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**New Evidence on the Interest Rate Effects of Budget Deficits and  
Debt**

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# New Evidence on the Interest Rate Effects of Budget Deficits and Debt

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## Abstract

Estimating the effects of government debt and deficits on Treasury yields is complicated by the need to isolate the effects of fiscal policy from other influences. To control for the effects of the business cycle, and associated monetary policy actions, on debt, deficits, and interest rates, this paper studies the relationship between long-horizon forward rates and future federal government deficits and debt as projected by the Congressional Budget Office. For the entire 30-year sample for which these projections are available, the estimated effects of government deficits and debt on interest rates are statistically significant and economically relevant: about 25 basis points per percentage point increase in the projected deficit/GDP ratio, and 3 to 4 basis points for the debt/GDP ratio. Under plausible assumptions the parameter estimates are shown to be consistent with predictions from the neoclassical growth model.

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# 1 Introduction

Much controversy surrounds the quantitative effects of government debt and deficits on long-term real interest rates. Economic theory provides different answers depending on issues such as whether deficits reflect changes in government expenditures or shifts in the timing of taxes, and on the planning horizon of households who hold government debt and pay taxes. One might hope that empirical evidence could be brought to bear on this question, but here the results are just as ambiguous. One major obstacle in obtaining empirical estimates is the need to isolate the effects of fiscal policy from the many other factors affecting interest rates. The most obvious of these factors is the state of the business cycle. If automatic fiscal stabilizers raise deficits during recessions, while at the same time long-term interest rates fall due to monetary easing, deficits and interest rates may be negatively correlated even if the partial effect of deficits on interest rates – controlling for all other influences – is positive.

This paper proposes to address this identification problem by focusing on the relationship between long-horizon expectations of both interest rates and fiscal variables. Deficits, debt, and interest rates expected to prevail several years in the future are presumably little affected by the current state of the business cycle, thus greatly reducing the reverse-causality effects induced by countercyclical monetary policy and automatic fiscal stabilizers. Of course, there are many conceivable factors that jointly determine fiscal variables and interest rates, and it is unlikely that a reduced-form regression would ever completely overcome this endogeneity problem, but focusing on long-horizon expectations is an important step in the right direction. Deficits projected several years into the future may be informative about the longer-run fiscal position, and may therefore approximate investors' expectations about the eventual level of government debt relative to GDP. Such measures of expectations thus hold out the prospect of uncovering any causal relationship from fiscal variables to interest rates.

Expectations of future fiscal policy are proxied in this paper by projections published by the Congressional Budget Office (CBO) for the federal government's unified budget deficit, the stock of federal government debt held by the public, and other fiscal variables, all expressed as percentages of projected GNP or GDP. The forecast horizon is five years in the future, which is the longest horizon for which a reasonably long time series of projections is available. Consistent with the use of 5-year-ahead projections of fiscal variables by the

CBO, the analysis focuses on forward rates 5 years ahead embedded in the term structure of interest rates.

The results reported below show that a percentage point increase in the projected deficit-to-GDP ratio raises the five-year-ahead 10-year forward rate by 20 to 29 basis points; a typical estimate is about 22 basis points. The estimates are precise compared to most of the literature mentioned below. Similarly, a percentage point increase in the projected debt-to-GDP ratio raises the forward rate by about 3 to 4 basis points, and these estimates are statistically significant, too. These estimates are shown to be robust along many dimensions.

This study is by no means the first to use published projections of future budget deficits. Wachtel and Young (1987) use projections by the CBO and the Office of Management and Budget (OMB) to analyze *changes* in long-term interest rates on the day of the release of the respective projection.<sup>1</sup> Unlike those shown here, their results therefore depend on correctly identifying the unanticipated component of the release. 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. However, many of their estimates are statistically insignificant.

Cohen and Garnier (1991) and Elmendorf (1993) present results concerning the effect of deficit projections on the change in interest rates between release dates. Like the present one, 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. The projections used in these studies, as well as in Wachtel and Young, are relatively short – for the current and next fiscal year in Wachtel and Young and in Cohen and Garnier; for up to eight quarters ahead in Elmendorf. Forecasts at this horizon are presumably still affected by the state of the business cycle. Using OMB projections, Cohen and Garnier find statistically significant effects of a percentage point unexpected (relative to the previous year's projection) increase in the deficit-to-GDP ratio on interest rates on the order of 40 to 55 basis points. Using DRI forecasts, 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

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<sup>1</sup>Other studies using similar event analysis are Elmendorf (1996) and Kitchen (1996).

insignificant. Canzoneri, Cumby, and Diba (2002) use 5-year-ahead and 10-year-ahead CBO projections of cumulative budget deficits and study their effects on the *spread* between 5-year or 10-year, and 3-month Treasury yields. Their estimates are of similar magnitude as those reported in Cohen and Garnier and in Elmendorf, but are considerably more precise.<sup>2</sup>

The present study confirms the importance of carefully measuring long-horizon expectations of deficits and debt for identifying their effects on interest rates.<sup>3</sup> It departs from the previous studies in several respects, notably by using long-horizon forward rates as the dependent variable instead of current long-term rates or the slope of the yield curve. In comparison to previous studies, it also examines the role of additional regressors suggested by economic theory.

The specifications and the data used in the empirical analysis are introduced in sections 2 and 3, respectively. Baseline empirical results are presented in section 4. Because economic models differ in their view on whether deficits or the stock of debt is what matters for interest rate determination, I present results concerning the effects of both projected deficits and projected debt on interest rates. Taking the view that what ultimately matters is the stock of debt, Feldstein (1986) argues that empirical estimates of the interest rate effects of *deficits* depend on how persistent these deficits are expected to be. The relative magnitudes of the estimated effects of deficits and the estimated effects of debt reported below are shown to be consistent, under this view, with the observed historical autocorrelation of actual deficits.

Section 5 examines the importance of using fiscal and interest rate *projections* by comparing results to those obtained using current long-term interest rates and current fiscal variables. As shown there, removing the short end of the yield curve by focusing on long-horizon forward rates improves substantially the precision of the estimates of the interest

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<sup>2</sup>Another strand of literature has focused on international evidence on the effects of deficits and debt on interest rates, see e.g. Ardagna et al. (2004) and Faini (2006). Because of the limited (if any) availability of term structure estimates and of fiscal projections for countries other than the U.S., these studies are confined to the relationship between current long-term interest rates and current fiscal conditions. On the other hand, they can address the critical question of spillover effects from one country's fiscal policies to interest rates abroad.

<sup>3</sup>This point is illustrated in Elmendorf (1993). He examines the findings of studies that proxy for expectations of fiscal variables by using forecasts from VARs (see Plosser 1982, 1987, and Evans 1987). Elmendorf shows that these VAR forecasts are poor compared to projections available at the time, and that the conclusions of these studies are overturned once better measures of expectations are used. For a taxonomy of studies in this area according to their measurement of expectations see Gale and Orzsag (2002).

rate effects of the fiscal variables. Given the historically large forecast errors in 5-year projections for deficits and debt, section 5 also examines whether these projections can be considered as proxies for market expectations of deficits and debt. Section 6 addresses several issues concerning the robustness of the baseline results. Excluding measures of near-term economic conditions from the basic specification is found to be consistent with the data. Stability tests reveal substantial evidence for time variation in the effects of fiscal variables. For the regressions including debt, the evidence suggests a break in the mid-1980s, but the estimate for the later subsample is close to the full-sample estimate, whereas for the early subsample it is substantially higher. By contrast, the break in the relationship between deficits and interest rates has most likely occurred in the late 1990s. Since then, this relationship is estimated to have been *negative*, likely pointing to omitted variable problems associated with the unusual behavior of long-term yields and distant forward rates over recent years.

