An Investigation into the Impact of Federal Government Budget Deficits on the Ex Ante Real Interest Rate Yield on Treasury Notes in the U.S.

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An Investigation into the Impact of Federal Government Budget Deficits on the *Ex Ante* Real Interest Rate Yield on Treasury Notes in the U.S.

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Abstract. Using four decades of data, this empirical study adopts a loanable funds model to investigate the impact of the federal government budget deficit in the U.S. on the *ex ante* real interest rate yield on ten-year Treasury notes. For the 40-year period 1973-2012, an autoregressive 2SLS estimate finds that the *ex ante* real interest rate yield on ten-year U.S. Treasury notes was an increasing function of the *ex ante* real interest rate yield on Moody's Aaa-rated corporate bonds, the *ex ante* real interest rate yield on three-month Treasury bills, and the increase in per capita real GDP, while being a decreasing function of net capital inflows (as a percent of GDP), which are treated as endogenous, and the monetary base (as a percent of GDP). In addition, it is found that that the federal budget deficit (relative to the GDP level) exercised a positive and statistically significant impact on the *ex ante* real interest rate yield on ten-year Treasury notes, a finding consistent in principle with a number of prior studies of other interest rate measures during shorter and earlier time periods. A modest robustness test using the *ex ante* real seven-year Treasury note yield generates the same conclusions.

Keywords budget deficit; *ex ante* real interest rate yield on ten-year Treasury notes; *ex ante* real interest rate yield on seven-year Treasury notes; international capital flows; 40-year study period

1 Introduction

The appearance of large central government budget deficits (by historical standards) in the U.S. and in many other nations across the globe understandably could raise concerns regarding the potential economic impacts of those deficits on other economic variables, such as interest rate yields. In point of fact, the impact of budget deficits on interest rates has been studied extensively; indeed, this literature is especially rich since the early 1980s (Al-Saji, 1993; Barth, Iden and Russek, 1984, 1985, 1986; Cebula, 1997, 2005, 2013; Cebula and Cuellar, 2010; Ewing and Yanochik, 1999; Findlay, 1990; Gissey, 1999; Hoelscher, 1983, 1986; Johnson, 1992; Ostrosky, 1990; Saltz, 1998; Swamy, Kolluri, and Singamsetti, 1990; Tanzi, 1985; Zahid, 1988). Many of these studies find that budget deficits raise intermediate and longer-term interest rates while not significantly affecting short term rates. Since capital formation is presumably much more affected by longer-term than by short term rates, it has been argued that budget deficits are a legitimate public policy concern because they *may* lead to the "crowding out" of private investment (Carlson and Spencer, 1975; Cebula, 1997; Ewing and Yanochik, 1999).

During recent years, the impact of budget deficits on interest rate yields has received only limited attention in the literature. Accordingly, in view of the resurgence of large federal budget deficits in the U.S., this study seeks to provide updated evidence as to the effect of the federal government budget deficit on the *ex ante* real interest rate yield on ten-year Treasury notes. Unlike most previous studies, this empirical study investigates this deficit/interest rate issue for a period 40 years in length, i.e., this study considers the issue in question over a relatively longer time period than most previous related studies. Focusing on a longer-term *ex ante real* interest rate rather than a longer-term *nominal* interest rate reflects the fact that investment is probably more influenced by *ex ante* real longer-term interest rates than by nominal interest rates, be they longer-term or short term.

Using *quarterly data*, this exploratory study investigates the period 1973.1 through 2012.4 in order to provide at least preliminary *contemporary* insights into whether federal budget deficits have over time elevated *ex ante real* longer-term interest rates in the U.S. over a somewhat extended time period. Section 2 of this study provides the loanable funds framework adopted, and section 3 defines the specific variables in the empirical model and describes the data. Section 4 first provides the empirical results of autoregressive, two stage least squares (2SLS) estimation for the study period (1973.1-2012-4). A simple robustness test using *annual data* for the same 1973-2012 time period and focusing upon the *ex ante* real interest rate yield on seven-year Treasury notes is subsequently provided in the second sub-section of Section 4 of the study. Conclusions are provided in Section 5.

