The Impact of the Federal Budget deficit on the Nominal Interest Rate Yield on US Treasury Notes

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Abstract

This study empirically examines the impact of the federal government budget deficit on the nominal interest rate yield on US Treasury notes over the 1979-2001 period. In a system that includes the monetary base, the civilian labor force unemployment rate, the ex ante real 52-week Treasury bill rate, and the percentage real growth rate of the S&P 500 stock index, Error-correction Model (ECM) estimation finds that the total federal budget deficit acted to increase the nominal interest rate yield on seven year US Treasury notes over the study period.

I. Introduction

Over the FY 1998 through FY 2001 period, US federal government budget surpluses made a brief appearance. Given the recession of 2001, the subsequent sluggish economy following the 2001 recession, a multi-stage federal income tax rate cut/inheritance tax cut statute passed in 2001, budgetary forecasts in light of the war on terrorism in the aftermath of the terrorist attacks on September 11, 2001 and the tax cut stimulus package enacted in 2003, the specter of federal budget deficits has appeared once again. Indeed, these circumstances, in concert with other continuing and evolving military/national security concerns (including post-War Iraq and the matters of Iran and North Korea) and insolvency forecasts for medicare and social security, would appear to make the prospects for historically huge budget deficits well into the foreseeable future a veritable certainty. This observation was recently echoed by Alan Krueger [2003], who warns that deficits have re-emerged as a major problem and that with the impending retirement of the first baby boomers, the "red" ink is likely to continue as far as the eye can see.

The potential impact of federal government budget deficits on domestic interest rates has been investigated extensively by a number of researchers, including Barth et al. [1984, 1985], Barth et al. [1989], Cebula [1988, 1991, 1997, 2000], Cebula and Belton [1993], Cukierman and Meltzer [1989], Darrat [2000], Feldstein and Eckstein [1970], Findlay [1990], Hoelscher [1983, 1986], Holloway [1988], Johnson [1992], McMillin [1986], Ostrosky [1990], Saltz [1998, 1999], Swamy et al. [1990], Tanzi [1985], and Zahid [1988]. Most of these empirical studies are couched within open or closed IS-LM or loanable funds models or variants thereof. Many of

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these studies find that the budget deficit raises intermediate and long-term rates of in while not significantly affecting short-term rates of interest, such as those on US Treasur (cf. Barth, et al. [1985]).

As capital formation is presumably much more affected by intermediate and longer interest rates than by shorter term interest rates, the inference has occasionally been mad these deficits may lead to "crowding out" [Carlson and Spencer, 1975; Cebula, 1 Alternatively stated, Alan Krueger [2003] has recently observed that personal savings dec as the federal budget deficit ballooned during the 1980s and 1990s and argues that, fo 1980s and 1990s, federal government borrowing both caused interest rates to rise and crov out private investment. Furthermore, Krueger [2003] foresees the predicted future fe budget deficits as raising interest rates and crowding out private investment in plant equipment in the years to come. Moreover, highly credible and visible support for Krue perspective is found in a summary in the May 1, 2003 issue of USA TODAY of public rem made on April 30, 2003 by Federal Reserve Chairman Alan Greenspan. USA TODAY [200 B-1] characterizes Greenspan as endorsing "...a recent Fed study showing persistent de raised long-term interest rates."

The present study investigates the federal budget deficit/interest rate relationship. study adopts cointegration and ECM estimation to investigate empirically whether the fec budget deficit acts to cause the nominal interest rate. The focus in this study is on the nom interest rate yield on seven-year US Treasury notes. This particular interest rate yield received comparatively little attention in the deficit-interest rate literature, yet is of a sufficie long maturity that it may exercise profound financial/economic impacts on home mortg markets, especially ARMs, certain intermediate term (if not long-term) corporate issues, even issues of state and local government agencies, all of which presumably directly or indire compete for funds with this seven-year rate.

