THE EFFECTS OF BUDGET DEFICITS ON INTEREST RATES: A REVIEW OF EMPIRICAL RESULTS

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Introduction

Economic theory yields ambiguous predictions for the effects of budget deficits on interest rates that depend on the structure of the economy. At one end of the spectrum are the small open economy and the assumptions underlying Ricardian equivalence. In the former, interest rates are exogenous and thus unaffected by any type of fiscal policy. The evidence discussed below relates mostly to the US, which is arguably too large an economy to qualify for this assumption. In a closed economy in which agents fully internalize the implications of current debt finance for the future tax burden, and in which households can freely borrow and lend, a shift in the timing of (non-distortionary) taxes to finance a given path of government spending leaves real allocations, and thus interest rates unchanged. While there is general agreement that the conditions for Ricardian equivalence do not hold exactly, whether the extent to which reality departs from these conditions implies large or negligible interest rate effects of changes in the timing of taxes is an empirical question.

Even if the necessary conditions for Ricardian equivalence do not hold, the interest rate effects of deficits remain ambiguous because observed changes in current and projected deficits are usually not the result of a pure shift in the timing of taxes. For example, the effects of a temporary change in government spending on current and future interest rates depend on the timing of the changes in government spending and, importantly, whether the government's intertemporal budget constraint will be satisfied by adjusting taxes or spending. Moreover, the manner in which the budget constraint will ultimately be satisfied is often unknown at the time of the increase in the budget deficit. Nonetheless, under plausible assumptions reviewed below an increase in the current budget deficit is predicted to raise the current interest rate.

This paper focuses on the empirical literature concerning the reduced-form relationship between interest rates and budget deficits. The main empirical problem in estimating this relationship is to control for other factors determining real interest rates, notably the response of monetary policy to the business cycle. In a setting in which the monetary authority can affect the short-term real interest rate, a monetary policy rule that responds to resource utilization combined with automatic fiscal

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stabilizers can produce a negative correlation between deficits and interest rates in the data even if an autonomous increase in the deficit through either a tax cut or a spending increase would raise interest rates. Hence the problem of endogeneity in such regressions is most likely severe (see, e.g., Bernheim, 1987) for a discussion of this issue). This paper presents a selective review of several approaches to address this problem. Gale and Orszag (2002) provide a more extensive survey of the recent literature in this area.[1] The paper's main conclusion, like Gale and Orszag's, is that studies that carefully measure expectations of both future deficits and interest rates tend to find strong evidence that increases in budget deficits raise interest rates. However, the evidence reviewed below does for the most part not permit any conclusions about the empirical relevance of the Ricardian equivalence hypothesis, as the studies do not attempt to isolate the effects of pure timing changes in taxation from the effects of changes in the path of government spending.

The following section briefly summarizes some results concerning theoretical predictions for the interest rate effects of deficits. Section 1 illustrates the point that simple regressions of current interest rates on current budget deficits yield ambiguous results, which is consistent with the view that endogeneity problems in such regressions are pervasive. The following two sections review different approaches to address this problem, primarily by using expectations measures of both deficits and interest rates, and summarize the findings. Section 5 offers conclusions.

1. Predictions from theory

In general it is difficult to obtain analytical results concerning the interest rate effects of various fiscal policies in models in which Ricardian equivalence does not hold. Two exceptions are the overlapping generations model of Diamond (1965) and Blanchard's (1985) model of perpetual youth. Diamond analyzes the effects of debt-financed government purchases, while Blanchard focuses on shifts in the timing of taxation. This section presents a simplified discrete-time version of Blanchard's model developed in Cohen and Garnier (1991) which permits the derivation of the interest rate effects of combinations of tax and spending policies. As Cohen and Garnier emphasize, this analysis shows that the effects of a current bond-financed tax cut on current and future interest rates depend on whether the government's budget constraint will be satisfied through future spending cuts or tax increases.

The key assumption in Blanchard's model is that every individual alive faces a constant probability p of dying at any point in time, regardless of his age. While this assumption excludes life-cycle behaviour, it makes the model analytically tractable in that every individual has the same marginal propensity to consume out

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[1] Gale and Orszag also review the implications of several structural macro models concerning the interest rate effects of budget deficits. Barth *et al.* (1991) review the earlier reduced-form literature.

of wealth.[2] Ricardian equivalence breaks down in this model because agents perceive that with a certain probability future taxes paying for a current tax cut will no longer fall on them. In the discrete-time version of Cohen and Garnier, every period a new cohort of size p, $0 \leq p \leq 1$ is being born, while a fraction p of the existing population of size 1 dies, so that the size of the economy remains constant. Cohen and Garnier simplify further by abstracting from physical capital accumulation and by assuming that labour is supplied inelastically, so that output is constant. Interest rates must then adjust such that the market clearing condition $Y_t = C_t + G_t$ holds.

