An Empirical Investigation into the Impact of U.S. Federal Government Budget Deficits on the Real Interest Rate Yield on Intermediate-term Debt Issues, 1972-2012

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An Empirical Investigation into the Impact of U.S. Federal Government Budget Deficits on the Real Interest Rate Yield on Intermediate-term Treasury Debt Issues, 1972-2012

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Abstract. The existence of large federal budget deficits in the U.S., especially in recent years, raises the specter of concern regarding their potential effects on real interest rates (as well as economic growth and capital formation). This study provides current and new empirical evidence on the impact of the federal budget deficit on the *real* interest rate yields on intermediate-term debt issues of the U.S. Treasury, represented herein by the *ex post* real interest rate yields on three-year Treasury notes and seven-year Treasury notes, two interest rate measures that have received essentially no attention in the economics and finance literature in recent years. The study is couched within a loanable funds model that includes two *ex post* real interest rate yields, the monetary base as a percent of GDP, the change in per capita real GDP, net financial capital inflows as a percent of GDP, and the budget deficit as a percent of GDP. This study uses annual data for the study period 1972-2012, a time period that includes "quantitative easing" monetary policies by the Federal Reserve. Two-stage least squares estimations reveal that the federal budget deficit, expressed as a percent of GDP, has exercised a positive and statistically significant impact on the *ex post* real interest rate yields on both three-year and seven-year Treasury notes, even after allowing for quantitative easing and other factors. The study also considers the 1980-2012 time period and offers simple robustness testing.

Keywords: *ex post* real interest rate yield; three-year Treasury notes; seven-year Treasury notes; budget deficit; loanable funds model

JEL Classification codes: E43, E52, E62, H62

1. Introduction

In the U.S., there was a brief experience involving federal government budget surpluses during the FY1998 through FY2001 period. However, given the 2001 recession, sluggish economic growth following 2001, and budgetary demands involving income tax cuts during the Bush Administration on the one hand and the "war on terrorism" in the aftermath of the terrorist attacks on the U.S. on September 11, 2001 on the other hand, the specter of federal government budget deficits, potentially huge ones, raised its ugly head once again by FY 2002. As Alan Krueger (2003) observed, by 2003 federal budget deficits in the U.S. had re-emerged as a major economic concern.

Over the course of the Bush Administration, the budget deficit as a percent of GDP rose from -1.3% (a surplus for FY2001) to values subsequently *averaging* 2.33% per fiscal year from FY2002 through FY2008 (Council of Economic Advisors, 2013, Table B-79). Furthermore, during the Obama Administration through FY 2012, the federal budget deficit as a percent of GDP has grown beyond these figures. Indeed, the federal budget deficit, expressed as a percent of GDP, during President Obama's first term was 10.1%, 9.0%, 8.7%, and 7.8% for FY 2009, FY2010, FY2011, and FY 2012, respectively (Council of Economic Advisors, 2013, Table B-79), for an average of 8.9%.[1]

The impact of government budget deficits on interest rates has been studied extensively (Al-Saji, 1992, 1993; Barth, Iden and Russek, 1984, 1985, 1986; Barth, Iden, Russek, and Wohar, 1989; Cebula, 1997, 2005; Cebula and Cuellar, 2010; Cukierman and Meltzer, 1989; Feldstein and Eckstein, 1970; Findlay, 1990; Gale and Orszag, 2003; Hoelscher, 1983, 1986; Holloway, 1988; Johnson, 1992; Kiani, 2009; Ostrosky, 1990; Tanzi, 1985; Allen and Wohar, 1996; Zahid, 1988). Most of these studies are couched within IS-LM or loanable funds models or variants thereof. Many of these studies find that budget deficits act 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 longer-term than by shorter-term interest rates, the inference has often been made in these studies that government budget deficits may lead to "crowding out" (Carlson and Spencer, 1975; Abram and Schmitz, 1978; Cebula, 1985; Krueger, 2003).

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[1] Arguably, at least some portion of the first federal budget deficit figure, 10.1%, can be attributable to policies during the Bush Administration, although Obama policies such as the "stimulus package" were in play during this fiscal year.

The interest rate/budget deficit literature has focused typically upon the interest rate yields, most commonly *nominal* yields, on 3 month Treasury bills, ten-year Treasury notes, and 20 year and 30 years Treasury bonds. This literature has also focused upon the interest rate yields on Moody's Aaa-rated and Baa-rated corporate bonds. In recent years, however, the impact of budget deficits on such interest rate yields has received only limited attention in the literature. Moreover, the focus on *real* interest rates has been even sparser in recent times.

The present study is motivated primarily by two basic sets of considerations. The first of these motivations, as suggested above, is the huge size of recent federal budget deficits, relative to GDP, especially in recent years but in many prior years as well, and the concomitant concern regarding potential economic implications thereof. The second motivation is that the impact of budget deficits on *ex post* real interest rate yields on intermediate-term Treasuries, especially those on the three-year Treasury note and the seven-year Treasury note, have been effectively altogether ignored in the economics and finance literature for a decade or longer.[2] Accordingly, the purpose of this study is to provide contemporary evidence regarding the effect of the federal budget deficit on the interest rate yield on intermediate-term debt issues of the U.S. Treasury, as represented by the *ex post* real interest rate yields on three-year and seven-year Treasury notes, for the post-Bretton Woods period running from 1972 through the end of 2012.