Using seasonally adjusted quarterly data, the study period is 1979:4-2001:2. The stu period begins with 1979:4 in part because this is the quarter that directly precedes the passa of the DIDMCA (the Depository Institutions Deregulation and Monetary Control Act of 198 As observed in Barth (1991), through a significant degree of increased financial mar deregulation, the DIDMCA profoundly affected financial markets in the US and distinguish those markets from the preceding years. Furthermore, November of 1979 is a point at wh the Fed decided to allow market interest rates to seek their own levels, so that the interest ra targeting policies of the Fed were modified at least somewhat (although there was a part reversal of this stance in 1982). Ending the study period with 2001:2 enables the study exclude any anomalous economic activities that may have occurred in US financial markets an immediate reaction to the terrorist attack of September 11, 2001 while at the same tir making the study current.

Section II of this study provides the framework for the empirical analysis. Section III precise defines the variables in the empirical model and describes the actual data, including th measurement of the expected inflation rate needed to compute the real short-term interest ra

yield. Sections IV and V provide the empirical results, whereas an overview of the study is found in Section VI.

II. The Empirical Framework

In developing the framework for the empirical analysis, the following intertemporal federal government budget constraint is introduced:

$$ND_{t+1} = ND_t + G_t + F_t + R_tND_t - T_t \quad (1)$$

where:

ND_{t+1} = the outstanding national debt in period t+1

ND_t = the outstanding national debt in period t

G_t = federal government purchases in period t

F_t = federal government non-interest transfer payments in period t

R_t = average effective interest rate on the national debt in period t

T_t = federal government tax and other revenues in period t

The total federal government budget deficit in period t (TD_t) is the difference between ND_{t+1} and ND_t:

$$TD_t = ND_{t+1} - ND_t = G_t + F_t + R_tND_t - T_t \quad (2)$$

One can incorporate the effects of: UR, the civilian labor force unemployment rate; LR, the nominal interest rate yield on Treasury notes; and EASR, the ex ante real interest rate yield on 52-week Treasury bills, into the model, as follows:

$$F = f(UR, OF1),\ f_{UR} > 0 \quad (3)$$

$$T = g(UR, LR, EASR, OF2),\ g_{UR} < 0,\ g_{LR} > 0,\ g_{EASR} > 0 \quad (4)$$

$$G = h(UR, LR, EASR, OF3),\ h_{UR} > 0,\ h_{LR} > 0,\ h_{EASR} > 0 \quad (5)$$

where OF_z, z=1,...,3, refers to unspecified factors that may in part affect F, T, and G, respectively.

It is hypothesized in this study that plausible factors influencing F, T, and G may well include the unemployment rate, UR. If UR were to rise, then government transfers (F) in the form of unemployment compensation would rise, whereas, on the other hand, tax collections (T) would diminish, ceteris paribus. Furthermore, to the extent that politicians respond to increased unemployment by raising discretionary government purchases (G), the latter may be an increasing function of UR (especially during an election year). Furthermore, higher LR and/or EASR levels, by raising the level of aggregate taxable income and/or the interest rate charged by the IRS on detected unreported income (tax evasion), might lead to increased tax and/or other federal government revenues (T). On the other hand, higher LR and/or EASR levels would tend to raise the cost of financing new debt and refinancing old debt, so that government outlays (G) would tend to rise.

Accordingly, the total federal budget deficit is likely to be a function of UR, LR, and such that:

$$TD = j(UR, LR, EASR, \ldots)$$

where $j_{UR} > 0, j_{LR} >< 0, j_{EASR} >< 0$

The intertemporal federal government budget constraint model provided above focus determinants of the budget deficit. To explain the determination of the nominal interes yield on seven - year US Treasury notes (LR), including the impact of the budget deficit on s a loanable funds model is adopted in which the interest rate yield on seven year Tre notes is determined by an equilibrium of the following form [Barth et al. 1985; Cebula, 1 1997; Hoelscher, 1986; Saltz (1998); Tanzi (1985):

$$D + M = S + TD$$

where:

D = real domestic demand for seven - year US Treasury notes

S = real domestic supply of seven - year US Treasury notes

M = a measure of the available real money supply

TD = real net borrowing by the federal government, as measured by the real total buc deficit (TD).