Section 7 discusses the predictions of the neoclassical growth model – the simplest general equilibrium framework for this purpose – for the relationship between the stock of debt and interest rates. Under plausible assumptions, the empirical results are close to the predictions from this model. Section 8 concludes.

## 2 Specification

Economic theory provides some guidance as to the determinants of long-term interest rates to be included in empirical analysis. A useful benchmark is the Ramsey model of optimal growth. Combined with a representative household with CES utility, it implies that in a deterministic steady state the real rate of return on capital net of depreciation is determined by

$$r = \sigma g + \theta \tag{1}$$

where  $g$  denotes the net growth rate of per capita consumption,  $\sigma$  is the inverse of the intertemporal elasticity of substitution, and  $\theta$  is the household's rate of time preference. The rate of return depends positively on all three of these parameters.

There are three issues that need to be addressed in moving from equation (1) to a regression of Treasury yields on fiscal variables. Most obviously, fiscal variables do not appear in (1). In closed-economy models, variations in the path of government spending

typically affect interest rates regardless of the mechanism by which they are financed, as the representative household has to be induced to adjust its consumption profile over time. However, government deficits or debt may reflect not only changes in the path of government spending, but also shifts in the timing of the taxes necessary to finance a given path of government spending. Shifts in the timing of taxes affect interest rates only if there is some departure from the paradigm of Ricardian equivalence. Examples of models featuring such departures are Blanchard’s (1985) model of finite horizons and models with distortionary taxation, such as Mankiw (2000). Which fiscal variable is relevant for interest rates depends then on the particular model. The regression analysis below therefore considers several alternatives.

A second issue is that equation (1) provides an expression for the rate of return on capital, which might be thought of as being more applicable to stocks than to Treasury securities. Whereas an increase in risk aversion should increase the real rate of return on capital, its effect on the yield of nearly risk-free Treasury securities is ambiguous. By raising the demand for safe assets relative to that for risky ones, greater risk aversion will raise the spread of risky over risk-free yields, which may *reduce* Treasury yields. Some of the regressions presented below therefore include proxies for time variation in risk aversion. Further details will be discussed when describing the data.

The third issue is the endogeneity problem referred to in the introduction. In neoclassical models with nominal rigidities, the short-term real interest rate  $r_t = i_t - E_t\pi_{t+1}$  can deviate from the “natural” rate of interest  $r_t^*$ , the real interest rate that would prevail absent nominal rigidities (see Woodford, 2003, for a comprehensive exposition). Suppose that

$$r_t^* = \alpha + \beta f_t + u_t \tag{2}$$

where  $f_t$  is the given measure of fiscal policy, and  $u_t$  denotes other factors affecting the natural rate such as those shown in (1). The observed real short-term interest rate can then be written as

$$r_t = \alpha + \beta f_t + u_t + (r_t - r_t^*) \tag{3}$$

Since the real-rate gap  $r_t - r_t^*$  is unobserved, it is subsumed in the residual of a regression of the current interest rate on fiscal factors. The endogeneity problem arises in a setting in which the real rate gap varies over time due e.g. to countercyclical monetary policy, while automatic stabilizers induce cyclical variation in the fiscal variable  $f_t$ . However, due

to the temporary nature of nominal rigidities, for sufficiently long horizons  $k$  the real rate gap should vanish in expectation, i.e.  $E_{t-k}(r_t - r_t^*) = 0$ . This paper therefore proposes to address the endogeneity problem by focusing on expectations of interest rates and fiscal variables sufficiently far into the future. Based on these considerations, the regressions reported in the next section are of the form

$$E_t i_{t+k} = \beta_0 + \beta_1 E_t \pi_{t+k} + \beta_2 E_t f_{t+k} + \beta_3 E_t u_{t+k} + \epsilon_t \quad (4)$$

where the dependent variable is the long-term *nominal* interest rate expected to prevail  $k$  periods ahead, the coefficient  $\beta_1$  on expected inflation can be different from 1, and  $u_t$  denotes additional regressors. The main interest is in the magnitude and statistical significance of  $\beta_2$ .

### 3 The Data and Their Stationarity Properties

I now briefly discuss the data used in this study; more details can be found in the appendix. Three different interest rate series are used as dependent variables. They are the five-year-ahead 10-year forward rate, the five-year-ahead 5-year forward rate, and the 10-year constant maturity Treasury yield.<sup>4</sup> The first two are calculated from the zero-coupon yield curve as described in the appendix. These forward rates include term premia in addition to expectations of the 10-year or 5-year Treasury yield, and can thus not be interpreted as that expectation only. But insofar as an increase in term premia affects real allocations similarly to an increase in expected future short-term interest rates, distinguishing between the effects on these two components of the forward rate is not essential.<sup>5</sup> Time variation in term premia means that expected interest rates are measured with error. If the coefficients

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<sup>4</sup>This study focuses on government yields, and the question arises to what extent budget deficits and debt affect corporate yields. Corporate yield curve estimates, and hence long-horizon corporate forward rates corresponding to the Treasury series, are not available for a sufficiently long period. Based on regression analysis, I find no evidence that yield spreads between corporate bonds and Treasuries, adjusted for cyclical variation, are systematically related to projected deficit-to-GDP ratios. By contrast, Krishnamurthy and Vissing-Jorgensen (2007) argue that increases in Treasury debt held by the public lead to a decline in the yield spread of AAA corporate debt over Treasuries, which suggests a muted transmission to corporate yields.

<sup>5</sup>Dai and Philippon (2005) estimate an affine term structure model in which they include fiscal variables as factors. This allows them to disentangle the effects of fiscal variables on expected future short-term rates and on term premia.



are interpreted as measuring the effect of the regressors on expected future long-term interest rates, this measurement error leads to less precise, but still unbiased, coefficient estimates as long as the time-varying term premia are orthogonal to the regressors.

To control for the effect of inflation expectations on long-term nominal interest rates, a measure of inflation expectations of matching maturity is needed. The measure used here is based on surveys of long-horizon inflation expectations by market participants and professional forecasters, except for the 1970s; details are provided in the appendix. The interest rate data are sampled on the last trading day of the month of the CBO release, whereas the inflation expectations are for the month of the release. The series of nominal interest rates and expected inflation are shown in Figure 1.<sup>6</sup>

From the CBO, five-year-ahead projections for both the unified budget deficit and GDP (GNP until 1991) are available at an annual frequency from 1976 to 1984, and at a semi-annual frequency from 1985 until August 2006. For the early years, the CBO did not publish projections for federal debt held by the public; those projections are therefore computed by adding the CBO's deficit projections for the current and next five fiscal years to the stock of debt held by the public at the end of the previous fiscal year. Projections for net interest payments and total outlays are also collected to analyze the effects of primary deficits or of outlays and revenues separately.

Figures 2 and 3 show the actual deficit-to-GDP ratios and debt-to-GDP ratios, expressed as percent of GDP, together with the CBO's current-year and five-year-ahead projections. The projections are shown for the (fiscal) year for which they were made. The forecast errors are large: For the period for which the 5-year-ahead projections can be evaluated (i.e. projections made for fiscal years 1981 to 2006), the RMSE for the current-year deficit/GDP projection is 0.84%, whereas the RMSE for the 5-year-ahead projection is 4.7%; the corresponding numbers for the debt/GDP projections are 2.16% and 14.7%. At the five-year horizon, the largest surprises are associated with the deficits during the early Reagan years, the emergence of surpluses in the late 1990s, and the subsequent return to deficits. While these forecast errors are large, the relevant question for the purpose of this study is whether these agency projections are useful proxies for market expectations at the time the projections were published. Arguably these projections are using most of the information about

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<sup>6</sup>As discussed in the next paragraph, until 1984 the CBO projections are at annual frequency. The mid-year observations for those years shown in Figure 1 are those for the last trading day of July.

future deficits and debt available at the time, although not with the objective of forming the most accurate forecast: The CBO's baseline projections are by statute based on fiscal policies that have been enacted at the time the projection is made, irrespective of whether a continuation of the current policies is likely or not.<sup>7</sup> In section 5 I will return to the question of the information value of these projections.

