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An Empirical Study of the Ricardian Equivalence Hypothesis, National Savings, and Interest Rates

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Abstract

This study examines the Ricardian Equivalence Hypothesis by testing the correlation between net government savings and its effect on yields of Treasury bills, bonds, and notes. The United States federal government has borrowed extensively in recent years to finance stimulus projects and to make up for the lost government revenue due to the 2008-2009 recession. In addition, the government will have to increase debt held by the public to finance the $4.5 trillion in intragovernmental holdings which are needed to finance Medicare and Social Security. Running a time-series ordinary least squared regression, I examined Treasury yields with maturity dates from one month to thirty years. I used quarterly data of Treasury yields from the Federal Reserve Bank of Saint Louis and macroeconomic data from the U.S. Bureau of Economic Analysis was examined going back to the year 1962. The Ricardian Equivalence Hypothesis was validated to an extent, with net government savings having a combined contemporary and one year lag effect of -0.618 on net private savings. Upon running multiple regressions, I could not establish a significant relationship between net government savings (either in a contemporary or previous period) and Treasury interest rates for any Treasury security, indicating that the crowding out effect does not necessarily have as strong of an effect on the private bond market.

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Introduction

1. Motivation

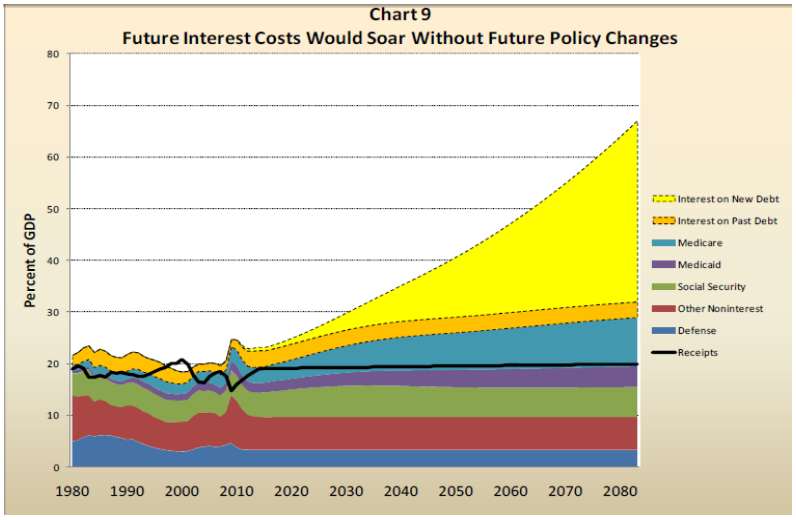
The United States federal government has run consistent deficits since the beginning of the 1980s. The federal deficit has increased in the new millennium, as spending for the wars in Iraq and Afghanistan has continued and as more Americans become eligible for entitlement programs like Medicare and Social Security. The recessions of 2008 and 2009 led to low government receipts which further increased the deficit. The federal government responded aggressively to the recession, and created programs like the Troubled Assets Relief Program, the American Recovery and Reinvestment Act also known as the stimulus bill, and a series of bailouts for companies like General Motors, AIG, and others. These policies enacted during a time of economic distress led to the highest nominal deficits in the history of the United States. The 2011 deficit is projected to exceed one trillion dollars for the third year in a row.

These large federal deficits have made some economists and Americans concerned. According to the Congressional Budget Office, the United States will run deficits of $9.5 trillion dollars through 2021 (Montgomery, 2011). The long term projections for entitlement programs, especially the increasing costs of the Medicare program, are the main cause of the projected deficit increases.

In a recent book, economists Carmen Reinhart and Kenneth Rogoff studied forty-four countries over two hundred years and found that countries reach a "danger point" when the gross national debt exceeds 90%. They argue that while the country still would not potentially default on its debt, the United States would suffer lower economic growth rates after passing this danger point (Chaddock, 2011). However, Nobel-prizing winning economist Paul Krugman disagrees, writing "Federal government is having no trouble raising money, and the price of that money — the interest rate on federal borrowing — is very low by historical standards. So

there's no need to scramble to slash spending now" (Krugman, 2011). However, as investor fears about inflation begin to pick up, these yields will increase (Christie, 2008). This raises the question of how the government debt, deficits or debt to GDP affects the yields on the government bonds in the United States. The United States faces a tremendous fiscal task to balance the federal budget in the next decade. The following figure shows the current growth in entitlement liabilities and subsequent interest increases at current spending levels (GAO, 2009).

Figure One: Fiscal projections under current spending assumptions.



2. The Ricardian Equivalence Hypothesis

The disagreement between economists Krugman and Reinhart and Rogoff reflects two sides of a debate concerning the Ricardian Equivalence Hypothesis, also known as the "Barro-Ricardo Equivalence Theorem." The theory states that "When a government tries to stimulate demand by increasing debt-financed government spending, demand remains unchanged" (Investopedia, 2011). When the government borrows money, it causes individuals to save to pay for the future tax increases, which leads to demand staying constant. A result is

that a tax has the same effect as a deficit in terms of its impact on demand. This debate is directly related to the potential danger of increasing national deficits.

An alternative theory to the Ricardian Equivalence Hypothesis is the Crowding-Out theory of government debt which states that if the government has to borrow a lot of money, it must sell it at a higher interest rate to attract investors. In addition, "Crowding out generally occurs because lenders prefer the government as a borrower because it is much less risky and the government is able to pay any interest rate. Thus, when the government is borrowing heavily and lenders have only a finite amount they can lend, it may crowd out private borrowers" (Farlex, 2009).