In this framework, it is expected that:

$$D = D(LR, EASR, UR, S\&P, \ldots),\ D_{LR} > 0,\ D_{EASR} < 0,\ D_{UR} > 0,\ D_{S\&P} < 0$$

$$S = S(LR, \ldots),\ S_{LR} < 0$$

where S&P is the percentage real growth rate of the S&P 500 stock index, as a measure alternative opportunities to bond issues.

It is expected that, in principle paralleling Barth et al. [1985], Cebula [1992, 1997], a Hoelscher [1986], the real domestic demand for seven year Treasury notes is an increasi function of their interest rate yield, whereas the real domestic supply of seven-year Treasu notes is a decreasing function of their interest rate yield. Next, the higher the ex ante real shc - term interest rate yield, EASR, the lower the demand for seven-year Treasury notes as bor demanders substitute the shorter term instruments for the relatively longer term ones at th margin, ceteris paribus [Hoelscher (1986)]. Moreover the higher the unemployment rate, th more attractive Treasury notes may become, as households and firms choose to buy (deman Treasury notes during "difficult times" because of their perceived low risk nature. Thus, th private demand for Treasury notes is an increasing function of the unemployment rate, ceter paribus. Finally, the greater the real growth rate of the S&P 500 stock index (adopted here as proxy for alternatives to bond-type instruments), the less the appeal of US Treasury notes ceteris paribus, as investors at the margin substitute equities and equity funds for the Treasur notes.

Substituting equations (8) and (9) into equation (7) and solving for LR yields:

$$LR = LR\,(TD, UR, EASR, S\&P, M) \tag{10}$$

such that:

$$LR_{TD} > 0,\ LR_{UR} < 0,\ LR_{EASR} > 0,\ LR_{S\&P} > 0,\ LR_{M} < 0 \tag{11}$$

The first of these five expected signs is positive in order to reflect the traditional argument that when the Treasury attempts to finance a budget deficit, it forces interest rates upwards as it competes for funds from the financial markets. The negative sign on LR_{UR} reflects the increased demand for, and hence the increased market price of, and lower yield on seven year Treasury notes as the unemployment rate rises. The positive sign on LR_{EASR} reflects competition between the seven - year Treasury notes and the ex ante real short-term Treasury bill yield [Hoelscher (1986)], which by definition includes the expected inflation rate. Next, the greater the real growth rate of the S&P 500 stock index, the less the demand for, and price of, Treasury notes, and hence the higher the yield on those Treasury notes. Finally, the greater the real money supply, ceteris paribus, the greater the degree to which there is downward pressure on interest rate yields.

III. Variables and Data

The initial step in the analysis is to develop an appropriate empirical measurement of expected inflation. This determination is essential to the computation of the variable EASR. One possibility is to adopt the well-known Livingston survey data. However, as observed by Swamy et al. [1990, p. 1013], there may be very serious technical problems with the Livingston series:

> Studies by some psychologists have shown that the heuristics people have available for forming expectations cannot be expected to automatically produce expectations that come anywhere close to satisfying the normative constraints on subjective probability judgments provided by the Bayesian theory. The failure of people to obey these constraints makes Livingston's survey data incompatible with stochastic law...

Following the lead by Swamy et al. [1990], instead of using the Livingston series, this study adopts a distributed lag model on actual inflation to construct the values for the expected inflation rate, P_t^e, for quarter t. In particular, to construct the values for P_t^e, a four-quarter distributed lag model of actual inflation (as measured by the annualized percent rate of change of the CPI, 1996 = 100.0) was used. The analysis also experimented with three-, five-, six-, seven-, and eight-quarter distributed lag models of actual inflation to generate the expected inflation values; however, while the empirical results were similar, the four-quarter lag provided the best forecasting model, as in Cebula [1997] and Swamy et al. [1990]. It should be noted that use of the average of actual inflation rate in the most recent four quarters to estimate expected inflation, as suggested in Al-Saji [1993], produces results entirely consistent with, and indeed very similar to, the findings of the present study.

Based on the framework expressed in Section II, the following variables are included in the empirical analysis:

TDY_t = the ratio of the seasonally adjusted nominal total federal budget deficit in quarter the seasonally adjusted nominal GDP in quarter t, as a percent.