Two sets of regressors other than fiscal variables are considered in the analysis. First, the relationship (1) implies that the per capita consumption growth rate  $g$  and the coefficient of relative risk aversion  $\sigma$  determine the steady-state real interest rate. As a proxy for expected trend consumption growth, I use the CBO's 5-year-ahead projections of the growth rate of real GNP or GDP. Concerning relative risk aversion, a considerable amount of anecdotal evidence suggests that time variation in attitudes toward risk may be an important determinant of Treasury yields, which are widely perceived as "safe haven" assets. The decline in long-term Treasury yields during the Russian default and the LTCM crisis in the autumn of 1998 is a good example. Unfortunately, no direct measure of risk attitudes is available. A measure of expected excess returns of risky over riskfree assets might reflect time variation in risk aversion. For the purpose of this study I use the dividend yield, defined as the dividend component of national income divided by the market value of corporate equity held (directly or indirectly) by households as reported in the Federal Reserve Board's Flow of Funds data. This measure is broader, but otherwise quite similar to the dividend yield measure based on the CRSP value-weighted portfolio that is widely used in the finance literature. Details about this, and alternative, measures of risk aversion are presented in the appendix. The series of projected GDP growth and the dividend yield are shown in Figure 4.

A second set of regressors is motivated by the concern whether the use of long-horizon forward rates as dependent variables justifies the omission of regressors characterizing the cyclical state of the economy. In section 6 I report results from regressions that include the

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<sup>7</sup>An earlier version of this paper also considered projections published by the OMB. The OMB's projections are different from the CBO's primarily because they include certain policy proposals that have not yet been enacted. The OMB's 5-year-ahead projections are available only at annual frequency and since 1983. For the period over which both the CBO's and the OMB's 5-year-ahead projections can be evaluated (for fiscal years 1988-2006), their RMSEs are very similar: the CBO's RMSEs for deficits and debt are 3.57% and 12.74%, the OMB's are 3.43% and 12.34%. The results of all the regressions reported in the earlier version did not differ substantially between CBO and OMB projections.

3-month Treasury bill yield and the output gap as additional regressors. Orphanides and van Norden (2002) demonstrate that real-time estimates of the output gap can be dramatically different from ex-post estimates. I therefore use as a measure of current perceptions of the cyclical state the output gap estimate of Orphanides (2003), which is based on real-time Federal Reserve staff estimates through 1997, and real-time CBO estimates thereafter.

Before turning to the regression analysis, the stationarity and cointegration properties of the data need to be assessed. The upper panel of Table 1 reports augmented Dickey-Fuller  $t$  test statistics and their  $p$  values for the interest rates, inflation expectations, and fiscal variables. Here and for the remainder of the paper,  $cy10$  denotes the current 10-year Treasury yield,  $fw514$  the five-year-ahead 10-year forward rate,  $tbill$  the 3-month Treasury bill rate,  $\pi^E$  the measure of inflation expectations,  $def0$  and  $debt0$  the CBO projections for the deficit/GDP ratio and debt/GDP ratio for the current fiscal year, and  $def5$  and  $debt5$  the projections for those ratios five years ahead. Given the small sample size (shown in the column labelled  $N$ ), especially for the annual data shown in the left half of the table, the power of these tests is of course very low. Nonetheless, the null hypothesis of a unit root is clearly not rejected for  $cy10$ ,  $fw514$ , and  $\pi^E$ ; for the fiscal projections, especially  $def5$ , the evidence is more mixed.

The basic regression format used in this study is based on the hypothesis that  $cy10$  and  $fw514$  are cointegrated with  $\pi^E$ , and that the fiscal variables are stationary. The middle panel reports  $t$  statistics for residual-based Phillips-Ouliaris cointegration tests together with 5% critical values.<sup>8</sup> The first two lines are consistent with the view that  $cy10$  and  $fw514$  are cointegrated with  $\pi^E$ ; the second two lines show that the residuals remain stationary when a fiscal variable is added to the bivariate relationship, suggesting no spurious regression is being run. In the regressions reported in the following sections, in which a long-term interest or forward rate is regressed on  $\pi^E$ , a fiscal variable, and possibly other stationary regressors, the coefficient on  $\pi^E$  is therefore assumed to follow a nonstandard distribution whereas the distributions of the estimated coefficients on all other variables are assumed to be standard.<sup>9</sup> Dynamic OLS estimates of the cointegrating relationship between either  $cy10$

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<sup>8</sup>The cointegration tests are performed only for annual data because of the missing semiannual observations in the early part of the sample.

<sup>9</sup>Results from FIML-based Johansen tests are sensitive to the number of lags included in the test VAR. The hypothesis that  $cy10$  and  $fw514$  are cointegrated with  $\pi^E$ , and that the fiscal variables are stationary, implies that in a trivariate VAR there should be two stationary linear combinations, one between  $cy10$  or

or  $\text{fw514}$  and  $\pi^E$  are shown in the bottom panel. The finding that the coefficients on  $\pi^E$  are larger than 1 is consistent with the view that investors demand higher risk premia on nominal assets when inflation expectations rise to compensate for greater uncertainty about future inflation (see e.g. Okun (1971) and Ball and Cecchetti (1990)). In addition, 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.

## 4 Baseline Results

Economic theory is ambiguous about the question whether it is deficits or the stock of government debt (or neither) that matters for interest rate determination. For example, in the IS/LM model, in which interest rates are determined by the flow equilibrium of aggregate demand and supply, the deficit/GDP ratio is the relevant fiscal variable. Conversely, in the neoclassical growth model the real interest rate is equal to the marginal product of capital and the question therefore turns on the degree to which government *debt* crowds out private capital. If Ricardian equivalence holds, deficits (or debt) *per se* are not the relevant variable, but the level of government consumption is. If Ricardian equivalence breaks down, the fiscal variable of relevance may depend on the reasons for this failure. For example, in Blanchard's (1985) model of finite horizons, the relevant variable is the present discounted value of current and future primary deficits, discounted at the household's discount rate that reflects the probability of death. Because this issue remains unresolved, this section presents results for the interest rate effects, first of deficits and then of debt. As argued below, even if the true structural relationship were between the level of debt and interest rates, regressions of long-horizon forward rates on projected deficits may nonetheless be meaningful to the extent that projected deficits are good proxies for agents' expectations of the future stock of debt.

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$\text{fw514}$  and  $\pi^E$ , the other being the fiscal variable itself. When including one lag in the test VAR, both the Trace and Maximum Eigenvalue statistics reject the hypothesis of one stationary linear combination in favor of two such combinations in a VAR of  $\text{fw514}$ ,  $\pi^E$ , and either  $\text{def5}$  or  $\text{debt5}$ . When including two lags, the hypothesis of one stationary linear combination is no longer being rejected.

## 4.1 Interest rates and deficits

Table 2 reports results for regressions using the five-year-ahead 10-year forward rate (fw514) as dependent variable and the deficit/GDP ratio projected five years ahead (def5) as fiscal variable. The first three columns use only the annual projections, the last three columns use all 53 available projections. As shown in the final row, omitting the mid-year updates reduces the serial correlation in the residuals. Within each block of columns, the first shows a regression in which only a constant (not shown in any of the tables),  $\pi^E$  and def5 are included; the second and third columns report regressions in which the additional regressors suggested by (1) are included as well. The estimated coefficients on  $\pi^E$  are similar to those shown in the dynamic OLS regressions in the lower panel of Table 1. The coefficients on def5 cluster in the range of 20 to 30 basis points per percentage point of the ratio, with  $t$  statistics of 2.5 or higher. The estimates for the annual data set are 5 basis points higher than those based on the semiannual data.

