Dynamics between government debt and budget deficits in the United States: a threshold VAR analysis

Haydory Akbar Ahmed

Department of Economics, Kansas State University

Abstract

This paper empirically investigates the dynamics between government debt and budget deficits in the United States. We investigate if government debt grows faster with budget deficits during recession as opposed to an expansion and vice-versa. Four different budget deficits definitions are used in a threshold VAR model on quarterly data from 1948:Q1 to 2015:Q3 for the United States. The LR specification test rejects the null for a linear VAR against nonlinear VAR. Nonlinear impulse response analysis shows that the response of debt to a budget deficits shock is asymmetric and counter-cyclical, implying policy makers prefer economic stability over budget deficits and debt during recessions. However, the response of budget deficits to a shock to government debt is asymmetric and pro-cyclical implying policy makers pursue austerity measures by reducing budget deficits if faced with government debt during recessions. These results hold for all four budget deficits measures used in this paper.

JEL Classification: H60, H62, H63, H68.

Keywords: Budget deficits, Government Debt, Threshold VAR

1. Introduction

Budget deficits, resulting either from a tax cut or an increase in government spending, will sway government debt. Rising government debt may subsequently shape future budget balance through policies aimed at deficit reduction. Government authorities justify austerity and deficit reduction arguing for a case of sustainable fiscal policy, which will prevent further debt accumulation, and therefore put less pressure on monetary policy (Vuctum and
In recent times, expansionary fiscal policy was used to curb the depressing consequences of Great Recession. Fiscal expansion increased budget deficits, which subsequently increased government debt in the United States. Post-WWII period has seen several recessions in the United States, where expansionary fiscal policy were adopted. Tax cuts and/or spending increases were pursued to stabilize the economy. Political conflicts, such as the Korean War, Cold War, and post-9/11 era are marked with rising defense spending. We also observe an increasing trend in non-discretionary government spending since late 1980s. All these factors jointly contributed towards increases in budget deficits. Subsequently government debt in the United States has grown over time along with budget deficits (Thornton, 2012).

Economists have investigated sustainability of the fiscal policy with rising debt (e.g. Quintos, 1995; Davig, 2005). Bohn (1998, 2007) uses a policy reaction function interpretation to investigate government debt sustainability in the United States. He argues that, historically, governments have taken corrective measures to respond to government debts whenever the debt to GDP ratio was increasing. Sustainability of debt and budget deficits is well researched in the existing literature. A political economy approach explain the budget deficits and debt as a consequence to political competition between the incumbent and successor, where the incumbent prefer debt and budget deficits to limit government spending choices for the successor (Alesina and Tabellini, 1990; Persson and Svensson, 1990). However, is the relationship between government debt and budget deficits asymmetric in nature? Do we observe cyclicality? Cassou, Shadmani and Vazquez (2016) investigate asymmetry between government debt and primary budget deficits using a structure analogous to Bohn (1998, 2007) finding asymmetry for sustainability, as well as, cyclicality of budget deficits in the United States.

Nonetheless, it remains unanswered how budget deficits impact government debt during a recessions as opposed to an expansion, and vice-versa. We observe the budget deficits to GDP ratio rises, and output gap (deviation of real GDP from its trend) become negative during recessions (see figure 1 above). The policy reaction function only shows the response of budget deficits to government debt and not the other way around. In the short run, governments tend to adopt expansionary fiscal policies during recessions to stabilize the economy which, in turn, increase budget deficits and government debt. At the same time, we also observe governments with large debt bur-
den tend to go for austerity measures at times of economic stress, despite the fact that economic stabilization need fiscal expansion. In this paper, we investigate how budget deficits impact the dynamics of government debt during recessions, as well as during expansions, and vice-versa. Our paper augments the existing literature in a number of ways. First, we use four different measures of budget deficits, which provide a more precise picture of the budget balances. Second, we use the regime-switching threshold VAR model to derive the impulse response, which enables us to understand the dynamics between government debt and budget deficits during recessions and expansions in a more objective manner. Finally, our sample covers the whole of post-WWII period till 2015, which includes the Great Recession. Non-linear impulse responses indicate, with a shock to budget deficits, government debt tend to rise faster during recessions vis-a-vis expansions, and tend to grow in a counter-cyclical fashion with a shock to output gap. We can infer governments preference for economic stability over fiscal balance and government debt during recessions. However, with a shock to government debt, budget deficits tend to grow faster during expansions vis-a-vis recessions, and exhibit pro-cyclicality with a shock to output gap. With higher debt burdens, governments tend to prefer austerity during recessions.
The rest of the paper is organized as follows: section II discusses the relevant literature, in section III we discuss the data and methodology, and section IV presenting the results and conclusion.