More specifically, using annual data, this study investigates the period 1972 through 2012 in

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[2] Cebula (2005) may be the most recent such study. He examines the deficit impact on *nominal* seven-year Treasury notes from 1992-2003 using quarterly data.

the pursuit of providing at least preliminary *contemporary* insights into whether federal budget deficits—in contrast to the perspective of "Ricardian Equivalence" (Barro, 1974)—have in fact elevated intermediate-term real interest rate yields in the U.S. We begin with 1972 because it was in August of 1971 that the U.S. unilaterally abandoned the Bretton Woods agreement, i.e., unilaterally terminated the convertibility of the U.S. dollar for gold, thereby helping to bring the Bretton Woods system to a *de facto* end. Moreover, the study period includes the time frame beginning with late November of 2008, which is when the Federal Reserve shifted from its traditional open market operations and initiated its "quantitative easing" policies. Indeed, the first of these quantitative easing policies, QE (1), involved significant and unprecedented Federal Reserve purchases of mortgage-backed securities, which by June, 2010 had totaled $2.1 trillion. In November of 2010, another stage of quantitative easing, QE (2), began and resulted in $600 billion of such purchases. Finally, beginning in September of 2012, stage QE (3) began, initially involving $40 billion per month of such purchases and escalating to $85 billion per month thereof as of December, 2012. Thus, the 1972-2012 study period includes not only four full years during which the U.S. economy experienced quantitative easing *and* but also experienced huge (relative to GDP)[3] federal budget deficits. This study endeavors to provide at least preliminary insights into the following question: "What has been the impact of budget deficits on intermediate-term *ex post* real interest rates in the U.S. over the last 42 years after Bretton Woods?" Furthermore, as a very simple test of the robustness

[3] Indeed, only during the World War II fiscal years (FYs) of 1942, 1943, 1944, and 1945 has the federal budget deficit as a percent of GDP exceeded those of FYs 2009, 2010, 2011, and 2012.

of the basic model, the study also examines the period from 1980-2012, based upon certain monetary policy and financial sector de-regulation statutes that were implemented in late 1979 and early 1980. Finally, a second simple robustness test is provided in the Conclusion section to the study.

Section 2 of this study provides the basic framework for the empirical analysis, an open-economy loanable funds model reflecting dimensions of the works of Barth, Iden and Russek (1984; 1985; 1986), Barth, Iden, Russek, and Wohar (1989), Hoelscher (1986), Koch (1994), Allen and Wohar (1996), Cebula (2005), Cebula and Cuellar (2010), and others. Section 3 defines the specific variables in the empirical model and describes the data adopted. Section 4 provides the empirical results of two stage least squares estimations for the period 1972-2012, whereas section 5 provides an analysis of the period 1980-2012, Finally, an overview of the study findings is found in the Conclusion, Section 6, where a second simple robustness test of the model is also provided.

2. The Framework

In developing the underlying framework for the empirical analysis, we first consider the following inter-temporal government budget constraint:

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

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;

AR_t = average effective interest rate on the national debt in period t; and

T_t = government tax and other revenues in period t.

The *total* government budget deficit in period t (TD_t), which is the deficit measured considered in this study, is simply the difference between ND_{t+1} and ND_t:

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

Based extensively on Barth, Iden, and Russek (1984; 1985; 1986), Barth, Iden, Russek, and Wohar (1989), and Hoelscher (1986), as well as Koch (1994), Cebula (1997; 2005), and Cebula and Cuellar (2010), this study seeks to identify determinants of the *ex post* real interest rate yields on both three-year and seven-year U.S. Treasury notes, including the impact of the federal budget deficit on same. To do so, a loanable funds model is adopted in which the *real* intermediate-term (three-year *or* seven-year) interest rate yield is, assuming all other bond markets are in equilibrium, determined by an equilibrium of the following form:

$$DY + MY = TDY - NCIY \quad \text{or} \quad DY + MY + NCIY = TDY \quad (3)$$

where:

DY = private domestic demand for three-year *or* seven-year U.S. Treasury notes, expressed as a percent of GDP;

MY = the monetary base, expressed as a percent of real GDP, adopted as a measure of the available potential domestic money supply;

TDY = net government borrowing, measured by the total federal budget deficit (as above), but expressed as a percent of real GDP; and

NCIY = net financial capital inflows, also expressed as a percent of real GDP.

In this framework, it is hypothesized that:

$$DY = DY (RTHREEYR \text{ or } RSEVENYR, \Delta Y, EPRSTBY, EPRLTBY,),$$

$$DY_{RTHREEYR} > 0 \text{ or } DY_{RSEVENYR} > 0, DY_{\Delta Y} > 0, DY_{EPRSTBY} < 0, DY_{EPRLTBY} < 0 \quad (4)$$

where:

RTHREEYR = the *ex post* real annual average interest rate yield on three-year Treasury notes;

RSEVENYR = the *ex post* real annual average interest rate yield on seven-year Treasury notes;

ΔY = the increase in per capita real GDP over the year;

EPRSTBY = the *ex post* real annual average interest rate yield on high quality short-term bonds; and

EPRLTBY = the *ex post* real annual average interest rate yield on high quality long-term bonds.