Individuals maximize

$$E_t \sum_{s=0}^{\infty} (1+\theta)^{-s} \log(c_{t+s})$$

where throughout lower-case variables denote individual decision variables and upper-case letters their aggregate counterparts. Given that the only source of uncertainty is the time of death, this is equivalent to maximizing

$$\sum_{s=0}^{\infty} \left(\frac{1-p}{1+\theta} \right)^{s} \log\left(c_{t+s}\right)$$

Agents' flow budget constraint is given by:

$$a_{t+1} = (1+r_t)(a_t + y_t - \tau_t - c_t)$$

where a_{t+1} denotes financial assets held at the beginning of period $t+1$, and $y_t - \tau_t$ denotes after-tax labour income. Assets pay a net return r_t between period t and $t+1$. Combined with a transversality condition, the flow budget constraint can be integrated to give:

$$\sum_{s=0}^{\infty} \delta_{t,t+s} c_{t+s} = a_t + h_t$$

where the discount factor $\delta_{t,t+s} = (1-p)^s / \prod_{j=0}^{s} (1+r_{t+j})$ used to discount future consumption reflects the probability of death. The same discount factor is used in computing human wealth h_t as the present discounted value of current and future after-tax labour income. Optimal consumption is determined by:

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2 Extensions of the Blanchard model that allow for lifetime earnings profiles and age-specific mortality rates are developed in Faruqee *et al.* (1997) and in Faruqee (2003), respectively.

$$c_t = \frac{\theta + p}{1+\theta}(a_t + h_t)$$

Aggregate consumption C_t is then given by:

$$C_t = \frac{\theta + p}{1+\theta}(A_t + H_t)$$

Since there is no physical capital, financial wealth A_t is equal to government debt $(1+r_{t-1})B_{t-1}$ at the beginning of period t. By the government's intertemporal budget constraint, this must equal the present discounted value of future primary surpluses:

$$(1+r_{t-1})B_{t-1} = \sum_{s=0}^{\infty} \delta^g_{t,t+s}\left(T_{t+s} - G_{t+s}\right) \qquad (1)$$

where the discount factor for financial wealth $\delta^g_{t,t+s} = \prod_{j=0}^{s}(1+r_{t+j})^{-1}$ is higher than the discount factor for human wealth. Using the budget constraint (1), aggregate demand at date t can be expressed as:

$$C_t + G_t = sG_t - (1-s)\sum_{j=1}^{\infty}\delta_{t,t+j}G_{t+j} +$$
$$+(1-s)\left[(1+r_{t-1})B_{t-1} + \sum_{j=0}^{\infty}\delta_{t,t+j}D_{t+j}\right] + (1-s)\sum_{j=0}^{\infty}\delta_{t,t+j}Y_{t+j}$$

where $1-s = (\theta + p)/(1+\theta)$ is the propensity to consume wealth, and D_t denotes primary deficits. When $p = 0$, $\delta_{t,t+s} = \delta^g_{t,t+s}$ and the expression in square brackets in the second line is 0. When $p > 0$, current aggregate demand increases with current government spending, initial debt and future primary deficits, and decreases with future government spending. Thus, the effects of current fiscal policies depend on the whole sequence of anticipated future budget deficits and government spending.

To derive results for current and future interest rates, Cohen and Garnier divide the horizon into the present ($t = 0$), the next period ($t = 1$), and a compound period thereafter, for which variables are defined as their present discounted value as of date $t = 2$, discounted by the constancy-equivalent interest rate r. The interest rate linking periods 0 and 1 is denoted r_0, and the interest rate linking period 1 and the compound future is given by r. They derive the following results for the case that $p > 0$:

- r_0 and r, whether the increase in debt is financed by a tax increase or a cut in purchases beginning at date 1.
- A current, temporary tax cut associated with a temporary increase in debt raises r_0, but leaves r unchanged if the debt increase is paid off by a temporary tax increase at date 1, and reduces r if it is paid off by a temporary spending cut at date 1.
- A permanent tax cut financed by a permanent cut in purchases at date 2 raises both r_0 and r.

Thus, even in a model without nominal rigidities in which there is no potential influence from monetary policy on real interest rates, there is no unambiguous prediction for the interest rate effects of current deficits. At the same time, in most cases deficits do raise interest rates. Only in the case in which the increase in debt caused by a current tax cut is fully repaid by future spending cuts can deficits be associated with lower interest rates, while any policy that leaves the stock of debt persistently higher leads to higher interest rates.

2. Current deficits, interest rates and the business cycle

Simple regressions of current interest rates on current budget deficits provide a natural starting point for reviewing the empirical evidence. Table 1 reports the results from four different regressions for each of the G7 countries. The dependent variable in the first regression is a measure of the *ex ante* 10-year real government bond yield, whereas in the third and fourth regressions it is the spread between the nominal 10-year government bond yield and the 3 month Treasury bill or interbank loan rate. The regressors in each of these regressions are a constant and the negative of general government net lending (on a standardized national accounts basis) as percentage of GDP (henceforth the deficit-to-GDP ratio). Because of concerns about the stationarity properties of the data, the second regression reruns the first regression in first differences. The data is quarterly, and the sample in the first three regressions is 1970:1-2002:4, except for Canada for which deficit data begin in 1981:1.[3] The sample of the fourth regression is roughly the second half of the full sample, excluding the volatile interest rate data during the first half.

