

A contemporary investigation of causality between the primary government budget deficit and the *ex ante* real long term interest rate in the US^{*}

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1. Introduction

In the US, there had been a brief, fleeting recent experience with federal government budget surpluses. However, given the recession of 2001, sluggish economic growth after the 2001 recession, a multi-year federal income tax rate cut statute enacted in 2001, and budgetary needs in light of the 'war on terrorism' in the aftermath of the terrorist attacks on the US on September 11, 2001, the specter of federal government budget deficits has reappeared. Indeed, the continued slow economic growth and other continuing and evolving military/national-security circumstances make the prospects for federal government budget deficits in the foreseeable future a virtual certainty.

The impact of federal budget deficits on interest rate yields in the US has been studied extensively (Barth, Iden and Russek 1984 and 1985; Barth *et al.* 1989, Carlson and Spencer 1975, Cebula 1988, 1997a, 1997b and 2000; Cebula and Belton 1993; Cebula and Saltz 1998; Cukierman and Meltzer 1989; Darrat 2000; Evans 1985 and 1987; Feldstein and Eckstein 1970; Findlay 1990; Hoelscher 1983 and 1986; Hol-

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* I am indebted to two anonymous referees and to my research assistant, Will Perry, for data assembly and processing.

loway 1988; Johnson 1992; Mascaro and Meltzer 1983; McMillin 1986; Ostrosky 1990; Swamy, Kolluri and Singamsetti 1990; Tanzi 1985; Zahid 1988). Most of these studies are couched within open or closed IS-LM or loanable funds models or variants thereof. Many of these studies find that the federal government budget deficit acts to raise longer term rates of interest while not significantly affecting shorter term rates of interest. Since capital formation is presumably much more affected by long term than by short term rates, the inference has occasionally been made that budget deficits may lead to partial 'crowding out' (Carlson and Spencer 1975, Cebula 1985).

It is worth noting that a large proportion of this literature ignores net international capital flows, thereby neglecting the potential interest-rate impact of such flows and, especially in the global economy, raising a question of a possible omitted-variable bias (Penner 1987). Similarly, an even larger proportion of this literature ignores personal income tax rates, thereby raising the question of omitted-variable bias on yet another level (for exceptions, see Cebula and Belton 1993 and Tanzi 1985). This omission seems especially serious since such tax rates arguably can profoundly influence private sector spending and savings decisions, and hence *tax collections*, *transfer payments* (such as *unemployment benefits*) and *budget deficits*.

Arguably even more interesting and potentially more significant, the budget deficit measures adopted most commonly in this literature, the NIPA (National Income and Product Accounts) total budget deficit, the structural budget deficit, and the cyclical budget deficit, all include interest payments on the national debt. This presence of interest payments on the national debt in the budget-deficit measure raises the question of a possible fundamental mis-specification. This is because the interest rate is typically treated in these studies as the dependent variable, whereas interest payments on the national debt are *simultaneously* a major component of a key 'right-hand-side' variable (i.e., the budget deficit itself), with causality allegedly flowing uni-directionally from the deficit to the interest rate. To address this problem, the present study adopts the *primary budget deficit* as the deficit measure, a deficit specification that has to date received little attention (*cf.* Cebula and Rhodd 1993). Furthermore, since changes in *ex ante* real long term interest rates presumably may either directly or *indirectly* alter the pace of real economic activity through changes in private sector purchases, especially capital forma-

tion/investment, they also may indirectly affect the federal budget deficit by changing federal government tax revenues, federal government transfer payments, and even discretionary fiscal policies. This possibility of a bi-directional budget deficit-interest rate causality typically has been overlooked but arguably should not have been dismissed so easily.