2 The Framework

Based extensively on Barth, Iden, and Russek (1984; 1985; 1986) and Hoelscher (1986), as well as Al-Saji (1993) and Cebula (1997; 2005), to identify determinants of the *ex ante* real interest rate yield on ten-year Treasury notes, a loanable funds model is adopted in which the *ex ante* real long term interest rate yield is, assuming all other bond markets are in equilibrium, determined by:

$$D + MY = TDY - NCIY \tag{1}$$

where:

D = private sector domestic demand for ten-year Treasury notes;

MY = a measure of the relative magnitude of the domestic money supply (the monetary base), expressed as a percent of GDP;

TDY = the federal budget deficit, expressed as a percent of GDP; and

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

In this framework, it is hypothesized that:

$$D = D\ (EARTEN, EARAaa, EARTHREE, CHPCGDP),\ D_{EARTEN} > 0,\ D_{EARAaa} < 0,\ D_{EARTHREE} < 0,\ D_{CHPCRGDP} > 0 \tag{2}$$

where:

EARTEN = the annual average *ex ante* real interest rate yield on ten-year Treasury notes;

EARAaa = the annual average *ex ante* real interest rate yield on Moody's Aaa-rated corporate bonds;

EARTHREE = the annual average *ex ante* real interest rate yield on three-month Treasury bills; and

CHPCRGDP = the increase in per capita real GDP.

According to the model, the private sector demand for ten-year Treasury notes is an increasing function of EARTEN since bond buyers prefer a higher real rate of return, *ceteris paribus*. On the other hand, the higher the *ex ante* real interest rate yield on Moody's Aaa-rated corporate bonds (EARAaa), the lower the private sector demand for ten-year Treasury notes as bond buyers at the margin substitute these corporate bonds for the Treasury notes, *ceteris paribus*. Similarly, the higher the *ex ante* real interest rate yield on three-month Treasury bills (EARTHREE), the lower the demand for U.S. Treasury notes, *ceteris paribus*, as private investors substitute these bills for the ten-year Treasury notes. Finally, following Barth, Iden and Russek (1984) and Hoelscher (1986), the variable CHPCRGDP is included in the analysis to capture any accelerator effects of real GDP changes on aggregate investment demand. According to Barth, Iden, and Russek (1984) and Hoelscher (1986), the expected sign on this partial is positive. This is at least in part because as the CHPCRGDP rises, the real transactions demand for money rises and the volume of private sector borrowing increases, thereby elevating interest rates.

Substituting equation (2) into equation (1) and solving for EARTEN yields:

$$EARTEN = f\ (TDY, MY, EARAaa, EARTHREE, NCIY, CHPCRGDP) \qquad (3)$$

such that: $f_{TDY} > 0$, $f_{MY} < 0$ $f_{EARAaa} > 0$, $f_{EARTHREE} > 0$, $f_{NCIY} < 0$, $f_{CHPCRGDP} > 0$

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, *ceteris paribus*. The expected sign on the money supply variable (MY) is negative because the greater the magnitude of the monetary base relative to the GDP, the greater the potential offset to new government debt issues, i.e., the greater the offset the interest-rate effects of budget deficits, *ceteris paribus*. The hypothesized signs on the two partial derivatives f_{EARAaa} and $f_{EARTHREE}$ are positive whereas the partial derivative for f_{NCIY} is negative. The first two of these hypothesized signs reflect, as observed above, the fact that ten-year Treasury notes *compete* with Moody's Aaa-rated corporate bonds and three-month Treasury bills. Consequently, if the *ex ante* real interest rate yield rises on either the Moody's Aaa-rated corporate bond or on the three-month Treasury bill, financial market investors will substitute purchases of these instruments for purchases of ten-year Treasuries, *ceteris paribus*. As for the third of these partial derivatives, it is hypothesized that the greater the magnitude of net capital inflows as a percent of GDP (NCIY), the lower the *ex ante* real interest rate yield on ten-year U.S. Treasury notes, *ceteris paribus*, because these capital inflows absorb domestic debt. Finally, given the expectation that $D_{CHPCRGDP} > 0$ (Barth, Iden, and Russek, 1984; Hoelscher, 1986; Saltz, 1998), it follows that the expected sign on the partial $f_{CHPCGDP}$ is negative, *ceteris paribus*.