2. Literature Review

Research investigations on debt and budget deficits vary in their approach. However, literature on asymmetry and cyclicality of government debt and budget deficits are sparse. The issue of debt sustainability is well researched; we can find single country time-series econometric papers as well as cross country evidence based on panel data. There are papers that use theoretical models as well to shed light on fiscal sustainability. Political economy approaches explain the use of budget deficits and debt as strategic tools among competing political players.

We can find two approaches in analyzing the sustainability of fiscal policy analyzed through government debt and budget deficits in the literature using time-series techniques. The first consists of testing the stationarity of the debt and/or budget deficits. Other studies look for a cointegrating relationship linking the primary budget deficits, the stock of outstanding debt and interest payments for the United States. Results vary with the specification of the budget constraint. Barro (1986) investigated the relationship between debt and budget deficits taking cyclical into consideration in the econometric specification. He reports strong counter cyclical behavior of budget deficits in the United States. Hamilton and Flavin (1986) reject the non-stationary of constant-dollar un-discounted government debt in the United States under the assumption of constant real interest rates. Wilcox (1989), allow for stochastic interest rates and trends, finding discounted government debt in the United States is non-stationary. Hamilton and Flavin (1986), Trehan and Walsh (1988), Quintos (1995) and Davig (2005) find evidence in support of sustainability. In contrast, Kremers (1989), and Hakkio and Rush (1991) show that in recent years fiscal policy violates the intertemporal budget constraint. In particular, Kremers (1988) showed the empirical finding of Hamilton and Flavin (1986) is reversed once their ADF regression for the budget balance, which suffers from auto-correlation, is extended to include the second lagged difference of the budget balance as an additional regressor in order to eliminate the auto-correlation problem. Ahmed and Rogers
(1995), using historical data that goes back to 1700s, find strong evidence favoring the sustainability of the fiscal policy in the United States and some support for the sustainability of the United Kingdom. Arestis, Cipollini and Fattouh (2004) find that large budget deficits in the United States are sustainable in the long run as policy makers will intervene to reduce per capita deficit when it reaches a certain threshold. Authors use threshold auto regression on data spanning from 1947 to 2002, where the regression equation stem from the intertemporal budget constraint of the government.

Bohn (2007) uses a VAR framework to investigate sustainability of the intertemporal budget constraint. Cointegration between government debt and primary budget deficits imply sustainability. He finds revenue and spending are not conintegrated, and thus are consistent with intertemporal budget constraint. Fiscal rules, such as the stability and growth pact (SGP), aim at constraining government spending. Governments revert to creative accounting to circumvent such rules and in the process hide budget deficits. More recently, Hatzinikolaou and Simos (2013) suggest a new test for sustainability of budget deficits. In particular, they define sustainability by requiring formally that both the intertemporal budget constraint is satisfied (i.e. the discounted debt converges to zero) and the undiscounted debt be bounded. According to this more restrictive definition, Hatzinikolaou and Simos (2013) found empirical evidence against sustainability of budget deficits in the United States. Cassou, Shadmani and Vzquez (2016) investigate the sustainability and cyclicality incorporating asymmetry in structure analogous to Bohn (1998). Authors use three different model specifications over a short and a long sample (this includes the Great Recession) to investigate asymmetry between primary budget deficits and debt in the United States. They find fiscal policy is asymmetric for the long sample, as the response of primary budget deficits to lagged government debt is asymmetric. But the asymmetry disappears for the short sample. They find evidence in support of fiscal sustainability for the short sample but this disappears for the long sample.

