Balancing the Federal Budget Over the Business Cycle

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Abstract
Balancing the Federal government’s budget has long been a controversial issue with a Balanced Budget Amendment nearly passing Congress in 1997. It has been argued that it would be better to attempt to balance the budget over the course of the business cycle instead of attempting to balance the budget on an annual basis because balancing the budget annually leads to procyclical policies. The inherent uncertainty concerning the duration and severity of the phases of the business cycle makes this approach difficult to accomplish in practice. In this paper we utilize a Markov switching regression to model, in a probabilistic sense, the expansion-contraction behavior of Federal tax revenue growth. This allows us to construct a probability distribution of the revenue shortfall the government is likely to confront during recessions. It also allows us to construct savings rate rules based on the uncertainty in both expansions and contractions in order to save enough during expansions (run large enough surpluses) to finance deficits during recessions.

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1. Introduction

The historical experience of the US Federal government deficits is well documented. In 1979, the on-budget deficit (excludes Social Security) of the federal government was $38.7 billion (equal to 1.5% of US GDP). By 1992, the deficit had grown to $340.5 billion (5.5% of GDP) and the deficits where projected to continue getting larger for the foreseeable future (see Table 1). In an attempt to curb increasing future deficits, a balanced budget amendment introduced in the Senate in 1997 and failed the two-thirds passage by one vote.

There are three basic approaches to balancing the Federal government’s budget. First, the Functional Finance approach supports the idea that government spending and tax policies should be set to promote “optimal” macroeconomic performance (such as inflation and unemployment measures). Second, the annual budget balance approach suggests that the government should balance it budget annually because in the absence of some sort of strict rule, such as a Balanced Budget Constitutional Amendment, the government has an incentive to expand spending policies and reduce taxes to appease their constituents. **FISCAL ILLUSION** This obviously leads to the potential for ever widening deficits and growing debt, and if crowding out is a problem then growing deficits have negative long-term consequences. The annual budget balance approach is opposed by many economists. In 1997, over 1100 economists (including 11 Nobel Prize winners) signed a statement opposing the idea of a Balanced Budget Amendment in large part because this approach encourages (even demands) pro-cyclical policies because during an economic downturn when production and income fall tax revenue falls. To compensate for this fall in tax revenue, the government is forced to either cut their spending or raise taxes – both of which could prolong or worsen the current economic downturn. A final approach to the
government’s budget is an alternative to annual budget balance, and the approach is to balance the budget over the business cycle. The traditional Keynesian thought is that during an economic expansion the government should raise taxes and cut their spending (leading to surpluses) and accumulated savings. Then during an economic contraction the government should reverse these policies and expand spending, lower taxes, and run deficits during economic downturns in an effort to shorten the duration of the downturns. The main problem with this approach is that the business cycle is neither symmetric nor predictable making the ability of the government to practice this approach questionable at best. In this paper, we present a solution to this problem.

In this paper we make use of a two-regime Markov switching regression, popularized by Hamilton (1989) to model the cyclical behavior of federal tax-revenue growth. Following the approach of Wagner and Elder (2006), this model allows us to describe, in a probabilistic sense, the expansion-contraction behavior of revenue. Specifically, using the estimates obtained from the switching regression, we calculate the probability that a particular expansion-contraction combination occurs (for example, we calculate the probability that a four-year expansion is followed by a two-year contraction). Then, assuming government spending increases at a constant rate and assuming a range of values for the tax revenue elasticity of GDP, for each expansion-contraction combination we calculate the rate of savings (and hence surplus) necessary in each expansion period to finance the accumulated revenue shortfall (and hence deficits) over the contraction duration. Combining the savings rates with the associated probabilities forms a probability distribution which is used to calculate two types of savings rate “rules”. First, the expected savings rate is the rate that on average would allow the government to save enough during the expansion periods to finance deficits during contraction periods. Furthermore, we calculate and report the “75% savings rate rule” which is the savings rate that
would allow the government to accumulate sufficient savings during expansions to cover their shortfalls during contractions in 75% of the possible expansion-contraction combinations. We find that if the tax revenue elasticity with respect to per capita GDP is 1.5 then the expected savings rate rule suggests a savings rate of 2.29% and the 75% savings rate rule suggests a savings rate of 3.30% during expansions to weather the contraction periods.

In the following sections of the paper we outline our empirical methodology and findings and offer concluding remarks.

2. Methodology and Results

It is well known that both spending and revenue are influenced by the business cycle with revenue being procyclical and spending being countercyclical making the budget position procyclical (for a given set of policies, the government’s surplus will be larger or their deficit will be smaller during an expansion). Therefore, in order to calculate how much the government should save during economic expansions to finance their deficits during contractions, the cyclical characteristics of both revenue and spending should be determined or more succinctly, the government’s cyclical surplus/deficit would capture the response of both revenues and expenditures to cyclical variations.