Following the conventional wisdom, it is expected that the demand for three-year (or seven-year) Treasuries is an increasing function of the real interest rate yield on those notes, i.e., RTHREEYR or RSEVENYR (Barth, Iden, and Russek, 1984; 1985; 1986; Hoelscher, 1986; Koch, 1994). Next, it is hypothesized that the greater the increase in *per capita* real GDP (ΔY), the higher the demand for three-year or seven-year Treasury notes, *ceteris paribus*, since such a circumstance more rapidly increases the potential pool of funds available for purchasing those notes (Hoelscher, 1986; Cebula, 2005). It is further hypothesized that, paralleling Barth, Iden, and Russek (1984; 1985),

Cebula (1997; 2005), Hoelscher (1986), and Koch (1994), the real domestic demand for three-year or seven-year Treasury notes is a decreasing function of the *ex post* real short-term rate, which in this case is the *ex post* real annual average six-month Treasury bill rate. In other words, as EPRSTBY increases, *ceteris paribus*, bond demanders/buyers at the margin substitute shorter-term issues for intermediate-term issues in their portfolios. Similarly, it is hypothesized that, in principle paralleling Barth, Iden, and Russek (1984; 1985), Cebula (2005), and Hoelscher (1986), the demand for three-year or seven-year Treasury notes is a decreasing function of one or more alternative high quality long-term interest rate yields, in this case represented by the *ex post* real annual average interest rate yield on Moody's Aaa-rated corporate bonds (EPRLTBY), *ceteris paribus* (Barth, Iden, and Russek, 1984; 1985; 1986; Hoelscher, 1983; 1986; Ostrosky, 1990; Koch (1994).

Substituting equation (4) into equation (3) and solving for RTHREEYR and then for RSEVENYR yields:

$$RTHREEYR = f (TDY, MY, EPRSTBY, EPRLTBY, \Delta Y, NCIY) \quad (5A)$$

$$RSEVENYR = g (TDY, MY, EPRSTBY, EPRLTBY, \Delta Y, NCIY) \quad (5B)$$

where it is hypothesized that:

$$f_{TDY} > 0, f_{MY} < 0, f_{EPRSTBY} > 0, f_{EPRLTBY} > 0, f_{\Delta Y} > 0, f_{NCIY} < 0 \quad (6A)$$

$$g_{TDY} > 0, g_{MY} < 0, g_{EPRSTBY} > 0, g_{EPRLTBY} > 0, g_{\Delta Y} > 0, g_{NCIY} < 0 \quad (6B)$$

In both (6A) and (6B), the first of these expected signs is positive to reflect the conventional wisdom that when the government attempts to finance a budget deficit, it forces interest rate yields

upwards as it competes with the private sector to attract funds from the financial markets, *ceteris paribus*. The expected sign on the monetary base/money supply variable (MY) is negative because the greater the available money supply relative to GDP, the greater the offset to the interest-rate effects of new debt issues, i.e., in the present context, a greater availability of funds presumably helps to offset interest rate effects of budget deficits, *ceteris paribus*. It is noteworthy that the empirical results are effectively identical if the M2 measure of the money supply, expressed as a percentage of GDP, is adopted in place of MY; nevertheless, the MY variable is adopted because it more directly reflects quantitative easing policies pursued in recent years. The expected sign on the net capital inflows variable is negative because the greater the ratio of net capital inflows to GDP, the greater the extent to which these funds absorb domestic debt (Koch, 1994; Cebula and Belton, 1993). Finally, the expected signs on $f_{EPRSTBY}$, $f_{EPRLTBY}$, f_Y, and f_{PE} and their counterparts in (6B) follow logically from equation (4).

3. Variables and Data

Given the presence *ex post* real interest rates in the model, there is no need to develop an empirical measurement of expected inflation. Thus, adopting *ex post* as opposed to *ex ante* real interest rate yields permits the analysis to circumvent the always dubious choice of an appropriate inflationary expectations measure (Swamy, Kolluri, and Singamsetti, 1990).

In any case, based upon the framework expressed above, the two stage least squares (2SLS) estimations involve the following linear models:

$$RTHREEYR_t = a_0 + a_1\ TDY_t + a_2\ MY_{t-1} + a_3\ EPRSTBY_t + a_4\ EPRLTBY_t + a_5\ \Delta Y_{t-1} + a_6\ NCIY_{t-1} + u_t \quad (7)$$

$$RSEVENYR_t = b_0 + b_1\ TDY_t + b_2\ MY_{t-1} + b_3\ EPRSTBY_t + b_4\ EPRLTBY_t + b_5\ \Delta Y_{t-1} + b_6\ NCIY_{t-1} + u_t' \quad (8)$$

where:

$RTHREEYR_t$ = the *ex post* real annual average interest rate yield on three-year Treasury notes in year t, expressed as a percent per annum;

$RSEVENYR_t$ = the *ex post* real annual average interest rate yield on seven-year Treasury notes in year t, expressed as a percent per annum;

a_0, b_0= constant terms;

TDY_t = the ratio of the nominal total federal budget deficit in year t to the nominal GDP in year t, expressed as a percent;

MY_{t-1} = the ratio of the monetary base in year t-1 to the nominal GDP in year t-1, expressed as a percent;

$EPRSTBY_t$ = the *ex post* real average interest rate yield on six-month Treasury bills in year t, expressed as a percent annum;

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

ΔY_{t-1} = the change in the level of per capita real GDP between the beginning of year t-1 and the end of year t-1;

$NCIY_{t-1}$ = the ratio of net financial capital inflows into the U.S. in year t-1, expressed as a percent of the GDP in year t-1; and

u_t, u_t'= stochastic error terms.

