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Original article

An empirical analysis for the US of the impact of federal budget deficits and the average effective personal income tax rate on the *ex post* real interest rate yield on ten-year Treasuries

RICHARD J. CEBULA and ROBERT BOYLAN

Abstract:

We investigate the impact of federal government budget deficits and federal personal income tax rates on the ex post real interest rate yield on ten-year US Treasury notes. Using autoregressive two-stage least squares estimations for the post-Bretton Woods era, we find that the yield on these Treasury issues has been an increasing function of the federal budget deficit as a percent of GDP, both in the form of the total/unified deficit and the primary deficit, and also an increasing function of the average effective federal personal income tax rate. The estimation reveals that growth in the M2 money supply (relative to GDP) acts to reduce the real interest rate yield on ten-year Treasuries. Consequently, while a growing money supply can help to keep real interest rates on Treasury notes (and hence federal debt service costs) down, policymakers should be sensitive to the fact that both budget deficit increases and tax rate increases can elevate the real interest rate..

Cebula: Jacksonville University,
email: rcebula@ju.edu,
Boylan: Jacksonville University
email: rboylan@ju.edu

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In the United States, the total federal budget deficit, inclusive of both on-budget and off-budget borrowing, has exceeded one trillion dollars (current) on four different occasions. These four budget deficits were experienced during fiscal years 2009, 2010, 2011, and 2012 (Council of Economic Advisors, 2018, table B-17), a time frame that included the US "Great Recession," running from December 2008 through July 2009. Despite the fact that, over the last half century, there were five fiscal years, namely, 1969, 1998, 1999, 2000, and 2001, during which the federal budget was in a state of surplus, the total federal budget deficit has otherwise been in a state of deficit since 1969. Indeed, as shown in table 1, the budget deficit has risen to a *relative* magnitude of as much as 9.8% (fiscal year 2009) of GDP (Council of Economic Advisors, 2018, table B-18).

Persistent federal government budget deficits in the US are of concern because of the potential they have to elevate interest rates and reduce (crowd out): (*a*) household purchases (especially of new housing and other new durable goods), (*b*) business investment in new plant and equipment, and (*c*) state and local government purchases and maintenance of public infrastructure. To the extent that this crowding out occurs, it begins with elevated interest rates resulting from the government budget deficits and ends with a diminution in the rate of aggregate real economic growth (Carlson and Spencer, 1975; Cebula, 1978; Chopin, 1998; Ewing and Yanochik, 1999).

Table 1 – *The federal budget deficit as percentage of GDP*

Year	Deficit/GDP (%)	Year	Deficit/GDP (%)
1968	2.8	1992	4.5
1969	–0.3	1993	2.8
1970	0.3	1994	2.8
1971	2.1	1995	2.2
1972	2.1	1996	1.3
1973	1.1	1997	0.3
1974	0.4	1998	–0.8
1975	3.3	1999	–1.3
1976	4.1	2000	–2.3
1977	2.6	2001	–1.2
1978	2.6	2002	1.5
1979	1.6	2003	3.3
1980	2.6	2004	3.4
1981	2.5	2005	2.5
1982	3.9	2006	1.8
1983	5.9	2007	1.1
1984	4.7	2008	3.1
1985	5	2009	9.8
1986	4.9	2010	8.7
1987	3.1	2011	8.5
1988	3	2012	6.8
1989	2.7	2013	4.1
1990	3.7	2014	2.8
1991	4.4	2015	2.5
		2016	3.3

Source: Council of Economic Advisors (2018, table B-18).

Given this background, our analysis is timely in the face of the recent *reduction* of federal personal income tax rates in the US (as well as corporate tax rates) that was implemented in 2018 in the statutory form of provisions in the Tax Cuts and Jobs Act. It has been argued, consistent with the "conventional wisdom," that the tax-rate reductions included in this statute are a potentially significant source of both short-term and long-term economic stimulus/expansion for the US economy. However, also based on the conventional wisdom, there is potential for the Tax Cuts and Jobs Act to increase the magnitude of the federal budget deficit; this would especially be the case in the short run, before the benefits/effects of the tax cut effects could be experienced.

