Personal Income Taxes and Government Deficits*

Andrew Keinsley and Shu Wu†

November 2, 2014

Abstract

We use a standard, structural vector autoregressive model with a novel tax policy time series to estimate the effects of exogenous shocks to personal income tax rates on government deficits. Our time series of tax rates is constructed with the use of a principal component analysis, allowing us to decompose the tax rate data into two representative tax rates, one governing high-income households and one for lower-income households while maintaining parsimony in the model. We find that shocks to the high-income tax rate have a much stronger effect on the government deficit/GDP ratio than do changes in the low-income tax rate due to differences in their effects on private spending. An increase in the high-income tax rate has a negligible effect on the aggregate private spending while an increase in the low-income tax rate has a significantly negative effect. Overall, the combined shocks to these tax rates account for less than 10% of the variations in the government deficit/GDP ratio.

JEL Classification: E62, H20, H62

Key Words: Fiscal Deficits, Personal Income Tax Rates, Structural VAR

---

*We are thankful to those who participated in the Midwest Econometrics Group Meetings (2013) and the Economics Department Macroeconomics Lunch at the University of Kansas for their helpful conversation and insight.

†Both Andrew Keinsley and Shu Wu are with the Economics Department at the University of Kansas, Lawrence, KS 66045. Andrew Keinsley: akeinsley@ku.edu, phone, 785-864-1884; Shu Wu: shuwu@ku.edu, phone, 785-864-2868.
1 Introduction

Large government debts have been at the center of recent policy debates in the United States. Reducing the country’s debt burden, however, must start with a reduction in its fiscal deficits, and changes in these deficits can be attributed to changes in government spending, tax rates, and aggregate income by a simple accounting identity. A consensus seems to be that the U.S. needs a combination of spending cuts and tax increases (especially on high-income households) in order to bring down the fiscal deficits. Indeed, as Figure (1) shows, the most recent federal individual income tax rates on the wealthiest Americans have been near their lowest levels since the 1930s (top panel) while government spending (middle panel) has risen to more than 20% of the U.S. GDP.

Figure (1) also shows that there are big cross-sectional variations in tax rates for different income brackets over time (see section 2.1 for more details on the construction of the tax rates for different income brackets). In some periods, while the tax rates for the top
and bottom income brackets remained roughly constant, the tax rates for middle income brackets have experienced large changes. How much do changes in these tax rates contribute to the government deficits? Will a hike of these tax rates hurt economic growth as some claim? What is the most effective way to reduce government deficits? The answers to these questions are complicated in part because government spending, tax policies, and aggregate income are all correlated. For example, an increase in government spending may increase aggregate income (at least in the short-term), possibly leading to a lower, instead of a higher, government deficit even if tax rates are held constant. On the other hand, an increase of tax rate may lead to slower economic growth and therefore a higher, rather than a lower, government deficit.

In this paper, we focus on the effects of changes in personal income tax rates on fiscal deficits. We use a novel tax policy time series and a simple structural vector autoregressive model (VAR) to estimate the effects of exogenous shocks to high- and low-income tax rates. In particular, we trace out historical changes in the federal individual income tax rate for fixed real income brackets. We then use principal component techniques to construct two representative tax rates, one for high-income households and one for low/middle-income households. This gives us a parsimonious representation of historical movements in the federal individual income tax codes. This VAR model allows us to quantify the effects of shocks to different tax rates, aggregate private spending and government spending on fiscal deficits based on post-war data from the U.S. We find that variations in the tax rates account for only a small fraction (less than 10%) of the changes in government deficit/GDP ratio, and that different rates have different effects on the economy. An increase in the high-income tax rate has a negligible effect on private spending growth while an increase in the low-income tax rate has a significantly negative effect. As a result, changes in the high-income tax rate have a much stronger effect on the deficit ratio than do changes in the low-income tax rate. Nonetheless, the most important driving forces underlying changes in government deficits are economic growth and government spending. We find that, in the short-run, shocks to government spending account for about 68% of the variations in government deficit/GDP ratio. In contrast, in the long-run, shocks to growth in private-spending account for almost 67% of the variations in the deficit ratio.