3 Variables and Data

Predicated upon the model shown above in equation (3), the initial estimation provided in this study involves the following model using seasonally adjusted quarterly data:

$$EARTEN_t = \alpha_0 + \alpha_1\, TDY_t + \alpha_2\, MY_{t-1} + \alpha_3\, EARAaa_t + \alpha_4\, EARTHREE_t + \alpha_5\, NCIY_t + \alpha_6\, CHPRCGDP_t + \alpha_7\, AR(1) + u_t \quad (4)$$

where:

$EARTEN_t$ = the *ex ante* real average interest rate yield on ten-year U.S. Treasury notes in quarter t, expressed as a percent per annum;

α_0 = constant term;

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

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

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

$EARTHREE_t$ = the *ex ante* real average interest rate yield on three-month U.S. Treasury bills in quarter t, expressed as a percent per annum;

$NCIY_t$ = the ratio of nominal net capital inflows in quarter t to the nominal GDP in quarter t, expressed as a percent per annum;

$CHPCRGDP_t$ = the change in per capita real (2005 dollars) GDP over quarter t;

AR (1) = the autoregressive term; and

u_t = the stochastic error term.

The expected signs on the coefficients in equation (4) are, as follows:

$$\alpha_1 > 0, \alpha_2 < 0, \alpha_3 > 0, \alpha_4 > 0, \alpha_5 < 0, \alpha_6 > 0 \quad (5)$$

The budget deficit and monetary base are both scaled by GDP because the sizes of the budget deficit and monetary base should be judged relative to the size of the economy (Hoelscher, 1986; Ostrosky, 1990, Cebula, 1997). As a reflection of the efficiency of U.S. financial markets. the dependent variable in this system, $EARTEN_t$, is expressed as contemporaneous with five of the six explanatory variables: the *ex ante* real average annual interest rate yield on Moody's Aaa-rated corporate bonds, $EARAaa_t$; the federal budget deficit, as a percent of GDP, TDY_t; the *ex ante* real average annual interest rate yield on three-month Treasury bills, $EARTHREE_t$; the ratio of net capital inflows to GDP, $NCIY_t$; and the increase in per capita real GDP, $CHPCRGDP_t$.

Given these contemporaneous components of this specification, the possibility of simultaneity bias arises, which in turn mandates the choosing of instrumental variables. The instrument chosen for the variable $EARAaa_t$ was the two-quarter lag of the *ex ante* real average annual interest rate yield on Moody Baa-rated corporate bonds, $EARBaa_{t-2}$; the instrument chosen for the deficit variable TDY_t was the two-quarter lag of the percentage average civilian unemployment rate, UR_{t-2} (Hoeslcher, 1986; Ostrosky, 1990; Cebula, 19987; Saltz, 1998); the instrument chosen for the *ex ante* real three-month Treasury bill yield was the two quarter lag of the *ex ante* real interest rate yield on six-month Treasury bills, $EARSIX_{t-2}$; the instrument chosen for the capital inflows variable was the two-quarter lag of the *ex ante* real interest rate yield on three-year Treasury notes, $EARTHREEYR_{t-2}$; and the instrument for the $CHPCRGDP_t$ variable was the two-quarter lag of the percentage growth rate of real GDP, $RGDPGR_{t-2}$. The choice of instruments was based on the fact that each of these instruments was highly correlated with the variable for which it was chosen, whereas these instruments were uncorrelated with the error terms in the system. The data for all of the variables in this analysis were obtained from the Council of Economic Advisors (2013; 2010; 2007; 2004; 2001; 1999; 1996; 1993; 1990; 1987; 1984; 1981; 1978; 1975).[1]

Naturally, the computation of *ex ante* real interest rates requires a suitable measure of expected inflation. One possible way to measure expected inflation 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…failure to obey these constraints makes Livingston…data incompatible with…stochastic law...

Accordingly, following Swamy, Kolluri, and Singamsetti (1990), this study adopts a distributed lag

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[1]Tables B-1, B-2, B-4, B-42, B-64, B-69, B-73, B-79, B-95. Data provided upon written request.

model on actual inflation to construct values for *expected future inflation* in *quarter t*. In particular, to construct values for PE^{t+1}_t, where subscript t is quarter t, a four-quarter distributed lag of actual inflation (measured by the annualized percent change of the CPI, 2005=100.00) was used. This is then the expected inflation measure used to transform each of the nominal interest rate yields in the system into *ex ante* terms.

Descriptive statistics for the variables in the model for the 1973.1-2012.4 study period are found in Table 1. Multi-collinearity was not a problems, as shown in Table 2. In addition, group unit root testing reveals that the variables in the model were stationary in levels over the study poeriod. Finally, an autoregressive, i.e., AR (1), process was applied to the model. The AR (1) process is well suited for dealing with highly volatile variables, such as stock market prices and interest rates.