3. National Accounts

The measure of economic activity in a country is called the Gross Domestic Product. GDP can be given by the equation:

$$Eq.1: Y = G + I + C + NX$$

Where Y is the gross domestic product, G is government spending, I is investment, C is consumption, and NX is net exports. Net exports are simply exports minus imports. The government budget constraint is given by:

$$Eq.2: G_t + iB_{t-1} = T + \Delta B_t$$

where G_t is government spending in the current period, and i is the interest rate for bonds sold in the previous period. This multiplied by the number of bonds sold in the previous period, B_{t-1}, yields the total interest payment on those bonds. The money to pay for this comes from T, tax revenue in the current period and the change in the amount of bonds sold to make up for any shortfall in government receipts. Hence, when$\Delta B_t < 0$, the government is running a surplus because the amount of bonds available for purchase is decreasing. If one assumes the Ricardian

equivalence, we can use Eq. 3 which gives us private savings in the economy, to find the net foreign flow of capital:

$$Eq.3: Y - C - G = S$$

$$Eq.4: Y - C - G - I = NX \quad from\ Eq.1$$

$$Eq.5: S - I = NX \quad by\ substitution\ and$$

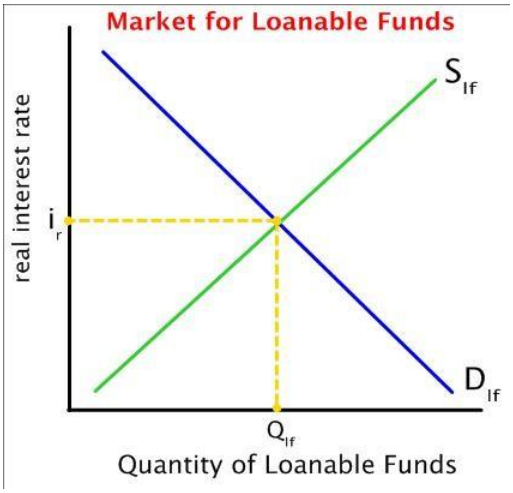
$$Eq.6: I - S = -NX$$

which is simply the negative of net exports, which intuitively makes sense as the change in monetary capital will be the equal and opposite value of the net goods traded.

4. The Bond Market and the "Crowding Out Effect"

The bond market follows the classical laws of supply and demand since an interest rate is, at a fundamental level, the price of borrowing or lending money. The typical bond market looks like Figure 2:[1]

Fig. 2:

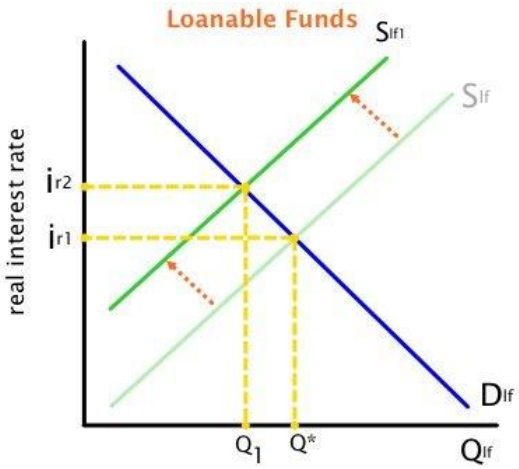


where the efficient quantity and price of loanable funds can be found at the intersection of the supply and demand curves for loanable funds. Assuming monetary policy and other factors

[1] The following two figures can be found at: http://welkerswikinomics.com/blog/2008/06/02/loanable-funds-vs-money-market-whats-the-difference/

ceteris paribus, an increase in government debt will increase the supply of loanable funds in the market which shifts the supply curve of bonds out:

Fig. 3:



This increases the interest rate and lowers the price of bonds. Prices and yields on securities are inversely related. When this happens, not only do more funds go towards this new public debt making money shift away from private debt, but also this shift forces banks to offer higher interest rates to attract investors to invest in private debt. This increase in interest rates increases the cost of borrowing for businesses, leading to the "crowding out effect." This is the phenomenon that will be empirically tested in the present study.

5. Treasury Securities and Auctions

According to Treasury Direct, a part of the official website of the Treasury of the United States, the gross national debt consists of two components. The first component represents the "Debt held by the Public." This component includes Treasury bills, notes, bonds, and Treasury Inflation Protected Securities (TIPS). These Treasury securities are available for purchase on the market, both for domestic and international buyers. Typically, large financial institutions, the Federal Reserve, or foreign governments purchase the Treasury securities. The securities are

sold at auctions that are announced by the United States Treasury with each auction having a unique CUSIP (Committee on Uniform Security Identification Procedures) number. Treasury bills have maturity dates that range from thirteen weeks to fifty two weeks, Treasury notes have maturity dates that range from one to ten years, and Treasury bonds are sold with maturity dates of twenty or thirty years. Longer term Treasuries typically pay a "coupon payment" every six months to pay the interest to the investor. Individual investors or pension funds typically purchase the Treasury securities from the large financial institutions. Investors can purchase these securities in hopes that the price will increase over time. These securities are also seen as some of the most solid and secure investments available on the market, and pension and retirement plans often include them as part of an investor's portfolio.

The second component of the national debt is called intragovernmental holdings. Intragovernmental holdings mainly consist of the accrued surpluses from the Social Security and Medicare programs. If these programs bring in more revenue than outlays, the surplus is invested into an account called the Government Account Series. This money can then be spent by Congress on other programs including defense and other discretionary spending areas. Congress pays interest on these holdings which is then used to pay for Social Security and Medicare benefits. The interest rate for these holdings is determined by actuaries and accountants in the federal government. Unlike debt held by the public which is sold on the market, intragovernmental holdings are considered non-marketable securities and the interest rates on these securities do necessarily reflect market demand. Thus, when examining the effect that deficits have on Treasury security interest rates, the level of intragovernmental holdings should be omitted from the final analysis.