There are some panel data studies on fiscal deficits and cyclicality. Von Hagen and Wolff (2006) provide empirical evidence of creative accounting in the European Union countries. Their two-stage IV regression in a dynamic panel setup find the tendency to substitute budget deficits with creative accounting is especially strong for cyclical component of the deficit. In the times
of recession, the cost of reducing the deficits is particularly large. Balassone, Francese and Zotteri (2010) uses a panel for 14 European Union countries and finds cyclical asymmetry between budget deficits and government debt. Mahdavi (2014) uses a panel of 48 US states to investigate the state fiscal sustainability using the framework proposed by Bohn (1998). He finds positive response of primary budget surpluses (negative primary budget deficits) to government debt are the sufficient condition for sustainability.

There are theoretical papers that also address the link between debt and budget deficits and explore their impacts on growth, as well as potential changes in the tax structure of future budgets. Barro (1979, 1987), Lucas and Stokey (1983) explain the role of budget deficits and debt accumulation to explain redistribution of income over time and across generations, as well as to explain how these two minimize the debt-weight losses of taxation for the provision of public goods. These papers, perhaps, explain accumulation of government debt in peace times. Uctum and Wickens (2000) derived conditions suitable for determining sustainability of fiscal policy in the long run, in the medium term, and in the presence of debt and budget deficits ceilings for the EU and United States using data ranging from 1965-1994. Using infinite horizon models for the long run, they do not find evidence for sustainability for many countries. However, there is some evidence that the government discounted net debt is mean-reverting for few countries, implying that their fiscal policies are sustainable. The evidence in favor of sustainability is strengthened for most countries when data are extended to incorporate future fiscal consolidation plans. They argue that, in practice, governments also need a medium-term framework for fiscal policy. Authors show that, in the absence of ceilings, most countries have sustainable fiscal policies in the medium term. This is in contrast to the result of the infinite horizon analysis. Furthermore, authors find that imposing deficit or debt limits in the medium term throws most government budgets onto an inter-temporally inconsistent path. They further argue that such arbitrary ceilings confound the government debt and fiscal sustainability as they do not take account of cyclical factors. Brauninger (2005) analyze the impact of public debt on endogenous growth using an overlapping generations model setup. Author assumes that government fixes the budget deficits ratio. When the budget deficits ratio is below a critical level there are two potential steady states - capital, output, and government debt all grow at a constant rate, and, increase in deficits ratio reduces the growth rate. As and when the budget
deficits ratio exceeds the critical level, there is no steady state with capital growth declining continuously. Marcet and Scott (2008) investigate the relationship between optimal taxation and stochastic behavior of debt for the United States. Under complete markets, they find debt is same or less persistent and it declines in response to shock that causes deficits to rise. Under incomplete markets, debt is persistent and increases in response to shock that causes higher deficits. Authors argue US data is more akin to the incomplete market. These papers, although differ in approach and research questions, indicate that investigating dynamics between government debt and budget deficits in a linear framework may not be sufficient to develop an in-depth insight.

Budget deficits and debt are explained as strategic tools used by competing political governments in the political economy literature. These models are intended to explain the growth in budget deficits and debt in peace times, when economic stabilization is unwarranted. Alesina and Tabellini (1990) find a bias toward budget deficits by the incumbent in a model of political competition between political actors: incumbent and future successor. The incumbent uses debt accumulation strategically to influence the choices of its successors. Disagreement among the political parties and uncertainty about who will get elected next period prevent the incumbent from internalizing the cost of leaving debt to its successors. The resulting equilibrium stock of public debt tends to higher than socially optimum choice. Their results also show that government debt tends to get larger with public consumption expenditure. Persson and Svensson (1989) consider a model where two policy-makers have different views about the level of public expenditure. Their results show that a conservative incumbent policy-maker (one who likes less public expenditure) has a bias towards deficits to force the liberal successor to spend less. Conversely, the liberal incumbent may choose to leave a surplus to its conservative successor.