As concerns the additional regressors, the dividend yield enters with the expected sign. Based on the evidence that a higher dividend yield predicts higher future excess returns on stocks (e.g. Campbell et al., 1997, Ch. 7), it may be interpreted as a sign of elevated risk aversion. Periods when investors demand higher than usual compensation for bearing risk may coincide with greater demand for safe Treasury securities, reducing their (current and expected) yields. The  $t$  statistics on the coefficients range from 1.1 to 1.3. Despite the fact that they are not significant at conventional levels, most of the subsequent regressions will include the dividend yield as regressor. By contrast, the trend growth rate enters with the opposite sign predicted by the neoclassical growth model, even though insignificantly different from zero. Possibly the CBO's projection of real GDP growth 5 years ahead is a poor proxy of agents' expectations of future consumption growth. This variable is therefore omitted from most of the regressions.

As discussed earlier, different economic models have different implications for which fiscal variable should matter in the determination of interest rates. Before presenting results for the debt/GDP ratio, two alternative variants of the relationship between deficits and interest rates are explored. The first column in Table 3 reports results using the projected ratio of the *primary* deficit to GDP, which excludes net interest payments. Using the primary deficit addresses the concern of reverse causality from the interest rate to projected deficits through higher outlays on debt service. As shown, the coefficient on the deficit/GDP ratio is larger

than the one reported in column 5 of Table 2, albeit less precisely estimated. The final two columns in Table 3 address the question whether it is only government consumption, rather than deficits, that affect interest rates by disaggregating the projected deficit into total (or primary) outlays and total revenues. A caveat to the use of total outlays is that a large share of these are transfer payments rather than government purchases of goods and services.<sup>10</sup> The hypothesis that the coefficients on outlays and revenues sum to zero cannot be rejected at conventional significance levels (the  $p$  value of the  $F$  statistic is 0.75 and 0.6, respectively). This suggests that the focus on the deficit/GDP ratio as the fiscal variable of interest is not misplaced.

## 4.2 Interest rates and debt

Table 4 repeats the regressions shown in Table 2, with the projected deficit/GDP ratio replaced by the ratio of the projected stock of federal debt held by the public to projected GDP (debt5). The coefficient estimates on debt5 are concentrated between 3 and 4.5 basis points. Except for the regressions including the trend growth variable (which as before enters with the wrong sign), the  $t$  statistics range from 2.2 to 2.6. The coefficients on expected inflation are similar to those shown in Table 2. The coefficients on the dividend yield are smaller, as are their  $t$  statistics, but they remain correctly signed.

Is the result that the estimated coefficients on the deficit/GDP ratio are about 6.5 times as large as the ones on the debt/GDP ratio economically plausible? If increases in deficits were serially uncorrelated, so that the effect of a projected increase in the deficit on the stock of debt in subsequent years would be simply one for one, the coefficients on the deficit/GDP ratio and the debt/GDP ratio ought to be the same. But consider the opposite extreme, in which every increase in projected deficits is expected to be permanent. The steady-state effect on the debt-to-GDP ratio of a permanent one percentage point increase in the deficit-to-GDP ratio is  $(1 + g)/g$  percent, where  $g$  is the net growth rate of nominal GDP. Over the sample 1976-2006, this growth rate averaged about 7 percent per year, implying that the coefficient on the deficit/GDP ratio ought to be 15 times as large as the coefficient on the debt/GDP ratio. The fact that the estimated coefficients on the deficit/GDP ratio

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<sup>10</sup>Under the Ricardian view, the financing of a given path of government outlays should be of no consequence, and hence changes in revenues that are orthogonal to changes in outlays should not affect interest rates. For the actual revenue projections used as regressors, this orthogonality does not hold.

are six to seven times as large as those on the debt/GDP ratio is consistent with the view that investors perceive increases in projected deficit/GDP ratios as highly persistent, but not strictly permanent. In fact, the serial correlation coefficient of the actual deficit/GDP ratio over the sample 1976 to 2006 is 0.83, which implies that on average a percentage point innovation in the deficit/GDP ratio leads to an ultimate increase in the debt/GDP ratio of  $1/(1-0.83)$  or 6 percent, closely in line with the empirical results.

## 5 The Role of Projections

Table 5 examines the importance of using long-horizon forward rates instead of current long-term rates as dependent variables, and of using long-horizon projections of fiscal variables instead of their current values as regressors. To keep with the timing convention of the semiannual data set in this comparison, I use CBO projections for the *current* fiscal year (def0) instead of the latest realized deficit/GDP ratio, which is available only at annual (fiscal-year) frequency. As discussed in section 3 and shown in Figure 2, these current-year fiscal projections are fairly close to actual outcomes. As shown in the first column of Table 5, a regression of current long-term Treasury yields on the current-year deficit/GDP ratio produces a negative, and borderline significant, coefficient estimate, presumably reflecting the previously discussed endogeneity problem due to cyclical responses of fiscal variables and interest rates. Although changing the dependent variable from cy10 to fw514 mitigates this problem somewhat, the coefficient on def0 is now insignificant, as shown in column 2. By contrast, the results shown in the final three columns of Table 5 illustrate the importance of using fiscal projections. The dependent variable in column 4 is the spread between the 10-year and 3-month yields, which is one of the dependent variables used by Canzoneri et al. (2002), and can be seen as a simpler method of controlling for monetary policy's influence on the short end of the yield curve compared to the use of long-horizon forward rates. Using either the spread or the five-year-ahead 5-year forward rate fwd59 as dependent variable leads to substantially larger and more precise estimates compared to using the current 10-year Treasury yield.

These results are further illustrated in the left column of Figure 5, which presents scatter plots and regression lines obtained from regressions of the cointegrating residuals  $rcy10_i \equiv cy10 - 1.57 \pi^E$  (top row of panels) and  $r fw514_i \equiv fw514 - 1.39 \pi^E$  (lower two

rows) on a constant and def0 (upper two rows) or def5. A systematic relationship is much more evident in the bottom left panel than in the other two.

The panels on the right of Figure 5 repeat these scatter plots for the debt/GDP ratio instead of the deficit/GDP ratio. The results of the regressions including the dividend yield are shown in Table 6. Although a regression of current long-term rates on current-year debt yields a positive coefficient, the relationship among these variables is much clearer when focusing on long-horizon projections and forward rates.

As discussed in section 3, the large projection errors over history of the 5-year-ahead deficit and debt projections, caused in part by the statutory rules under which they are produced, raise the question whether these projections did influence market participants' expectations of future deficits and debt. Unfortunately no direct measure of those expectations is available. In Table 7 I therefore pursue two indirect approaches, based on instrumental variables regressions. First, I use the deficit/GDP or debt/GDP ratio realized five years into the future as regressor, and the latest available actual deficit/GDP and debt/GDP ratios as well as the (real-time) output gap as instruments.<sup>11</sup> As shown in the first column, such a regression produces a significantly *negative* coefficient on the deficit/GDP ratio. The coefficient on the debt/GDP ratio shown in the third column is similar to the baseline estimate, but is statistically insignificant.<sup>12</sup> The second column shows a regression in which the CBO's current 5-year-ahead projection of the deficit/GDP ratio (def5) is allowed to enter in addition to the instrumented five-year-ahead outcome. As shown, the CBO projection clearly absorbs the explanatory power of the five-year-ahead outcome, with a coefficient estimate identical to the one shown in column 2 of Table 2, and a standard error only slightly larger. Similarly, the coefficient on the debt/GDP projection (debt5) in column 4 is similar to the one shown in column 2 of Table 4 and is statistically significant, whereas the coefficient on the instrumented five-year-ahead outcome becomes negligible. The conclusion from this section is therefore that both long-horizon forward rates and long-horizon fiscal projections are important for identifying the partial effect of fiscal policy on interest rates, as hypothesized in section 2.