This paper uses an ordinary least squares regression and time series regressions to examine the Ricardian Equivalence Theorem and whether government deficit levels have an effect on Treasury security interest rates for Treasury securities with different maturity dates. The next section examines the literature as it pertains to this question, followed by a section on the data used for this study, followed by a section on methodology, followed by a results and conclusions section.

Literature Review

There is a debate in the literature about the effect of increasing debt ratios and economic yields. Some studies suggest that there is a causational link between real interest rates and the primary budget deficit (Cebula, 2003). Cebula's model ignored interest payments on the debt and focused on long term government municipal bonds. An additional study of Latin American interest rates that used econometric tests of six Latin American countries found that "external debt plays a central role in the sustainable behavior of domestic interest rates on assets" (Rojas-Suarez, Liliana, Sotelo, Sebastian, 2007). Some studies that have looked at the history of the United States debt and interest rates agree. "Based on monthly and quarterly data from January 1971 to December 1997, we found that federal deficits had significant positive effect on the real interest rates" (Tseng, K.C., 2000).

However, other studies find "[an] absence of causality in the long-run between government debt and real interest-rate related variables" (Kalulululumia, 2002). Kalulululumia's study looked at four countries - the United States, Germany, the United Kingdom, and Canada. Another paper found that "Dispersion-based uncertainty about the future course of monetary policy is the single most important determinant of Treasury bond volatility across all maturities,"

(Ivo. Et.al. 2010). Many papers on the subject open with an analysis of the debate in the literature. "Does government debt affect interest rates? Despite a substantial body of empirical analysis, the answer based on the past two decades of research is mixed" (Engen, Eric, Hubbard, Glenn, 2004).

The buildup of debt and subsequent low interest rates may serve as a counter example to invalidate many of the older models and data. In a discussion of a paper written in 2003, Parker writes about an old government rule, thus: "A conservative rule of thumb based on this relationship is that interest rates rise by about 3 basis points for every additional $200 billion in government debt" (Parker, 2004). This rule of thumb may be put into question by the current economic reality. The final interesting feature is the buildup of global debt. The *Economist* reports that many countries have large debt and so the global debt is currently amounting to over forty trillion dollars. A paper that focused on international interest rate stated that "the increase in OECD-wide government debt since the late 1970s was a major factor in the rise in real interest rates." (Ford, Robert, Laxton, Douglas, 1999). The opposite of this seems to be occurring today. Perhaps the government debt is not as big a factor in interest rates as was previously thought. There is also the possibility that there is some third factor (like global confidence) that affects interest rates. Or, perhaps there is some as yet unidentified marker, for example, the debt to GDP ratio which, when at a certain value, causes investors to lose confidence in a government and which then causes interest rates to spike.

The answers to these questions will impact the policies that will have to be implemented by the United States. The United States faces some large looming liabilities on the Social Security Medicare programs (US Treasury, 2009). All plausible scenarios show major increases in spending (Manchester, 2010). While some reports argue that the problems facing Social

Security are not substantiated (Rosnick, 2010), the Congressional Budget office projections show a 65% chance of the Trust Fund being exhausted by the year 2040 (CBO Social Security Actuarial Report, 2010). A spike in inflation or interest rates could have a profound effect on the fund because of the built in COLA increases that would impact the fund even more quickly. "Government will not be able to inflate its way out of the problem" (Fair, 2010). However, this force would be countered by the fact that the federal government would pay a higher interest rate on its intergovernmental holdings to the fund. It is impossible for a closed economy to just continue to submit bonds forever to finance the public debt (Aspromourgos, 2008). Of course, the United States is not a closed economy, so relaxing this assumption may prove otherwise.

Some argue that there is no need to worry about the size of that national debt (Davidson, 2010). This claim may be untrue if a true link between the size of the national debt compared to GDP and interests rates can be verified. This is especially the case for the United States since, "…feasible tax increases within the current tax structure cannot generate sufficient revenues to bring federal budget deficits under control" (Altsuler et. al., 2010).

As mentioned, there is significant debate in the literature both over how budget deficits affect Treasuries, and also how to set up the model. Many studies have found that there was no empirical relationship between Treasuries and interest rates (Evans, 1987) (Motley, B 1983) Al-Saji, 1993). Other studies state that there is a measurable effect (Hutchinson, J. 1984) (Cebula, 1990). Almost 50% of government Treasuries have maturity dates of five years or fewer. Thus, the amount of interest the government pays is susceptible to interest rate shifts. The volatility of this effect will increase as the total level of debt increases. One final note is that in addition to the ongoing debate on this topic, there is always a widening gap in the literature as time passes and more data become available for study. This paper will attempt to fill in this gap by using

these new data to run an analysis of the effect of net government savings on private savings and interest rates of Treasury securities.

Data

The data for this study came from three sources. Data for the yields for Treasury Notes, Bills, and Bonds came from the Federal Reserve Bank of St. Louis. Data were available by day, month, and quarter. It was possible to collect quarterly data by either taking the value of the Treasury security from the first date of the quarter, the last date of the quarter, or to take the average of all of the daily Treasury yield values over the length of the quarter. This latter value was collected for the one, three, and six month notes, going back to the first quarter of 1982. Data were also collected in the same way for one, two, three, five, seven, and ten year notes, and for twenty and thirty year bonds quarterly starting the first quarter of 1962.