The budget deficit is scaled by GDP, as are the monetary base and net capital inflows; this is because the sizes of the budget deficit, the monetary base, and net capital flows should be judged relative to the size of the economy (Barth, Iden, and Russek, 1985; Hoelscher, 1986; Holloway, 1986; Ostrosky, 1990; Day, 1992). The dependent variable in this system, first specified in the form of $RTHREEYR_t$ and then specified instead in the form of $RSEVENYR_t$, is expressed as contemporaneous with the budget deficit variable (TDY_t), as well as with the *ex post* real six-month Treasury bill interest rate yield variable ($EPRSTBY_t$), and the *ex post* real interest rate yield on Moody's Aaa-rated long-term corporate bonds variable ($EPRLTBY_t$). Given that the data are annual and given the fact that financial markets are quick-acting markets, such contemporaneous specifications are not uncommon in this literature (Hoelscher, 1986; Ostrosky, 1990; Day, 1992; Koch, 1994; Cebula, 1997; 2005; Cebula and Cuellar, 2010).

Given the contemporaneous components of the specifications in equations (7) and (8), the possibility of simultaneity bias naturally arises, which in turn mandates the choosing of instrumental

variables for each of the three right-hand side variables in question. The three instruments chosen were, as follows: the two-year lag of the annual percentage civilian unemployment rate (UR_{t-2}) for the budget deficit variable TDY_t in year t; the two-year lag of the *ex post* real average Moody's Baa-rated corporate bond interest rate yield (Baa_{t-2}) for the *ex post* real Moody's Aaa-rated bond interest rate yield in year t, $EPRLTBY_t$; and the two-year lag of the *ex post* real three-month Treasury bill interest rate yield (TBR_{t-2}) for the *ex post* real six-month Treasury yield in year t, $EPRSTBY_t$. The choice of instruments for these variables was based on the fact that, in each case, the lagged instrument was highly correlated with the explanatory variable in question, whereas the instruments in question were uncorrelated with the error terms in the system.

The net capital inflow variable, $NCIY_{t-1}$, the monetary base variable, MY_{t-1}, and the change in per capita real GDP variable, ΔY_{t-1}, are all lagged one period in order to avoid multicollinearity problems. The data for the variables in this analysis were obtained from the Council of Economic Advisors (2013, Tables B-1, B-2, B-35, B-42, B-64, B-71, B-73, B-79).

For the interested reader, descriptive statistics for each of the variables expressed in equations (7) and (8) are provided in Table 1 for the1972-2012 study period. In addition, it is observed for the interested reader that, as shown in Table 2, multicollinearity is not a serious problem for the explanatory variables in this model for the study period. Indeed, there are only two cases of an elevated and potentially problematic (in theory) correlation. The first is that between the EPRSTBY variable and the EPRLTBY variable, where $r = 0.650$; this does not seem to be a concern, however,

because the estimated coefficients on both of these variables are highly statistically significant in all of the estimates. The second potential problem is the correlation between MY and TDY, where r = 0.540; however, this case also seems of little concern because the estimated coefficients on both of these variables are statistically significant in all of the estimates. Finally, group unit-root testing reveals that the variables in equation (7) are stationary in levels; similarly, the group unit-root testing reveals that the variables in equation (8) are stationary in levels.

4. Initial Estimation Results, 1972-2012

In this section, empirical results are presented for the two *ex post* real intermediate Treasury interest rate yields for the period 1972-2012; a different study period, one reflecting a possible break in the data, is considered in the subsequent section of this study.

The Real Three-Year Interest Rate Yield

Testing for heteroskedasticity revealed the need to make a correction for same. Accordingly, the 2SLS estimate of equation (7), *after* adopting the Newey-West (1987) heteroskedasticity correction, is provided in Table 3. In Table 3, all six of the estimated coefficients on the explanatory variables exhibit the expected signs, with four of these six coefficients being statistically significant at the 1% level and one being statistically significant at nearly the 5% level. Furthermore, there is no indication of an autocorrelation problem. Furthermore, the F-statistic is statistically significant at the 1% level, attesting to the overall dependability of the model

In this estimate, the coefficient on the monetary base variable, MY_t, is negative, as expected,

and statistically significant at the 1% level, implying that a higher ratio of the monetary base relative to GDP acts to reduce the *ex post* real interest rate yield on three-year U.S. Treasury notes. The estimated coefficient on the *ex post* real short-term interest rate variable, $EPRSTBY_t$, is positive, as hypothesized, and statistically significant at the 1% level, implying that the higher the *ex post* real interest rate yield on six-month Treasury bills, the higher the real interest rate yield on three-year Treasury notes. This finding presumably reflects competition between the three-year Treasury note and counterpart high-quality short-term debt. Similarly, the coefficient on the variable $EPRLTBY_t$ is also positive, as hypothesized, and statistically significant at the 1% level, implying that the higher the *ex post* real interest rate on long-term Moody's Aaa-rated corporate bonds, the higher the real interest rate yield on three-year Treasury notes, presumably because of competition between three-year Treasury notes and high-quality long-term debt. Next, the estimated coefficient on the net capital inflows variable, $NCIY_{t-1}$, is negative, as expected and statistically significant at the 3% level, implying that such capital flows may act to absorb domestic debt and thereby reduce the real interest rate on that debt, i.e., the real three-year Treasury note interest rate yield, in this case. Although the estimated coefficient on variable reflecting the change in per capita real GDP, ΔY_{t-1}, is positive, it is not statistically significant at the even the 10% level, implying that the increase in the level of per capital real GDP does not significantly influence the ex post real interest rate yield on three-year U.S. Treasury bills.