4 Empirical Findings

Basic Findings

The autoregressive 2SLS estimate of equation (4), after adopting the Newey and West (1987) heteroskedasticity correction, is provided in Table 3, where estimated coefficients, t-values, and prob. values 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, with all six of these coefficients being statistically significant at the 1% level. The DW statistic is 2.05, so that there is no gross evidence of an autocorrelation problem. The J-statistic is statistically significant at the 2.5% level, attesting to the overall dependability of the estimation.

For the post-Bretton Woods 1973.1-2012.4 study period, the estimated coefficient on the monetary base variable, MY_{t-1}, is negative, as expected, and statistically significant at the 1% level, implying that the higher the ratio of the monetary base relative to GDP, the lower the *ex ante* real interest rate yield on ten-year Treasury notes. The estimated coefficient on the *ex ante* real interest rate yield on Moody's Aaa-rated corporate bonds ($EARAaa_t$) is positive, as hypothesized, and statistically significant at the 1% level, implying that the higher this *ex ante* real interest rate yield, the higher the *ex ante* real interest rate yield on ten-year Treasury notes. This finding presumably reflects financial market competition between long term corporate bonds and ten-year Treasury notes. The estimated coefficient on the *ex ante* real three-month Treasury note interest rate yield is also positive, as hypothesized, and statistically significant at the 1% level, implying that the higher the value of the variable $EARTHREE_t$, the higher the *ex ante* real interest rate yield on ten-year Treasury notes. Once again, this presumably is a consequence of financial market competition between these two Treasury issues. The estimated coefficient on the $NCIY_t$ variable is negative, as expected, and statistically significant at the 1% level, a finding that is hypothesized here as suggesting that the greater the level of net capital inflows as a percentage of GDP, the greater the degree to which domestic debt issues are absorbed, thereby leading to lower interest rate yields. The estimated coefficient on the $CHPCRGDP_t$ variable is positive, as hypothesized, and statistically significant at the 1% level, implying that the greater the increase in per capita real GDP, the higher the *ex ante* real interest rate yield. Finally, the coefficient on the budget deficit variable, TDY_t, is positive and statistically significant at the 1% level. Thus, the higher the federal budget deficit (as a percent of GDP), the higher the *ex ante* real interest rate yield on ten-year Treasury notes. This finding is consistent with a variety of empirical studies of *earlier* and shorter time periods, including Al-Saji (1993), Barth, Iden and Russek (1984, 1985, 1986), Cebula (1997, 2005, 2013), Cebula and Cuellar (2010), Findlay (1990), Gissey (1999), Hoelscher (1986), Saltz (1998), Tanzi (1985), and Zahid (1988), among others. In this case, a 1% increase in the budget deficit as a percent of GDP would elevate the *ex ante* real ten-year interest rate yield by 17.3 basis points. Thus, a budget deficit increase on the order of magnitude of, say, 5% of GDP, would raise the *ex ante* real ten-year yield by 86-87 basis points, *ceteris paribus*.

Simple Robustness Testing

In an effort to test the resiliency and consistency of the results shown in Table 3, this sub-section of the study offers a simple robustness test. In particular, the robustness check offered here differs in two ways from its counterpart in the previous sub-section. First, the focus is on the *ex ante* real interest rate yield on seven-year U.S. Treasury notes rather than the *ex ante* real yield on ten-year Treasury notes. Second, rather than adopting quarterly data, annual data are adopted.

Given the presence of six *ex ante* real interest rates in the model (explanatory variables plus instrumental variables), the first step in the analysis is to develop a useful empirical measurement of *expected inflation*. One possibility is to adopt the well-known Livingston survey data. However, as observed above, Swamy, Kolluri, and Singamsetti (1990, p. 1013), find that there may be serious problems with the Livingston series. Accordingly, rather than using the Livingston series, the study adopts a linear-weighted-average (LWA) specification involving actual current and past inflation (of the overall consumer price index) to construct the values for the *expected (future) inflation rate* in year t, PE^{t+1}_t. In particular, to construct the values for the current (year t) *expected future* (i.e., for next year, year t+1) inflation, the following approach is adopted (Cebula, 1992; Koch, 1994):

$$PE^{t+1}_t = (3PA_t + 2PA_{t-1} + PA_{t-2})/6 \qquad (6)$$

where:

PA_t is the *actual* percentage inflation rate in the current year (t); PA_{t-1} is the *actual* inflation rate in the previous year (t-1); and rate PA_{t-2} is the *actua*l inflation rate in year t-2. Clearly, this construct weights current inflation more heavily than previous-period inflation in establishing the inflationary *expectation* for the subsequent/future period.