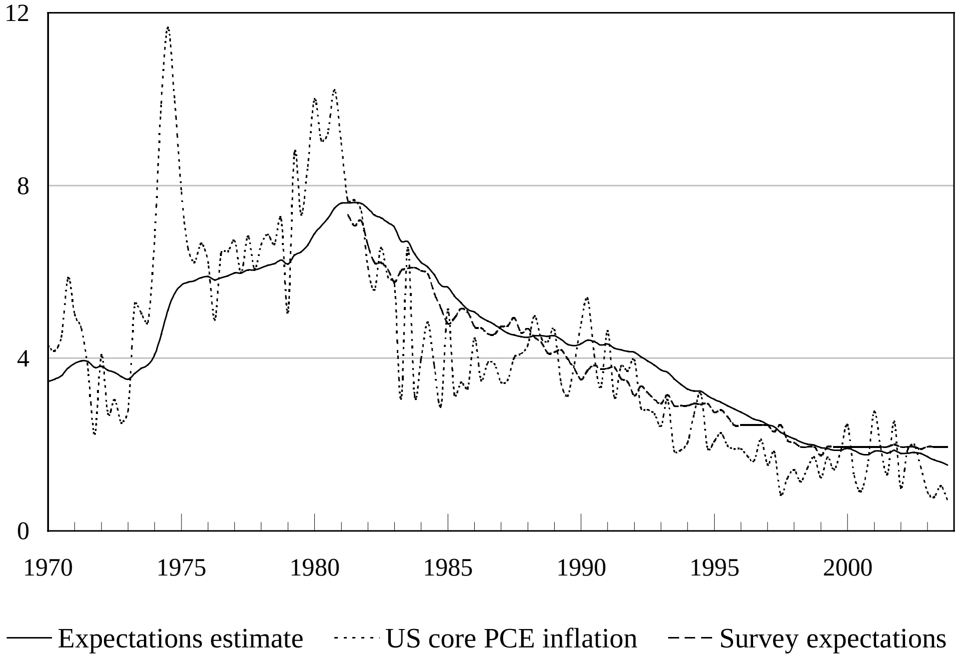
Computing *ex ante* real long-term rates requires a proxy for average inflation expectations over the life of the long bond, denoted as $\overline{\pi}_t^e$. The proxy used here is computed by setting $\overline{\pi}_t^e$ equal to actual inflation in some initial period (1965:1 for all countries except Japan, for which due to data constraints the initial period is 1970:2) and then iterating over the equation:

$$\overline{\pi}_t^e = 0.92 \cdot \overline{\pi}_{t-1}^e + 0.08 \cdot \pi_t \qquad (2)$$

3 Except for the US and Canada, the underlying data for the deficit-to-GDP ratio are for most of the sample annual data interpolated to quarterly frequency.

Figure 1

Inflation and Inflation Expectations in the US



Source: Bureau of Economic Analysis, Federal Reserve Board, author's calculations.

where current inflation π_t is quarterly inflation expressed at annual rate. The inflation measure used for the UK, France and Canada is the personal consumption deflator, for the US the personal consumption deflator excluding food and energy, and for the remaining countries the core consumer price index.

Figure 1 shows actual inflation and $\overline{\pi}_t^e$ for the US, and Figure 2 shows the same variables for the UK. Figure 1 also shows survey measures of US long-term inflation expectations from 1981:2, based on the Hoey Survey (through 1991:2) and on the Survey of Professional Forecasters (from 1991:3 onward).[4] The coefficient 0.92 on $\overline{\pi}_{t-1}^e$ is chosen so as to produce a close fit between $\overline{\pi}_t^e$ and the survey series. An advantage of the proxy $\overline{\pi}_t^e$ compared to a trend derived from applying

4 Since these surveys ask respondents about their expectations for CPI inflation, this series has been shifted down by 55 basis points to reflect the mean difference between CPI inflation and PCE inflation. For details see Laubach (2003).

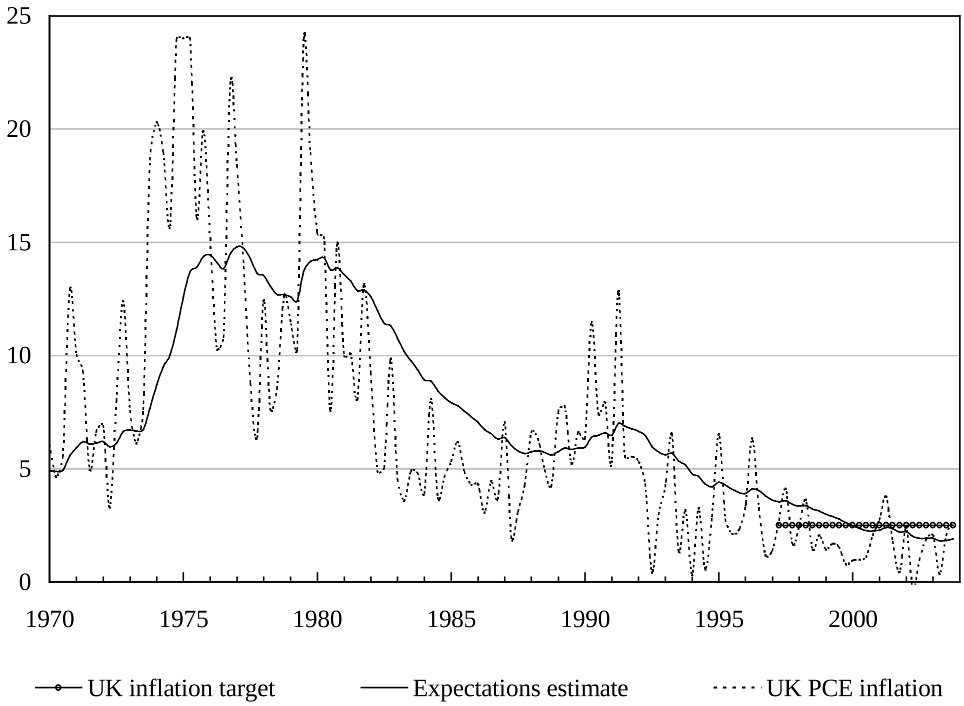
the Hodrick-Prescott filter is that the former is backward-looking, lagging behind the rise in inflation in the Seventies and the fall in inflation in the Eighties and Nineties, a feature which appears to fit the evolution of the survey expectations quite well.

