant and no trend.[11] Standard errors are calculated using the Newey-West (Newey and West 1987) estimator.

5 Results and Discussion

We must first determine the stationarity properties of the variables. The ARDL model requires each variable to be either I(0) or I(1). We thus employ the Augmented Dickey-Fuller (Dickey and Fuller 1979) and Phillips-Perron (Phillips and Perron 1988) tests in both levels and first differences.[12] It is evident from the results in Table 1 that there is a mixture of I(0) and I(1) variables. It is therefore inappropriate to use the standard cointegration techniques such as Johansen (1988) which require all variables be I(1). We proceed with the ARDL bounds test which allows for a blend of I(0) and I(1) variables.

[11] Our conclusions are qualitatively unchanged using the other four specifications but they generally suffer from functional misspecification as indicated by the RESET test. This is in contrast to our models which include a restricted constant and exclude a trend parameter. Results are available upon request.

[12] Tests include a constant. We also ran two additional tests: with a constant and trend and without a constant or trend. The results still indicated a combination of I(0) and I(1) variables.

Table 1: Unit root tests

	Level				First Difference			
	ADF		PP		ADF		PP	
Variable	t-Statistic	Prob.	t-Statistic	Prob.	t-Statistic	Prob.	t-Statistic	Prob.
10Y	-1.651	0.455	-1.640	0.460	-13.428	0.000	-13.428	0.000
5Y10Y	-1.396	0.583	-1.027	0.743	-14.006	0.000	-16.067	0.000
CBO5DEF	-3.379	0.013	-2.451	0.130	-5.768	0.000	-7.361	0.000
FOMC (5Y10Y)	-14.485	0.000	-14.971	0.000	-11.398	0.000	-61.339	0.000
FOMC (10Y)	-13.393	0.000	-13.427	0.000	-10.866	0.000	-53.589	0.000
GOVGDPAS	-1.683	0.438	-2.062	0.261	-13.876	0.000	-13.854	0.000
HOLD	0.484	0.986	1.337	0.999	-7.817	0.000	-7.752	0.000
INF	-2.589	0.097	-2.819	0.058	-11.731	0.000	-11.733	0.000
TOTDEF	-1.074	0.725	-3.506	0.009	-12.163	0.000	-15.688	0.000
VIX	-4.963	0.000	-7.241	0.000	-9.793	0.000	-47.879	0.000
GAP	-4.418	0.000	-4.271	0.001	-11.058	0.000	-15.840	0.000

Notes: The null hypothesis is that each variable contains a unit root. The number of lags is determined by the AIC. Each test has a constant. ADF is the Augmented Dickey-Fuller test and PP is the Phillips-Perron test.

Table 2: Results of F-Bounds Test

	F-statistic			Critical Values	
	CBO5DEF	GOVGDPAS	TOTDEF	I(0)	I(1)
5Y10Y	11.514	7.881	11.688	2.88	3.99
10Y	7.113	9.038	8.337	2.88	3.99

Notes: Test of the null hypothesis that the functional form of the model is correctly specified. Critical values are for a 1% significance level from Pesaran, Shin, and Smith (2001).

Next, the null hypothesis of no long-run equilibrium relationship must be tested. Table 2 shows the corresponding F-statistics and the lower and upper bounds for the test. The null is rejected across the six models as all F-statistics are significant at the 1% level.

Table 3: Estimated ARDL model for the long-term forward rate

Long Run	β	t-stat		β	t-stat		β	t-stat
INF	1.445	14.269	INF	1.377	15.001	INF	1.356	12.803
HOLD	-0.273	-6.656	HOLD	-0.280	-10.786	HOLD	-0.286	-8.257
FOMC	2.689	3.981	FOMC	1.452	1.927	FOMC	2.673	3.984
GAP	0.384	1.330	GAP	0.012	0.040	GAP	0.007	0.017
VIX	0.006	0.285	VIX	-0.009	-0.611	VIX	0.010	0.559
CBO5DEF	-0.100	-1.142	GOVGDPAS	-0.271	-3.471	TOTDEF	-0.119	-1.631
C	4.127	7.009	C	5.273	8.929	C	4.761	7.195