Finally, the estimated coefficient on the budget deficit variable is positive and statistically

significant at the 1% level. Thus, it appears that after allowing for a variety of other factors, the higher the federal budget deficit (as a percent of GDP) the higher the *ex post* real interest rate yield on intermediate-term, i.e., in this case, on three-year Treasury notes. More specifically, for every 1% increase in the size of the budget deficit (as a percent of GDP), the *ex post* real yield on three-year Treasury notes rises by about 10 basis points. Hence, a rise in the TDY variable of 5% would elevate RTHREEYR by about 50 basis points. This finding, in principle, is consistent with a variety of studies of earlier periods, including Al-Saji (1992, 1993), Barth, Iden and Russek (1984, 1985, 1988), Barth, Iden, Russek, and Wohar (1989), Cebula (1997), Cebula and Belton (1993), Cebula and Cuellar (2010), Findlay (1990), Gale and Orszag (2003), Gissey (1999), Hoelscher (1986), Johnson (1992), Kiani (2009), Tanzi (1985), Allen and Wohar (1996), and Zahid (1988).

In closing this sub-section of the study, it is noted that 2SLS estimates for a number of alternative specifications of the basic model yield a conclusion for the impact of the budget deficit on the real three-year Treasury note interest rate yield that is consistent with that in Table 3, including specifications that adopt the percent growth in GDP rather than ΔY_{t-1} and/or adopt the *ex post* real 52 week Treasury bill yield to represent $EPRSTBY_t$ and/or adopt the *ex post* real interest rate yield on 30 yield Treasury bonds to represent $EPRLTBY_t$.

In any event, the evidence provided in Table 3 would seem to indicate that, among other things, the federal budget deficit in the U.S. exercised a positive and statistically significant impact upon the *ex post* real three-year Treasury note interest rate yield over the 1972-2008 study period. The

following sub-section of this study investigates empirically whether this conclusion is reached for the case of the *ex post* real seven-year Treasury note yield.

The Real Seven Year Interest Rate Yield

In this sub-section of the study, using annual data once again, we empirically investigate the impact of federal budget deficits on the *ex post* real interest rate yield on seven-year Treasury notes over the 1972-2012 study period. The 2SLS estimate of equation (8), after adopting the Newey-West (1987) heteroskedasticity correction, for the study period 1972-2012 is provided in Table 4. In Table 4, all six of the estimated coefficients on the explanatory variables exhibit the expected signs, with four being statistically significant at the 1% level and one being statistically significant at the 5% level.

In this estimate, the estimated coefficient on the monetary base *(de facto* available money supply) variable, MY_t, is negative and statistically significant at the 1% level, implying that a higher ratio of the monetary base relative to GDP acts to reduce the *ex post* real interest rate yield on seven-year U.S. Treasury notes. The estimated coefficient on the *ex post* real short-term interest rate variable, $EPRSTBY_t$, is positive, as expected, and statistically significant at the 1% level, implying that the higher the *ex post* real interest rate yield on six-month Treasury bills, the higher the real interest rate yield on seven-year Treasury notes. This finding conforms to the hypothesized relationship proffered in this study and presumably reflects competition between the seven-year Treasury note and shorter-term debt instruments. The coefficient on the variable $EPRLTBY_t$ is also positive and statistically significant at the 1% level, implying that the higher the *ex post* real interest

rate on long-term Moody's Aaa-rated corporate bonds, the higher the real interest rate yield on seven-year Treasury notes, presumably also because of competition, in this case, between seven-year Treasury notes and longer-term debt instruments. The estimated coefficient on the $\Delta Y_{t-(t-1)}$ variable is positive, as hypothesized, but not statistically significant at the 10% level, implying that this variable did not exercise a statistically significant impact on the real interest rate yield on seven-year Treasury bills. Next, the estimated coefficient on the net capital inflows variable, $NCIY_{t-1}$, is negative and statistically significant at the 2.5% level, implying that such capital flows act to absorb domestic debt and thusly reduce the real interest rate on that debt, i.e., on seven-year Treasury notes.

Finally, the estimated coefficient on the budget deficit variable for the 1972-2012 study period is positive and statistically significant at the 1% level. Thus, it appears that after allowing for a variety of other factors, the higher the federal budget deficit (as a percent of GDP) the higher the real interest rate yield on intermediate-term, i.e., in this case, on seven-year U.S. Treasury notes. This finding is consistent with a host of empirical studies of earlier periods, including Al-Saji (1992, 1993), Barth, Iden and Russek (1984, 1985, 1988), Barth, Iden, Russek, and Wohar (1989), Cebula (1997; 2013), Cebula and Belton (1993), Cebula and Cuellar (2010), Findlay (1990), Gale and Orszag (2003), Gissey (1999), Hoelscher (1986), Johnson (1992), Koch (1994), Kiani (2009), Tanzi (1985), Allen and Wohar (1996), and Zahid (1988).

Clearly, overall, these results are also consistent with those for the real three-year U.S. Treasury note yield found in Table 3. In other words, among other things, the federal budget deficit,

expressed as a percent of GDP, is once again found to exercise a positive impact on the real seven-year Treasury note yield, despite quantitative easing policies beginning in 2008. Indeed, it appears that for every 1% increase in the size of the budget deficit (as a percent of GDP), the *ex post* real interest rate yield on seven-year Treasury notes rises approximately 11 basis points. Hence, a rise in the budget deficit of 5% would elevate RTHREEYR by about 55 basis points.