One can think of equation (2) as the steady-state Kalman filter in which the public tries to discern from the observed data an unobserved inflation target that follows a random walk. Also shown in Figure 2 is the Bank of England's inflation target from the time when the Bank was granted independence from the Treasury. Inflation expectations derived from the yields on nominal and inflation-indexed UK Treasury bonds show a noticeable decline at that time. While the proxy $\overline{\pi}_t^e$ does not reproduce that fall, it nonetheless remains fairly close to the inflation target. In summary, the inflation proxies should provide a reasonably accurate measure of *ex ante* real long-term yields.

The results reported in the first column of Table 1 illustrate the problems with uncovering the relationship between deficits and interest rates. For each regression the Table reports the coefficient on the deficit-to-GDP ratio and its *t* statistic, the R^2

Figure 2

Inflation and Inflation Expectations in the UK



Source: OECD, author's calculations.

Table 1

Current Deficits and Current Interest Rates in the G7 Countries

Dependent variable	**Real 10-year yield, levels**	**Real 10-year yield, first differences**	**10-year/ 3-month spread**	**10-year/ 3-month spread**
Sample	70:1 - 02:4	70:2 - 02:4	70:1 - 02:4	85:1 - 02:4
US	.06 (.80)	–.17 (2.05)	.47 (4.04)	.31 (5.18)
	.01, .20	.05, 1.60	.26, .29	.35, .25
Japan	–.18 (2.05)	.03 (.36)	.29 (3.75)	.21 (4.89)
	.07, .08	.00, 1.84	.21, .34	.47, .37
Germany	–.18 (2.22)	–.10 (1.08)	.34 (1.79)	.07 (.43)
	.07, .15	.02, 1.30	.10, .19	.00, .11
UK	–.14 (1.70)	.02 (.46)	.25 (2.85)	.28 (3.13)
	.04, .17	.00, 1.56	.13, .29	.27, .25
France	.24 (3.24)	–.01 (.21)	–.03 (.22)	–.15 (.66)
	.15, .16	.00, 1.32	.00, .32	.02, .28
Italy	.01 (.06)	–.08 (.56)	–.11 (2.37)	–.12 (2.36)
	.00, .08	.01, 1.20	.05, .38	.16, .41
Canada	.04 (1.05)	.08 (1.02)	.07 (1.19)	.01 (.25)
	.02, .38	.01, 1.53	.02, .22	.00, .24

Notes: The first line in each cell reports the coefficient on the deficit-to-GDP ratio and in parentheses its Newey-West *t* statistic. The second line reports the R^2 and the Durbin-Watson statistic.
Source: Author's calculations.

and the Durbin-Watson statistic.[5] Except for France, the coefficients on the deficit-to-GDP ratio are either insignificant or imply (for Japan and Germany) that deficits reduce real long-term interest rates. The results in the second column are even less informative, with R^2s close to zero. The results shown in columns 3 and 4, using the 10-year-minus-3-month spread as dependent variable, appear more informative for the US, Japan, and the UK, with significant coefficients and modest R^2s, but the extremely low Durbin-Watson statistics point to misspecification of

[5] The *t* statistics need to be interpreted with caution because ADF tests for the deficit-to-GDP ratio cannot reject the hypothesis of a unit root at the 5 per cent level for all countries except Germany. By contrast, the real interest rate appears stationary for all countries except Japan, and the 10-year-3-month spread is stationary for all countries. The inability to reject a unit root for the deficit-to-GDP ratios is, however, probably a small-sample problem, as the hypothesis of a non-stationary deficit-to-GDP ratio implies that with probability 1 the government will ultimately violate its inter-temporal budget constraint.

these regressions. For the remaining countries the results continue to be uninformative. The issue of the proper definition of the dependent variable will be discussed further in section 4.