This study seeks to investigate the budget deficit/*ex ante* real long term interest rate relationship after accounting for these three potential problems. The present study adopts cointegration and error-correction model estimation to investigate empirically the *possibility* that, in contrast to the conventional wisdom, the direction of causality between federal budget deficits and the *ex ante* real long term interest rate may be bi-directional rather than simply uni-directional. As stated above, a flow of causality from the interest rate to the primary deficit is plausible because a rise in long term interest rates, especially *ex ante* real long term rates, should – according to the conventional wisdom – lead to a decline in real economic activity as aggregate real investment outlays (and potentially other private sector real outlays as well) decline (Hoelscher 1986). Furthermore, aside from implications for the cyclical component of the total budget deficit in terms of diminished tax collections and increased government transfer payments, it follows that to the extent that policymakers are sensitive to a slowing pace of real economic activity (or to rising unemployment rates), the federal government budget deficit may also be increased through discretionary fiscal policies (e.g., increased government purchases or income tax rate cuts). Finally, the model includes net international capital inflows as well as a federal personal income tax rate measure, so as to avoid omitted-variable bias (Penner 1987, Cebula and Belton 1993, Tanzi 1985). Focusing on the *ex ante* real interest rate yield on Moody's Aaa-rated long term corporate bonds and adopting the primary budget deficit measure should permit an analysis of whether there is an actual *economic* relationship (as suggested above) between the federal budget deficit and the *ex ante* real long term interest rate other than a merely *de facto* accounting relationship involved in the mechanical payment of interest on the national debt.

Using seasonally adjusted quarterly data, the study period is 1973.2-1999.4. I begin with 1973.2 because this is the quarter by which time the system of fixed exchange rates (Bretton Woods) had effectively collapsed. Thus, over the entire study period, there effectively is

a uniform exchange rate system in place; this of course simplifies the inclusion of net international capital flows in the analysis. Ending the study period with 1999.4 makes the study contemporary.

Section 2 provides the framework for the empirical analysis. The system includes not only the primary budget deficit and the *ex ante* real interest rate yield on Moody's Aaa-rated long term corporate bonds, but also net international capital inflows, a federal personal income tax rate measure, the unemployment rate, an *ex ante* real short term interest rate yield, and the M2 money supply. Section 3 precisely defines the variables in the empirical model and describes the actual data, including the measurement of the expected inflation rate needed to compute the *ex ante* real long term and short term interest rates in the model. Sections 4 and 5 provide the empirical results, whereas an overview of the study findings is found in Section 6.

2. The basic framework

In developing the underlying framework for the empirical analysis, I first consider the following intertemporal government budget constraint:

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

where ND_{t+1} = the national debt in period $t+1$; ND_t = the national debt in period t ; G_t = government purchases in period t ; F_t = government non-interest transfer payments in period t ; R_t = average effective interest rate on the national debt in period t ; T_t = government tax and other revenues in period t .

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

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

Rather than focusing on the total deficit, this study focuses on the *primary budget deficit*, which excludes interest payments made by the Treasury. Adopting this budget deficit measure may permit avoidance of a possible mis-specification in the budget deficit/interest rate causality analysis. The primary deficit (PD_t) is given by:

$$PD_t = TD_t - R_t ND_t = ND_{t+1} - ND_t - R_t ND_t = G_t + F_t - T_t \quad (3)$$

One can incorporate the effects of: I , the federal income tax rate; $EALR$, the *ex ante* real interest rate yield on Moody's Aaa-rated long term corporate bonds; C , net international capital inflows; and UR , the unemployment rate of the civilian labor force, into the model, as follows:

$$F = f(EALR, C, UR, OF1), f_{EALR} > 0, f_C < 0, f_{UR} > 0 \quad (4)$$

$$T = g(I, EALR, C, UR, OF2), g_I < 0, g_{EALR} < 0, g_C > 0, g_{UR} < 0 \quad (5)$$

$$G = h(EALR, UR, OF3), h_{EALR} > 0, h_{UR} > 0 \quad (6)$$

where OF_z , $z = 1, \dots, 3$ refers to 'other' factors that may affect F , T and G , respectively.