The extent of increase in government spending or the tax cuts intended to invigorate aggregate demand during recessions in recent years in the United States render the above argument less attractive. In Europe, on the other hand, we observe the case of austerity measures domination the policy space. The Great Recession era present us with a divergent picture on how budget deficits and government debt interact in designing stabilization policy. The aforementioned literature does not fully explain the governments rationale for
macroeconomic policies in contemporary times. The literature thus far, do not explore the dynamics between debt and budget deficit during recessions juxtaposed against expansions. The definition of budget deficits also focuses largely on primary budget deficits. In this paper, we will explore the dynamics between government debt and budget deficits using non-linear time-series econometric specification that allows us to incorporate fluctuations of the business cycle. We use four different definitions for budget deficits in the United States. Thus we expand the discussion on dynamics between government debt and budget deficits filling a gap hitherto unaddressed.

3. Data and Methodology

In this paper, we use quarterly data from 1948: Q1 to 2015:Q3 collected from the NIPA tables and Federal Reserve Bank of Dallas for the United States. We collect Real GDP, deflator, and government spending and receipt data from the NIPA tables available in the United States Bureau of Economic Analysis website. Government debt data are collected from Federal Reserve Bank of Dallas website.

We use the following definitions to measure budget deficits \(^1\) in the United States. Primary deficits and primary current deficits show how much government receipts fall short of the spending outlays each period. On the other hand, gross deficits and current deficits show how much government need to borrow each period. Figure 1 below shows all the budget deficits, in real terms \(^2\), over the period of analysis use in this paper. Budget deficits depict relatively less variability until early 1970s. The mid-1970s visibly depict a decline in deficits and similar pattern emerges during the presidency of Bill Clinton. The 1980s depict large rise in budget deficits and also during the Great Recession. In recent times, we observe a continuous decline in the budget deficits.

- Gross Deficit = (Government Purchase + Transfer and Subsidies + Net Interest Payment) - Government Receipts

\(^1\)We use the budget deficits definition as in Macroeconomics, 9th Edition, authored by Andrew B. Abel, Ben S. Bernanke and Dean Croushore published by Pearson

\(^2\)We use GDP deflator to convert the nominal values into real terms
• Primary Deficit = Gross Deficit - Net Interest Payment.

• Current Deficit = (Gross Deficit + Government Investment Expenditure) - Government Receipts.

• Primary Current Deficit = Current Deficit - Net Interest Payment.

All the variables are in real terms in the subsequent analysis. We use the following variables: debt to GDP ratio, budget deficits to GDP ratio and output gap. Following Cassou, Shadmani and Vzquez (2016) output gap is defined as the deviation of the observed annual output growth rate from its long-term average. For the output gap, we computed the difference between the observed annual growth rate and the average growth rate over the sample period of 1947 to 2015. In particular, we computed the growth rate in percentage terms by multiplying 100 times the log difference between the current value of real GDP and the value four quarters earlier. In the next step these growth rates were averaged and then the average was subtracted from the annual growth rate series. The resulting series has positive values when the current growth rate exceeds the average and negative values when

Figure 2: Budget Deficits in the United States, 1947-2015
the growth rate is below the average.

In this paper, the endogenous threshold VAR is estimated following the method proposed by Tsay (1998), and Lo and Zivot (2001). They generalize the univariate and single equation estimation by Tong (1983), Chan (1993) and Hansen (1997) for a multivariate VAR. We will use an endogenous threshold VAR (TVAR) model and to compute the non-linear impulse responses to explore the dynamics between government debt and budget deficits. Why are we using endogenous threshold VAR? Afonso, Baxa and Slavik (2011) note that the endogenous TVAR model has a number of interesting features. First, it is a relatively simple way to capture possible nonlinearities such as asymmetric reactions to shocks or the existence of multiple equilibria. Since the effects of the shocks are allowed to depend on the size and the sign of the shock, and also on the initial conditions, the impulse response functions are no longer linear. It is possible to distinguish, for instance, between the effects of fiscal developments under different economic states. Second, the variable by which different regimes are defined itself is an endogenous variable included in the VAR. Therefore, it is possible that regime switches may occur after the shock to each variable. In particular, fiscal expansion through budget deficits shock might either boost the output or increase the debt that harm the prospects of economic growth, and the overall effect to the economy of a fiscal expansion though increased budget deficits might became negative. The endogenous threshold VAR can be specified in the following manner:

\[
Y_t = (B^1(L)Y_{t-p}I[S_{t-d} < \theta] + (B^2(L)Y_{t-p}(1 - I[S_{t-d} < \theta])) + \varepsilon_t
\]