5. Estimates for the Period 1980-2012

In this section of the study, we re-estimate the model using data for a 1972-2012 sub-period, namely, the period 1980-2012. The choice of this sub-period is twofold: (1) to provide a *de facto* simple test of robustness of the initial results for 1972-2012 for the impact of the budget deficit on RTHREEYR and RSEVENYR; and (2) to test whether the deficit-real interest rate linkage was significantly affected during a period when (a) the Federal Reserve embarked on a new monetary policy experiment and (b) when significant statutory deregulation of the financial services industry was implemented.

In November of 1979, the Federal Reserve essentially abandoned, albeit temporarily, i.e., until November of 1982 (Barth, 1991), its interest rate targeting policy for a money growth targeting policy. In addition, shortly after this policy shift, the Depository Institutions Deregulation and Monetary Control Act of March, 1980 was enacted, largely de-regulating the financial services system generally and banks and savings and loan associations in particular (Barth, 1991); this de-regulation was reinforced on a more limited scale by the Garn-St. Germain Depository Institutions

Act of 1982 (Barth, 1991). By beginning the study period with the year 1980, this study can potentially clarify whether these changed public policies altered the impact of the federal budget deficit on RTHREEYR and RSEVENYR or caused a break in the data. Accordingly, equations (7) and (8) are re-estimated for the 1980-2012 time period. The 2SLS results for these two estimates are provided in Tables 5 and 6, respectively, for equations (7) and (8), with the Newey-West (1987) heteroskedasicity correction adopted in both instances.

In Table 5, five of the six estimated coefficients exhibit the expected sign (that on ΔY being the exception), with four of these five coefficients being statistically at the 1% level; the coefficients on variables NCIY and ΔY both fail to be statistically significant at the 10% level. Thus, as found in Table 3 for the 1972-2012 study period, the *ex post* real interest rate yield on three-year Treasury notes is a decreasing function of the monetary base variable (MY), while being an increasing function of the *ex post* real short term interest rate yield (EPRSTBY), the *ex post* real long term interest rate yield (EPRLTBY), and the federal budget deficit variable (TDY). The F-statistic is statistically significant at the 1% level once again, attesting to the overall strength of the model for the 1980-2012 period.

Thus, the estimated coefficient on the monetary base *(de facto* available money supply) variable, MY_{t-1}, is negative and statistically significant at the 1% level, implying that a higher ratio of the monetary base relative to the GDP acts to reduce the real interest rate yield on three-year U.S. Treasury notes. Interestingly, we observe that these empirical results are essentially identical if the

M2 measure of the money supply, expressed as a percent of GDP, is adopted in lieu of MY_{t-1}. The estimated coefficient on the *ex post* real short-term interest rate variable, $EPRSTBY_t$, is positive and statistically significant at the 1% level, implying that the higher the *ex post* real interest rate yield on six-month Treasury bills, the higher the real interest rate yield on three-year Treasury notes. This finding presumably reflects competition between the three-year Treasury note and counterpart short-term financial instruments. Similarly, the coefficient on the variable $EPRLTBY_t$ is also positive and statistically significant at the 1% level, implying that the higher the *ex post* real interest rate on long-term Moody's Aaa-rated corporate bonds, the higher the real interest rate yield on three-year Treasury notes, presumably because of competition between three-year Treasury notes and high-quality long-term financial instruments. Although the estimated coefficient on the net capital inflows variable, $NCIY_{t-1}$, is negative, it fails to be statistically significant at the 10% level for the 1980-2012 period, a result at odds with the findings for this variable for the 1972-2012 study period (see Table 3). Finally, the estimated coefficient on the budget deficit variable is positive and statistically significant at the 1% level. Thus, the higher the federal budget deficit (as a percent of GDP), the higher the real interest rate yield on intermediate-term, i.e., in this case, on three-year U.S. Treasury notes. In this case, a 5% rise in the deficit-GDP ratio would elevate the real three-year yield by approximately 36 basis points.

Table 6 provides the model estimate for the case of the real seven-year Treasury note for the period 1980-2012 period. These results effectively parallel those in Table 5. Four of the six estimated

coefficients are statistically significant with the expected signs at the 1% level, so that RSEVENYR is a decreasing function of the monetary base variable and an increasing function of both the real short and real long term interest rate variables and the budget deficit variable. In this case, a 5% increase in the deficit-GDP ratio would raise the real seven-year Treasury note rate by 46 basis points.

6. Concluding Observations

The present study adopts an open loanable funds model and, first using annual data for the period 1972-2012 and then for the period 1980-2012, consistently finds that the *ex post* real interest rate yield on three-year U.S. Treasury notes and the *ex post* real interest rate yield on seven-year Treasury notes are both an increasing function of the *ex post* real six-month Treasury bill interest rate yield and the *ex post* real interest rate yield on long-term corporate bonds (Moody's Aaa-rated), while being a decreasing function of the ratio of the monetary base to the GDP level (expressed as a percent) and--for the 1972-2012 study period but not the 1980-2012 period-- net financial capital inflows expressed as a percent of GDP (expressed as a percent). Furthermore, in contrast to the predictions found in Ricardian Equivalence (Barro, 1974), it also is found consistently that the greater the federal budget deficit (relative to the GDP level), the higher the *ex post* real interest rate yield on three-year Treasury notes and the higher the *ex post* real interest rate yield on seven-year Treasury notes. More specifically, for every 1% increase in the size of the budget deficit (as a percent of GDP), the real interest rate yield on three-year Treasury notes rises approximately by between 7 and 10 basis points, while that on real seven-year Treasury notes yield rises between 9 and 11 basis points.. This finding

is consistent in principle with a variety of empirical studies of earlier periods, including Al-Saji (1992, 1993), Barth, Iden and Russek (1984, 1985, 1988), Barth, Iden, Russek, and Wohar (1989), Cebula (1997; 2013), Cebula and Belton (1993), Cebula and Cuellar (2010), Findlay (1990), Gale and Orszag (2003), Gissey (1999), Hoelscher (1986), Johnson (1992), Kiani (2009), Tanzi (1985), Allen and Wohar (1996), and Zahid (1988).[4]