The national accounts data were made available by the United States Bureau of Economic Analysis (BEA). National accounts data were collected quarterly for a plethora of macroeconomic variables including Gross Domestic Product, gross and net government savings, net federal savings, personal consumption expenditures, exports, imports, gross private domestic investment, gross government investment, and gross and net private savings. These data were adjusted for inflation and were also seasonally adjusted. It was critical for this study to use data that were seasonally adjusted. Without this adjustment, federal savings appears positive for the month of April and for following months due to the timing of the federal income tax deadline. The data for these macroeconomic variables were quarterly, beginning in January of 1947.

Finally, data for the Consumer Price Index (CPI) were made available by the Federal Reserve Bank of Cleveland. The data included the consumer price of "all items" tracked by the

Bureau of Labor Statistics, including food and energy. The value for these data was quarterly and represents the year-over-year growth as a percent change in the CPI. These data were collected starting with the first quarter of 1947. Since the data for inflation are independent of seasonal adjustments from the national account data from the BEA, and from the Treasury security data from the Federal Reserve Bank of St. Louis, there was no chance of the seasonal adjustments between these data sources conflicting or corrupting the data for the regressions.

Descriptive Statistics

The interest rates of the Treasury Notes and Bonds are provided in Figure 4. Most of these Treasury securities reached their peak interest rate around middle of 1980. Since that time, nearly all of the rates have steadily fallen over the years. During the early 1990 recession, the 2001 recession, and the 2008-2009 recession, the yields on the different Treasury securities disperse with the longer maturity rates showing less volatility compared to the Treasury securities with shorter security maturity dates.

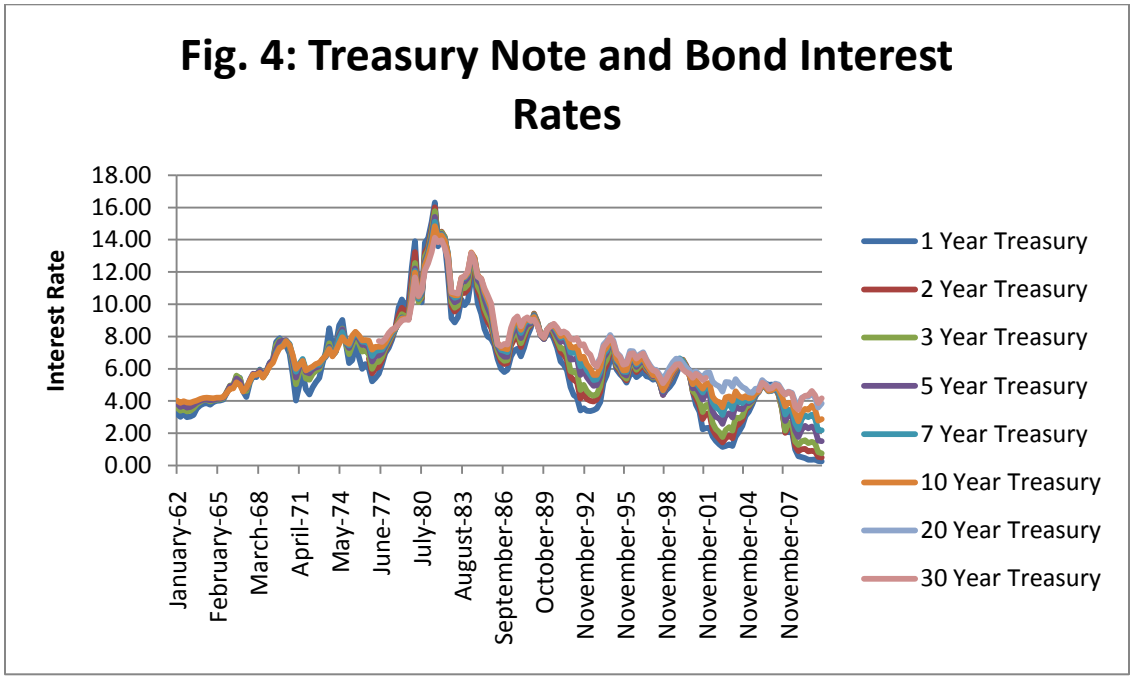


Figure 5 below shows the interest rates on one, three, and six month Treasury Bills. Data for the one month Treasury bill were only available starting in the first quarter of 2001. The interest rates for these three Treasury securities are nearly identical. The recent Quantitative Easing policies of the Federal Reserve Board have pushed the yields of these short term securities to nearly zero percent.