LR_t = the nominal average interest rate yield on seven-year US Treasury notes in quarter t, percent per annum.

$EASR_t$ = the ex ante real average interest rate yield on 52-week US Treasury bills in quarter t particular, $EASR_t$ = the nominal average interest rate yield in quarter t on 52-week US Treas bills (as a percent per annum) minus the expected inflation rate in quarte (as a percent per annum, P_t^e).

UR_t = the seasonally adjusted average unemployment rate of the civilian labor force in qua t, as a percent.

MBY_t = the ratio of the nominal seasonally adjusted monetary base in quarter t to the nom seasonally adjusted GDP in quarter t, as a percent.

$S\&P_t$ = the seasonally adjusted real growth rate of the S&P 500 stock index, as a percent annum.

The monetary base is adopted as the measure of the money supply and monetary pol The total federal budget deficit is scaled by the GDP level, as is the monetary base. Thi because the budget deficit and the monetary base (the monetary policy measure) should b be judged relative to the size of the economy, as in Hoelscher [1986], Cebula [1997], Hollov [1986], and Ostrosky [1990]. As in Holloway [1986], the EASR variable adopts the 52 - week Treasury bill rate. The study period, using quarterly data, is 1979:4-2001:2.

The data sources are as follows:

- Board of Governors of the Federal Reserve System [2002]: http://www.federalreserve.g Releases/H15/data;
- The Council of Economic Advisors [1974, Table C-58; 1979, Table B-65; 1984, Table B- 1989, Table B-71; 1992, Table B-69; 1995, Table B-72; 1998, Table B-71; 2002, Table 73];
- Bureau of Labor Statistics [2002, Tables 1.1 and 3.2]: http://www.bea.doc.gov/bea/ nipaweb/SelectTable.asp?Selected=N.

IV. Initial Analysis

The empirical analysis begins by testing the variables in the system for order of integration and cointegration. To begin this process, the Phillips-Perron (P-P) test for a unit root was performed. All of the variables in the system were found to be stationary in first differences, as reported in Table 1. The choice of lag length was determined using the SBC (Schwarz-Bayesian criterion).

Table 1: P-P Unit Root Test-statistics
P-P Statistics

Variable	First Differences
TDY	-10.65**
LR	-7.90**
EASR	-8.91**
MBY	-5.98**
S&P	-16.62**
UR	-4.63**

** Indicates rejection of the null hypothesis of unit root at the 99% confidence level (99% critical value = -3.51)

Since all six series in this analysis contain a unit root in levels, but are stationary in first differences, all causality tests must be performed in first differences. Furthermore, to determine the correct specification of the causality test, we must test for cointegration among the variables. This is accomplished using the Johansen [1990] cointegration test. In order to perform the Johansen cointegration test, we must first determine the appropriate lag-length to be used to estimate the VAR (Vector Auto regressive) model below:

$$[Y_t] = [a] + \sum_{i=1}^{p} [b_i][Y_{t-i}] + [u_t] \qquad (12)$$

where [ ] indicates a matrix, [a] is the matrix of constant terms, and $[u_t]$ is the matrix of stochastic error terms. The lag length p is so chosen that it minimizes the final prediction error using log-likelihood ratio tests and ensures that all u_t are white noise. In the present model, p was determined to be 3.

Empirical testing reveals that CY contains a deterministic trend. Accordingly, the Johansen cointegration procedure was applied to the model with a deterministic trend on the one hand and to the model without a deterministic trend on the other, in order to test as to which form of the model is more appropriate. We find that, according to the likelihood-ratio test, we can at the 95% confidence level reject that the VAR contains a deterministic trend. Accordingly, the results of the trace test, using p = 3 but excluding a deterministic trend, are provided in Table 2.