The impact of government budget deficits on interest rates in the US and in other nations has been empirically researched extensively. Indeed, this literature includes a number of studies published in recent years (Hoelscher, 1986; Ostrosky, 1990; Day, 1992; Al-Saji, 1993; Cebula and Koch, 1994; Chopin, 1998; Ewing and Yanochik, 1999; Gissy, 1999; Taylor, 1999; Gale and Orszag, 2003; Fullwiler, 2007; Kiani, 2009; Laubach, 2009; Cebula, 2013; 2014a; 2014b; Choi and Holmes, 2014; Cebula and Nair-Reichert, 2018). Most of these scholarly studies have concluded that larger budget deficits raise longer-term interest rates, such as those on US Treasury bonds, corporate bonds, new home mortgages, and on tax-exempt municipal bonds. The emphasis in nearly all of these studies is on private sector or federal government *nominal* interest rate yields (cf. Cebula, 2014a; Choi and Holmes, 2014). Given these observations, the two-part objective of this study is to provide contemporary empirical insights regarding whether or not federal budget deficits and/or personal income tax rates influence the *ex post* real interest rate yield on ten-year Treasury notes. Section 1 of this study provides the framework/model for the analysis. Section 2 defines and describes both the specific variables in the model and the data. Section 3 provides the empirical results of the autoregressive two-stage least squares (AR/2SLS) estimation, whereas in section 4 we provide our conclusions and public policy implications of the study findings.

1. An open-economy loanable funds model

Paralleling the modeling in Hoelscher (1986), Ostrosky (1990), Day (1992), Al-Saji (1993), Ewing and Yanochik (1999), and Cebula and Nair-Reichert (2018), an open-economy loanable funds model is adopted in which the *ex post* real interest rate yield on ten-year Treasury notes is determined, assuming all other bond markets are in equilibrium, according to the following construct:

$$S + DEFY = D + \Delta(M2MS/Y) + NCI/Y \quad (1)$$

where:
S = the supply of ten-year US Treasury notes;
$DEFY$ = the total federal budget deficit, expressed as a percentage of GDP;
D = the demand for ten-year US Treasury notes;
$\Delta(M2MS/Y)$ = the increase in the ratio of the M2 money supply to GDP, expressed as a percentage; and
NCI/Y = net international capital inflows, expressed as a percentage of GDP.

It is hypothesized in the present study that:

$$D = \mathrm{D}\ (EPR10, EPR30, EPR3, TAX), \qquad D_{EPR10} > 0,\ D_{EPR30} < 0,\ D_{EPR3} < 0,\ D_{TAX} < 0 \quad (2)$$

$$S = \mathrm{S}\ (EPR10, EPR30, EPR3), \qquad S_{EPR10} < 0,\ S_{EPR30} > 0,\ S_{EPR3} > 0 \quad (3)$$

where:
$EPR10$ = the *ex post* real interest rate yield on ten-year US Treasury notes, expressed as a percentage;
$EPR30$ = the *ex post* real interest rate yield on thirty-year US Treasury bonds, expressed as a percentage;

EPR3 = the *ex post* real interest rate yield on three-year US Treasury notes, expressed as a percentage; and
TAX = the average effective federal personal income tax rate, expressed as a percentage.

The value of any *ex post* real interest rate yield in this study in year t is the nominal interest rate yield in question minus the actual inflation rate of the overall consumer price index in that year.