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<sup>11</sup>The first-stage regressions produce  $R^2$  of .69 and .47 respectively, with  $p$  values on the regressions'  $F$  statistics of .000 and .002.

<sup>12</sup>The overidentifying restriction that the instruments enter only through their prediction of future deficit/GDP or debt/GDP ratios is not rejected at any conventional levels.



## 6 Robustness of the results

Two issues related to the robustness of the results reported in the previous two sections are being addressed here. The first is whether the use of long-horizon forward rates as dependent variable justifies the omission of regressors measuring the cyclical state of the economy, as claimed in section 2. Table 8 reports results from regressions that include the real-time output gap estimate and the 3-month Treasury bill rate to capture near-term economic conditions. As shown in the first and third columns, the output gap enters with a statistically insignificant coefficient while leaving the remaining coefficients, especially those on *def5* (in column 1) and *debt5* (in column 3) unchanged. Adding the 3-month T-bill rate changes the coefficient on expected inflation due to the stochastic trend common to *fw514*,  $\pi^E$  and the T-bill rate, and leads to slightly higher and more precisely estimated coefficients on the fiscal variables.

A second issue addressed here is the stability of the coefficient estimates on the fiscal variables. There might be concern that the early 1980s, which were a time of surging deficits and real interest rates, might be largely responsible for the findings reported earlier. I address this issue by performing tests for a break in the coefficients at unknown date, using the critical values of Andrews and Ploberger (1994). These tests strongly suggest a break in the coefficients on the deficit/GDP ratio (for the semiannual data set, the value of the exponential Wald statistic is 4.59, compared to a 5% critical value of 2.08) and the debt/GDP ratio (the exponential Wald statistic is 5.19).<sup>13</sup> In contrast to the strong evidence for instability in the fiscal coefficients, there is no evidence for an intercept shift.

Figure 6 plots the  $p$  values of the  $t$  statistics associated with the different break dates. As shown by the solid line, the evidence for a break in the deficit coefficient is pervasive. The  $p$  value assumes its minimum in 1999:1, but there is also evidence for another break in the mid-1980s. The high value of the test statistic for the debt coefficient is largely driven

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<sup>13</sup>For the semiannual data the test is for a structural break in the coefficient on the fiscal variable at a date between 1981:2 and 2003:2. I am therefore excluding the first and last 6 observations ( $\pi_0 \simeq 10\%$ ) of the sample. The formula for the exponential Wald test is then

$$\log[(T(1 - 2\pi_0))^{-1} \sum_{\pi_0 T}^{(1-\pi_0)T} \exp(F_t/2)]$$

where  $F_t$  is the  $F$  statistic for the break dummy at date  $t \in [\pi_0 T, (1 - \pi_0)T]$ . Results based on the annual data are similar.

by a break right at the beginning of the period over which the test is being performed, which may be considered less reliable. However, there is also strong evidence for a break in the mid-1980s, coinciding with the second break date mentioned for the deficit coefficient, and consistent with the view that the early 1980s were an exceptional period in the relationship between interest rates and fiscal variables.

Table 9 reports results from regressions that allow for one or two breaks in the fiscal coefficients. As shown in the first column, if the coefficient on the deficit/GDP ratio is allowed to change in 1999:1, the relationship between the ratio and interest rates turns from positive to negative, and statistically significantly so. The cause of this result is easily seen from Figures 1 and 2. While the projected deficit/GDP ratio (the dash-dotted line in Figure 2, shifted five years to the right) rose sharply on balance during this period, forward rates (adjusted for inflation expectations, which were constant over this period) first moved sideways and then declined. This latter decline, which has sometimes been labelled a “conundrum” (Greenspan, 2005), has been attributed variously to a substantial decline in term premia over this period (Kim and Wright, 2005) or to a “global savings glut” depressing expectations of future equilibrium real interest rates (Bernanke, 2005). Either of these explanations suggest that the finding of a negative relationship between projected deficits and long-horizon forward rates since 1999 may be driven by omitted factors, rather than a change in the structural relationship between these variables. Allowing for a second break in the coefficient in 1986:1 (the preferred break date for the debt coefficient) confirms the view that the post-1999 period is special, with the coefficients over the two earlier subsamples similar to the full-sample estimates. The final column shows that, when the coefficient on the projected debt/GDP ratio is allowed to change in 1986:1, the estimate over the later sample is very similar to the full-sample estimates reported earlier, whereas for the earlier subsample it is twice as large. After allowing for a break in 1986:1 there is no evidence for further instability later in the sample.

## **7 Are the Results Consistent with Economic Theory?**

Notwithstanding the evidence presented in the previous sections, the endogeneity problems discussed earlier may be too severe to be ever completely controlled for in reduced-form regressions. One may therefore ask whether the empirical results can be reconciled with

priors based on economic theory. One potential answer to this question, based on the neoclassical growth model, is sketched below; the argument is closely akin to the one developed in Elmendorf and Mankiw (1999).<sup>14</sup> Because in the neoclassical growth model the real interest rate is determined by the capital-output ratio, the discussion below focuses on the link between the stock of debt and the capital stock, and assesses the plausibility of the results for the debt-to-GDP ratio reported in the previous sections. As mentioned above and discussed by Elmendorf and Mankiw (1999), however, whether it is deficits or debt that matter for the determination of interest rates depends on questions such as which model of consumer behavior one assumes. The analysis below therefore illustrates only one particular argument by which the empirical results can be related to economic theory.

Suppose that an increase in government debt reduces the private capital stock by a fraction  $c$ ; that is, if  $D$  denotes the stock of government debt, and  $K$  the private capital stock,  $\partial K/\partial D = -c$ . The parameter  $c$  denotes the degree of crowding out, with the remaining fraction  $1 - c$  being the increase in private savings or capital inflows from abroad in response to the increase in the interest rate. Assuming factors of production earn their marginal product, the share of capital in income,  $s$ , is equal to the marginal product of capital times the capital-output ratio  $k = K/Y$ . Moreover, the marginal product is equal to the sum of the depreciation rate  $d$  of the private capital stock and the real interest rate  $r$ . Hence we can solve for  $r$  as  $r = s/k - d$ .

The effect of a one percentage point increase in the debt-to-GDP ratio on  $r$  can now be computed by calculating the partial derivative  $\partial r/\partial D = \partial r/\partial k \cdot \partial k/\partial D \cdot (-c)$ . Using a Cobb-Douglas production function  $Y = K^s L^{1-s}$ , we find that  $k = K^{1-s} L^{-(1-s)}$ , and therefore  $\partial k/\partial K = (1 - s)/Y$ . Putting the pieces together, an increase  $\Delta D = 0.01Y$  raises the interest rate by  $(1 - s)cs/k^2$  basis points.

The final step in obtaining numerical predictions of the interest rate effects is to choose values for  $c$ ,  $s$ , and  $k$ . As an example, consider  $s = 0.33$ , consistent with a capital share in national income accounts data of about 1/3. For the parameter  $k$ , consider the BEA's estimate of private fixed assets at the end of 2005 (\$29.3 trillion) divided by gross value added by businesses, households and institutions in 2006 (approximately \$11.8 trillion). This yields  $k = 2.5$ . The most difficult parameter to quantify is the degree of crowding out,  $c$ . Elmendorf and Mankiw (1999) survey a number of studies which show that, under

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<sup>14</sup>A similar argument is used in Council of Economic Advisers (2003). See also Engen and Hubbard (2004).

assumptions for households' intertemporal elasticity of substitution consistent with household data, the increase in private savings in response to the change in interest rates is close to zero. Moreover, recent studies in the vein of Feldstein and Horioka (1980) suggest that roughly two-thirds of saving in developed countries is retained for domestic investment in the long run, implying that capital inflows from abroad offset about one-third of the increase in debt. Suppose, therefore, that  $c = 0.6$ . Then a percentage point increase in the debt-to-GDP ratio raises the real interest rate by 2.1 basis points, not too far below the estimates reported in Tables 4 and 6.