From a practical perspective, it may be possible to construct a cyclical deficit/surplus series for the Federal government’s budget which is equal to the difference between the cyclical components of revenue and spending, holding constant tax rates and non-welfare spending. A regime-switching regression could then be applied to the deficit series in order to construct a probabilistic model of the savings required during the cyclical surplus during expansions to offset the deficits during contractions.
A potential problem arises with using the cyclical deficit because studies such as Knight et al. (2003), Baker et al. (2002), and Kusko and Rubin (1993) find that state budgets tend to be structurally imbalanced. Based on CBO estimates, the structural deficit for 2005 was over $200 billion (2006). I'm not sure how to cite this – my feeble attempt is in the References section. If a structural deficit is present, then how meaningful and intuitive is it to model the business cycle behavior of the cyclical deficit? For example, suppose, using the cyclical deficit, it is estimated that the government would require savings equal to 10 percent of revenue (to be accumulated during an expansionary phase when the cyclical surplus is positive) in order to weather 75 percent of the possible cyclical deficits that may arise during downturns. This level of savings would be sufficient to close the gap between cyclical revenue and cyclical spending in three out of every four recessions, but it would be insufficient to close the gap between actual revenue and actual spending in three out of four recessions due to the structural gap. In addition, if a structural gap is present, then the government's actual budget position could be in a deficit at a time when the cyclical position is one of surplus.

Given the structural deficit issue, we focus on modeling the cyclical behavior of revenue growth and compute savings-rate rules assuming constant growth in the government’s spending. The obvious disadvantage of focusing on only revenue is that our estimates do not account for the cyclical behavior of spending.  

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1 Knight et al. (2003) and Kusko and Rubin (1993) reach their conclusion using a high-employment budget surplus/deficit measure for the aggregate state and local sector. Baker et al. (2002) examine the present value of projected expenditures, revenues, and net debt of individual states in FY1999 and find that well over half of the states have structural deficits. The high-employment budget approach uses data from the National Income and Product Accounts and Kusko and Rubin (1993) discuss the difficulties in applying this approach to individual states due to data limitations.

2 In examining the high-employment deficit for the state and local sector, Kusko and Rubin (1993) note that "the bulk of the cyclical influence on state and local budgets is on the receipts side of the ledger" (p. 413). Moreover, Sorensen and Yoshia (2001), who examine how state total revenues and expenditures react to current and lagged output changes, also find that revenues respond more strongly than expenditures to shocks. This suggests that, while
FEDERAL SPENDING IS INFLUENCED BY THE BUSINESS CYCLE COMPARED TO FEDERAL REVENUE. Since government spending, to the extent that it is sensitive to the phases of the business cycle, increases during contractions and decreases during expansions, our results may be viewed as the minimum savings rates that Federal government should undertake to balance the budget over the business cycle.

The motivation behind regime-switching models is that many time series appear to be generated from multiple, distinct data generating processes. The switching regression approach was popularized by Hamilton (1989) applying a two-regime autoregression to the quarterly growth rate in real U.S. Gross National Product in which the regimes exogenously switched according to an unobserved Markov process. Since tax revenue clearly depends on GDP, it seems logical to estimate a switching regression for tax revenue. An important issue concerning the estimation of a switching regression for tax revenue is that there have been significant tax changes over the past few decades (for example, 1981, 1993, 2001). Therefore, if a switching regression is estimated using the actual federal tax revenue series, the business cycle effects on tax revenue as well as the effect of the discretionary changes of the tax rates would be captured. We would like to capture only the cyclical characteristics of revenue so it is necessary to remove the effects of policy changes. Wagner and Elder (2006) attempt to do this by estimating an error-correction model with the growth of revenue and personal income and using the predicted values as a “policy-reduced” series.