According to this specification, the demand for ten-year Treasury notes is modeled as being an increasing function of EPR10 since note buyers would logically prefer a higher real rate of return on their investments, ceteris paribus. On the other hand, in theory, the Treasury (the issuer of new ten-year Treasury issues) would supply/issue fewer ten-year notes in response to a higher *EPR10*, ceteris paribus, since such a condition would elevate the level of Treasury's debt service. The higher the value of either *EPR30* or *EPR3*, the greater the degree to which investors substitute thirty-year Treasury bonds or three-year Treasury notes, respectively, for ten-year Treasuries in their portfolios. It follows, therefore, that there would be a diminished demand for the ten-year Treasuries as a result of either a higher value for *EPR30* or *EPR3*.[1] On the other hand, the higher the value of either *EPR30* or EPR3, the greater the supply of new ten-year Treasury notes, ceteris paribus. This is because the Treasury would issue more of the ten-year notes in place of either new thirty-year issues or new three-year issues, respectively, so as to reduce debt service payments. In other words, the public sector will try to issue more of the kind of debt that pays the lower interest rate. Furthermore, the higher the average effective federal personal income tax rate, the lower the demand for ten-year Treasuries as investors substitute tax-free municipals for the Treasury issue (the interest paid on which is fully subject to federal income taxation). And the lower the demand for ten-year Treasuries, the lower the price thereof and hence the higher the yield. This expectation is built upon the following relationship between the taxable interest rate yield, $R_{TAXABLE}$, and the tax-exempt interest rate yield, $R_{TAX\text{-}EXEMPT}$ (Cecchetti, 2006; Madura, 2008):

$$R_{TAX\text{-}EXEMPT} = R_{TAXABLE} \cdot (1 - FEDTAXRATE) \quad (4a)$$

$$R_{TAX\text{-}EXEMPT} \,/\, (1 - FEDTAXRATE) = R_{TAXABLE} \quad (4b)$$

where *FEDTAXRATE* is the relevant federal income tax rate, expressed as a decimal. Clearly, the higher the relevant federal income tax rate, the higher the $R_{TAXABLE}$ value must be in order to be equal to the prevailing value of the $R_{TAX\text{-}EXEMPT}$, ceteris paribus.

The overall supply of loanable funds, which by its nature can be available for the purchase of a multitude of alternative financial investments (including ten-year Treasury notes), can be reflected in various ways. In this study, the aggregate supply of loanable funds is taken as being reflected in large part by growth in the M2 money supply (*M2MS*), with the money supply being expressed as a percent of GDP (*Y*), i.e., the money supply variable is $\Delta(M2MS/Y)$. This specification provides an evaluation of the monetary base relative to the size of the economy as a whole. Moreover, in the US, for the period December 2008 through October 2014, the central bank (the Federal Reserve) engaged in three stages of somewhat unconventional monetary policy labeled "quantitative easing". The policy was unconventional because the Fed targeted specific longer-term securities in each stage. In the first stage, QE1, the Fed focused on purchasing agency debt and mortgage-backed securities. In QE2, the Fed focused on

[1] Thus, the ten-year Treasury yield is in direct competition with short-term and long-terms yields on otherwise comparable securities.

purchasing long-maturity Treasury securities, and in QE3 the Fed focused on purchasing mortgage-backed securities and long-maturity Treasury securities. In turn, these forms of quantitative easing influenced the magnitude of the money supply; therefore, adopting this variable, $\Delta(M2MS/Y)$, as a measure of the availability of loanable funds, possesses the advantage that it, in theory, reflects to some degree the impact of quantitative easing (Cebula, 2014b).

The model specification also includes net financial capital inflows (*NCI*). Naturally, when there is a net inflow of financial capital, the funds can be directed toward a wide variety of alternative investment options, including those offered in the financial markets. More specifically, within the latter context, net capital inflows may be used to purchase any of a variety of equity issues and/or bonds. Other things held constant, the greater the volume of *NCI* (relative to GDP) that is used to purchase debt such as bills, notes, and bonds in the US, the greater the downward pressure on interest rates in the financial markets as a whole, including that on ten-year Treasury issues. Consequently, consistent with the conventional wisdom as well as empirical evidence (Cebula and Koch, 1994), we hypothesize that the *ex post* real interest rate yield on ten-year Treasury notes is a decreasing function of NCI/Y, *ceteris paribus*.