Before closing, we provide an additional set of estimations that serve as another *de facto* robustness test of the basic model. These estimates involves an autoregressive, i.e., AR(1) process, 2SLS estimation with (once again) a Newey-West (1987) heteroskedasticity correction. AR(1) models are of interest as a simple process for many times series applications, perhaps best applicable to time series that exhibit more volatile behavior, such as stock market indices and prices and interest rates. In any case, Tables 7 and 8 provide the AR(1), 2SLS estimates of equations (7) and (8). In both tables, all of the estimated coefficients exhibit the expected signs. In Table 7, three of the six coefficients are statistically significant at the 1% level and two are statistically significant at the 2% level. In Table 7, five of the six estimated coefficients are statistically significant at the 1% level. In both estimates, autocorrelation is not an issue, whereas the F-statistic is statistically significant at the 1% level in both cases.

Based upon the results in Table 7, the *ex post* real interest rate yield on three-year Treasuries

[4] Moreover, it is noteworthy that 2SLS estimates for a number of alternative specifications of the basic model yield results for the impact of the budget deficit on the *ex post* real interest rate yield on ten-year Treasury notes that are consistent with those in Tables 3, 4, 5, 6, 7, and 8. These results will be provided upon request.

is a decreasing function of the monetary base variable (MY) and the net capital inflows variable (NCIY) and an increasing function of the *ex post* real interest rate yield on six-month Treasury bills, the *ex post* real interest rate yield on Moody's Aaa-rated corporate bonds, and the federal budget deficit expressed as a percent of GDP. In this estimate, a 1% increase in the latter (TDY) would raise RTHREEYR by 7 basis points; a 5% increase in TDY would elevate this real interest rate yield by 35 basis points.

As for the results in Table 8, the *ex post* real interest rate yield on seven-year Treasury notes is a decreasing function of the monetary base variable (MY) and the net capital inflows variable (NCIY) while being an increasing function of the *ex post* real interest rate yield on six-month Treasury bills, the *ex post* real interest rate yield on Moody's Aaa-rated corporate bonds, and the federal budget deficit expressed as a percent of GDP. In this estimate, a 1% increase in the value of TDY would raise RSEVENYR by 10.3 basis points; a 5% increase in TDY would elevate this real interest rate yield by 51-52 basis points.

In sum, it appears that factors elevating the U.S. budget deficit act to raise the real intermediate-term (real three-year and real seven-year) cost of borrowing, presumably through increasing the competition for loanable funds. This confirms Alan Krueger's (2003) statement that federal budget deficits cause interest rates to rise. Thus, federal government policies that raise the budget deficit cannot be viewed in a vacuum since they may very well impact adversely upon the finances of corporations and households and, accordingly, the real investment in new plant and

equipment, durable consumption outlays, real GDP growth, and both the level of the employment rate and rate of employment growth of the U.S. Crowding out of private investment may be a very real threat to the economy, at least over the longer run, so long as huge budget deficits largely financing government transfers continue to be incurred (Carlson and Spencer, 1975; Abram and Schmitz, 1978; Cebula, 1985; Krueger, 2003). These results further imply that it behooves policy-makers to take responsible steps to limit the relative magnitude of federal budget deficits so as to enable the economy to sustain investment in new plant and equipment and continue a sustainable long term economic growth path. Indeed, a continuation of huge budget deficits in concert with quantitative easing by the Federal Reserve could, among other things, lead to a decline in faith in the U.S. dollar and the loss of its stature as the principal reserve currency of the global economy; such a development could yield a harvest of economic difficulties for the U.S.

Arguably, identifying specific policies to alleviate the federal budget deficit problem in the U.S. are beyond the scope of this study. Nevertheless, as stressed above, it is clear that a continuation of huge budget deficits in concert with quantitative easing by the Federal Reserve is not sustainable. Candidates for reform to alleviate the deficit problem could (and perhaps should) include some form of overhaul of the myriad entitlement programs provided by the federal government. Many state governments within the U.S. are already making such adjustments. For example, implementation of a significant near-term an permanent implementation of a raising of the minimum age at which benefits such as Social Security can be received would seem appropriate if not necessary to the long

term sustainability of the federal budget and to the control of budget deficits. Age-eligibility policies can of course be linked to the life expectancy data of the U.S. population. A review of what constitutes "disability" for the purposes of receiving Social Security Disability Insurance (SSDI) benefits would seem worth considering. Revocation of the increasingly unpopular *Patient Protection and Affordability Act of 2010* would be an example of another course of action to consider, with perhaps a simpler, more efficient, and less Draconian, less-political and less costly approach to healthcare in the U.S. adopted in its place. The passage of a meaningful balanced-budget amendment could also be a useful tool to facilitate and expedite budget deficit reduction. Such modest suggestions as these remain however simply speculative for purposes of the present study. Additional alternative analyses within one or more different analytical/empirical frameworks should nevertheless be undertaken so as to provide arguably less speculative deficit-size solutions.