It is hypothesized in this study that *plausible* factors influencing F , T and G may well include long term interest rates, especially the *ex ante* real long term interest rate yield, $EALR$. If $EALR$ were to rise, as a practical matter, then other markets competing for long term loanable funds, including long term Treasury issues and private-sector mortgages, would presumably be faced with higher real interest rates as well, due to competition. To the extent that these higher real long term interest rates lead to reduced real economic activity, tax collections would likely fall and government transfers, especially unemployment compensation, would likely increase. Indeed, *discretionary* fiscal actions also might be undertaken. For example, government purchases might be increased and/or extensions of unemployment insurance benefits might be enacted and/or income tax rates reduced in order to alleviate recessionary, i.e., higher unemployment rate, conditions resulting from a higher $EALR$, especially in an election year. Furthermore, higher $EALR$ levels *might* act to create interest-induced (negative) wealth effects (in the form of declining bond prices), that themselves could act to reduce private sector spending and hence slow real economic activity. To the extent that these additional potential effects of a higher $EALR$ are manifested, they *might* to some degree *further* act to raise F and lower T , if not potentially even affect G and/or I . In any case, the plausible outcome from increased levels of $EALR$ would be an increased primary budget deficit.

In theory, the higher the effective income tax rate, the higher the level of tax collections, *ceteris paribus*, and hence the lower the

primary deficit. On the other hand, to the extent that a higher effective income tax rate either slows real economic activity or induces increased income tax evasion, tax collections could potentially decline (Feige 1994, Tanzi 1982 and 1983). Accordingly, the net impact of I on PD is (theoretically) unclear. Next, the greater the net inflow of international capital (C), the greater the supply of loanable funds and hence the more likely the economy is to expand, which would act automatically to lower F and raise T . Finally, the higher the UR (unemployment rate), the higher unemployment compensation outlays will be and hence the higher F will be, *ceteris paribus*. In addition, a higher UR will likely lead to reduced tax collections. Moreover, to the extent that policymakers are sensitive to higher unemployment rates, they may react by raising government purchases, G , and/or reducing tax rates, I .¹

Thus, the primary deficit is likely to be a function of I , $EALR$, C and UR , such that:

$$PD = j(I, EALR, C, UR, \dots) \quad (7)$$

$$\text{where } j_I \geq < 0, j_{EALR} > 0, j_C < 0, j_{UR} > 0 \quad (8)$$

The intertemporal government budget constraint model above focuses on determinants of the primary deficit. In order to explain the determination of the *ex ante* real interest rate yield on Moody's Aaa-rated long term corporate bonds ($EALR$), including the impact of the primary budget deficit on same, an open-economy loanable funds model is adopted in which the *ex ante* real long term interest rate yield on high quality (low risk) corporate bonds is determined by a loanable funds equilibrium of the following form (Barth, Iden and Russek 1985; Cebula 1992 and 1997a; Hoelscher 1986):

$$D + C + M = S + PD \quad (9)$$

where D = real domestic demand for long term high quality corporate bonds; C = real net international capital inflows (as above); $M2$ = real domestic money supply; S = real domestic supply of long term high quality corporate bonds; PD = real net borrowing by (the

¹ The GDP is not used as a separate variable here because it is used to scale the deficit and capital inflows variables. UR is used in the estimations in place of the real GDP to reflect real economic activity.

budget deficit of) the federal government, as measured by the primary budget deficit.

In this framework, it is expected that:

$$D = D(EALR, I, EASR, UR, \dots), \quad (10)$$

$$D_{EALR} > 0, D_I < 0, D_{EASR} < 0, D_{UR} > 0$$

$$S = S(EALR, \dots), S_{EALR} < 0, \quad (11)$$

$$C = C(EALR, EASR, \dots), C_{EALR} > 0, C_{EASR} > 0 \quad (12)$$

In equations 10 and 12, the symbol *EASR* refers to the *ex ante* real short term interest rate yield.