where \(Y_t\) is a vector of endogenous variables that includes debt to GDP ratio, budget deficit to GDP ratio and output gap, and ‘\(p\)’ denotes the lag length. We estimate four different threshold VAR for each budget deficits defined earlier, where each deficits definition is used for four different deficit to GDP ratio. \(I(.)\) is an indicator function that takes the value of ‘1’ when output gap \(s_{t-d}\) is less than threshold \(\theta\), and ‘0’ otherwise. The time lag for the output gap is set to 1, \(d = 1\). The lag length of the endogenous variables, ‘\(p\)’, is determined by the usual information criteria (Schwarz SIC).

To address the issue of specification, we carry out a likelihood ratio test with the null of linear VAR model against non-linear alternative. Since we are estimating a threshold VAR model and the threshold value is not known
a priori, the testing procedure involves non-standard inference. $\theta$ is not identified under the null hypothesis of no threshold. Therefore, first, the TVAR model is estimated for all possible values of $\theta$ (to avoid over-fitting, the possible values were set so that at least 15 per cent of the observations fall under each regime). This test is the multivariate extension proposed by Lo and Zivot (2001) of the linearity test of Hansen (1999). Instead of an F-test comparing the SSR for the univariate case, a Likelihood Ratio (LR) test comparing the covariance matrix of each model is computed.

$$LR_{ij} = T[\ln(det \Sigma_i) - \ln(det \Sigma_j)]$$

where $\Sigma_k; (k = i, j)$ is the estimated covariance matrix of the model with $k$ regimes (e.g. $k=1$, 1 threshold regime). We test a linear model against 1 threshold alternative. Since we are interested in the impulse responses, we need to discuss the ordering of the variables i.e. Cholesky ordering. We use a recursive identification scheme using the intertemporal budget constraint (IBC) as in Bohn (2007).

$$IBC : B_t = \sum_{k=0}^{\infty} \rho^k E_t(T_{t+i} - G_{t+i})$$

where $E_t(T_{t+i} - G_{t+i})$ is expected future deficit and $\rho$ is the discount factor. Using the IBC, we order debt to GDP ratio first followed by budget deficits to GDP ratio and finally output gap. We argue that a contemporaneous increase in budget deficits or change in output gap do not affect government debt contemporaneously.

In a linear model, the impulse responses can be derived directly from the estimated coefficients and the estimated responses are symmetric both in terms of the sign and of the size of the structural shocks. Furthermore, these impulse responses are constant over time as the covariance structure does not change. These convenient properties do not hold within the class of nonlinear models as shown by Potter (1994) and Koop, Pesaran and Potter (1996). As per Enders (2010), interpretation of the impulse responses are history dependent. The impact of a shock on the time path of the system depends on the magnitude of the current and subsequent shocks. The sign as well as size of the shocks are important, e.g. impact of a negative shock on the time-path of the system in a contractionary regime will be different than
an expansionary regime. The moving average representation of the TVAR is nonlinear in the structural disturbances, because some shocks may lead to switches between regimes, thus their Wold decomposition does not exist (Afonso, Baxa and Slavik, 2011). Consequently, in contrast to linear models, we cannot construct the impulse responses as the paths the variables follow after an initial shock, assuming that no other shock hits the system. To cope with these issues, Koop, Pesaran and Potter (1996) proposed nonlinear impulse response functions defined as the difference between the forecasted paths of variables with and without a shock to a variable of interest. Formally, the nonlinear impulse responses functions (NIRF) are defined as:

$$NIRF_Y(k, \varepsilon_t, \Omega_{t-1}) = E(Y_{t+k}|\varepsilon_t, \Omega_{t-1}) - E(Y_{t+k}|\Omega_{t-1})$$ (4)