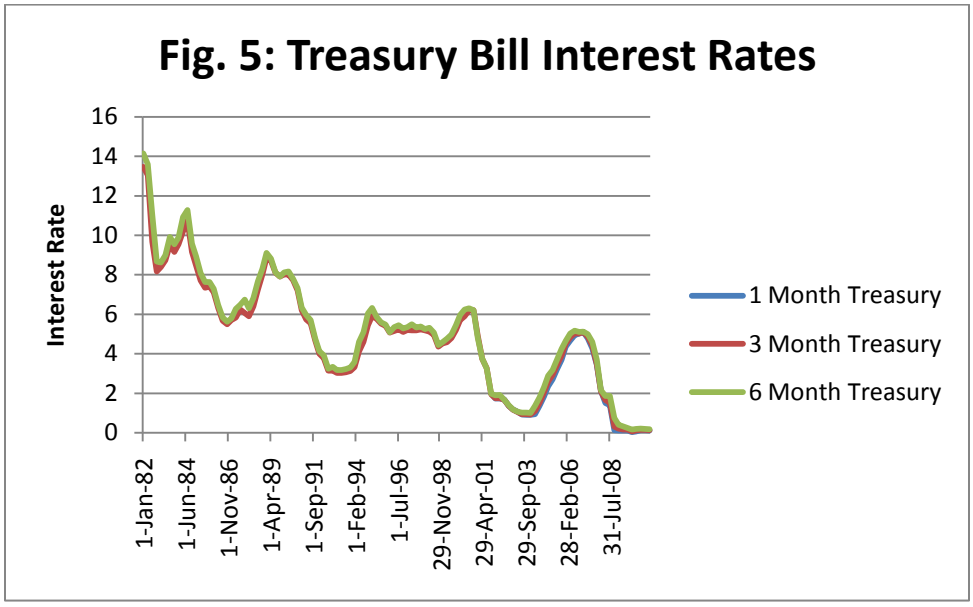
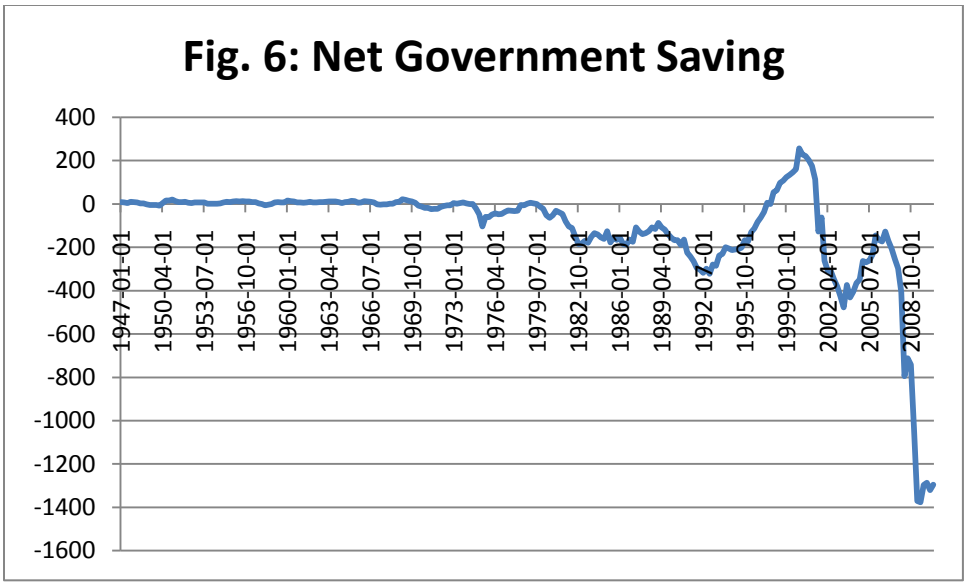
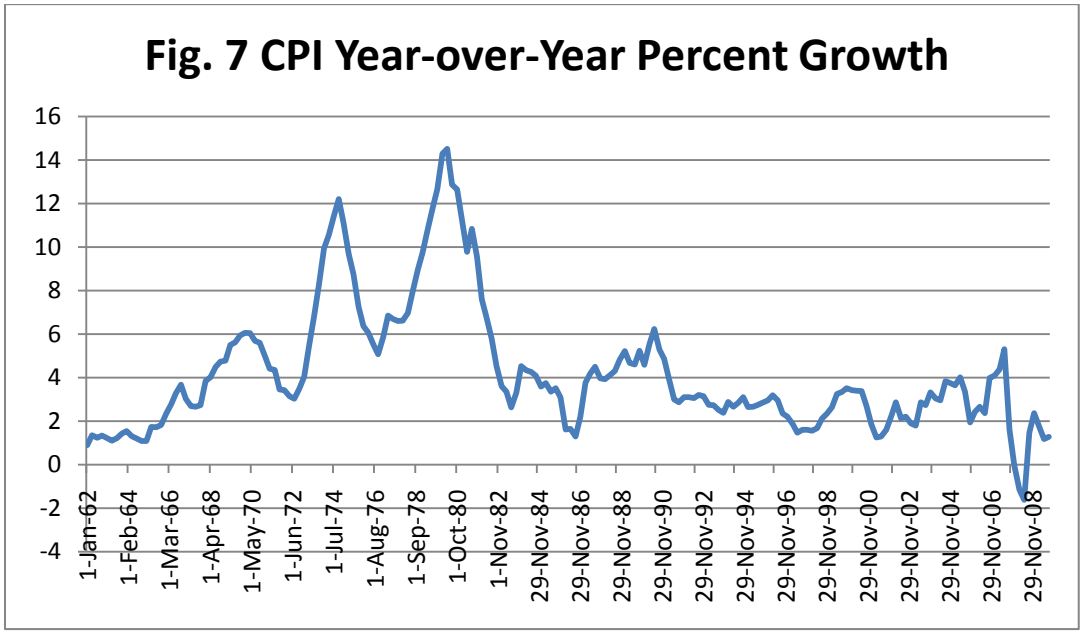


Figure 6 shows net federal saving starting in the first quarter of 1962. These data are adjusted for inflation and are also seasonally adjusted. During the late 1990s, the federal government was running a surplus that turned into a deficit during the 2000s. As the recession of 2008 began, government receipts fell significantly and the TARP and American Recovery and Reinvestment Act of 2009 began to add significantly to the deficit, pushing net federal savings deep into a deficit.



Finally, Figure 7 represents the Consumer Price Index change as a year-over-year percentage growth in the price of all goods. Since the inflation spikes during the 1970s, the inflation has remained in between the two and four percent mark except for a sharp decline as a result of the 2008 recession.