Substituting equations (2) and (3) into equation (1), while also allowing for the oil-price shock issue raised above, solving for *EPR10* yields the model to be estimated:

$$EPR10 = f(DEFY, \Delta(M2MS/Y), NCI/Y, EPR30, EPR3, TAX) \quad (5)$$

$$\text{with: } f_{DEFY} > 0, f_{\Delta(M2MS/Y)} < 0, f_{NCI/Y} < 0, f_{EPR30} > 0, f_{EPR3} > 0, f_{TAX} > 0 \quad (6)$$

The first of these hypothesized signs involves the federal budget deficit, expressed in this study as a percentage of GDP. Naturally, the budget deficit consists of several forms of Treasury debt issues, including but not restricted to the following: Treasury bills (short-term Treasury debt issues); Treasury notes (intermediate-term Treasury issues); and Treasury bonds (long-term Treasury issues). With that clarification, the first of the hypothesized signs shown in equations (5) and (6) is positive. This hypothesized sign reflects the conventional wisdom that, when the federal government attempts to finance a budget deficit (whether through the sale of bills, notes, bonds, or other forms of Treasury debt instruments), it forces market interest rate yields upwards as it *competes* in the financial markets for funds, *ceteris paribus* (Carlson and Spencer, 1975; Cebula and Koch, 1994; Gale and Orszag, 2003; Kiani, 2009; Laubach, 2009). The second and third signs on the variables shown in equations (5) and (6) reflect the conventional wisdom regarding the impact of a relatively greater availability of loanable funds as reflected in either a greater increase in the relative money supply or greater relative international financial capital inflows, respectively. In particular, a greater value for each of these sources of funds enables the financial markets to absorb more government sector (as well as private sector) debt and thereby acts to diminish upward pressure on interest rates. The remaining three hypothesized signs for the variables shown in equation (5) and summarized in equation (6) derive directly from equations (2) and (3) above. For example, the opposing signs on both D_{EPR30} and S_{EPR30} *jointly* serve to create a hypothesized positive sign for f_{EPR30}. In other words, as *EPR30* rises, the demand for ten-year notes declines, lowering the price and raising the yield on ten-year Treasuries, whereas the supply of ten-year notes increases, *also* lowering the price and raising the yield on ten-year Treasuries. Similarly, the opposing signs on both D_{EPR3} and S_{EPR30} *jointly* serve to yield a hypothesized positive sign for f_{EPR3}.

2. The initial empirical model and the data

Based on the model expressed in equations (4) and (6), the following specification is to be estimated:

$$EPR10_t = \alpha_0 + \alpha_1 DEFY_t + \alpha_2 \Delta(M2MS/Y)_t + \alpha_3 (NCI/Y)_t + \alpha_4 EPR30_t + \alpha_5 EPR3_t + \alpha_6 TAX_t + \alpha_7 \text{AR}(1) + \mathcal{E}_t \quad (7)$$

where:
$EPR10_t$ = the *ex post* real average interest rate yield on ten-year Treasury notes in year *t*, expressed as a percent per annum;
α_0 = constant term;
$DEFY_t$ = the ratio of the nominal federal budget deficit to the nominal GDP in year *t*, expressed as a percent;
$\Delta(M2MS/Y)_t$ = the increase in the ratio of the nominal M2 money supply to the nominal GDP in year *t*, expressed as a percent;
$(NCI/Y)_t$ = the ratio of the nominal value of net international financial capital inflows to the nominal GDP level in year *t*, expressed as a percent;
$EPR30_t$ = the *ex post* real average interest rate yield on thirty-year Treasury bonds in year *t*, expressed as a percent per annum;
$EPR3_t$ = the *ex post* real average interest rate yield on three-year Treasury notes in year *t*, expressed as a percent per annum;
TAX_t = the average effective federal personal income tax rate, expressed as a percent;
AR (1) = the autoregressive term; and
$\mathcal{E}_t$ = the stochastic error term.

The budget deficit variable, the monetary base variable, and the net international financial capital inflows variable are all scaled by the GDP level because the size of each of these variables should be judged relative to the size of the economy (Ostrosky, 1990; Day, 1992). Given that there are no lags on the explanatory variables in the model, the dependent variable in this system, $EPR10_t$, is contemporaneous with all of the explanatory variables. Given these contemporaneous components in this specification, the possibility of simultaneity bias arises; consequently, the circumstances mandate the adoption of instrumental variables and subsequently estimating by 2SLS (two-stage least squares). The instruments chosen for the contemporaneous explanatory variables found in equation (7) were the two-year lags of each of these explanatory variables.