Social assistance spending is countercyclical, most fiscal stress may in fact manifest itself through the revenue side of the budget. In addition, the Personal Responsibility and Work Opportunity Reconciliation Act of 1996 altered the social assistance funding mechanism between states and the federal government. States now receive an annual block grant, as opposed to matching grants, and are able to retain surplus funds for use in future years, which may improve their ability to absorb increased caseloads during downturns. For an overview of the sensitivity of state social assistance spending to the business cycle see McGuire and Merriman (2005).
The basic problem with their approach is that the “policy reduced” series does not necessarily reflect the current structure of tax revenue. We use a different approach to estimate the cyclical characteristics of revenue. For any given tax structure the Federal government has used over the past fifty years, government revenue depends on economic activity, but to what degree revenue is sensitive to economic activity depends on the specifics of the tax system (what the actual tax rates/brackets are and how progressive is the tax structure), \textit{i.e.}, the elasticity of tax revenue with respect to GDP should theoretically differ according to the specific tax structure. With a progressive tax structure, this elasticity should be greater than one, but how much larger depends on how progressive the structure is. Estimating the magnitude of this number is not the main focus of this essay, but in order to estimate the cyclical characteristics of revenue we do the following. We estimate the cyclical characteristics of a “policy-reduced” revenue series by estimating a switching regression for real per capita GDP and then multiplying the estimates of the growth rates by a range of elasticities (from 1.2 to 1.7). 3

Our empirical specification follows Owyang \textit{et al.} (2005) and Wagner and Elder (2006) who use the Bayesian Gibbs-sampling approach for Markov switching models developed by Kim and Nelson (1998). \textsuperscript{4,5} \textbf{TAKE A LOOK AT FOOTNOTE 5 ABOUT THE AR TERMS - ALSO, DO WE WANT TO INCLUDE A FOOTNOTE CONCERNING THE PRIOR DISTRIBUTIONS.} The basics of the switching regression are well known so a detailed

\textsuperscript{3} Similar results are obtained if we construct a “policy-reduced” revenue series by multiplying the growth in real per capita GDP by the tax revenue elasticity of GDP and then estimating the switching regression for the created “policy-reduced” revenue series.

\textsuperscript{4} We acknowledge use of the computer routines described in Kim and Nelson (1999). Our models are estimated via the Bayesian Gibbs sampling approach because, as Hamilton (1991) notes, a global maximum does not exist for the classical Markov regime-switching likelihood function, which causes parameter estimates to be very sensitive to the starting values. See Goodwin (1993) for a more detailed discussion of this issue.

\textsuperscript{5} Albert and Chib (1993) developed the Bayesian approach to Markov regime-switching models and re-estimated Hamilton’s (1989) AR(4) model of GNP growth, finding no evidence of significant autoregressive dynamics. We explored the use of autoregressive terms but did not find evidence to support their inclusion. A standard AR(q) model of each state's revenue growth indicated that fourteen states had one significant lagged AR term and thirty-six states had no significant AR terms. This suggests that the Markov regime-switching sufficiently captures the autoregressive dynamics in quarterly revenue growth.
discussion is omitted. We estimate a two-regime (high and low) switching regression for per capita real GDP. For notational purposes, let \( \hat{g}_H^{GDP} \) and \( \hat{g}_L^{GDP} \) denote the estimated growth rates for the high-growth and low-growth regimes respectively for per capita GDP; the estimated growth rates of tax revenue, \( g_H \) and \( g_L \), are found by \( g_i = \hat{g}_i^{GDP}, i = H, L \). The transition probabilities (which are the same for per capita GDP and tax revenue) are characterized by a two-state Markov chain with \( P_{HH} \) denoting the probability the current state will be high conditional on the previous period being in the high state and \( P_{LL} \) denoting the probability the current state will be low given conditional on the previous period being in the low state.

The empirical model is applied to the growth rate in quarterly real per capita GDP over the period from 1959 to 2005. The estimate for the high growth regime, \( \hat{g}_H^{GDP} \), is 1.16% and the estimate for the low-growth regime, \( \hat{g}_L^{GDP} \), is -0.37%. The estimated transition probabilities are \( P_{HH} = 0.93 \) and \( P_{LL} = 0.76 \). These results are similar to those obtained by Hamilton (1989) (using quarterly GNP) of 1.16%, -0.36%, 0.90, and 0.76 respectively. With these estimates, the expected duration of an expansion is 14.3 quarters and the expected duration of a contraction is 4.2 quarters.

3. Savings Rules

In this section of the paper we follow Wagner and Elder (2006) and illustrate how savings rate rules may be constructed. These “rules” are based on the uncertainty in expansion and contraction lengths and show the fraction of revenue that the government would need to save during each expansion period to hedge a given percentage of all the possible expansion-contraction combinations that may occur in a given revenue cycle.
To construct the savings rate rules, we calculate the accumulated savings from an
expansion lasting $t_H$ periods, compare the accumulated savings to the shortfall that would prevail
from a recession lasting $t_L$ periods, and solve for the savings rate associated with that specific
high-growth, low-growth combination. This process is repeated for all possible expansion-
contraction combinations, and a cumulative density function for savings rates is constructed. We
derive the savings rate rules under the assumption that spending grows at rate $g_H$ during
expansions and contractions.