Adopting this measure of expected future inflation, the equation to be estimated is given by the following:

$$EARSEVEN_t = \beta_0 + \beta_1\ TDY_t + \beta_2\ MY_{t-1} + \beta_3\ EARAaa_t + \beta_4\ EARTHREE_t + \beta_5\ NCIY_t + \beta_6\ CHPRCGDP_t + \beta_7\ AR\ (1) + u'_t \qquad (7)$$

where:

$EARSEVEN_t$ = the *ex ante* real average interest rate yield on seven-year U.S. Treasury notes in year t, expressed as a percent per annum;

β_0 = constant term;

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

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

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

$EARTHREE_t$ = the *ex ante* real average interest rate yield on three-month U.S. Treasury bills in year t, expressed as a percent per annum;

$NCIY_t$ = the ratio of nominal net capital inflows in year t to the nominal GDP in year t, expressed as a percent;

$CHPCRGDP_t$ = the change in per capita real (2005 dollars) GDP over year t;

AR (1) = the autoregressive term; and

u'_t = the stochastic error term.

The autoregressive 2SLS estimate of equation (7) is provided in Table 4, where estimated coefficients, t-values, and prob. values for the explanatory variables are provided and where the Newey and West (1986) heteroskedasticity correction has again been adopted. In Table 4, as in Table 3, all six of the estimated coefficients on the explanatory variables exhibit the expected signs and are statistically significant at the 1% level. The DW statistic is 1.97, so that there is no evidence of an autocorrelation problem. The J-statistic is statistically significant at the 2.0% level, attesting to the dependability of the estimation. Clearly, in qualitative terms, the results in Table 4 closely parallel those in Table 3.[2]

For the 1973-2012 study period, the coefficient on the monetary base variable, MY_{t-1}, is negative and statistically significant at the 1% level, implying that the higher the ratio of the monetary base relative to GDP in a given year, the lower the *ex ante* real interest rate yield on seven-year Treasury notes in the following year. The coefficient on the *ex ante* real interest rate yield on Moody's Aaa-rated corporate bonds ($EARAaa_t$) is positive, as hypothesized, and statistically significant at the 1% level, implying that the higher this *ex ante* real interest rate yield, the higher the *ex ante* real interest rate yield on seven-year Treasury notes. This finding presumably reflects competition between long term corporate bonds and seven-year Treasury notes. The estimated coefficient on the *ex ante* real three-month Treasury note interest rate yield is also positive and statistically significant at the 1% level, as hypothesized, implying that the higher the value of the variable $EARTHREE_t$, the higher the *ex ante* real interest rate yield on seven-year Treasury notes. Once again, this presumably is a consequence of market competition between these two Treasury issues. The estimated coefficient on the $NCIY_t$ variable is negative and statistically significant at the 1% level, a finding that suggests that the greater the level of net capital inflows as a percentage of GDP, the greater the degree to which domestic debt issues are absorbed, thereby leading to lower interest rates. The estimated coefficient

2 The mean of EARSEVEN = 2.2541%; the standard deviation = 2.3874%.

on the $CHPCRGDP_t$ variable is positive and statistically significant at the 1% level, implying that the greater the increase in per capita real GDP, the higher the *ex ante* real interest rate yield. Finally, the coefficient on the budget deficit variable, TDY_t, is positive and statistically significant at the 1% level. Thus, the higher the federal budget deficit (as a percent of GDP), the higher the *ex ante* real interest rate yield on seven-year Treasury notes. This finding is consistent with the results in the preceding sub-section of this study as well as a number of prior empirical studies of various interest rates during *earlier* and shorter time periods, including Al-Saji (1993), Barth, Iden and Russek (1984, 1985, 1986), Cebula (1997, 2005, 2013), Cebula and Cuellar (2010), Findlay (1990), Gissey (1999), Hoelscher (1986), Saltz (1998), Tanzi (1985), and Zahid (1988), among others.[3]