Short Run	β	t-stat		β	t-stat		β	t-stat
Δ5Y10Y(-1)	0.038	0.594	Δ5Y10Y(-1)	0.076	1.194	Δ5Y10Y(-1)	0.025	0.399
Δ5Y10Y(-2)	0.051	0.783	Δ5Y10Y(-2)	0.064	1.013	Δ5Y10Y(-2)	0.054	0.828
Δ5Y10Y(-3)	0.173	2.663	Δ5Y10Y(-3)	0.214	3.430	Δ5Y10Y(-3)	0.158	2.459
ΔHOLD	0.002	0.027	ΔHOLD	0.194	1.992	ΔHOLD	-0.021	-0.257
ΔHOLD(-1)	0.195	2.223	ΔFOMC	0.871	8.066	ΔHOLD(-1)	0.151	1.519
ΔGAP	0.309	2.409	ΔGAP	0.229	1.455	ΔHOLD(-2)	0.188	2.025
ΔGAP(-1)	0.359	2.890	ΔGAP(-1)	0.205	1.278	ΔGAP	0.087	0.620
ΔGAP(-2)	0.270	2.172	ΔGAP(-2)	0.461	3.090	ΔGAP(-1)	0.224	1.547
ΔVIX	-0.011	-2.099	ΔGOVGDPAS	0.001	0.021	ΔGAP(-2)	0.388	2.815
ΔCBO5DEF	-0.148	-2.399	ΔGOVGDPAS(-1)	0.146	2.181	ΔVIX	-0.010	-2.005
ΔCBO5DEF(-1)	0.147	2.450	ΔGOVGDPAS(-2)	-0.025	-0.382	USREC	0.172	1.447
USREC	0.218	1.714	ΔGOVGDPAS(-3)	0.158	2.359	FTS	-0.245	-2.659
FTS	-0.235	-2.544	USREC	0.059	0.500	ECT(-1)	-0.370	-9.909
ECT(-1)	-0.343	-9.836	FTS	-0.205	-2.303			
			ECT(-1)	-0.396	-8.147			
Lags	(4, 0, 2, 0, 3, 1, 2)		Lags	(4, 0, 1, 1, 3, 0, 4)		Lags	(4, 0, 3, 0, 3, 1, 0)	
LM(2)	0.614		LM(2)	0.401		LM(2)	0.680	
LM(4)	0.406		LM(4)	0.254		LM(4)	0.457	
RESET	0.343		RESET	0.982		RESET	0.452	

Notes: ΔX(-i) is the i lag of the first differenced variable X.

Table 3 displays the results for forward rates. Projected deficits have an insignificantly negative long-run impact on the forward rate though in the short run there are both significantly negative and positive impacts at lags zero and one, respectively. For deficits excluding automatic stabilizers, there is a significantly positive effect in the short run at lags one and three of about 15 and 16 basis points respectively. However, there is a significantly negative effect in the long run of -27 basis points which takes less than three quarters to accumulate. Finally, the total deficit only has an insignificantly negative coefficient of 12 basis points in the long run which also takes less than three months to accumulate with no corresponding impact in the short run. The results in Table 4 correspond to current 10-year rates and largely echo the results of forward rates. One particular difference is with current total deficits where there is now a significant positive effect at lags one and three of 10 and 18 basis points, respectively. Overall, there is a positive temporary effect while all the estimated long-run coefficients are negative, three of which are significant. We conclude that the impact of various measures of the deficit on forward and current long-term rates is neutral overall.[13]

The bottom of Tables 3 and 4 contain the values of various diagnostic tests. The Breusch-Godfrey Lagrange Multiplier (Godfrey 1978; Breusch 1979) tests the null of no serial correlation in the residuals with two and four lags. All models cannot reject the null indicating the residuals are serially uncorrelated. The results of the RESET (Ramsey 1969) test confirm there is no functional misspecification across the models. To assess the stability of the parameters, Figures 1 and 2 plot the results of the cumulative sum of recursive residuals (CUSUM) and the CUSUM of squares (CUSUMSQ) (Brown, Durbin and Evans 1975) tests, respectively. The CUSUM lines are all within the limits of the test. However, three of the six models breach the critical limits of the CUSUMSQ test potentially indicating minor instability or a structural break.