where $Y_{t+k}$ is a vector of forecasts at horizon $k$, $\Omega_{t-1}$ is the available information set and $\varepsilon_t$ is the shock at time $t$. The following discussion draws on from Afonso, Baxa and Slavik (2011). This formulation implies that the impulse response functions depend on the initial conditions and that there is no restriction regarding the symmetry of the shocks. Therefore, in order to get the complete information about the dynamics of the model, the impulse responses have to be simulated for various sizes and for the signs of the shocks. The algorithm proceeds as follows. First, the shocks for the periods from 0 to $q$ are drawn from the residuals of the estimated VAR model. Then, for each initial value, this sequence of shocks is fed through the model to produce forecasts conditional on initial conditions. These steps are repeated for the same initial condition and the same set of residuals except for the shock to the variable of interest, which is set to (+/-) 1 standard error and (+/-) 2 standard errors at time 0. Second, we can calculate the forecasts conditional on the shocks and on the initial conditions with and without an additional shock at $t = 0$, and the difference between these two is the impulse response function. This procedure is replicated 500-times for each initial condition, and then we compute averages over the initial conditions from each regime to get the average impulse responses for both regimes.

4. Results and Analysis

In this section we present the results and analysis. We begin our analysis comparing the model specification, Table 2 below present the likelihood ratio
based specification tests described earlier. We estimate four threshold VAR models, each model is with a separate budget deficits definition. In all cases we reject the null of linear VAR, thus estimating a threshold model is justified.

Table 1: Specification Test

<table>
<thead>
<tr>
<th>Model</th>
<th>Threshold</th>
<th>Null: Linear VAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1: Gross Budget Deficits</td>
<td>-2.80</td>
<td>102.20***</td>
</tr>
<tr>
<td>Model 2: Primary Budget Deficits</td>
<td>-2.49</td>
<td>94.09***</td>
</tr>
<tr>
<td>Model 3: Current Budget Deficits</td>
<td>-2.42</td>
<td>98.26***</td>
</tr>
<tr>
<td>Model 4: Primary Current Budget Deficits</td>
<td>-2.42</td>
<td>92.48***</td>
</tr>
</tbody>
</table>

Note: 1. p-value in the parenthesis,
2. Alternative hypothesis in one threshold model

We proceed to the nonlinear impulse response analyses below. We present the nonlinear impulse responses for positive 1 standard deviation shock. Figures 3 and 4 below present the good state (expansion) and bad state (recession) comparisons for debt to GDP ratio. For all the budget deficits definitions, we observe a 1 standard deviation shock to budget deficits to GDP ratio causes debt to GDP ratio rise over the forecast horizon. Shock to budget deficits to GDP ratio does not have an immediate impact, as debt to GDP ratio rises after one quarter. This is consistent with our inter-temporal budget constraint, as well as the fiscal policy process. As we know the expansionary budget proposal (once approved by the Senate) does not impact the government debt immediately. We observe debt to GDP ratio grows faster during bad state (recessions) as oppose to good state (expansions). Debt to GDP ratio escalates above 1 after 5 quarters during recessions over the fore-

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3We estimate the non-linear IRF for +1, -1, +2, and -1 standard deviation shocks. We present the results for +1 standard deviation shock only. Results for other shocks are available upon request.
cast horizon, whereas during good times it is around 0.5 after 5 quarters. The impulse responses show that we have asymmetric response of debt to GDP to a shock to budget deficits to GDP ratio. This implies governments prioritize economic stabilization over budgetary balances during recessions. These findings are consistent with the history of United States as there were several examples of tax cuts, and/or, increases in governments discretionary spending by the government to stimulate the economy during recessions. Budget deficits, resulting from the fiscal stimulus, increased government debt in the United States. Cassou et al (2015) also find asymmetry, and the impulses responses conform to theoretical predictions in Marcet and Scott (2008).

Figure 3: Response for Debt to GDP with shock to Deficits to GDP

Figures 5 and 6 below present the good state (expansions) and bad state (recessions) comparisons for the impulse response of budget deficits to GDP ratio to a shock to debt to GDP ratio. For all the budget deficits definitions, we observe a positive 1 standard deviation shock to debt to GDP ratio causes budget deficits to GDP rise for some time before they decline over the fore-