There has been a growing literature that uses VAR models to examine the effects of fiscal policies on the aggregate economy. Blanchard and Perotti (2002) consider the effects of shocks to tax revenues and government spending on output, finding that spending shocks have a proportional effect whereas shocks to revenues have an inverse effect. Mountford and Uhlig (2009) use sign restrictions and announcement effects to analyze fiscal revenue shocks and their effect on GDP. Our paper, on the other hand, considers shocks to the tax rates themselves, not the tax revenues overall. Total tax revenues can change due to cyclical variations of the tax base and other non-policy forces such as tax evasion, implying that an analysis of the tax rates will provide a better understanding of the effects of fiscal policy. Later literature considered movements in these rates. For example, Easterly and
Rebelo (1993) and Piketty, Saez, and Stantcheva (2011) find that there is a very weak connection between output growth and various tax rates.\footnote{See Mendoza, Razin, and Tesar (1994); Easterly, Kremer, Pritchett, and Summers (1993); and Stokey and Rebelo (1995) for more examples.} Mertens and Ravn (2010, 2012, 2013) consider the differences between anticipated and unanticipated tax rate shocks, using a combination narrative/empirical approach to identify various tax rate shocks and analyze their effects on the economy.\footnote{See Romer and Romer (2010) for further details on the narrative approach to identifying tax policy shocks. Mertens and Ravn (2013) discuss the drawbacks of such a technique due to inherent, and sometimes sizable, measurement errors that occur in a purely narrative approach to tax policy. Also, as Mertens and Ravn (2010) find, anticipation effects in these structural VAR models do not alter the results in the literature significantly. This, coupled with our use of annual data, allows us to deviate from the anticipation effect, making the analysis simpler without sacrificing the precision of our results. We do, however, consider such anticipation effects as a robustness check, also finding that these expectations do not drastically alter the results.} This literature, however, considers average or effective tax rates, whereas the current political and policy debates have also emphasized the structure or progressiveness of tax rates. From the top panel of Figure (1), we see that there are many instances when the highest and lowest rates are relatively stable, but the middle-income tax rates vary quite dramatically.\footnote{This volatility in the tax rates is due to bracket creep, as the federal individual income tax code was not indexed for inflation until 1985 as a result of the Economic Recovery Tax Act of 1981. This result allows gives us the natural experiment of tax rate changes without explicit legislative action.} Also, since there are many different tax instruments available to the government, the effective tax rate can change when the composition of different types of income changes. Shifts in household and firm preferences/habits can also alter these measurements. For example, if there is a stock market boom that raises investment income relative to labor income, the average tax rate will change since long-term capital gains and labor income are taxed at different rates. In contrast, changes of a specific tax rate such as the top marginal income tax rate can give better indications of changes of tax policy because they are completely legislated tax changes.

Another difference between our paper and the papers mentioned above is that the main objective of the latter is to evaluate the aggregate effects, especially the fiscal multiplier, of these various exogenous policy shocks. Our paper instead focuses on the narrower issue of government deficits. Our goal is to quantify the effects of different tax rates on government deficits based on U.S. historical data. The literature that comes closest to our investigation is Mertens (2013), which studies the effects of different marginal income rates. He finds that cutting average tax rates to the top one percent of earners has a large and positive effect on GDP, implying that raising the top marginal tax rate for the purpose of deficit reduction could have serious drawbacks. We find that, however, raising the lower marginal tax rate has a bigger effect on aggregate private spending.

There are two caveats of using specific tax rates to evaluate the effects on government deficits. One is that changes of different tax rates are often positively correlated and
therefore an increase or decrease in the government deficit can come from changes in the tax rates other than the one considered in our econometric model. We control for this by incorporating a representative time series of low/middle-income tax rates. Another problem is the endogeneity of the tax rate changes. This problem is common to all measures of tax policy actions, and different approaches have been used to identify exogenous changes in tax policy in the literature. For example, Romer and Romer (2010) relies on narrative records to identify exogenous policy shocks. Blanchard and Perotti (2002) achieve identification in a structural VAR model by exploiting institutional features of the tax system. As will be seen later, our results seem to capture this endogeneity via lagged increases in the lower tax rates after a shock to private spending. In the robustness check, the use of a future tax news proxy further captures the endogeneity of the tax rates, particularly when it comes to changes in private spending.