Taken at face value, the results in Table 1 do not seem to provide support for the view that budget deficits raise real long-term interest rates, and only limited support for effects on the yield spread. Apart from the issue of measuring expectations, part of the problem might be omitted variable bias. For example, Orr *et al*. (1995) perform pooled time-series regressions for 17 countries, using an error-correction framework in which the "equilibrium" long-term real interest rate is determined by the rate of return on capital, a measure of domestic bond portfolio risk, and the current account balance in addition to the deficit-to-GDP ratio. The coefficients on the long-run determinants are constrained to be identical across countries. Using quarterly data for the period 1981:2-1994:2, they find that, all other factors equal, the long-run effect of a percentage point increase in the deficit-to-GDP ratio on long-term real rates is a 15 basis point increase. Yet adjustment of actual to equilibrium real interest rates is very slow, suggesting that little of the variation in actual interest rates is explained by variations in the equilibrium rate.

3. The role of expectations of future budget deficits

Because current long-term interest rates depend on expected future short-term rates, if budget deficits raise interest rates it is not only current, but also expected future budget deficits that affect today's long-term rates (an observation going back at least to Feldstein, 1986). Moreover, as discussed above, the simultaneous response of monetary policy and automatic fiscal stabilizers can in principle mask the effect of budget deficits on interest rates. To identify the interest rate effects of budget deficits that are not caused by cyclical responses of fiscal policy, the empirical studies discussed below have pursued two alternative approaches. The first approach is event analysis, focussing on changes in asset prices on the day of the release of new information (such as official projections) about the future budget outlook. The main issue here is to correctly identify the unanticipated component of the release. The second approach is to reduce the cyclical influences on the deficit-interest rate relation by using current projections of future deficits; at a sufficiently long horizon, these projections are presumably not much influenced by events that independently affect current interest rates, thus mostly eliminating the endogeneity problem.[6]

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6 Another alternative is to use cyclically adjusted budget balances. These balances are usually constructed by cyclically adjusting separately the components of revenues and outlays, and then aggregating up the cyclically adjusted components (see, e.g., Giorno *et al.*, 1995). However, using cyclically adjusted instead of actual balances in the analysis reported in Table 1 has very little effects on the results.

As will be discussed below, obtaining measures of expected future deficits is quite difficult. Unlike other macroeconomic variables, many fiscal variables, which are determined by a political process, do not appear to be modelled well by standard linear methods. The first subsection reviews results of studies that nonetheless rely on such methods. The second subsection discusses studies that employ publicly available budget projections based on the analysis of current and announced future fiscal policies.

3.1 VAR expectations

The studies in this area focus on the effects of unexpected innovations in fiscal variables, such as debt per capita (Plosser 1982, 1987) or the deficit-to-GDP ratio (Evans 1987a, b), on interest rates, where expectations are derived from VARs. Plosser (1982, 1987) takes as point of departure a model for the one-period nominal interest rate on a risk-free asset, such as a one-month Treasury bill:

$$R_{1,t} = a(L)X_t + \varepsilon_t \tag{3}$$

where X_t is a vector of variables that determine the one-period interest rate including measures of output, inflation, government spending, money supply and government debt, and ε_t is a white-noise error. Combining this process with the expectations hypothesis, and omitting constant term premia, the excess holding period return $H_{n,t+1}$ on an *n*-period bond held between periods t and $t+1$ over the one-period return $R_{1,t}$ can be expressed as:

$$H_{n,t+1} - R_{1,t} = \beta(X_{t+1} - E_t X_{t+1}) + e_t \tag{4}$$

Under the linear term structure model employed, the left-hand side of equation (4) is an expectational error, implying that only information orthogonal to the date t information set affects the excess return.

The key assumption for the empirical implementation of equation (4) is that the process X_t follows a VAR:

$$X_t = A(L)X_{t-1} + \eta_t$$

Regressing the excess holding period returns on the one-step-ahead prediction errors of the elements of X_t then allows to assess the effect of fiscal variables on interest rates. Using monthly data for the period 1968-85, Plosser (1987) finds that for maturities between 2 months and 10 years the one-step-ahead prediction errors for real debt per capita enter equation (4) insignificantly, and for the later subsample with a positive sign, raising excess holding period returns and thus reducing interest rates. To address Feldstein’s (1986) observations that expected future deficits are likely to be more persistent and thus have larger effects on interest rates, he computes multi-year forecasts of real debt per capita using the VAR. Again the deficit forecasts enter with a positive sign.

Evans (1987a) starts by specifying a structural equation for the short-term interest rate that includes lagged interest rates as well as lagged, current and expected future values of a number of other variables, including the real budget deficit. He then argues that standard macroeconomic theory implies that the coefficients on all leads and lags of the deficit should be positive. Using again a VAR to model expectations of the variables other than the interest rate he shows that, if all coefficients on the deficit in the structural equation are positive, so must be the sum of coefficients in the reduced form obtained from replacing the expectations by their VAR predicitions. For the nominal and *ex post* real commercial paper rate as well as a corporate bond yield, and using data spanning the period 1908-84 and various subsamples, he finds that the sum of coefficients on the deficit is almost always negative, and sometimes statistically significant.[7]

To assess whether his results are due to the fact that economic agents have a larger information set than the VAR, Evans examines the residuals from the fitted interest rate equations during the 12 months leading up to major tax changes. He argues that individuals were probably anticipating that these tax measures would be passed, information that is not contained in the VAR forecasts. If deficits raised interest rates, the residuals of the interest rate equation should be negative during the 12 months leading up to a tax increase (which is expected to reduce deficits) and positive before a tax cut. Identifying 18 tax cuts and 27 tax hikes during his sample, he finds no evidence that the residuals behave in this way. His conclusion is that deficits, whether current or expected, do not affect interest rates.