\footnote{There are some instances when both tax cut and spending increase are used to stimulate the economy}
cast horizon. We also note that shock to debt to GDP ratio increases budget deficits on impact as the budget deficits to GDP ratio increases on impact. Larger debt implies the government has to pay interest and repay the debt, which creates added pressure on fiscal balances. We can find budget deficits to grow faster during good state (expansions) as oppose to bad state (recessions). Budget deficits to GDP ratio escalates to around 0.8 and above after 5 quarters in a good state, whereas during bad times it is below or around 0.4 after 5 quarters over the forecast horizon. The impulse responses show that we have asymmetry, and budget deficits tend to grow relatively slower during recessions when the government is facing an increase in the debt. These findings imply that policy makers adopt austerity measures to reduce the budget deficits during recessions, when faced with larger debt burden. The extent of the austerity measures are more during recessions as oppose to expansion. It is imperative that governments with larger debt burden tend to prefer deficit reduction in bad state as oppose to in good state. These

\footnote{We observe such behavior for countries such as Greece and Portugal. Large debt actually made these economies to circumcise their spending in order to reduce budget deficits}
results also conform to predictions in Uctum and Wickens (2000). We observe the deficit to GDP ratio gradually fall over the forecast horizon, where the debt to GDP ratio tends to increase over the forecast horizon. Despite an initial surge, the ensuing decline in budget deficits over the forecast horizon indicate governments prefer to reduce deficits over time conforming to findings in Arestis et al (2004).

Figure 5: Response for Deficits to GDP with shock to Debt to GDP

Figures 7 to 9 below present the non-linear impulse responses of debt to GDP and budget deficits to GDP ratios with respect to a shock to the output gap. For intuitive purposes, let us assume these positive 1 standard deviation shock to output gap are positive technology shocks that boost the economy’s productivity and output. Since we have four different definitions for budget deficits, we present the impulse responses for each of these model estimates. Figures 7 and 8 present the impulse responses for debt to GDP ratio with a positive 1 standard deviation shock to output gap. The impulse responses for each state show that debt to GDP ratio reacts after one lag. In a good state, debt to GDP ratio falls continuously. However, in a bad state, a positive output gap initially increases debt to GDP for a quarter, which falls subsequently. This shows that debt to GDP postulates some counter-
cyclicality in bad state conforming to findings of Cassou et al (2015), who also report similar counter-cyclicality. This, once again, implies that in a bad state governments prefer economic stabilization over budgetary balances and government debt. We observe a steady decline in debt to GDP ratio over the forecast horizon in good state. The decline in debt to GDP ratio could potentially emerge from the fact that increase in output raises governments tax revenues through the tax codes, thus reducing budget deficits and, at the same time, subsequent debt re-payment.

Figures 9 and 10 present the non-linear impulse responses of budget deficits to GDP ratio with respect to a positive 1 standard deviation shock to output gap. The impulse response below indicate a shock to output gap reduces budget deficits with a lag. A positive shock to output may reduce budget deficits through increases in tax revenues as well as reduction in some of the components of discretionary government spending. However, the budget deficits to GDP ratio do not show a steady reduction over the forecast horizon. We observe asymmetric response of budget deficits to GDP ratio over the forecast horizon with pro-cyclicality.
Figure 7: Response for Debt to GDP with shock to Output Gap

Figure 8: Response for Debt to GDP with shock to Output Gap
Figure 9: Response for Deficits to GDP with shock to Output Gap

Figure 10: Response for Deficits to GDP with shock to Output Gap
4.1. Evaluation using Cyclically Adjusted Data

Thus far, our analysis about the dynamics between budget deficits and debt is conducted using data from the NIPA sources. One potential criticism may arise due to cyclical adjustments, as we know that there are automatic stabilizers designed within the fiscal system, especially the tax codes and some of the spending programs (especially transfers) to counter business cycle fluctuations. These influence the government revenues as well as the expenditures during expansions and contractions of the business cycle. Thus the budget deficits measure may reflect these cyclicality. Golinelli and Moigliano (2008) use the cyclically adjusted data. Cassou et al (2015) note that using cyclically adjusted data may be advantageous because they reflect the true reaction function of the policy makers. The cyclically adjusted data eliminate the built-in fiscal measures, thus showing actual contemporaneous budgetary decisions. However, there are economists who argue that automatic stabilizers are also policy decisions, hence using the observed data is sufficient. Regardless of the debate, it is useful to investigate whether the results described above are robust using the cyclically adjusted budget data. For our analysis, we use cyclically adjusted data computed by the Congressional Budget Office of the United States (CBO). One problem with this data is period of availability is 1963:Q3 to 2013:Q3, whereas our analysis uses data from 1947:Q1 to 2015:Q3. Although there are several CBO sources of data, we chose to use the data from a single source that was put out in 2014 in a document called The Budget and Economic Outlook: 2014 to 2024. A second problem that we face is the other definitions of deficits. We are only able to compute the primary budget deficits and not the other definitions. Thus we confine our analysis to primary budget deficit to GDP ratio.  