Adopting the 5% level of significance as the appropriate criterion, the trace test statistics indicate that the cointegration matrix is rank 2. Thus, testing for causality among the variables requires the use of the ECM, which in this case must be estimated using two error-correction terms in order to avoid mis-specification. The error-correction terms are the normalized cointegrating vectors, $z1_t$ and $z2_t$, as given below:[1]

Table 2: Basic Cointegration Test Results
Trace Test Results

Rank	LLR	5% CV	1% CV
r=0	118.83 **	82.49	90.45
r=1	61.27 *	59.46	66.52

** Indicates rejection of the null hypothesis at the 99% confidence level;
* indicates rejection of the null hypothesis at the 95% confidence level.
L.L.R. is log-likelihood ratio and c.v. is the critical value.

$$z1_t = +\ 1.0\ LR_t(-1) - 14.59\ MBY_t(-1) - 0.29\ UR_t(-1) - 0.054\ S\&P_t(-1) - 0.963\ EASR_t(-1) \qquad (13)$$

$$z2_t = +\ 1.0\ TDY_t(-1) - 4469.2\ MBY_t(-1) - 120.95\ UR_t(-1) + 51.62\ S\&P_t(-1) + 89.66\ EASR_t(-1) \qquad (14)$$

[1] The normalized equation is of the form: $z = -b_0 - bw_j$ where wj is a vector of j right-hand-side variables.

Testing for causality between TDY_t and LR_t in the ECM requires not only checking the stati significance of the lagged independent variables, but also checking the statistical signific of the error-correction terms. We test for causality by estimating the full ECM used to tes cointegration. This ECM contains three lags of each exogenous variable and two error-corre terms. The parameters of the ECM are estimated using OLS, correcting for heteroskedas using Newey-West heteroskedasticity-consistent standard errors and covariances. In the int of efficiency, and given the emphasis in this study on the impact of the total federal bu deficit on the nominal interest rate yield on seven - year US Treasury notes, the ECM estimates for each of these two variables are provided in the following section of study.[2]

V. The ECM Results

The ECM estimate for the seven - year Treasury note interest rate yield variable is:

$$vLR_t = +\ 0.004\ vTDY_t^{-1} + 0.0005\ vTDY_{t-2} + 0.007\ vTDY_{t-3}$$
$$(+1.26) \qquad (+0.15) \qquad (+2.03)^*$$
$$+\ 0.795\ vLR_{t-1} - 0.305\ vLR_{-2} + 0.54\ vLR_{t-3}$$
$$(+4.01)^{**} \qquad (-1.47) \qquad (+2.68)^{**}$$
$$-\ 16.2\ vMBY_{t-1} - 49.95\ vMBY_{t-2} + 45.6\ vMBY_{t-3}$$
$$(-0.12) \qquad (-0.34) \qquad (+0.33)$$
$$-\ 0.019\ vS\&P_{t-1} - 0.041\ vS\&P_{t-2} + 0.003\ vS\&P_{t-3}$$
$$(-1.07) \qquad (-2.69)^{**} \qquad (+0.25)$$
$$-\ 0.046\ vEASR_{t-1} + 0.02\ vEASR_{t-2} - 0.15\ vEASR_{t-3}$$
$$(-0.29) \qquad (+0.14) \qquad (-1.02)$$
$$+\ 0.52\ vUR_{t-1} - 0.967\ vUR_{t-2} + 0.15\ vUR_{t-3}$$
$$(+1.32) \qquad (-1.99)^* \qquad (+0.33)$$
$$-\ 0.17\ z1_t - 0.001\ z2_t$$
$$(-1.31) \quad (-2.06)^*$$
$$R^2 = 0.46,\ LI = -55.45 \qquad (1!$$

** Indicates statistically significant at 1% level.

* Indicates statistically significant at 5% level.

where terms in parentheses are t-values and "v" is the first-differences operator.

In equation (15), the estimated coefficient on $z2_t$ is negative and statistically significant the 5% level; in addition, the estimated coefficient on the vTD_{t-3} term is positive and statistica

[2] The ECM results for other variables will be provided upon written request.