The most important criticism of this literature is that VAR expectations are probably poor measures of agents' expectations for many variables, particularly for budget deficits. These expectations can change dramatically, for example during war times, or more recently following the Reagan and Bush tax cuts. This information is not captured by VAR forecasts. Elmendorf (1993) examines the performance of VAR forecasts of several variables, including budget deficits, relative to forecasts for the same variables published by Data Resources, Inc. (DRI) since 1971. He shows that the DRI forecasts seem to be much better proxies of expectations than the VAR forecasts. In particular, VAR forecasts are by construction extrapolating the past and do not allow for learning nor for incorporating non-quantitative information which may be important for the fiscal outlook. When replacing the VAR proxies for future deficits by the DRI forecasts, he shows that the findings of the studies by Plosser (1987) and Evans (1987a) discussed above are overturned. Thus, their conclusion that budget deficits do not raise interest rates seems to be a figment of the poor measurement of expected future deficits. Elmendorf also argues that Evans' (1987a) test of the residuals of his interest rate equations prior to tax changes is uninformative because the residuals contain unmeasured expectations of many variables, and could therefore easily be uncorrelated with tax changes.

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[7] Evans (1987b) reports similar results for a set of six countries.

3.2 Published budget projections

Most of the evidence discussed in this section refers to the US only, as there are several institutions producing budget projections, some of them publicly available. Two of these, namely the projections published by the Congressional Budget Office (CBO) and the Office of Management and Budget (OMB), deserve particular mention. Since its establishment in the mid Seventies, the CBO has published projections for the federal budget deficit as well as detailed components of spending and outlays five years into the future (ten years beginning in 1992). With few exceptions, the projections have been released each year in January or February in its Budget and Economic Outlook, and mid-year updates have been released in the summer. Its baseline projection is by statute predicated on the continuation of current legislation, including specific assumptions about future discretionary spending. The OMB is responsible for publishing the President's budget in early February of each year (in April for years in which a new administration takes office), and publishes mid-session updates usually in July. While OMB projections have been available for a longer time than CBO projections, only since 1983 has OMB published projections at a five-year horizon. In contrast to the CBO's baseline, the OMB's projections reflect the policies proposed by the administration rather than current policies.[8] Many private sector analysts use either the CBO or OMB projections as the starting point for their own analyses. Thus, while market expectations do not necessarily coincide with either the CBO or the OMB projections, arguably these projections are the most important pieces of information shaping market views about future budget deficits.

One of the earliest studies using deficit projections is Wachtel and Young (1987). In the spirit of event studies, these authors focus on the change in long-term interest rates on the day of the release of CBO and OMB projections. Their results depend on correctly identifying the unanticipated component of the release, which they identify with the change in the projection for a particular period from the previous release. They consider a sample of ten OMB projections and 12 CBO projections released between 1979 and 1986, at the horizons of the current fiscal year as well as one and two years ahead. Considering interest rates at maturities between three months and 30 years, they find that a $1 billion increase in the projected deficit (at that time roughly 0.025 percent of nominal GDP) raises interest rates by between 0.15 and 0.4 basis points, depending on the maturity of the interest rate series and the source of the projections. Their estimates therefore imply an increase in interest rates on the order of 6 to 16 basis points in response to a percentage point increase in the deficit-to-GDP ratio. Not all of their estimates are statistically significant. Similarly to Wachtel and Young, Kitchen (1996) studies the

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8 Both CBO and OMB publish projections for the unified budget balance as well as its separate components, the on-budget and off-budget balances. The latter reflects mainly the balance of revenues and outlays in the Social Security trust funds. All the studies discussed here focus on the unified budget balance, which is the relevant measure of the federal government's borrowing needs in capital markets.

effects of 37 OMB releases between 1981 and 1994 on various asset prices, including Treasury securities with maturities between three months and 30 years. He finds very small effects, on the order of 1 to 5 basis points per percentage point increase in the current or projected (averaged over several years) budget deficit.

In another event study, Elmendorf (1996) examines events surrounding the passage of the Gramm-Rudman-Hollings deficit reduction act in 1985 and the Budget Enforcement Act in 1990. Although his method does not allow him to quantify the size of the effects on real interest rates, he nevertheless can reject at the 1 per cent confidence level the hypothesis that real interest rates were unaffected by changes in the outlook for budget deficits: events that made passage of either of these two laws less likely raised interest rates, and events that made passage more likely reduced them.