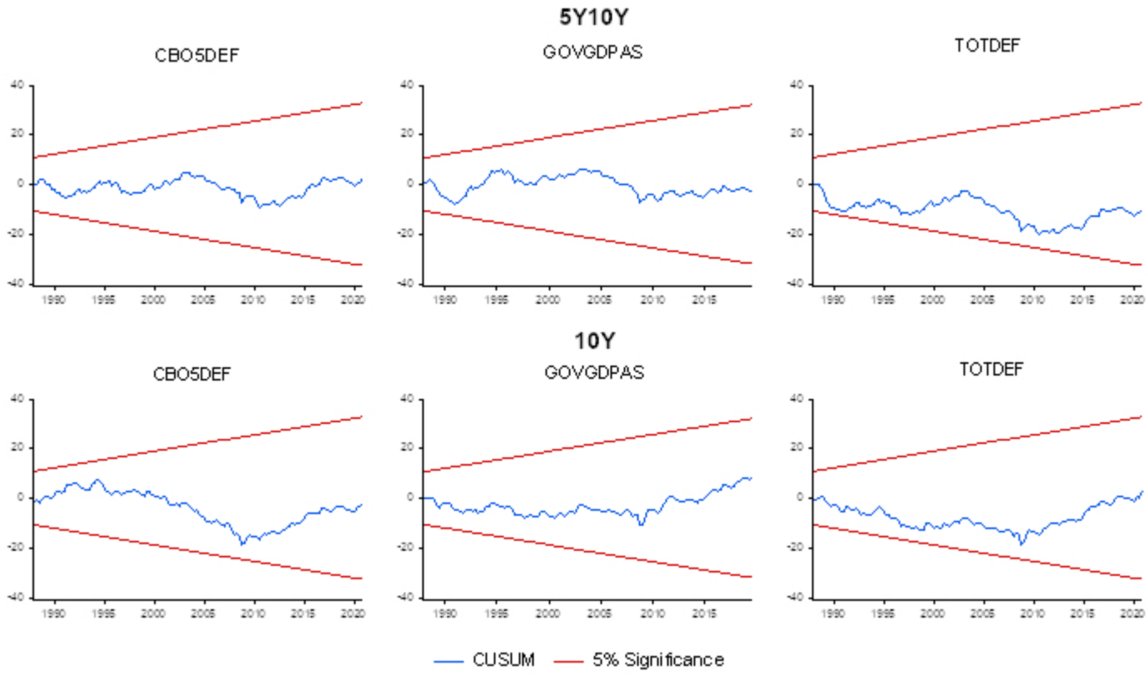
[13] Although our focus here is on deficits, we are able to draw the same conclusion on the impact of projected and current debt as a percent of GDP on long-term interest rates. Results are available upon request.