It is expected that, in principle paralleling Barth, Iden and Russek (1985), Cebula (1992 and 1997a) and Hoelscher (1986), as well as the conventional wisdom, the real domestic demand for long term high quality corporate bonds is an increasing function of their *ex ante* real interest rate yield, whereas the real domestic supply of long term high quality corporate bonds is a decreasing function of their *ex ante* real interest rate yield. In addition, as suggested in Penner (1987, p. 123), it is expected that 'high real interest rates [...] would attract massive inflows of international capital'; this accounts for the expected positive signs on C_{EALR} and C_{EASR} . In addition, following Hoelscher (1986), Cebula (1997a) and others, the real demand for long term high quality corporate bonds is treated as a decreasing function of the *ex ante* real short term bond yield because as this short term rate rises, bond buyers at the margin substitute short term bonds for long term bonds in their portfolios. The real demand for long term high quality corporate bonds is a decreasing function of income tax rates since higher income tax rates reduce household *after-tax*, i.e., disposable, income and hence private-sector (household) saving. Finally, the higher the unemployment rate, the higher may be the demand for Moody's Aaa-rated corporate bonds because, during times of higher unemployment (or recession), investors tend to seek more conservative financial investments, such as high quality (low-risk) bonds (Cebula 1997a).

Substituting equations 10, 11 and 12 into equation 9 and solving for *EALR* yields:

$$EALR = EALR(PD, M2, C, I, EASR, UR) \quad (13)$$

such that:

$$\begin{aligned} EALR_{PD} > 0, EALR_{M2} < 0, EALR_C < 0, \\ EALR_I > 0, EALR_{EASR} > 0, EALR_{UR} < 0 \end{aligned} \quad (14)$$

The first of these expected signs is positive in order to reflect the traditional argument that, when the federal government (Treasury) attempts to finance a budget deficit, it forces interest rates upwards as it competes for funds from the financial markets. The expected negative sign on the second partial reflects the fact that a greater real money supply provides a larger source of loanable funds and indeed may act to offset the interest rate effects of budget deficits. The expected sign on the capital flows variable is negative because net capital inflows absorb domestic debt issues and presumably help offset the effects of primary budget deficits (Cebula and Belton 1993). The positive sign on $EALR_I$ reflects the decreased demand and hence decreased market price for (and thus higher yield on) long term high quality corporate bonds as income tax rates are elevated. The positive sign on $EALR_{EASR}$ reflects the impact of competition from short term bond markets. Finally, the sign on $EALR_{UR}$ reflects the increased demand for and hence decreased yield on high quality corporate bonds during times of higher unemployment (or recession).

3. Variables and data

The first step in the analysis is to develop an appropriate empirical measure of *expected inflation*. This determination is essential to the measurement of the variables $EALR$ and $EASR$. One possibility is to adopt the well-known Livingston survey data. However, as observed by Swamy, Kolluri and Singamsetti (1990, p. 1013) there may be serious 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”.

Accordingly, following the lead by Swamy, Kolluri and Singamsetti (1990), rather than using the Livingston series, the 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) 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 1997a; Swamy, Kolluri and Singamsetti 1990). It should be noted that use of the average of the actual inflation rate in the most recent four quarters to estimate expected inflation, as suggested in Al-Saji (1993), produces results entirely consistent with the findings of the present study.

Based on the framework in Section 2 above, the following variables are included in the empirical analysis:

PDY_t = the ratio of the seasonally adjusted nominal *primary* federal budget deficit in quarter t to the seasonally adjusted nominal GDP in quarter t, as a percent;

$EALR_t$ = the *ex ante* real average interest rate yield in quarter t on Moody's Aaa-rated long term corporate bonds, as a percent per annum;

$EASR_t$ = the *ex ante* real average interest rate yield in quarter t on 52 week US Treasury bills, as a percent per annum;

I_t = the average effective federal personal income tax rate in quarter t, as a percent;

$M2Y_t$ = the ratio of the seasonally adjusted nominal M2 money supply in quarter t to the seasonally adjusted nominal GDP in quarter t, expressed as a percent;

UR_t = the seasonally adjusted percentage unemployment rate of the civilian labor force in quarter t;

CY_t = the ratio of the seasonally adjusted nominal net international inflow of capital in quarter t to the seasonally adjusted nominal GDP in quarter t, as a percent.