## 8 Conclusions

This study has shown that statistically significant and economically plausible estimates of the effects of government deficits and debt on interest rates can be obtained by focusing on long-horizon forward rates and projections of deficits or debt. The projections of deficits and debt published by the CBO are arguably among the best publicly available information about these variables. The effects of these projections manifest themselves at the longer end of the yield curve, as economic reasoning would predict. All else equal, the results of this study suggest that forward rates five and more years into the future rise by 20 to 30 basis points in response to a percentage point increase in the projected deficit-to-GDP ratio, and by about 3 to 4 basis points in response to a percentage point increase in the projected debt-to-GDP ratio.

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## A Data Sources

As described in the main text, the five-year-ahead yields of a five-year and a ten-year Treasury note are computed as simple averages of one-year forward rates 5 to 9 years and 5 to 14 years ahead, respectively, calculated from the zero-coupon yield curve. The forward rates are taken from the data set of Gürkaynak et al. (2006), who use the Nelson-Siegel (1987) method as extended by Svensson (1994). Specifically, instantaneous forward rates

$i$  years ahead at time  $t$ , denoted  $f_t(i)$ , are modeled by a continuous function with six parameters:

$$f_t(i) = \beta_{0,t} + \beta_{1,t} \cdot \exp(-i/\tau_{1,t}) + \beta_{2,t} \cdot i/\tau_{1,t} \cdot \exp(-i/\tau_{1,t}) + \beta_3 \cdot i/\tau_{2,t} \cdot \exp(-i/\tau_{2,t})$$

This function has the property that forward rates begin at horizon zero at  $\beta_0 + \beta_1$  and eventually asymptote to  $\beta_0$ . In between, forward rates can have two “humps,” with the magnitude and sign of the humps determined by the parameters  $\beta_2$  and  $\beta_3$ , and the location of the humps determined by  $\tau_1$  and  $\tau_2$ . Given values for these six parameters, the zero-coupon yields and discount function can be computed for all maturities. The discount function can in turn be used to price any outstanding Treasury security with specific coupon rates and maturity dates. The parameters are therefore estimated by minimizing the weighted sum of the squared deviations between actual and predicted prices of Treasury securities, where the weights are inversely related to the duration of each security. Further details of the estimation and the underlying price data are provided in Gürkaynak et al. (2006).

The series of inflation expectations consists of three different pieces. Until 1981:Q1, the series is an estimated step function based on the changepoint model developed in Kozicki and Tinsley (2001). From 1981:Q2 until 1991:Q1, the series is based on the Hoey survey of bond market participants, which was conducted on a quarterly basis by Richard Hoey, an economist at Drexel Burnham Lambert. Participants in this survey were polled for their expectation of CPI inflation over the second five years of a 10-year horizon. From 1991:Q3 the series is based on the Survey of Professional Forecasters conducted quarterly by the Federal Reserve Bank of Philadelphia, in which participants are asked for their expectation of the average CPI inflation rate over the next ten years.<sup>15</sup> Overall, while the series is not ideal, it should provide a good measure of inflation expectations over either of the horizons of the nominal yield series described above. The series is interpolated to monthly frequency, and is sampled in the months corresponding to the yield data. Replacing the SPF expectations by expected inflation 5 to 10 years ahead from the University of Michigan’s

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<sup>15</sup>Detailed information about the Survey of Professional Forecasters can be found at [www.philadelphiafed.org](http://www.philadelphiafed.org). The series of inflation expectations is taken from the Federal Reserve Board’s FRB/US model. Because it is used there to proxy for expectations of PCE deflator inflation rather than CPI inflation, the survey measures have been reduced by 55 basis points to account for the average difference between CPI and PCE inflation over this period.



Survey of Consumers, for which monthly data are available since 1990, has little effect on the results.

The months of CBO releases used in this study (releases omitted from the annual data set are marked by \*) are 1/76, 12/76, 1/78, 1/79, 2/80, 7/81, 2/82, 2/83, 2/84, 2/85, 8/85\*, 2/86, 8/86\*, 1/87, 8/87\*, 2/88, 8/88\*, 1/89, 8/89\*, 1/90, 7/90\*, 1/91, 8/91\*, 1/92, 8/92\*, 1/93, 9/93\*, 1/94, 8/94\*, 1/95, 8/95\*, 12/95\*, 5/96, 1/97, 9/97\*, 1/98, 8/98\*, 1/99, 7/99\*, 1/00, 7/00\*, 1/01, 8/01\*, 1/02, 8/02\*, 1/03, 8/03\*, 1/04, 9/04\*, 1/05, 8/05\*, 1/06, 8/06\*. For the early years of the sample (1976-1982), constructing the series of both projected deficits and debt entails a choice because the CBO reported different projections of future deficits depending mainly on alternative assumptions regarding policy responses to the inflation-induced uptrend in tax receipts. To be consistent across the entire sample, I used the estimates based on the assumption of no policy change. The January 1991 projections are not the CBO baseline, but are based on the already legislated discretionary spending caps, which were the CBO's baseline for the remainder of the 1990s. The December 1995 projections are included despite the fact that they were based on a budget resolution already vetoed by the President. By contrast, the August 1996 update is omitted because of incomplete projections, given that the annual projections had only been published in May.

As mentioned in section 3, the dividend yield used in the regressions is defined as the dividend component of national income divided by the market value of corporate equity held (directly or indirectly) by households as reported in the Federal Reserve Board's Flow of Funds data. Until 1975 this measure is nearly identical to the dividend yield measure based on the CRSP value-weighted portfolio. Thereafter, it is broader in that it includes distributions from Subchapter S corporations, which are not traded and therefore not included in the CRSP portfolio. An alternative measure is the cointegrating residual between (nondurables and services) consumption, labor income, and household net worth. Lettau and Ludvigson (2001) show that this residual outperforms the dividend yield and several other measures in forecasting one-quarter-ahead excess returns of the S&P 500 over Treasury bills. I therefore constructed a series of these residuals, reestimating the cointegrating relationship successively for each quarter beginning with a sample 1952:1 to 1975:4 and storing the latest value of the residual. When I replace the dividend yield by this series of cointegrating residuals as proxy for risk aversion, the results are nearly unchanged.

Table 1: Unit Root and Cointegration Test Results

Augmented Dickey-Fuller Tests						
Variable	Annual Data			Semiannual data		
	<i>t</i> stat	<i>p</i> value	N	<i>t</i> stat	<i>p</i> value	N
cy10	-1.14	.69	30	-1.41	.57	61
fw514	-1.07	.72	30	-1.04	.73	61
tbill	-2.29	.18	29	-1.96	.30	61
$\pi^E$	-0.52	.87	30	-0.39	.90	61
def0	-2.24	.20	29	-1.90	.33	42
debt0	-2.03	.27	29	-1.99	.29	41
def5	-2.52	.12	30	-2.35	.16	43
debt5	-1.92	.32	30	-1.51	.52	41

Phillips-Ouliaris Cointegration Tests			
Variables	<i>t</i> stat	5% CV	N
cy10, $\pi^E$	-3.39	-2.76	30
fw514, $\pi^E$	-3.20	-2.76	30
fw514, $\pi^E$ , def5	-4.16	-3.27	29
fw514, $\pi^E$ , debt5	-3.67	-3.27	29

DOLS Estimate of Cointegrating Vector	
cy10, $\pi^E$	$cy10 = 1.87 + 1.56\pi^E$
fw514, $\pi^E$	$fw514 = 3.48 + 1.31\pi^E$

Notes: cy10 is the 10-year constant maturity Treasury yield; fw514 is the five-year-ahead 10-year forward rate; tbill is the 3-month Treasury bill yield;  $\pi^E$  are long-horizon inflation expectations; def0 and debt0 are CBO projections for the deficit/GDP and debt/GDP ratios for the current fiscal year; def5 and debt5 are the projections for those ratios five years ahead.