The table below presents the specification test, which rejects the null of linear VAR model. Estimated non-linear impulse responses are presented below. We present the impulse response for debt to GDP ratio to positive 1 standard deviation shock to budget deficits to GDP ratio. We again find the asymmetry presented earlier and we observe the government debt to GDP ratio grows faster during recessions as oppose to expansions. With respect to a shock to output gap, we can observe the counter-cyclical behavior as well for

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6There are studies that use potential GDP as denominator for deficits to GDP ratio. We in this paper use the observed real GDP to measure the ratio
Table 2: Specification Test

<table>
<thead>
<tr>
<th>Model</th>
<th>Threshold</th>
<th>Null: Linear VAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclically Adjusted</td>
<td>-2.80</td>
<td>102.20***</td>
</tr>
<tr>
<td>Primary Budget Deficits</td>
<td></td>
<td>(0.00)</td>
</tr>
</tbody>
</table>

Note: 1. p-value in the parenthesis,
2. Alternative hypothesis in one threshold VAR

debt to GDP ratio as well for budget deficits to GDP ratio. These asymmetry and counter cyclicality conforms our earlier finding that government prefer economic stabilization over fiscal balances and debts during recessions. With budget deficits to GDP ratio, we can again find conformity to our earlier conclusions. Budget deficits to GDP ratio rises faster during expansions as oppose to recessions with a shock to debt to GDP ratio. We observe some counter cyclicality with budget deficits but they portray similar behavior over the forecast horizon. These again conform to our earlier finding that governments tend to prefer austerity during recessions while faced with larger debt burden.

Figure 11: Response for Debt to GDP with shock to Primary Deficits to GDP
5. Conclusion

In this paper, we investigate the dynamics between government debt and budget deficits in the United States during recessions as well as expansions using quarterly data for the post-World War II period. The econometric specification in endogenous threshold VAR, and the estimated non-linear impulse responses allows us to explore the dynamics between the two in a more objective manner.

Nonlinear impulse response analysis shows that the response of government debt to GDP ratio to a shock to budget deficits to GDP ratio are asymmetric and counter-cyclical. Debt to GDP ratio increases more during a recession, as oppose to during an expansion. These results imply policy makers prefer economic stability over budget deficits or government debt during recessions. On the other hand, response of budget deficits to GAP ratio to a shock to government debt to GDP ratio is asymmetric and procyclical. We observe the budget deficits to GDP ratio to rise more during an expansion, as oppose to a recession. Thus policy makers pursue austerity measures by reducing deficits if faced with larger government debt during a recession. We checked the robustness of our findings using a time-series of
primary budget deficits cyclically adjusted for variations arising from automatic stabilizers, which conforms to our findings.

The findings above provide an important empirical insight on governments preference for economic stabilization policy in the United States in the post- World War II period. The results also provide validation for austerity measures adopted in the EU countries after the Great Recession.
References


6. Appendix A: Algorithm to compute nonlinear impulse responses:

1. The shocks for the periods from 0 to q are drawn from the residuals of the estimated VAR model.
2. For each initial value this sequence of shocks is fed through the model to produce forecasts conditional on initial conditions.
3. Repeat step 2) with the initial shock into one variable equal to +/- 1 or 2 SD to get forecasts if there was an initial shock.
4. The difference between the forecasts from step 2 and 3 is the impulse response function. Repeat this 500-times and derive an average impulse response for this particular initial condition.
5. Repeat steps 2-4 for each initial conditions. Final impulse responses are average impulse responses over initial conditions of each regime.
7. Appendix B: Threshold VAR: Threshold Estimation

B.1. Gross Deficit to GDP Ratio

B.2. Primary Deficit to GDP Ratio:

Figure 13: Threshold Computation Graph