Methodology

To analyze the relationship between private savings and government savings and to analyze the national deficit and interest rates on government Treasuries, this study ran two sets of ordinary-least-squares regressions. In the first set of regressions, the dependent variables were net private savings and gross private savings. Independent variables included percentage change in quarter GDP growth, defined as $(Y_n\text{-}Y_{n-1})/Y_n$, gross government savings, gross federal savings, net government savings, net federal government savings, net exports, personal consumption and expenditures, personal income, gross private investment, and CPI year over year percentage change. The change in GDP term was scaled by one hundred to more easily examine the effect of a one percent change in GDP. These controls were used in different regressions to see the effects on private savings, and the results can be found in the results section and tables at the end of this paper. Some regressions included terms with multi-collinearity issues which will also be discussed in the results section. The regression took the form:

$$Eq.7\text{: } (GrossPrivateSavings)Y = \alpha + \beta_1(GrossPublicSaving) + \beta_n(Control_n) + \varepsilon$$

$$Eq.8\text{: } (NetPrivateSavings) = \alpha + \beta_1(NetPublicSaving) + \beta_n(Control_n) + \varepsilon$$

In addition to these controls, time lags were used for several of the independent variables. There is a lot of evidence in the literature of the importance of using time series regressions in these kinds of models. A recent paper by Olivier Cardi focused on the importance of habit performance. Fundamentally, if a study were to only look at the contemporary period, one would get results that show that the price is driving the behavior. Only by controlling over several periods (up to four quarters in this case) can regressions be used to see how the behavior

is driving the price. This is especially important when habit persistence gets stronger (Cardi, 2009). These regressions were run without the assumption of homoscedasticity.

During the course of the research, I ran a regression was run just by looking at lags of net government saving on private government saving. The result was that the a one quarter lag and a one year (four quarters) lag were significant, while two and three quarter lags were not significant. This result came up frequently, so one and four lags were used in future regressions.

The second set of regressions which analyzed the effect of federal and governmental savings on Treasury interest rates used a similar Ordinary-Least-Squares regression. For these regressions, the dependent variable was individual Treasury yields. The technique of several studies including Tseng et al. and Ford and Laxton et al. was utilized to run several regressions to examine the effects of debt levels on individual types of Treasuries. The effects on short term bills (3 month notes), medium notes (two, five, and seven year bills), and longer term bonds (twenty and thirty year bonds) were examined. Controls for these regressions include net private savings, net government savings, net federal savings, gross domestic investment, the change in GDP, and net exports. Time lags were also used on key controls to break the habit persistence effect as before. This was mainly done through a trial and error to see which lags were significant and which ones were not significant. No lags greater than four quarters (one year) were used. Since the Ten Year Treasury is the industry standard for the general confidence in government bonds and in economic activity, those results are the most applicable when comparing results across the literature. The economics regressions were done with the STATA program, and all regressions were run without the assumption of homoscedasticity. A typical regression equation for this section would look like:

$$Eq.9:\ (Ten\ Year\ Treasury\ Yield)Y_i = \alpha + \beta_1(NetGovernmentSaving) + \beta_2(NetPrivateSaving) + \beta_n(Control_n) + \varepsilon$$

Results and Conclusions

My results from examining the Ricardian Equivalence Hypothesis were pretty similar to other research in the literature, and seemed to confirm the Ricardian Hypothesis. With no controls, gross government saving and net government saving had strong negative correlations with gross private saving and gross government savings respectively. When controls were added, these magnitudes decreased indicating a negative omitted variable bias effect. When other controls were added, the effect of net government savings was cut nearly in half. After experimenting with the lags on several controls and on the net government savings variable, it became apparent that the first and fourth lag were significant, but that the contemporary net government savings variable took the credit for one lag. In the final regression, if we combine the effect of net government saving in the contemporary period with the effect of net government saving lagged for four quarters, we get a combined -0.6018. This value is fairly consistent in the literature across different studies, and seems to affirm the Ricardian Equivalence Hypothesis, although it is not a one-to-one effect. The results of these regressions can be found in Table 1.

When examining the ten year Treasury note, first examined were the effect that lags had on the Treasury note yield. Short term lags had a positive coefficient, while longer term lags had a negative coefficient. As expected, each lag lost significance the higher the number of lags. This result is not surprising because upon examining the descriptive statistics of the Treasury securities, the long term trend on Treasuries has been a downward slope since 1980. Thus to keep a one quarter lag and a four quarter lag along with the other controls then ran regressions on current period independent variables and on once lagged dependant variables. Both the effect of net government and net private saving lost significance once lagged one time. This was also found to be the case with Treasury securities of differing maturity dates. Thus to run that

regression for the ten year note on Treasury securities of different dates to stack the deck in favor of a government or private saving effect. The results of the ten year note regressions can be found in Table 2 and the results on Treasury securities of different maturity dates can be found in Table 3.

Running the regression across Treasury maturity dates led to some interesting results. Despite stacking the deck in favor of a net government savings effect and a net private savings effect, the regression could not establish a significant effect on Treasury interest rates of any maturity date. This suggests that the "crowding out" effect may not be as powerful of an effect. Variables that did have an effect across the board were the percentage change in GDP, inflation, and the lag. The percentage change in GDP was positively correlated with the yield which is the effect that we would expect. When GDP increases, or when the economy is expanding, Treasury security yields increase. During recessions, as investors look for more secure investments, the demand for Treasury's increase which drives up the price and lowers the yield. Furthermore, CPI was positively correlated with Treasury security yields. This is also the effect that we would suspect since inflation is an endogenous factor of Treasury security yields. The results for the one month Treasury bill should not be taken with two much weight. Most of these results were insignificant due to the lack of empirical data points. The private and government savings effect did get more significant as the maturity date decreased which is an interesting observation. It could be that increases in government borrowing effects shorter term Treasury securities more than longer term Treasury securities.