If the government saves a fraction of revenue ($s$) during each period of a high-growth
regime, then after $t_H$ periods of high-growth the government's accumulated savings,
compounding at a rate $r$, may be written as:

$$ R_0s \sum_{j=1}^{t_H} (1+r)^{t_H-j+1}(1+g_H)^j . $$

If the contraction lasts for $t_L$ periods, the accumulated deficit is:

$$ R_0(1+g_H)^{t_H} \left[ (1-s) \sum_{i=1}^{t_L} (1+g_H)^i \right] - \sum_{i=1}^{t_L} (1+g_L)^i . $$

Equating the accumulated savings and trend-revenue shortfall given by (1) and (2) and
solving for $s$ yields:

$$ s_z(t_H, t_L) = \frac{(1+g_H)^{t_H} \left[ \sum_{j=1}^{t_H} (1+g_H)^j - (1+g_L)^j \right]} {\sum_{j=1}^{t_H} (1+r)^{t_H-j+1}(1+g_H)^j + (1+g_H)^{t_H} \sum_{i=1}^{t_L} (1+g_H)^i} . $$

The savings rate in (3) applies to a specific $(t_H, t_L)$ combination. Since the probability
that a given regime will last exactly $t_j$ periods is $P_j(t_j) = P_{jj}^{t_j-1} - P_{jj}^{t_j}$ for $j = H, L$, the probability
that a high-growth regime lasting exactly $t_H$ periods will be followed by a low-growth regime
lasting exactly $t_L$ periods is $P_H(t_H) \times P_L(t_L)$, assuming the high- and low-growth regime durations are independent.

This process is continued for each $t_H, t_L$ combination, and a probability distribution of savings rates from the possible $(t_H, t_L)$ combinations is constructed.\(^6\)^7

If a tax structure has a tax revenue elasticity of GDP of 1.2 then the expected savings rate rule is 1.83% and the 75% savings rate rule is 2.38% per expansion year. The more sensitive tax revenue is to GDP the larger the surpluses the government has to run during expansions to accumulate sufficient savings to cover deficits in future contractions. For example, if the elasticity is 1.5 then the expected savings rate is 2.33% (the 75% savings rate rule is 3.00%) and if the elasticity is 1.7 then the expected savings rate is 2.67% (the 75% savings rate rule is 3.42%). Over the range of elasticities of 1.0 to 2.5 the expected savings rate and the 75% savings rate both increase in an approximately linear fashion at the rates of 17 and 22 basis points respectively per 0.1 increase in the elasticity.

4. Conclusion

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\(^6\) The shortfalls were computed using the point estimate that is the mean of the posterior distribution. An alternative approach would be to use draws from the entire simulated posterior distributions in place of the posterior mean, which has the added benefit that it becomes trivial to form confidence intervals around the shortfall and savings rate figures. There is not a significant qualitative difference between the point estimates from using the posterior mean or entire distribution and the confidence interval was omitted to conserve space.

\(^7\) In the actual calculation of the shortfalls we use a maximum recession and maximum expansion length of 50 years each. Also, equation (3) assumes that time is an integer value. To increase precision, an equivalent functional form for incremental values of time involves replacing all of the summation terms that appear in those equations. This equivalent functional form is $\sum_{i=1}^{M} \left( 1 + g_i \right)^{-i} = \left( 1 + g_k \right) \left[ \frac{1 - (1 + g_k)^{M-i}}{g_k} + (1 + g_k)^{M-1} \right]$, where $M$ denotes the appropriate measure of time (either $t_H$ or $t_L$) and $g_k$ denotes the appropriate mean growth rate (either $g_H$ or $g_L$). In constructing the cumulative density functions we vary $t_k$ and $t_{\mu}$ from 1/3 to 20 years in increments of 1/3, which produces 57,600 different shortfall values. The actual density functions for state savings rate rules were further simplified by setting the real interest rate ($r$) equal to zero in equation (3).
In this paper we estimate a Markov regime-switching regression of federal tax revenue to model the cyclical behavior of revenue expansions and contractions. This allows us to construct savings rate rules that are based on the uncertainty inherent in both expansions and contractions. The savings rate rules show the fraction of revenue that policymakers would need to save during each expansion period to hedge the possible expansion-contraction combinations that may occur with a given level of certainty. We find that if the tax revenue elasticity of GDP is 1.5 then the government needs to save 2.33% during expansion years to balance their budget over the business cycle. These results should not be interpreted as meaning that if the government starts saving 2.33% of their current revenues then they can start balancing their budget over the business cycle because the above analysis assumes that government spending and revenue are initially roughly equal and with the current government deficit of $300 billion (or $500 billion if the only the on-budget items are considered) that is clearly not the case.
References