significant at the 5% level. Thus, based on both the error-correction term results ($z2_t$) and the estimated coefficient on $vTDY_{t-3}$, the nominal interest rate yield on seven - year US Treasury notes is an increasing function of the total federal budget deficit, i.e., a higher federal budget deficit acts to raise (causes an increase in) the nominal seven - year Treasury note yield. Next, based on the one-quarter and three-quarter lag results for the LR variable, it appears that previous-period values of the seven - year yield have positively impacted on the current yield. Based on the negative, significant coefficient on vUR_{t-2} and the negative, significant coefficient on $z2_t$, the seven yield Treasury note yield is negatively caused by the unemployment rate, as hypothesized in (11). The variable MBY, through $z2_t$, appears to have negative impact on the seven-year Treasury note yield, as expected. Furthermore, through the error-correction term $z2_t$, the EASR variable appears to positively cause the seven-year Treasury note yield, as hypothesized in (11). However, the impact of the S&P 500 index variable appears from $z2_t$ to have a positive impact but from the two-period lag result to have a negative impact; hence, we infer that the influence of this variable on the seven-year Treasury note yield is unclear.

Simply in order to test for the possibility of a bidirectional relationship between variables TDY and LR over the study period, the ECM estimate for TDY is given by equation:

$$
\begin{aligned}
vTDY_t = {} & -0.14\ vTDY_{t-1} + 0.20\ vTDY_{t-2} + 0.079\ vTDY_{t-3} \\
& (-1.02) \qquad (+1.40) \qquad (+0.62) \\
& + 0.23\ vLR_{t-1} - 12.49\ vLR_{t-2} - 2.44\ vLR_{t-3} \\
& (+0.03) \qquad (-1.53) \qquad (-0.31) \\
& - 8661.8\ vMBY_{t-1} + 2119.8\ vMBY_{t-2} - 2396.3\ vMBY_{t-3} \\
& (-1.61) \qquad (+0.37) \qquad (-0.44) \\
& + 50.4\ vUR_{t-1} - 38.6\ vUR_{t-2} + 18.59\ vUR_{t-3} \\
& (+3.25)^{**} \quad (-1.95) \qquad (+1.07) \\
& + 0.18\ vS\&P_{t-1} + 0.28\ vS\&P_{t-2} + 0.23\ vS\&P_{t-3} \\
& (+0.26) \qquad (+0.47) \qquad (+0.46) \\
& + 3.44\ vEASR_{t-1} + 2.99\ vEASR_{t-2} + 3.02\ vEASR_{t-3} \\
& (+0.54) \qquad (+0.51) \qquad (+0.52) \\
& +7.33\ z1_t + 0.0099\ z2_t \\
& (+1.39) \quad (+0.54) \\
& R^2 = 0.42;\ LI = -359.91 \qquad (16)
\end{aligned}
$$

The estimated coefficients on $z1_t$ and $z2_t$, both fail to be statistically significant; hence, inferences from equation (16) are based solely on the lagged coefficients. The estimation shown in equation (16) reveals that the coefficient for all of the lagged LR terms are not statistically significant at even the 10% level; hence, the seven-year Treasury note yield does not appear to influence the federal budget deficit over the study period. Consequently, there then is no evidence of a bidirectional causality between the seven - year Treasury note interest rate yield and the total federal budget deficit over the study period.

VI. Conclusion

The "conventional wisdom" argues that, ceteris paribus, the federal budget deficit ac elevate the long-term rate of interest. Despite the appearance and high visibility of Rica Equivalence arguments and studies based thereupon, a number of studies in recent years provided empirical support for the conventional wisdom.

The present study has used cointegration and Error-Correction Model (ECM) techniqu investigate the causality relationship between the federal budget deficit and the nor interest rate yield on seven-year US Treasury notes. In this study, strong empirical suppo provided over the 1979:4-2001:2 period, that the federal budget deficit positively ca (acted to raise) the nominal interest rate yield on seven-year US Treasury notes. Giver relative lack of segmentation among bond markets within the US, it would appear that fa elevating the total federal budget deficit may act directly and/or indirectly to raise the co borrowing not only for the US Treasury but also for private firms, households (esp., in tern home mortgage rates and home equity lines of credit), and even state, county, and government agencies, presumably through increasing the competition for loanable fund the extent that such rates of interest are thus affected by the federal budget deficits, long- growth and productivity in the private sector may be adversely affected [Krueger (2003); Car and Spencer (1975); Cebula (1975)], and state, county, and local government agencies ma exposed to increased financial stress. ❖

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