The two *ex ante* real interest rate variables are computed, as follows:

$EALR_t$ = nominal average interest rate yield on Moody's Aaa-rated long term corporate bonds in quarter t (as a percent per annum) minus the expected inflation rate in quarter t , P_t^e (as a percent per annum); and

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

The primary budget deficit is scaled by the GDP level, as are net international capital inflows and the M2 money stock. This is because the primary budget deficit, international capital inflows and the M2 money stock should all be judged relative to the size of the economy (Hoelscher 1986, Evans 1985 and 1987, Cebula 1997a, Holloway 1986, Ostrosky 1990). The variable I_t represents the personal income tax rate variable, I , in the model developed above. The study period, using quarterly data, is 1973.2-1999.4.

The data sources are, as follows: Board of Governors of the Federal Reserve System: <http://www.federalreserve.gov/Releases/H15/data>; The Council of Economic Advisors (1974, Table C-58; 1979, Table B-65; 1984, Table B-67; 1989, Table B-71; 1992, Table B-69; 1995, Table B-72; 1998, Table B-71; 2002, Table B-73); Bureau of Labor Statistics (2002), Tables 1.1 and 3.2: <http://www.bea.doc.gov/bea/dn/nipaweb/SelectTable.asp?Selected=N>; Tax Facts, Urban Institute, Brookings Institution (2002): <http://www taxpolicycenter.org/TaxFacts/individual/schedule.cfm>.

4. Empirical analysis

It is necessary in the empirical analysis to test the variables in the system for order of integration and cointegration. To begin this process, the results of the Phillips Perron (P-P) and Augmented Dickey-Fuller (ADF) tests for a unit root were 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 Schwarz-Bayesian (SBC) criterion.

TABLE 1

P-P AND ADF UNIT ROOT TEST-STATISTICS

Variable	P-P statistics	ADF statistics
	First differences	
PDY	-10.69*	-5.30*
EALR	-8.20*	-4.35*
I	-9.21*	-4.31*
M2Y	-5.10*	-4.39*
CY	-9.02*	-4.51*
UR	-4.77*	-4.50*
EASR	-9.14*	-5.03*

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

Given that all seven of the series in this analysis are stationary in first differences, all causality tests are performed in first differences. Furthermore, to determine the correct specification of the causality test, I must test for cointegration among the variables. This is accomplished using the Johansen (1990) cointegration test. In order to perform the Johansen cointegration test, I must first determine the appropriate lag-length to be used to estimate the VAR (Vector Auto-Regressive) model below:

$$[Y_t] = [a] + \sum_{i=1}^p [b_i][Y_{t-i}] + [u_t] \tag{15}$$

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 2.

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 then alternatively to the model without a deterministic trend in order to test for which form of the model is more appropriate. I find that, according to the likelihood-ratio test, I can at the 95% confidence level reject that the VAR contains a deterministic trend. Accordingly, the results of the trace and maximum *eigenvalue* tests, using *p* = 2 but excluding a deterministic trend, are provided in Table 2.

TABLE 2

BASIC COINTEGRATION TEST RESULTS

Trace test			Maximum <i>eigenvalue</i> test				
Rank	L.L.R.	5% c.v.	1% c.v.	L.L.R.	5% c.v.	1% c.v.	
$r \leq 0$	156.6 *	109.99	119.80	$r=0$	59.05*	41.51	47.15
$r \leq 0$	97.55*	82.49	90.45	$r=1$	36.91**	36.36	41.00
$r \leq 0$	60.65**	59.46	66.52	$r=2$	26.09	30.04	35.17

*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 critical value.