The data for all of the variables in this specification were obtained from the Federal Reserve Bank of St. Louis (2017), the Tax Policy Center (2018), the Internal Revenue Service (2018), and the Council of Economic Advisors (2018, tables B-1, B-10, B-11, B-18, B-25). The data for TAX_t are available only on an annual basis and *cannot be allocated to calendar quarters*. The average effective income tax rate has so many components, including income and other factors shown on Form 1040, Schedule A, Schedule B, Schedule C, Schedule D, and so forth, and given the non-uniform dispersion of the factors reflected in these components, that it can only be expressed as an annual estimate; unfortunately, it cannot be simply broken down into quarterly data (Tax Policy Center, 2018). Given that the data begin with the year 1971 (Tax Policy Center, 2018; Internal Revenue Service, 2018), and given that the instrumental variables are lagged two years, the study period runs from 1973 through 2016. Thus, the number of observations is 43. The descriptive statistics for the annual data (mean, maximum, minimum, and standard deviation values) for the variables in this specification are found in table 2.

Table 2 – *Descriptive statistics*

	Mean	Maximum	Minimum	Standard deviation
$EPR10_t$	2.409	9.2	–4.74	2.551
$DEFY_t$	2.554	9.8	–2.3	2.376
$\Delta(M2MS/Y)_t$	2.451	57	–5.645	10.989
$(NCI/Y)_t$	2.058	5.723	–0.0098	1.738
$EPR30_t$	2.918	8.96	–4.35	2.719
$EPR3_t$	1.851	9.13	–4.46	2.593
TAX_t	20.788	22.8	17.3	1.518
$PRIMARYDEFY_t$	0.888	9.4	–4.7	2.741
N = 43				

3. Estimation findings

Based on the initial model presented in equation (7), the AR/2SLS estimation technique provided in this study involves the autoregressive process, AR(1). This process is of interest and relevance as a process having many times-series applications, with the autoregressive process being best applicable to time series that exhibit more volatile behavior. Examples of the latter include stock market (equity) indices, individual stock (equity) prices, and, as is the focus in the present study, interest rates (Allison, 1999; Hair et al., 2006; Greene, 2012). Testing was unable to reject the null hypothesis H_0 of homoscedasticity (Newey and West, 1987), so that no such correction was necessary.

The AR/2SLS estimate of equation (7) is provided in table 3, where coefficients, standard errors, *t*-values, and values for the significance level ("prob.") are provided for each of the explanatory variables. In table 3, all six of the estimated coefficients on the explanatory variables exhibit the expected signs. Three are statistically significant at the 1% level, one is statistically significant at the 2.5% level, and one is statistically significant at the 5% level. Only the coefficient on the net international capital flows variable fails to be statistically significant at the 10% level. The DW statistic is 2.02. The inverted root is –0.21, implying that the estimation shown in table 3 was the result of a stationary autoregressive process. The instrument rank of 14 attests favorably to the efficiency of the instrumental variables.

Thus, regarding the control variables, the autoregressive two-stage least squares estimation summarized in this study provides strong empirical evidence that the *ex post* real average interest rate yield on ten-year US Treasury notes has been an increasing function (at the 1% statistical significance level) of the *ex post* real interest rate yields on both three-year Treasury notes and thirty-year Treasury bonds. Furthermore, the real average interest rate yield on ten-year Treasury notes has been (at the 2.5% statistical significance level) a decreasing function of the increase in the M2 money supply (expressed as a percent of GDP).

Table 3 – *AR/2SLS estimation results for the total deficit. Dependent variable:* $EPR10_t$

	Coefficient	Std. error	*t*-statistic	Prob.
$DEFY_t$	0.07***	0.0205	3.17	0.0031
$\Delta(M2MS/Y)_t$	–0.063**	0.0268	–2.36	0.0237
$(NCI/Y)_t$	–0.025	0.0244	–1.01	0.3207
$EPR30_t$	0.726***	0.0511	14.21	0.0000
$EPR3_t$	0.293***	0.0479	6.11	0.0000
TAX_t	0.097*	0.0446	2.18	0.0358
Constant	–1.67			
AR (1)	–0.212			
DW	2.02			
Inverted root	–0.21			
Instrument rank	14			
N (after adjustments) = 43				

*** statistically significant at the 1% level; ** statistically significant at the 2.5% level; * statistically significant at the 5% level.