Thus, in conclusion, based on the evidence from these regressions, despite testing a number of controls and lags on different Treasury securities and despite choosing the time period

to maximize the effect of net government and net private savings, the "crowding out effect" could not be established on any Treasury security.

Limitations and Future Research

One important factor and limitation to consider in this research is the problem of multiple (serial) collinearity. This problem was avoided as much as possible by using a careful selection of independent variables. One final limitation on this study is that this kind of research is as much of an art as it is a science. There are an infinite number of ways to lag the macroeconomic variable, and it is possible that there are better combinations of lags and controls to uncover the correlation between government savings levels and the yields of Treasury securities. This inconclusive evidence suggests that future research should continue on this topic. Indeed, one hypothesis to be tested as a result of these findings is that, under normal economic circumstances, there is not a crowding out effect in the market. However, once investors lose confidence in government bonds, yields on Treasury securities spike leading to negative effects on the private market, like what happened in Portugal and Greece. One final note is that as time moves forward, and more data points become available, it is possible that a private crowding out effect could become more pronounced as results become more significant. Indeed, if the United States continues running large fiscal deficits, and as the gross national debt to GDP ratio exceeds 90%, it is possible that the United States could start to head into uncharted fiscal territory.

Table 1: Examining the Ricardianq2 Equivalence Hypothesis $\alpha^{*}<0.1$ $\alpha^{**}<0.05$ $\alpha^{***}<0.01$

(T-statistic)	Reg 1 N=255 Gross Private Saving	Reg 2 N=255 Net Private Saving	Reg 3 N=251 Gross Private Saving	Reg 4 Net Private Saving N=254	Reg 5 Net Private Saving N=254 Variables lagged one quarter	Reg 6 Net Private Saving N=251
R^2	0.164	0.547	0.584	0.988	0.962	0.971
Constant	687.85 (16.65)***	201.5821 (16.21)***	198.8 (15.41)***	-224.07 (-24.36)***	-71.393 (-14.0)***	-61.664 (-14.05)***
Gross Govt. Saving	-1.448647 (-6.06)***			-1.061 (-43.57)***		
Net Gov Saving		-0.74102 (-16.53)***			-0.4533 (-20.67)***	-0.3145 (3.06)**
Net Exports				0.6291 (9.74)***	0.6232 (16.36)***	0.5943 (18.19)***
Gross Domestic Private Investment				1.2156 (71.22)***	0.4568 (47.88)***	0.4408 (46.71)***
CPI Year over Year %change				-10.39 (-5.07)***	-2.0421 (-3.47)***	-2.1870 (-3.92)***
Percent Change in GDP				-22.241 (-4.9)***	3.16 (1.05)	-1.33 (-0.58)
Net Gov. Saving Lagged Once			-0.421 (01.82)**			0.06055 (0.49)
Net Gov. Saving Lagged Twice			0.17759 (0.41)			
Net Gov. Saving Three Lags			-0.08591 (-0.21)			
Net Gov. Saving Four Lags			-0.58446 (-2.05)**			-0.2873 (-4.84)***

Table 2: Examining the Ten Year Treasury Note $\alpha^{*}<0.1$ $\alpha^{**}<0.05$ $\alpha^{***}<0.01$

(T-statistic)	Reg 1 Ten Year Yield N=191	Reg 2 Ten Year Yield N=192	Reg 3 Ten Year Yield N=192	Reg 4 Ten Year Yield N=191	Reg 5 Ten Year N = 192 All variables lagged on period
R^2	0.966	0.964	0.966	0.97	0.967
Constant	0.1576 (1.27)	0.15689 (1.25)	0.0634 (0.46)	-0.042 (-0.30)	0.2084 (1.33)
Net Government Saving			0.00009 (0.46)	0.00007 (0.36)	0.000016 (0.06)
Net Private Saving				0.00028 (1.05)	0.0000007 (0.04)
Percent Change in GDP			0.134 (2.91)***	0.1872 (3.64)***	0.08457 (1.82)*
Net Exports				0.0002315 (1.14)	0.00025 (1.18)
CPI Year over Year % Change				0.0821 (3.82)***	0.0528 (2.13)**
One Lag Ten Year	1.2579 (12.27)***	1.0725 (20.58)***	1.0841 (22.73)***	0.966 (18.73)***	0.9837 (17.19)***
Two Lags Ten Year	-0.39644 (-2.65)***				
Three Lags Ten Year	0.2810 (1.536)				
Four Lags Ten Year	-0.1659 (-1.27)	-0.9599 (-1.88)*	-0.10697 (-2.31)**	-0.03966 (-0.9)**	-0.0503 (-1.01)

Table 3: Examining Multiple Treasury Securities Note $\alpha^{*}<0.1$ $\alpha^{**}<0.05$ $\alpha^{***}<0.01$