Using the 5% level of significance as the appropriate criterion, the trace test and maximum *eigenvalue* test statistics indicate that the cointegration matrix is rank 2.² Thus, testing for causality among the variables requires the use of the error-correction model (ECM), which in this case must be estimated using two error-correction terms in order to avoid mis-specification. The two error-correction terms are the two normalized cointegrating vectors, $z1_t$ and $z2_t$, as given below:³

$$z1_t = + 1.00 \text{ EARL}_t(-1) + 88.63 \text{ PDY}_t(-1) - 0.51 \text{ EASR}_t(-1) - 59.49 \text{ CY}_t(-1) + 9.315 \text{ M2Y}_t(-1) - 1.699 \text{ UR}_t(-1) \quad (16)$$

$$z2_t = + 1.00 \text{ I}_t(-1) + 76.74 \text{ PDY}_t(-1) + 0.199 \text{ EASR}_t(-1) + 158.79 \text{ CY}_t(-1) - 7.257 \text{ M2Y}_t(-1) - 1.289 \text{ UR}_t(-1) \quad (17)$$

Testing for causality between PDY_t and $EARL_t$ in the ECM requires not only checking the statistical significance of the lagged independent variables, but also checking the statistical significance of the error-correction terms. For this reason, I need to be able to reject the hypothesis that the coefficient on PDY_t in equation 16 is zero. That $z1_t$ is stationary means that PDY_t , $EARL_t$, $EASR_t$, $M2Y_t$, UR_t , and CY_t are cointegrated. If the coefficient on PDY_t is zero, then the system of variables would still be cointegrated without the inclusion of PDY_t . Performing the Johansen cointegration test excluding PDY_t reveals that the remaining variables are not cointegrated. This allows us to re-

² Although the trace test indicates the possibility of three cointegrating vectors, the *maximum eigenvalue* test indicates only two. Consequently, the ECM is based on two error-correction terms.

³ The normalized equation is of the form:

$z = -b_0 - bw_j$, where w is a vector of j right-hand-side variables.

ject the hypothesis that the coefficient on PDY_t in 16 is zero. Performing the same procedure for equation 17 yields the same conclusion. Thus, there apparently is a long run equilibrium relationship between PDY_t and $EARL_t$, *ceteris paribus*. In fact, repeating this process for each variable in the system allows us to reject that any of the coefficients in 16 or 17 are zero.

Having established that the system of endogenous variables are cointegrated of rank 2, the appropriate model for testing the direction of causality is the ECM. Next, I proceed with testing for causality by estimating the full ECM used to test for cointegration. This ECM contains 2 lags of each exogenous variable and two error-correction terms. The parameters of the ECM are estimated using OLS. In the interest of efficiency, and given the emphasis in this study on the primary budget deficit and the *ex ante* real interest rate yield on Moody's Aaa-rated long term corporate bonds, only the ECM estimates for each of these two variables are provided in the following section of this study.⁴

5. ECM results

The estimate for the primary deficit variable is given by:

$$\begin{aligned}
 vPDY_t = & -0.377 vPDY_{t-1} & + 0.075 vPDY_{t-2} & + 0.0157 vUR_{t-1} & + 0.006 vUR_{t-2} \\
 & (-3.39)^* & (+ 0.71) & (+ 7.47)^* & (+ 2.27)** \\
 & + 0.0013 vEALR_{t-1} & + 0.0094 vEALR_{t-2} & -0.00087 vEASR_{t-1} & -0.00088 vEASR_{t-2} \\
 & (+ 3.21)^* & (+ 0.72) & (-0.78) & (-0.83) \\
 & + 0.157 vCY_{t-1} & + 0.111 vCY_{t-2} & -0.107 vM2Y_{t-1} & -0.056 vM2Y_{t-2} \\
 & (+ 1.00) & (+ 0.68) & (-1.21) & (-0.61) \\
 & + 0.0004 vI_{t-1} & + 0.0001 vI_{t-2} & & \\
 & (+ 0.27) & (+ 0.08) & & \\
 & -0.00099 z1_t & -0.00136 z2_t & & \\
 & (-2.22)** & (-3.00)^* & &
 \end{aligned} \tag{18}$$

* Indicates statistically significant at 1% level.
 ** Indicates statistically significant at 5% level.

$$R^2 = 0.58, \text{adj}R^2 = 0.51, \text{Ll} = 426.57$$

⁴ The ECM results for other variables will be provided upon written request.