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Table 1. Descriptive Statistics

	1972-2012 (Annual Data)			
Variable	Mean	Standard Deviation	Maximum	Minimum
RTHREEYR	1.96	2.64	7.62	-3.16
RSEVENYR	2.47	2.62	8.12	-3.28
TDY	3.13	2.67	10.1	-2.40
MY	67.25	31.98	73.24	47.59
EPRSTBY	1.04	2.34	5.54	-3.10
EPRLTBY	3.70	2.58	8.84	-2.53
ΔY	113.90	46.4	222.80	-41.40
NCIY	1.961	1.73	5.725	-0.832

Table 2. Correlation Matrix among Independent Variables, 1972-2012

	TDY	MY	EPRSTBY	EPRLTBY	ΔY	NCIY
TDY	1.000					
MY	**0.540**	1.000				
EPRSTBY	-0.151	-0.444	1.000			
EPRLTBY	0.229	-0.179	**0.650**	1.000		
ΔY	-0.417	-0.235	0.149	-0.032	1.000	
NCIY	-0.037	0.173	-0.086	0.001	0.471	1.000

Table 3. 2SLS Estimation Results, 1972-2012
Dependent Variable: RTHREEYR

	Coefficient	t-value	p-value
Explanatory Variable			
Constant	0.69	1.83	0.0746
TDY	0.096***	4.13	0.0002
MY	-0.012***	-4.91	0.0000
EPRSTBY	0.759***	7.04	0.0000
EPRLTBY	0.292***	3.97	0.004
ΔY	96.6	0.59	0.5585
NCIY	-0.106**	-2.28	0.0301
DW	2.06		
Rho	-0.03		
Instrument Rank	10		
F-Statistic***	45.44		

Terms in parentheses are t-values. ***statistically significant at 1% level; **statistically significant at 5% level; *statistically significant at 10% level.

Table 4. 2SLS Estimation Results, 1972-2012
Dependent Variable: RSEVENYR

Variable	Coefficient	t-value	p-value
Constant	0.334	2.48	0.0182
TDY	0.108***	6.53	0.0000
MY	-0.012***	-7.13	0.0000
EPRSTBY	0.397***	4.97	0.0000
EPRLTBY	0.622***	11.08	0.0000
ΔY	0.056	0.56	0.5789
NCIY	-0.09**	-2.40	0.0217
DW	2.07		
Rho	-0.04		
Instrument Rank	10		
F-Statistic***	68.7		

Terms in parentheses are t-values. ***statistically significant at 1% level; **statistically significant at 5% level; *statistically significant at 10% level.

Table 5. 2SLS Estimation Results, 1980-2012
Dependent Variable: RTHREEYR

	Coefficient	t-value	p-value
Explanatory Variable			
Constant	0.55	2.39	0.0244
TDY	0.072***	3.91	0.0006
MY	-0.009***	-2.95	0.0066
EPRSTBY	0.871***	6.63	0.0000
EPRLTBY	0.247***	2.81	0.0092
ΔY	-44.4	-0.24	0.8139
NCIY	-0.042	-0.58	0.5665
DW	2.24		
Rho	-0.12		
Instrument Rank	10		
F-Statistic***	35.74		

Terms in parentheses are t-values. ***statistically significant at 1% level; **statistically significant at 5% level; *statistically significant at 10% level.

Table 6. 2SLS Estimation Results, 1980-2012
Dependent Variable: RSEVENYR

Variable	Coefficient	t-value	p-value
Constant	0.206	1.23	0.2280
TDY	0.092***	6.86	0.0000
MY	-0.01***	-4.26	0.0002
EPRSTBY	0.439***	4.68	0.0001
EPRLTBY	0.615***	10.90	0.0000
ΔY	-2.59	-0.02	0.9819
NCIY	-0.06	-1.31	0.2030
DW	2.16		
Rho	-0.08		
Instrument Rank	10		
F-Statistic***	40.27		

Terms in parentheses are t-values. ***statistically significant at 1% level; **statistically significant at 5% level; *statistically significant at 10% level.

Table 7. Autoregressive 2SLS Estimation Results, 1972-2012
Dependent Variable: RTHREEYR

Variable	Coefficient	t-value	p-value
Constant	0.24	0.34	0.7304
TDY	0.07**	2.56	0.0155
MY	-0.011***	-5.27	0.0000
EPRSTBY	0.713***	14.01	0.0000
EPRLTBY	0.329***	8.05	0.0000
ΔY	131.75	1.40	0.1726
NCIY	-0.117**	-2.64	0.0126
AR (1)	0.092	0.34	0.7304
DW	1.87		
Rho	0.06		
J-Statistic**	12.05		
Inverted AR Root	0.09		
Instrument Rank	14		

Terms in parentheses are t-values. ***statistically significant at 1% level; **statistically significant at 5% level; *statistically significant at 10% level.

Table 8. Autoregressive 2SLS Estimation Results, 1972-2012
Dependent Variable: RSEVENYR

Variable	Coefficient	t-value	p-value
Constant	0.23*	2.02	0.512
TDY	0.103***	6.27	0.0000
MY	-0.013***	-9.17	0.0000
EPRSTBY	0.349***	6.99	0.0000
EPRLTBY	0.663***	19.03	0.0000
ΔY	127.3	1.42	0.1649
NCIY	-0.11***	-3.18	0.0032
AR (1)	-0.087	-0.42	0.6779
DW	2.03		
Rho	-0.02		
J-Statistic**	12.37		
Inverted AR Root	-0.09		
Instrument Rank	14		

Terms in parentheses are t-values. ***statistically significant at 1% level; **statistically significant at 5% level; *statistically significant at 10% level.