In view of the two-part objective of this study, the empirical results for the budget deficit and personal income tax variables are of greater relevance than those summarized above. Accordingly, the estimation reveals that the *ex post* real interest rate yield on ten-year Treasuries is (at the 1% and 4% statistical significance levels, respectively) an increasing function of the federal government budget deficit (expressed as a percent of GDP), $DEFY_t$, and the average effective federal personal income tax rate, TAX_t. In particular, a one percent increase in the ratio of the budget deficit relative to GDP raises the *ex post* real interest rate yield on ten-year Treasuries by 7 basis points. In addition, a one percent increase in the average effective federal personal income tax rate elevates the *ex post* real interest rate yield on ten-year Treasuries by approximately 10 basis points.

As a test of the consistency of the results, an alternative version of the model is considered, one in which the budget deficit measure is the primary budget deficit, $PRIMARYDEFY_t$. The primary deficit is the total (unified) budget deficit minus net interest payments. Making this substitution yields the following equation:

$$EPR10_t = b_0 + b_1\, PRIMARYDEFY_t + b_2\, \Delta(M2MS/Y)_t + b_3\, (NCI/Y)_t + b_4\, EPR30_t + b_5\, EPR3_t + b_6\, TAX_t + b_7\, \text{AR (1)} + \varepsilon_t \quad (8)$$

The AR.2SLS estimation of equation (8) is provided in table 4. All six of these estimated coefficients on the explanatory variables exhibit the hypothesized signs. In addition, three are statistically significant at the 1% level, and two are statistically significant at the 5% level. Once again, only the coefficient on the net international capital flows variable fails to be statistically significant at the 10% level. The DW statistic is 2.02. The inverted root is –0.19, implying that the estimation shown in table 4 was the result of a stationary autoregressive process. The instrument rank of 14 attests favorably to the efficiency of the instrumental variables.

Based upon this estimate, the *ex pos*t real interest rate yield on ten-year Treasury notes is a decreasing function of the money supply variable (at the 3% level), and an increasing function (at the 1% level) of the *ex post* real interest rate yields on both thirty-year Treasury bonds and three-year Treasury notes. Finally, the yield on ten-year Treasuries is an increasing function of not only the average effective federal personal income tax rate (at the 5% level) but also the

primary budget deficit as a percent of GDP (at the 1% level). Thus, the estimation results shown in this alternative specification involving the primary deficit as shown in table 4 are entirely compatible with those involving the total budget deficit as shown in table 3.

Table 4 – *AR/2SLS estimation results for the primary deficit. Dependent variable:* $EPR10_t$

	Coefficient	**Std. error**	***t*-statistic**	**Prob.**
$DEFY_t$	0.06***	0.0189	3.04	0.0045
$\Delta(M2MS/Y)_t$	–0.064*	0.0284	–2.27	0.0299
$(NCI/Y)_t$	–0.024	0.0247	–0.97	0.3369
$EPR30_t$	0.732***	0.0486	15.06	0.0000
$EPR3_t$	0.297***	0.0473	6.27	0.0000
TAX_t	0.099*	0.0488	2.04	0.0497
Constant	–1.58			
AR (1)	–0.191			
DW	2.02			
Inverted root	–0.19			
Instrument rank	14			
N (after adjustments) = 43				

*** Statistically significant at the 1% level; * statistically significant at the 5% level.

Table 5 – *Canonical Cointegrating Regression (CCR). Dependent variable: EPR10*

	Coefficient	**Std. error**	***t*-Statistic**	**Prob.**
EPR30	0.713869	0.039591	18.03130	0.0000
EPR3	0.311753	0.038063	8.190428	0.0000
DEFY	0.068644	0.016385	4.189532	0.0002
TAX	0.072854	0.033114	2.200078	0.0345
$\Delta(MSMS/Y)$	–0.039953	0.020137	–1.984051	0.0551
NCI/Y	–2.377094	1.750631	–1.357850	0.1832
C	–1.285980	0.647071	–1.987386	0.0547
@TREND	–0.000672	0.017248	–0.038946	0.9692
@TREND^2	–2.39E-05	0.000230	–0.103940	0.9178
R-squared	0.994582	Mean dependent var		2.460455
Adjusted R-squared	0.993344	S.D. dependent var		2.876328
S.E. of regression	0.234664	Sum squared resid		1.927356
Durbin-Watson stat	2.295648	Long-run variance		0.020289
Sample (adjusted): 1973-2016. Included observations: 44 after adjustments				