Table 4: Estimated ARDL model for the current long-term rate

Long Run	β	t-stat		β	t-stat		β	t-stat
INF	1.677	11.861	INF	1.631	17.130	INF	1.599	12.721
HOLD	-0.274	-5.731	HOLD	-0.263	-9.752	HOLD	-0.237	-7.198
FOMC	-2.132	-1.520	FOMC	0.143	0.149	FOMC	-0.387	-0.427
GAP	1.358	4.183	GAP	0.485	1.716	GAP	0.365	0.773
VIX	-0.056	-2.893	VIX	-0.045	-3.047	VIX	-0.052	-3.458
CBO5DEF	-0.098	-0.989	GOVGDPAS	-0.329	-4.305	TOTDEF	-0.277	-3.225
C	3.463	5.016	C	4.303	7.057	C	4.583	6.543
Short Run	β	t-stat		β	t-stat		β	t-stat
Δ10Y(-1)	0.087	1.195	Δ10Y(-1)	0.136	1.971	Δ10Y(-1)	0.124	1.743
Δ10Y(-2)	0.127	1.880	Δ10Y(-2)	0.116	1.814	Δ10Y(-2)	0.118	1.744
Δ10Y(-3)	0.244	3.996	Δ10Y(-3)	0.325	5.064	Δ10Y(-3)	0.296	4.576
ΔINF	-0.166	-0.547	ΔINF	-0.149	-0.539	ΔINF	-0.265	-0.932
ΔHOLD	0.088	1.557	ΔHOLD	0.105	1.108	ΔHOLD	0.158	1.751
ΔHOLD(-1)	0.087	1.409	ΔFOMC	0.885	6.079	ΔHOLD(-1)	0.008	0.063
ΔHOLD(-2)	0.094	1.716	ΔFOMC(-1)	0.274	1.541	ΔHOLD(-2)	0.245	2.250
ΔFOMC	0.819	5.535	ΔFOMC(-2)	0.012	0.073	ΔFOMC	0.941	6.769
ΔFOMC(-1)	0.787	4.591	ΔFOMC(-3)	-0.226	-1.635	ΔFOMC(-1)	0.543	3.291
ΔFOMC(-2)	0.367	2.538	ΔGAP	0.421	2.607	ΔFOMC(-2)	0.303	2.161
ΔCBO5DEF	-0.094	-1.487	ΔGAP(-1)	-0.043	-0.269	ΔGAP	0.323	1.862
ΔCBO5DEF(-1)	0.156	2.488	ΔGAP(-2)	0.471	3.111	ΔGAP(-1)	0.131	0.771
USREC	0.391	2.809	ΔGOVGDPAS	-0.020	-0.308	ΔGAP(-2)	0.466	2.943
FTS	-0.319	-3.371	ΔGOVGDPAS(-1)	0.177	2.637	ΔTOTDEF	-0.027	-0.752
ECT(-1)	-0.310	-7.732	ΔGOVGDPAS(-2)	-0.036	-0.538	ΔTOTDEF(-1)	0.096	2.075
			ΔGOVGDPAS(-3)	0.160	2.355	ΔTOTDEF(-2)	0.068	1.485
			USREC	0.218	1.790	ΔTOTDEF(-3)	0.185	2.956
			FTS	-0.257	-2.892	USREC	0.252	1.929
			ECT(-1)	-0.387	-8.731	FTS	-0.310	-3.427
						ECT(-1)	-0.379	-8.379
Lags	(4, 1, 3, 3, 0, 0, 2)		Lags	(4, 1, 1, 4, 3, 0, 4)		Lags	(4, 1, 3, 3, 3, 0, 4)	
LM(2)	0.456		LM(2)	0.660		LM(2)	0.773	
LM(4)	0.227		LM(4)	0.924		LM(4)	0.952	
RESET	0.577		RESET	0.654		RESET	0.368	

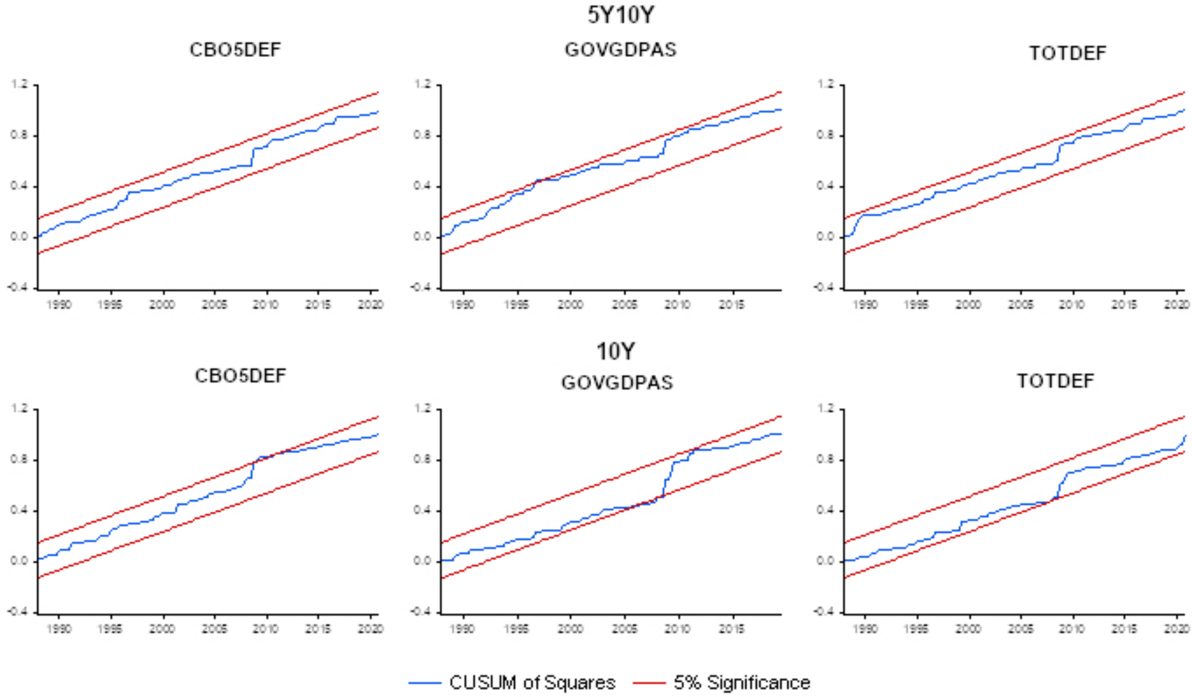
Notes: ΔX(-i) is the i lag of the first differenced variable X.