2 Structural Vector Autoregressive Model

Here we outline our baseline four-variable SVAR model, its identification scheme, and the data used in our analysis. As described thoroughly in Bohn (2008), we can use the simple accounting identity to show that changes in government deficits can be decomposed into three components $d_t = G_t - R_t + iD_{t-1}$ where $G_t$ represents non-interest fiscal spending; $R_t \equiv R(\tau_t, Y_t)$ represents revenues, which is a function of both tax rates and income, respectively; and $i$ is the nominal interest rate on past fiscal debt. Since interest payments on past debt are fixed for a given level of debt, we will only consider the primary deficit $d_p^t = d_t - iD_{t-1}$.

2.1 The Data

This analysis uses annual data from 1953–2012 after the Second World War. We exclude the data before 1953 because tax rates increased dramatically to fund the war effort and private spending was dramatically reduced due to rationing programs, causing serious structural breaks in economic time series. Our original tax rate time series was taken from an annual report issued by the Citizens for Tax Justice, a public interest research and advocacy organization. To maintain parsimony in our model, we consider only the federal individual income tax rate. We focus on this rate because it has composed roughly 40% of government revenues since 1950, the single largest contributor by far, and is at the heart of many policy considerations. The main goal of our exercise is to use these time series to identify exogenous tax policy shocks, not to measure effective tax rates of individual households. For this reason, we also abstract from tax deductions and credits. Deductions and credits are not typically part of this base tax code and are inconsistent across agents in the economy. While we do believe that these can have impacts on the economy and fiscal
debt, we do not believe they help address the specific question at hand. So, for simplicity and tractability, we omit these from our analysis.

After mapping the tax rates into artificially created real marginal income tax brackets, we use a principal component analysis (PCA) to extract the convex combination of tax brackets that encompasses the most variation.4 A graph of the resulting “representative” rates can be found in Figure (2) and a more thorough breakdown of the methodology for building the time series can be found in Appendix A. Using one tax rate or an average tax rate can eliminate much of the variations in related rates. This method of decomposing the tax rate data allows us to retain these variations without losing parsimony. For example, in our benchmark specification, we separate the tax rates of those making over $400,000 annually from those earning less.5 This dividing point roughly separates today’s top 1% of earners from the rest of the population. The top representative rate accounts for 95.47% of the variations in the upper echelon of the tax code, while the lower representative rate accounts for 91.37% of the variation in the lower tax brackets. The growth in real private spending per capita was created using nominal gross domestic product in 2009 dollars and removing government outlays. The resulting values were then divided by the population and adjusted for inflation using the derived GDP deflator. Finally, the primary deficit-to-gdp ratio can be found in the data sets for Bohn (2008).

2.2 Setup and Identification

For the first two variables in our analysis, we utilize our derived representative top and lower marginal income tax rates. The remaining two variables include the growth rate of the private spending term described above and the primary federal deficit as a percent of GDP. Due to the accounting identity mentioned above, we identify the four corresponding

---

4 This technique is commonly used in dynamic factor modeling as well as in financial market analyses. See Forni, Hallin, Lippi, and Reichlin (2000) for an example of the former and Hasbrouck and Seppi (2001) for an example of the latter.

5 Measured in 2012 dollars.
shocks as shocks to the individual tax rates, private spending, and government spending; respectively. Henceforth, we refer to the private spending shock as an output growth shock for simplicity and because we consider this a non-fiscal shock to output growth. The shock to government spending is identified in this manner because the revenue components are identified in the other shocks, leaving only fiscal spending in the accounting identity. Further details can be found in Appendix B.

This model considers a simple Cholesky-style short-run restriction matrix to identify the structural shocks. We consider the tax rates to be more exogenous than the other variables due to assumed legislative lags. The top marginal rate is ordered first, but adjusting this order does not effect the results significantly.\(^6\) We assume that output growth and the deficit ratio react contemporaneously to shocks to the tax rates. Ordering output growth ahead of the deficit ratio is intuitive, assuming that a shock to fiscal spending will have a lagged effect on private spending. Additionally, since the deficit ratio is a function of all the other variables, it must react contemporaneously to all the shocks. In a later section we also consider alternative identification schemes and obtained similar results. Details on setup and solution methods are also found in Appendix B.