Cohen and Garnier (1991) and Elmendorf (1993) present results concerning the effect of deficit projections on the change in interest rates between release dates. These studies are based on the weaker assumption (in comparison to Wachtel and Young's) that the deficit projections are good proxies of private agent's expectations of future fiscal policy at the time of the release. As in Wachtel and Young, the projections used in these studies are relatively short – for the current and next calendar year in Cohen and Garnier, for up to eight quarters ahead in Elmendorf. Forecasts at this horizon are still affected by the state of the business cycle. Using the spread between 10-year and 1-year nominal Treasury yields as dependent variable and OMB projections during the period 1971-90 as regressors, Cohen and Garnier find statistically significant impact effects of a percentage point increase in the current prediction error of the deficit-to-GDP ratio on the spread on the order of 40 to 55 basis points. Using DRI forecasts published during the period 1971:4-1987:3, Elmendorf finds a statistically significant increase in interest rates at maturities up to five years of about 50 basis points, but the effects on long-term interest rates are smaller and statistically insignificant.

The studies discussed so far (except Elmendorf, 1996, who uses a different methodology) all use budget projections at short horizons, at most two years ahead. Canzoneri *et al*. (2002) extend previous work by using deficit projections from the CBO at substantially longer horizons – either five or ten years ahead. The longer projection horizon should help to identify the interest rate effects of budget deficits because, compared to current deficits, it is less likely that changes in deficit projections at long horizons are driven by events other than autonomous fiscal policy changes that jointly determine those projections and current interest rates. The dependent variables used by these authors are a constant and either the 5-year-minus-3-month or the 10-year-minus-3-month government yield spread. For semi-annual projections at the 5-year horizon published between 1984 and 2002, as for projections at the 10-year horizon over the shorter sample 1992-2002, the authors find statistically significant effects on the 5-year spread of 52 to 60 basis points, and on the 10-year spread of 41 to 45 basis points. Compared to previous studies, their estimates are considerably more precise, indicating that indeed the focus on the longer projection horizon facilitates identification of the interest rate effects.

4. The role of expectations of future interest rates

If, all else equal, budget deficits at some future date raise short-term interest rates at that date, the expectation of such future budget deficits raises long-term interest rates today. However, their effect on current long-term interest rates may be masked by movements at the short end of the yield curve driven by current and expected future monetary policy actions. Developments in the US over the past three years illustrate this point, when short-term and long-term interest rates fell to levels not seen in decades despite a dramatic deterioration in the fiscal outlook. Bernheim (1987) emphasizes that the analysis must focus on expected future interest rates in order to properly identify the effects of projected deficits. This section argues that, once interest rates are measured at the long end of the yield curve, the effects of expected future deficits become much clearer.

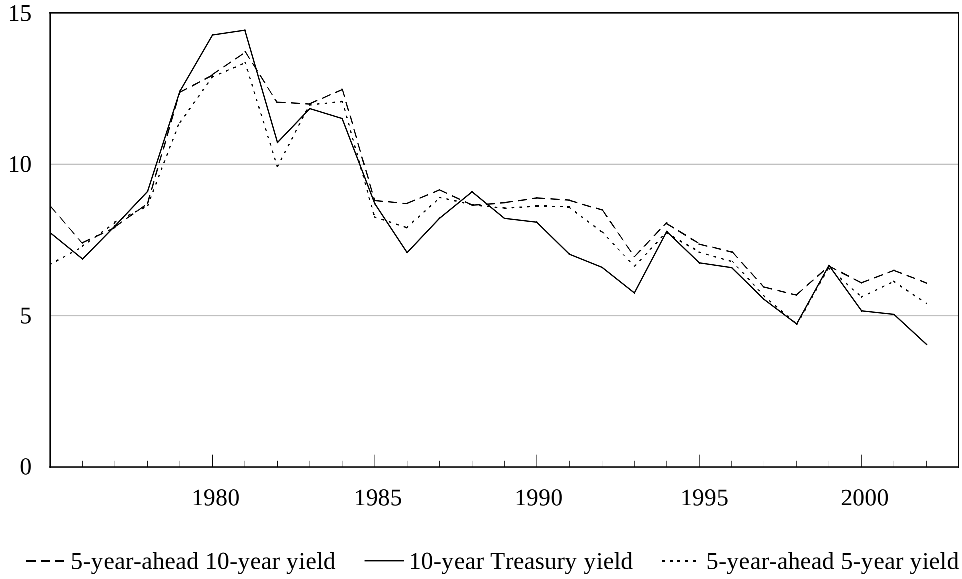
The use of a yield spread instead of the level of some long-term interest rate can be viewed as a first step in controlling for the short end of the term structure. The results by Cohen and Garnier (1991) and Canzoneri *et al.* (2002) suggest that doing so helps to identify the interest rate effects of budget deficits. This issue is taken up directly in Laubach (2003), where the dependent variable is a measure of expected future long-term interest rates rather than a spread. These expectations are derived from estimated forward rates from the zero-coupon yield curve. Figure 3 shows two of these measures: the 5-year Treasury yield expected to prevail five years into the future is obtained by averaging over 1-year-forward rates five to nine years ahead, and the 10-year Treasury yield expected to prevail five years into the future is obtained by averaging forward rates five to 14 years ahead. Observations are sampled at the end of months in which the CBO projections used in the regressions below were released. As can be seen, these expected future interest rates show considerably less of a decline during the two most recent recessions than the 10-year (constant maturity zero-coupon) Treasury yield.