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

In equation 18, the estimated coefficient on $z1_t$ is negative and statistically significant at the 5% level. Based on this error-correction term result, the *ex ante* real interest rate yield on Moody's Aaa-rated long term corporate bonds positively 'causes', i.e., exercises a positive and significant impact on the primary budget deficit. This conclusion is reinforced by the positive and statistically significant coefficient on the one-quarter lag of the EALR variable in equation 18.

Also, in equation 18, since the error-correction term $z1_t$ is significant at the 5% level, it appears that the M2 money supply variable positively causes the primary deficit. However, the coefficient on $z2_t$ is negative and statistically significant at the 1% level, implying that the M2 money supply variable negatively causes the primary deficit. Thus, from equation 18, the *net* impact of M2 (as a percent of GDP) on primary budget deficits is unclear. The coefficients on the tax variable are both statistically insignificant. However, the fact the coefficient on $z2_t$ is negative and statistically significant implies that the income tax rate positively causes, i.e., exercises a positive impact on the primary deficit. This finding indicates the possibility that higher income tax rates may induce increased income tax evasion and/or slower economic expansion, so that the primary deficit would rise. Potentially, then, it may well be that *lower* income tax rates, over the long run, would reduce income tax evasion and/or elevate economic growth, so that the primary budget deficit could actually decline. This issue clearly lies beyond the scope of the present study, however. The coefficients on the capital flows and *ex ante* real short term interest rate (EASR) variables are all statistically insignificant. Given as well the conflicting results for both the capital flows and EASR variables from $z1_t$ and $z2_t$, it appears that the net impacts of capital flows and EASR on the primary deficit are unclear. Finally, I come to the unemployment rate variable. In equation 18, the coefficients on the one-quarter and two-quarter lags of the unemployment rate variable are positive and statistically significant, implying that higher unemployment rates may elevate the primary deficit. This conclusion is questionable, however, in view of the opposite conclusion inferred from both of the error-correction term results. Hence, the net impact of the unemployment rate on the primary deficit is unclear.

The estimate for the *ex ante* real interest rate yield on Moody's Aaa-rated long term corporate bonds is given by:

$$\begin{aligned}
 VEALR_t = & + 18.73 \ vPDY_{t-1} & + 16.18 \ vPDY_{t-2} & + 0.20 \ vUR_{t-1} & - 0.78 \ UR_{t-2} \\
 & (+ 2.38)** & (+ 1.41) & (+ 0.88) & (-2.67)* \\
 & + 0.336 \ EALR_{t-1} & + 0.118 \ vEALR_{t-2} & + 0.256 \ vEASR_{t-1} & + 0.119 \ vEASR_{t-2} \\
 & (+ 2.23)** & (+ 0.08) & (+ 2.12)** & (+ 1.04) \\
 & + 8.91 \ vCY_{t-1} & - 45.08 \ vCY_{t-2} & - 19.43 \ vM2Y_{t-1} & + 5.34 \ vM2Y_{t-2} \quad (19) \\
 & (+ 0.51) & (-2.53)* & (-2.01)* & (+ 0.54) \\
 & - 0.042 \ vI_{t-1} & + 0.112 \ vI_{t-2} & - 0.142 \ z1_t & - 0.058 \ z2_t \\
 & (-0.24) & (+ 0.66) & (-2.92)* & (-1.17)
 \end{aligned}$$

$$R^2 = 0.27, \text{adj}R^2 = 0.15, \text{Ll} = -61.68$$

Although the estimated coefficient on the $z2_t$ term in equation 19 is not statistically significant, the estimated coefficient for the $z1_t$ term is negative and statistically significant at the 1% level. This result implies that the primary budget deficit positively 'causes', i.e., acts to positively and significantly raise *EALR*. Furthermore, the estimation shown in equation 19 also reveals that the estimated coefficient for variable $vPDY_{t-1}$ is positive and statistically significant at the 5% level. These results actually both imply that the primary budget deficit positively 'causes' the *ex ante* real interest rate yield on Moody's Aaa-rated long term corporate bonds. This finding, in combination with the results reported in equation 18, suggests strongly that there exists a bi-directional causality between the primary budget deficit and the *ex ante* real interest rate yield on high quality long term corporate bonds in the US.