(T-statistic)	Ten Year Yield N=191	Thirty Year Yield N=111	Five Year Yield N=194	One Year Yield N=191	One Month Yield N=32
R^2	0.97	0.972	0.963	0.947	0.978
Constant	-0.042 (-0.30)	0.4811 (1.09)	-0.09946 (-0.60)	-0.2252 (-0.94)	-1.839 (-1.68)
Net Government Saving	0.00007 (0.36)	-0.000329 (-1.42)	0.000208 (0.89)	0.0004274 (1.7)*	0.000026 (0.04)
Net Private Saving	0.00028 (1.05)	-0.0005635 (-1.01)	0.000444 (1.43)	0.00061 (1.82)*	0.00107 (1.29)
Percent Change in GDP	0.1872 (3.64)***	0.2504 (3.24)***	0.2425 (3.82)***	0.3474 (3.38)***	-0.0266 (-1.71)*
Net Exports	0.0002315 (1.14)	0.000243 (0.95)	0.00032 (1.39)	0.00032 (1.34)	-0.00475 (-0.09)
CPI Year over Year % Change	0.0821 (3.82)***	0.0709 (2.45)**	0.0954 (3.64)***	0.1193 (2.7)***	-0.00475 (-0.09)
Yield: One Lag	0.966 (18.73)***	0.9866 (16.75)***	0.9481 (17.38)***	0.931 (13.61)***	1.0728 (16.75)***
Yield: Four Lags	-0.03966 (-0.9)**	-0.793616 (-1.42)	-0.3424 (-0.78)	-0.0408 (-0.76)	-1.839 (-2.44)**

References

Data:
Federal Reserve Bank of St. Louis
Federal Reserve Bank of Cleveland
U.S. Bureau of Economic Analysis

Al-Saji, A.K. (1993). "Government Budget Deficits, Nominal and Ex Ante Real Long-Term Interest Rates in the U.K. *Atlantic Economic Journal*. 71-77.

Altsuler, Rosanne, et. al. (January 2010.) "Desperately Seeking Revenue." Urban Institute.

Aspromourgos, Tony, Rees, Daniel, White, Graham. (October 2008). "Public debt sustainability and alternative theories of interest." Cambridge Journal of Economics. Volume 34, Issue 3. Pp 433-447

Cardi, Olivier. (July, 2009). "Habit Persistence and Effectiveness of Fiscal Policy in an Open Economy." ERMES, Universite Pantheon-Assas Paris 2, Departement d'Economie, Ecole Polytechnique.

Cebula, Richard. (September 2003). "Budget Deficits and Real Interest Rates: Updated Empirical Evidence on Causality." American Economic Journal. Vol 31. No. 3.

Cebula, R.J. (1990). "A Note on Budget Deficits and Ex Ante Real Long Term Interest Rates in the United States." *Southern Economic Journal.* 56, 797-801.

Chaddock, Gail. (March 8, 2011). "What Happens if Congress doesn't reign in National Debt?" *Christian Science Monitor.*

Christie, Rebecca, Torres, Craig. (October 28, 2010). "Fed Asks Dealers to Estimate Size, Impact of Debt Purchases." October 28, 2010. *Bloomberg News*

Congressional Budget Office: Budget 2010

Congressional Budget Actuarial Report on Social Security (2010).

Davidson, Paul. (2010). "Making dollars and sense of the U.S. government debt." Journal of Post Keynesian Economics Volume 32 Number 4. 661-666.

Engen, Eric, Hubbard, Glenn. (August 2004) "Federal Government Debts and Interest Rates." National Bureau of Economic Research Working Paper Series, 10681.

Evans, P., (1985). "Do Large Deficits Produce High Interest Rates?" *American Economic Review* 75, 68-87.

Fair, Ray. Feb. 2010. "Possible Macroeconomic Consequences of Large Future Federal Government Deficits."Cowles Foundation.

Farlex Financial Dictionary. (2009). "Crowding Out." http://financial-dictionary.thefreedictionary.com/Crowding+Out

Ford, Robert, Laxton, Douglas. (1999). "World Public Debt and Real Interest Rates." Oxford Review of Economic Policy. Vol. 15 No. 2

Government Accountability Office (GAO). 2009. "A Citizen's Guide to the 2009 Financial Report of the U.S. Government."

Hutchinson, M.M. and D. H. Pyle. (1984). The Real Interest Rate/Budget Deficit Link: International Evidence, 1973-1982. *Economic Review*, Federal Reserve Bank of San Francisco. 4, 26-35.

Investopedia. (March 2011). "Ricardian Equivalence." http://www.investopedia.com/terms/r/ricardianequivalence.asp

Ivo, Arnold, Vrugt, Evert. August 2010. "Treasury Bond Volatility and Uncertainty about Monetary Policy." The Financial Review; Volume 45, Issue 3, pages 707–728,

Joyce Manchester, Jonathan A Schwabish. Jun 2010. "The Long Term Budget Outlook in the United States and the role of Health Care Entitlements." National Tax Journal. Vol. 63, Iss. 2; p. 285

Kalulumia, Pene. (July 2002). "Effects of government debt on interest rates: evidence from causality tests in johansen-type models." Cahiers de recherche,02-07.

Krugman, Paul. (March 10, 2011). "Dumbing Down Deficits." *New York Times*. p. A27

Montgomery, Lori. (Marcy 18, 2011). "CBO: Obama Policies would require deficits of $9.5 trillion through 2011. *Washington Post*.

Motley, B. (1983). "Real Interest Rates, Money and Government Deficits." *Economic Review*, Federal Reserve Bank of San Francisco, 3, 31-45.

Parker, Jonathan. (June 2004). Discussion of Federal Government "Debt and Interest Rates by Eric Engen and Glen Hubbard." NBER 19th Annual Macroeconomic Conference.

Rojas-Suarez, Liliana, Sotelo, Sebastian. (July 2007). "The Burden of Debt: An Exploration of Interest Rate Behavior in Latin America." Contemporary Economic Policy Volume 25, Issue 3, pages 387–414.

Rosnick, David. June 2010. "Social Security and the Age of Retirement." Center for Economic and Policy Research.

Tseng, K.C. (2000). "The Relationship between Federal Deficits and Real Interest Rates." Review of Quantitative Finance and Accounting. 14; 5-15