Notes: regressor equations estimated using differences. Long-run covariance estimate (Bartlett kernel, Newey-West fixed bandwidth = 4). Cointegrating equation deterministics: C @TREND @TREND^2. Additional regressor deterministics: *NEWUR Y*.

In closing this empirical section of the study, it is emphasized that the findings presented here are only preliminary. Proceeding, it also is noteworthy that alternative empirical methods yield very similar results to those shown in tables 3 and 4. Consider, e.g., the results of the CCR (Canonical Co-integrating Regression) shown in table 5, where the regressor equations are estimated using differences and a quadratic time trend is included. In this estimation, which is one of many with the same basic results, it is found that $EPR10_t$ is an increasing function of the total/unified deficit as a percent of GDP and the average effective tax rate.

4. Concluding observations

In this study we adopt an open-economy loanable funds model to investigate empirically the impact of the federal government budget deficit and the average effective federal personal income tax rate on the *ex post* real interest rate yield on ten-year US Treasury notes during the post-Bretton Woods era. The model integrates economic and financial market control variables, including the M2 money supply variable, $\Delta(M2MS/Y)_t$. The empirical estimates, which are offered as preliminary and certainly not definitive, suggest that the *ex post* real interest rate yield on ten-year US Treasuries has been a statistically significant increasing function of the total/unified federal budget deficit (as a percent of GDP) *and* the primary budget deficit (as a percent of GDP). The *ex post* real interest rate yield has also been found to be a statistically significant increasing function of the average effective federal personal income tax rate. The finding for the budget deficit is, in principle, consistent with several recent studies (Gale and Orszag, 2003; Fullwiler, 2007; Kiani, 2009; Laubach, 2009; Choi and Holmes, 2014; Cebula and Nair-Reichert, 2018), as well as with previous studies of somewhat earlier time periods (Al-Saji, 1993; Chopin, 1998; Gissy, 1999; Ewing and Yanochik, 1999; Taylor, 1999). The finding for impact of the average effective federal personal income tax rate is not found in the recent related literature and is an important part of our contribution to the literature.

Over the long run, failure to address the federal budget deficit issue could have profound negative impacts on the finances of firms, households, and state and local governments. Indeed, since ten-year Treasury notes compete in the financial markets for funds with households, firms, and state and local governments, a higher yield on Treasury securities resulting from higher federal budget deficits would create upward pressure on the yields of competing securities issued by these other sectors of the macro-economy. Consequently, through a crowding out effect, budget deficits would likely increase the cost of debt and exercise a negative impact on the pace of aggregate capital formation, household purchases of new goods and services (especially housing and other durable goods), and state and local government infrastructure investment (roads, schools, tunnels, water and sewerage systems, and so forth). Accordingly, a pattern of persistent and rising budget deficits would act to reduce the long-term growth of the economy.

However, if, in order to attempt to address this deficit problem, a federal tax policy involving increases in the federal personal income tax rate were to be implemented, it too could very well elevate the cost of borrowing in the US and thereby compromise long-term aggregate economic growth.

Although our investigation is somewhat limited in scope, there nonetheless are potentially significant policy implications. We suggest that better policies to address the budget deficit problem could take the form of carefully managed fiscal austerity on the part of the federal

government, e.g., restricting entitlement programs, along with carefully managed increases in the money supply. Indeed, perhaps such policies could be coupled, at least potentially, with policies that lead to increased economic freedom, which have been found in a number of studies to stimulate economic growth (Gwartney et al., 1999; De Haan and Sturm, 2000; Gwartney et al., 2004; Cebula et al., 2015), which would arguably lead to increased tax revenues and hence reduced budget deficits.

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