3 Results

Here we present the findings of the benchmark specification described in Section 2. This model is also referred to as our “base” model in the robustness checks of Section 4.

3.1 Estimation

We obtain the estimates for the model’s solution using simple OLS with the given identifying restrictions. The table below shows the short run and long run consequences of each of the shocks, represented by the impact multiplier matrix \(C\) and the accumulated response matrix \(A\).

The impact multiplier matrix gives us the contemporaneous movements of the variables to the exogenous shocks. As can be seen in the left panel of Table 1, the initial impact follows our Cholesky identification procedure. The first shock \(\varepsilon_{1,t}\) is a shock to the tax rates on high-income households. We do find some correlation between this rate and the lower-income rate, which is shown as a positive, significant response (second row, first column). We find that a positive shock to the top tax rate causes the growth rate of

\(^{6}\) As can be seen in Figure (1), the top marginal tax rates change less frequently than the lower rates due in part to bracket creep. We use this fact to further justify the ordering of the tax rate variables in the identification scheme.
private spending to rise slightly (third row, first column). This could be capturing a shift from wage income to unrealized capital gains in order to avoid the tax, causing more funds to be kept in the investment side of the economy and spurring growth. With the increase in output and possibly an increase in revenues (depending on the level of avoidance), we see that an increase in the top income tax rates will cause the primary deficit ratio to fall initially, though it is not statistically significant (fourth row, first column). The second shock $\varepsilon_{\tau 2}$ is an innovation to the lower-income tax rate (second column). Unlike the shock to the higher-income tax rate, a one-standard-deviation increase in the lower-income tax rate will cause the growth rate of private spending to fall by about 1%, which is statistically significant at the 95% level. As a result, the decrease in the deficit ratio from an increase of the lower-income tax rate (fourth row, second column) is about two-thirds the magnitude of an increase of the higher-income tax rate (fourth row, first column). The difference in the tax effects on the deficit ratio is more pronounced when we consider the accumulated effects (right panel of Table 1). These co-movements between output growth and the deficit ratio in response to tax rate changes may reflect different elasticities of labor hours to income taxes for low-income and high-income households as documented in some other studies.\footnote{Mertens (2013) finds that the elasticity of income to marginal tax rate changes for the bottom 99% of households is nearly twice that of the top 1% of earners. This contradicts the findings of Saez (2004), who suggests that this particular elasticity is insignificant and possibly even negative for the bottom 99% of earners.}

The final two shocks $\varepsilon_y$ and $\varepsilon_g$ are a non-government-spending output growth shock and a government-spending shock, respectively. The use of a Cholesky decomposition rules out contemporaneous responses of (legislated) tax rates to to these shocks. Our model, however, does capture the increase in revenues through a positive non-fiscal-spending output shock, which drives the deficit ratio down. A positive non-government growth shock decreases the

---

**Table 1: Short and Long Run Effects**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Short Run ($C$)</th>
<th></th>
<th></th>
<th></th>
<th>Long Run ($A$)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\varepsilon_{\tau 1}$</td>
<td>$\varepsilon_{\tau 2}$</td>
<td>$\varepsilon_y$</td>
<td>$\varepsilon_g$</td>
<td>$\varepsilon_{\tau 1}$</td>
<td>$\varepsilon_{\tau 2}$</td>
<td>$\varepsilon_y$</td>
<td>$\varepsilon_g$</td>
</tr>
<tr>
<td>Top Tax Rate</td>
<td>3.9223*</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>119.9363*</td>
<td>-65.6617</td>
<td>0.7306</td>
<td>-24.4873</td>
</tr>
<tr>
<td></td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.0410)</td>
<td>(0.1174)</td>
<td>(0.5229)</td>
<td>(0.3138)</td>
</tr>
<tr>
<td>Lower Tax Rate</td>
<td>0.8971*</td>
<td>1.2577*</td>
<td>0.0000</td>
<td>0.0000</td>
<td>23.1085*</td>
<td>-7.1858</td>
<td>0.2673</td>
<td>-2.5028</td>
</tr>
<tr>
<td></td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.0407)</td>
<td>(0.4122)</td>
<td>(0.5268)</td>
<td>(0.4978)</td>
</tr>
<tr>
<td>Output Growth</td>
<td>0.2032</td>
<td>-0.9641*</td>
<td>2.8119*</td>
<td>0.0000</td>
<td>1.0416</td>
<td>-0.5218</td>
<td>1.7906*</td>
<td>1.4157*</td>
</tr>
<tr>
<td></td>
<td>(0.4164)</td>
<td>(0.0340)</td>
<td>(0.0000)</td>
<td>(0.0000)</td>
<td>(0.3310)</td>
<td>(0.3289)</td>
<td>(0.0476)</td>
<td>(0.0469)</td>
</tr>
<tr>
<td>Deficit Ratio</td>
<td>-0.0699</td>
<td>-0.0412</td>
<td>-0.7470*</td>
<td>1.1020*</td>
<td>-5.6103</td>
<td>0.9014</td>
<td>-5.9577*</td>
<td>2.6295</td>
</tr>
<tr>
<td></td>
<td>(0.3223)</td>
<td>(0.3730)</td>
<td>(0.0010)</td>
<td>(0.0000)</td>
<td>(0.1859)</td>
<td>(0.5384)</td>
<td>(0.0362)</td>
<td>(0.1361)</td>
</tr>
</tbody>
</table>