Table 2 presents results from Laubach (2003) that illustrate the importance of using expected future interest rates. Compared to the studies discussed above, there are a few additional regressors included in these regressions. The dependent variable in each case is a nominal interest rate, and inflation expectations are included as a regressor with a coefficient not constrained to 1. Inflation expectations are measured by the survey expectations shown in Figure 1. The coefficient on expected inflation is always estimated to be larger than 1, possibly reflecting a demand by investors for increased risk premia on nominal assets to compensate for greater uncertainty about future inflation when the current level of inflation is elevated. Moreover, Feldstein (1976) points out that, because taxes are levied on nominal returns, nominal interest rates have to increase more than one-for-one with expected inflation.

A prediction of the neoclassical growth model is that trend growth and risk aversion should play a role in determining yields on risk-free Treasury instruments: an increase in trend growth should raise interest rates, whereas an increase in risk

Figure 3

Current and Expected US Long-term Interest Rates



Source: Federal Reserve Board, author's calculations.

aversion should lower Treasury yields because it raises the demand for safe assets.[9] Three of the regressions reported in Table 2 therefore include both CBO's 5-year-ahead projections of the growth rate of real GNP or GDP as a proxy for agents' views about the trend growth rate of the economy at a given point in time, and the equity premium as a proxy for risk aversion. The equity premium is calculated as the dividend component of national income, expressed as a percent of the market value of corporate equity held (directly and indirectly) by households, minus the real 10-year Treasury yield, plus the trend growth rate. Details of all the data used are provided in Laubach (2003).

The sample includes the 28 annual CBO releases between 1976 and 2003; the mid-year updates are omitted, but results are very similar when they are included. The first column in Table 2 shows the basic result: a percentage point increase in the deficit-to-GDP ratio projected five years ahead raises the 5-year-ahead 10-year yield by 23 basis points, and the associated *t* statistic exceeds 4. Although trend growth does not enter significantly in any of the regressions reported in Table 2, it does so in other regressions reported in Laubach (2003) and is retained for the theoretical

9 In a closed economy, an increase in the trend growth rate implies a faster rate of decline in marginal utility, and hence a higher real return on capital as consumers demand a higher return on savings to forgo consumption today. The real interest rate therefore rises, and the desired capital-output ratio declines.

Table 2

Effects of Projected Deficits on Current and Expected Interest Rates

Dependent variable	5-year-ahead 10-year yield	5-year-ahead 10-year yield	5-year-ahead 5-year yield	Current 10-year yield
Expected inflation	1.19 (5.63)	1.23 (9.62)	1.21 (5.94)	1.62 (7.13)
Projected deficit/GDP	.23 (4.17)	.21 (3.96)	.19 (2.38)	.09 (1.40)
Trend growth	.68 (1.53)	-	.65 (1.40)	.73 (1.25)
Equity premium	–.40 (4.30)	-	–.50 (3.66)	–.72 (4.93)
R^2	.92	.89	.90	.93
Standard error	.69	.80	.79	.76
Durbin-Watson	2.05	1.57	1.50	1.47

Notes: Newey-West *t* statistics in parentheses.
Source: Laubach (2003).

reasons discussed above. A percentage point increase in the equity premium reduces expected future long-term interest rates by 40 basis points. Column 2 shows that the coefficient estimate for the deficit-to-GDP ratio and its *t* statistic are little affected by inclusion of the additional regressors. The R^2 of the regressions are high, close to 0.9, although this is partly due to including expected inflation as an unconstrained regressor. Even when the dependent variable is nominal interest minus expected inflation, the R^2 is 0.7, with a coefficient on the deficit-to-GDP ratio of 0.28 and a *t* statistic of 12.

By comparing the results across columns 1, 3 and 4, the effect of properly controlling for monetary policy's influence on the short end of the yield curve becomes evident. When using the simple 10-year Treasury yield as dependent variable, for example, the coefficient on the deficit-to-GDP ratio is only 9 basis points, and the estimate is no longer significant at conventional levels. As shown in Laubach (2003), these results become even sharper when the projected primary deficit-to-GDP ratio is used instead of the deficit-to-GDP ratio including net interest payments. Moreover, the results remain robust when the early part of the sample is omitted.

5. Conclusions

This paper argues that the diversity of the reduced-form evidence concerning the interest rate effects of budget deficits is closely linked to the issue of measurement of expectations. For the G7 countries it shows that simple regressions of current long-term interest rates on current deficit-to-GDP ratios provide no support for a role of deficits in interest rate determination. Next, it discusses the measurement of expectations of future deficits: studies that use projections from small-scale VARs to proxy these expectations find no effects, while studies using published official or private forecasts are more successful. Finally, it is important to extend the measurement of expectations to interest rates as well so as to abstract from monetary policy's influence on long-term rates through the short end of the yield curve. Regressions of expected future long-term rates on expected future deficit-to-GDP ratios produce economically plausible and statistically significant estimates of the effects of deficits on interest rates.

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