5 Conclusion

Using forty years of data, this empirical study adopts a simple loanable funds to investigate the impact of the federal budget deficit on the *ex ante* real interest rate yield on ten-year Treasury notes. For the period 1973.1-2012.4, an autoregressive 2SLS estimate finds that the *ex ante* real interest rate yield on ten-year U.S. Treasury notes is found to be an increasing function of the *ex ante* real interest rate yield on Moody's Aaa-rated corporate bonds, the *ex ante* real interest rate yield on three-month Treasury bills, and the increase in per capita real GDP, while being found a decreasing function of the ratio of the monetary base to GDP and the ratio of net capital inflows to GDP. This analysis also finds that federal budget deficit (relative to the GDP level) exercised a positive and statistically significant

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[3] A 1% increase in the deficit ratio raises the *ex ante* real seven-year interest rate 10.3 basis points.

impact on the *ex ante* real interest rate yield on ten-year Treasury notes, a finding consistent with a number of earlier studies of shorter time periods such as those by by Al-Saji (1993), Barth, Iden and Russek (1984, 1985, 1986), Cebula (1997, 2005, 2013), Cebula and Cuellar (2010), Findlay (1990), Hoelscher (1986), Saltz (1998), Tanzi (1985), and Zahid (1988), among others. Indeed, the estimation using annual rather than quarterly data and adopting the *ex ante* real interest rate yield on seven-year Treasury notes rather than the *ex ante* real interest rate yield on ten-year Treasury notes yields qualitatively identical results for all of these explanatory variables.

Thus, it appears that factors elevating the federal budget deficit act to raise the *real* cost of borrowing to the U.S. Treasury and hence to the U.S. taxpayer. Given the time period studied, 1973 through 2012, this relationship appears to be an enduring one, one that policy-makers cannot afford to overlook in the long run if the private sector of the economy is to grow and prosper.

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Table 1. Descriptive Statistics, 1973.1-2012.4

Variable	Mean	Standard Deviation
$EARTEN_t$	2.5471	2.3669
TDY_t	3.1550	2.6942
MY_{t-1}	64.6753	27.7426
$EARAaa_t$	3.6836	2.3183
$EARTHREE_t$	0.8759	2.1694
$NCIY_t$	2.0872	1.7195
$CHPCRGDP_t$	26.7412	16.2578

Table 2. Correlation Matrix, Explanatory Variables, 1973.1-2012.4

	TDY	MY	EARAaa	EARTHREE	NCIY	CHPCRGDP
TDY	1.000					
MY	0.496	1.000				
EARAaa	0.106	-0.469	1.000			
EARTHREE	-0.257	-0.217	0.594	1.000		
NCIY	-0.058	-0.249	0.140	-0.021	1.000	
CHPCRGDP	-0.417	0.235	-0.016	0.155	0.461	1.000

Table 3. AR/2SLS Estimation Results, 1973.1-2012.4
Dependent Variable: $EARTEN_t$

Variable	Coefficient	t-value	Prob.
Constant	-0.523		
TDY_t	0.173**	6.87	0.0000
MY_{t-1}	-0.0134**	-4.91	0.0000
$EARAaa_t$	0.789**	12.86	0.0000
$EARTHREE_t$	0.201**	2.78	0.0091
$NCIY_t$	-0.226**	-3.90	0.0005
$CHPCRGDP_{t-1}$	7.024**	4.29	0.0002
AR (1)	-0.172	-0.62	0.5424
DW	2.03		
Rho	-0.03		
Inverted Root	-0.17		
J-statistic*	14.61		
Instrument Rank	14		

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

Table 4. AR/2SLS Estimation Results, 1973-2012
Dependent Variable: $EARSEVEN_t$

Variable	Coefficient	t-value	Prob.
Constant	-0.106		
TDY_t	0.103**	7.20	0.0000
MY_{t-1}	-0.0122**	-7.61	0.0000
$EARAaa_t$	0.699**	27.05	0.0000
$EARTHREE_t$	0.339**	8.12	0.0000
$NCIY_t$	-0.166**	-4.53	0.0001
$CHPCRGDP_{t-1}$	4.517**	3.63	0.0010
AR (1)	-0.178	-0.99	0.3300
DW	1.97		
Rho	0.01		
Inverted Root	-0.18		
J-statistic*	15.86		
Instrument Rank	14		

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