Table 2: Baseline results: Projected Deficits

Frequency	Annual (76 - 06)			Semiannual (76:1 - 06:2)		
$\pi^E$	1.23 (.155)	1.39 (.212)	1.44 (.274)	1.26 (.144)	1.41 (.194)	1.46 (.216)
def5	.25 (.081)	.29 (.073)	.26 (.085)	.20 (.079)	.24 (.074)	.20 (.080)
Div Yield	–	-.32 (.276)	-.28 (.242)	–	-.29 (.237)	-.23 (.205)
Trend Growth	–	–	-.25 (.544)	–	–	-.34 (.373)
Adj. $R^2$	.84	.84	.84	.84	.84	.84
S.E.	.98	.97	.99	.90	.89	.89
DW	1.17	1.27	1.25	.45	.51	.49

Notes: The dependent variable is the five-year-ahead 10-year forward rate (fw514). Newey-West standard errors in parentheses.

Table 3: Primary Deficits, Outlays, and Revenues

Frequency Fiscal Variable	Semiannual, 1976:1-2006:2		
	Primary Deficit	Outlays and Revenues	Pr. Outlays and Revenues
$\pi^E$	1.41 (.192)	1.43 (.177)	1.45 (.178)
Prim. Def/GDP	.29 (.111)	–	–
Outlays/GDP	–	.23 (.086)	.24 (.138)
Revenues/GDP	–	-.28 (.142)	-.35 (.160)
Div. Yield	-.25 (.244)	-.30 (.238)	-.26 (.240)
$R^2$	.82	.84	.82
S.E.	.93	.90	.94
DW	.48	.51	.48

Notes: The dependent variable is the five-year-ahead 10-year forward rate (fw514). Newey-West standard errors in parentheses.

Table 4: Baseline results: Projected Debt

Frequency	Annual (76 - 06)			Semiannual (76:1 - 06:2)		
$\pi^E$	1.34 (.171)	1.46 (.206)	1.50 (.250)	1.34 (.143)	1.44 (.189)	1.47 (.199)
debt5	.039 (.017)	.044 (.017)	.033 (.019)	.030 (.014)	.034 (.014)	.022 (.016)
Div. Yield	-	-.20 (.259)	-.13 (.196)	-	-.18 (.229)	-.08 (.190)
Trend Growth	-	-	-.37 (.683)	-	-	-.42 (.432)
Adj. $R^2$	.81	.81	.80	.82	.82	.82
S.E.	1.06	1.07	1.08	.94	.94	.94
DW	1.13	1.17	1.14	.46	.48	.47

Notes: The dependent variable is the five-year-ahead 10-year forward rate (fw514). Newey-West standard errors in parentheses.

Table 5: The Role of Fiscal and Interest Rate Projections: Deficits

Frequency	Semiannual, 1976:1-2006:2				
Dep. Variable	cy10	fw514	cy10	spread	fw59
Fiscal Variable	def0	def0	def5	def5	def5
$\pi^E$	1.43 (.185)	1.26 (.186)	1.59 (.238)	-	1.45 (.198)
Deficit/GDP	-.22 (.121)	.065 (.129)	.13 (.088)	.26 (.094)	.23 (.074)
Div. Yield	.42 (.291)	.006 (.303)	-.19 (.308)	-.26 (.204)	-.30 (.251)
$R^2$	.84	.79	.83	.19	.84
S.E.	1.01	1.03	1.03	1.14	.91
DW	.51	.42	.49	.44	.54

Notes: see Table 1. spread is the 10-year Treasury minus 3-month T-bill yield; fw59 is the five-year-ahead 5-year forward rate. Newey-West standard errors in parentheses.

Table 6: The Role of Fiscal and Interest Rate Projections: Debt

Frequency	Semiannual, 1976:1-2006:2				
Dep. Variable	cy10	fw514	cy10	spread	fw59
Fiscal Variable	debt0	debt0	debt5	debt5	debt5
$\pi^E$	1.57 (.222)	1.37 (.168)	1.59 (.239)	–	1.48 (.194)
Debt/GDP	.025 (.026)	.044 (.024)	.015 (.016)	.042 (.017)	.032 (.014)
Div. Yield	-.022 (.270)	.031 (.195)	-.10 (.303)	-.12 (.177)	-.20 (.239)
$R^2$	.83	.81	.83	.18	.82
S.E.	1.05	.98	1.05	1.15	.95
DW	.51	.48	.50	.42	.53

Notes: see Table 5. Newey-West standard errors in parentheses.

Table 7: Instrumental Variables Regressions

Frequency	Annual, 1976-2001				
	Deficits		Debt		
Def/GDP <sub>t+5</sub>	-.35 (.186)	.10 (.241)	Debt/GDP <sub>t+5</sub>	.035 (.055)	.002 (.063)
def5	–	.29 (.104)	debt5	–	.041 (.020)

Notes: The dependent variable is the five-year-ahead 10-year forward rate (fw514). Def/GDP<sub>t+5</sub> and Debt/GDP<sub>t+5</sub> are the deficit/GDP and debt/GDP ratios realized five years ahead, def5 and debt5 are the current five-year-ahead projections. Shown are only the coefficients on the fiscal variables. All regressions include a constant,  $\pi^E$ , and the dividend yield. The instruments in all regressions are the latest realized deficit/GDP and debt/GDP ratios and the real-time estimate of the output gap. Newey-West standard errors in parentheses.

Table 8: The Role of Business Cycle Conditions

Frequency	Semiannual, 1976:1-2006:2			
	Deficits		Debt	
$\pi^E$	1.46	.94	$\pi^E$	1.47 .90
	(.215)	(.306)		(.207) (.305)
def5	.25	.27	debt5	.034 .041
	(.073)	(.057)		(.014) (.013)
Div. Yield	-.25	-.32	Div. Yield	-.15 -.25
	(.233)	(.187)		(.230) (.194)
Real-time gap	.045	-.047	Real-time gap	.028 -.079
	(.045)	(.061)		(.056) (.071)
T bill	-	.25	T bill	- .28
		(.107)		(.127)
$R^2$	.84	.87		.82 .85
S.E.	.89	.82		.95 .86
DW	.53	.64		.49 .60

Notes: The dependent variable is the five-year-ahead 10-year forward rate (fw514). Newey-West standard errors in parentheses.

Table 9: Regressions with Breaks in Fiscal Coefficients

Frequency	Semiannual, 1976:1-2006:2		
Fiscal Variable	Deficits		Debt
Break Date	1 break	2 breaks	1 break
$t < 86 : 1$		.35	.070
		(.101)	(.019)
$t \geq 86 : 1$			.034
			(.013)
$86 : 1 \leq t < 99 : 1$		.22	
		(.082)	
$t < 99 : 1$	.30		
	(.076)		
$t \geq 99 : 1$	-.20	-.18	
	(.097)	(.098)	

Notes: The dependent variable is the five-year-ahead 10-year forward rate (fw514). Shown are only the coefficients on the fiscal variables. All regressions include a constant,  $\pi^E$ , and the dividend yield. Newey-West standard errors in parentheses.