The coefficient on the two-quarter lag of the *UR* variable is negative and statistically significant at the 1% level. Given as well that the coefficient on $z1_t$ is negative and statistically significant at the 1% level, it appears, as hypothesized, that the unemployment rate negatively 'causes' the *ex ante* real interest rate yield on long term high quality corporate bonds. The coefficient on $vEASR_{t-1}$ is positive and significant at the 5% level, whereas the coefficient on $z1_t$ is negative and significant. Together, these results conflict with one another, so that the impact of *EASR* on *EALR* is unclear. The coefficient on the two-quarter lag of the *CY* variable is negative and significant at the 1% level. Combined with the negative, significant coefficient on $z1_t$, the results imply that net capital inflows may on balance act to reduce,

i.e., negatively 'cause' *EALR*. The estimated coefficient on the one-quarter lag of the M2 money supply variable is negative and significant at the 5% level. Combined with the negative, significant coefficient on $z1_t$, the findings indicate that the net impact of M2, as a percent of GDP, on the *ex ante* real interest rate yield on high quality long term corporate bonds is unclear. Finally, the results in equation 18 indicate that the income tax rate is not a significant factor in determining *EALR*.⁵

6. Conclusion

The conventional wisdom argues that, *ceteris paribus*, the federal budget deficit acts to elevate the long term rate of interest. Despite the appearance and high visibility of Ricardian Equivalence arguments and studies based thereupon, a number of studies in recent years have provided strong empirical support for the conventional wisdom.

Within a system that includes federal personal income tax rates, as well as net international capital inflows, the M2 money supply, the unemployment rate and an *ex ante* real short term interest rate, the present study has used cointegration and error-correction model (ECM) techniques to investigate the causality relationship between the federal budget deficit and the *ex ante* real interest rate yield on high quality long term corporate bonds. To avoid a possible misspecification, 1) the primary budget deficit, which excludes Treasury net interest payments, is adopted as the federal budget deficit measure, 2) a federal income tax rate measure is included in the system, and 3) net international capital inflows are included in the analysis. The use of the primary budget deficit permits evaluation of whether there may exist *economic* reasons for an impact of the *ex ante* real long term interest rate on the primary budget deficit.

⁵ Simultaneity is potentially an issue in ECM estimations. In this particular system as a whole, of the 14 error-correction terms estimated for all of the variables in the analysis, only 7 were statistically significant. Of the 4 shown here, only 2 were significant at the 1% level, with a third significant at the 5% level. The fourth was altogether statistically insignificant. While these facts do not conclusively eliminate the possibility of a simultaneity problem, there is no compelling evidence that such a problem exists.

In this study, strong empirical support based on the ECM estimates is provided indicating that there exists a bi-directional relationship between the *ex ante* real interest rate yield on Moody's Aaa-rated long term corporate bonds and the primary budget deficit of the federal government in the US over the 1973.2-1999.4 period. Thus, federal government policies that affect the primary budget deficit cannot be viewed in a vacuum since they impact profoundly on significant market interest rate yields. Moreover, there is a feedback mechanism between federal primary deficits on the one hand, and the *ex ante* real long term interest rate yield on the other hand.

While this result may be only preliminary in the sense that additional inquiry into the issue at hand may be needed, at the very least the findings obtained here raise the specter of a far more complex relationship between the federal budget deficit and long term interest rates than has heretofore been suspected.

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