Figure 2: Results of the cumulative sum of recursive residuals (CUSUM) tests



It is also important to assess whether our results accurately reflect our theoretical model. All coefficients on expected inflation are highly significant and exceed unity. This is consistent with the theory that investors require an additional risk premium for inflation uncertainty (Ball and Cecchetti 1990; Wright 2011). The coefficients on federal reserve holdings of government debt as a percent of GDP are all significantly negative in the long run at around 28 basis points, but there is a modestly positive impact in the short run. The changes around FOMC announcement days all have significantly positive long-run coefficients for the forward rate whereas none are significant for the current rate, however, they are mostly positive and significant in the short run. With regards to the VIX, it is clear that current risk aversion has much less of an impact on forward rates than current rates. All coefficients for the VIX are significantly negative for current rates and none for forward rates. The average expected output gap over the next ten years is only significantly positive in the long run in two of the six models. However, of the four that are insignificant, they all contain positive short-run coefficients that are mostly significant. Finally, almost all coefficients on recessions are significantly positive and all coefficients on flights-to-safety are significantly negative. This could reflect greater term premiums for recessions that fall outside of flight-to-safety episodes. Overall, we believe that our theoretical model has effectively captured the long-rate setting dynamics.

Figure 3: Results of the cumulative sum of squares of recursive residuals (CUSUMSQ) tests



6 Conclusion

The existing empirical literature on the effect of government deficits on long-term interest rates is inconclusive. Using a variety of deficit measures and interest rates within a model that effectively captures long and short-term effects, we can offer clarity on why that is and how it is consistent with John Maynard Keynes' expectations-driven theory of long-term interest rates. Our results show that in the short run, market convention is that changes in the budget deficit positively alter either the path of monetary policy or the risk of holding longer duration government securities. However, the short-term increase ultimately reverts to the expected path of monetary policy as implied by the central bank. Thus, our results provide evidence for Keynes' belief that monetary policy administered by a credible central bank can overcome market convention. In the words of Keynes (1936):

> It is evident, then, that the rate of interest is a highly psychological phenomenon… The short-term rate of interest is easily controlled by the monetary authority, both because it is not difficult to produce a conviction that its policy will not greatly change in the very near future, and also because the possible loss is small compared with the running yield (unless it is approaching a vanishing point). The long-term rate may be more recalcitrant when once it has fallen to a level which, on the basis of past experience and present expectations of future monetary policy, is considered "unsafe" by representative opinion. (p. 202)

This theory rules out any notion of government borrowing raising interest rates and crowding out private borrowing in a loanable funds market since the long-term rate of interest is driven by psychological, rather than purely economic, factors. To the extent that government borrowing has any direct impact on interest rates, it would be through convention in bond markets and must be viewed as a psychological or second-order effect.

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