Figure 1: Interest Rates and Inflation Expectations

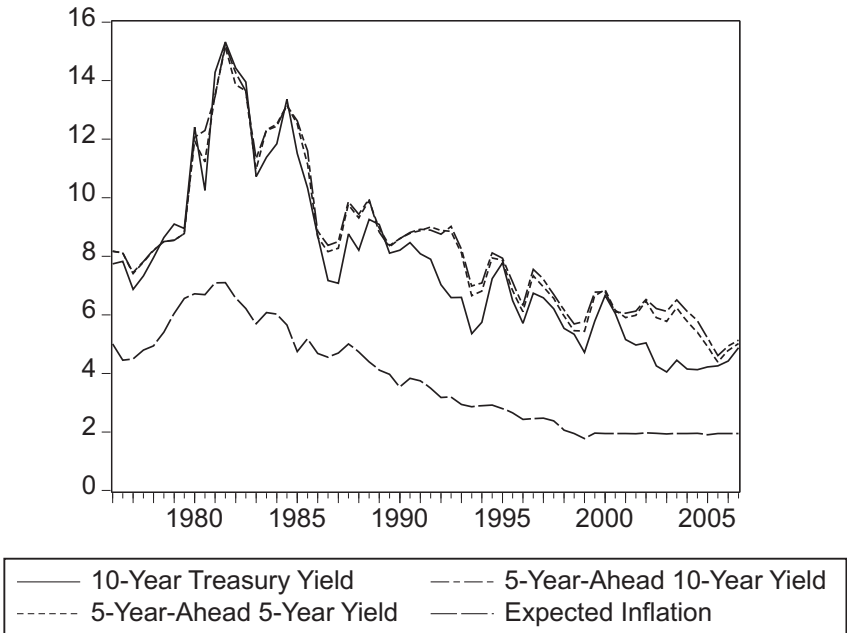


Figure 2: Actual and Projected Deficits as Percent of GDP

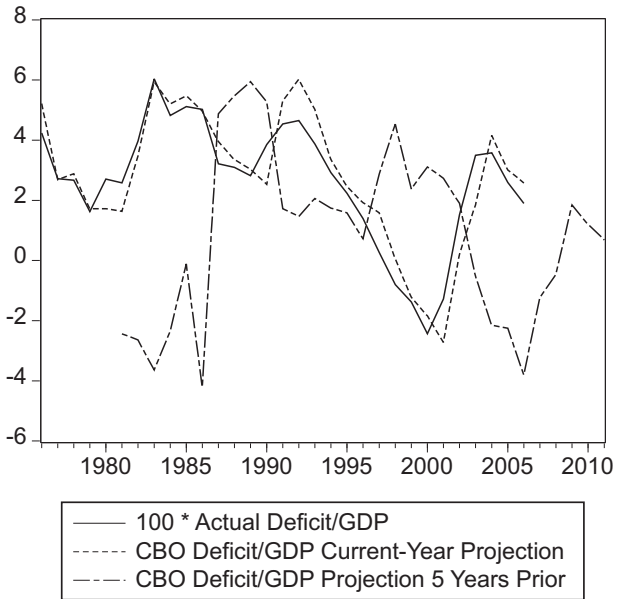


Figure 3: Actual and Projected Debt as Percent of GDP

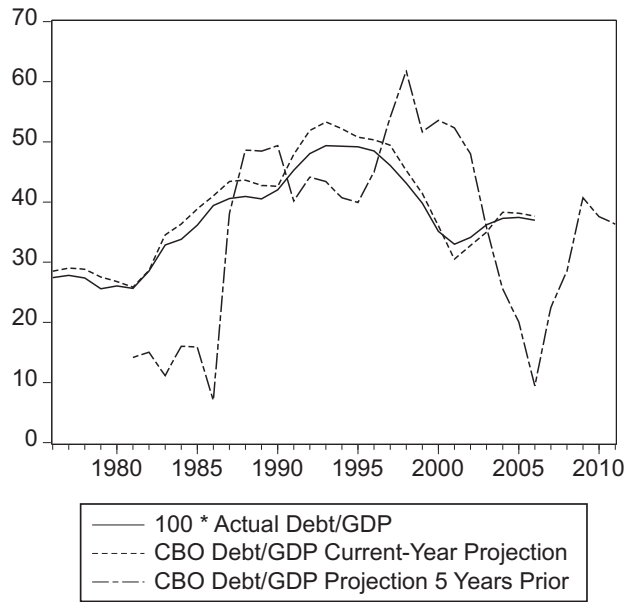


Figure 4: Projected GDP Growth and the Dividend Yield

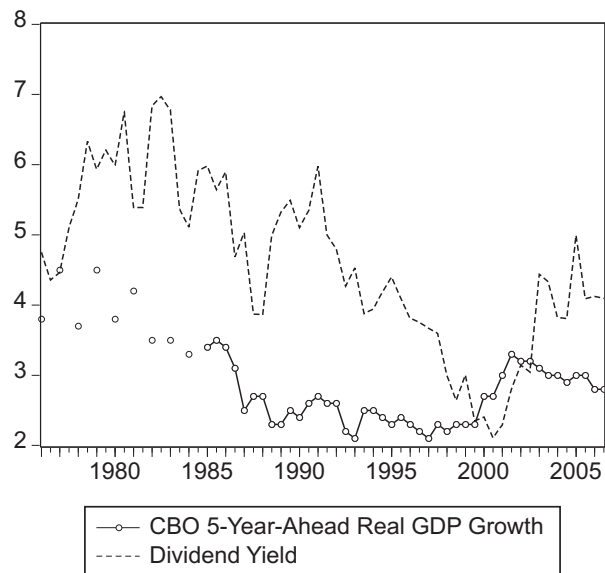




Figure 5: The Role of Fiscal Projections and Forward Rates

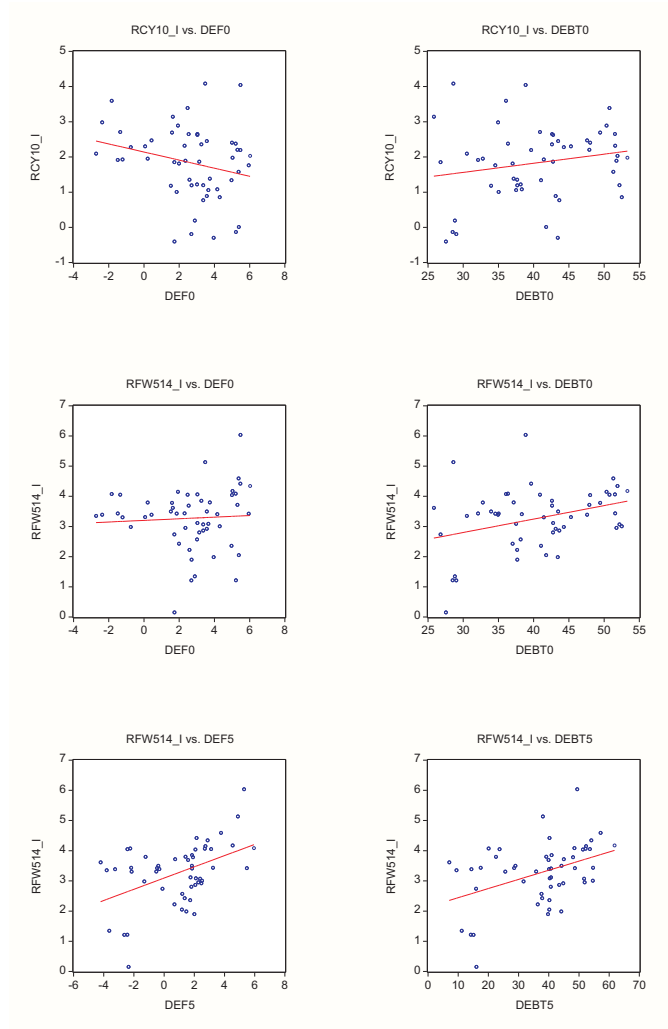


Figure 6: Coefficient Break Tests for Fiscal Variables