Bootstrap p-values in parentheses. Star (*) denotes significance at a 95% confidence level. Bootstrap procedure consists of 10,000 draws.
deficit ratio by about 0.7% and is highly significant (fourth row, third column). Finally an exogenous shock to government spending increases the deficit ratio significantly, as expected (fourth row, fourth column).

If we consider $B(L)$ to be the lag polynomial matrix of VAR coefficients, $A = (I - B(1))^{-1}C$ describes the accumulated effects of each of the shocks on each of the variables.\(^8\) These effects are reported in the right panel of Table 1. We see that shocks to the different tax rates cause output and the deficit ratio to diverge in different directions (although the sampling errors become much larger when estimating these accumulated effects). In the long-run, a positive shock to the higher-income tax rate increases the output level (the sum of changes in growth rate) by a full percentage point and results in a 5.6% reduction in deficit-output ratio (third and fourth rows, first column). In contrast, a positive shock to the lower-income tax rate decreases the level of output by 0.5% and leads to a 0.9% increase of deficit-output ratio (third and fourth rows, second column). The effect of tax policy on the government deficit depends critically on how changes in the policy affect the aggregate output and income. Falling output and income associated with positive innovations to the lower tax rate cancel out any increases in tax revenue, whereas increasing the top rate seems to generate only higher revenues without the output loss.

The interpretations of the effects of the two tax rate shocks, however, must proceed with care because of the strong positive correlation between these two tax rates. A positive shock to the higher-income tax rate also leads to a contemporaneous positive increase in the other tax rate (second row, first column of the left panel of Table 1). Due to the progressive nature of the U.S. tax code, a positive shock to the lower-income tax rate while holding the higher-income tax rate constant most likely captures more of the effect of a decrease in the spread of tax rates across different income brackets (as opposed to the effect of a change of the tax rate level). Indeed as we can see from the first two rows of the second column (right panel), in response to an $\varepsilon_{\tau 2}$ shock, both the top tax rate and the lower rate declines, but the top rate declines much more that the lower rate does, indicating a reduction of the spread between the top rate and the lower rate.\(^9\) We confirm this conjecture in the next subsection.

The long-run effect of an output shock on government deficits is shown in third column of the right panel of Table 1. A positive one-standard deviation shock to the growth rate of private spending leads to a 1.8% increase in the level of output and a 5.9% decrease in deficit-output ratio. Both effects are statistically significant at the 95% level. This result highlights the central role of the growth of private spending in reducing government deficits

---

\(^8\) See Appendix B for further details on the notation and setup of the model.

\(^9\) The accumulated effects of $\varepsilon_{\tau 1}$ and $\varepsilon_{\tau 2}$ on the top tax rate and the lower tax rate are large because tax rates are very persistent (see Figure 2 and the impulse response functions below). And a positive $\varepsilon_{\tau 2}$ shock has a negative accumulated effect on the tax rates simply because the spread between the the top rate and the lower rate are shrinking while at the same time all tax rates are declining during our sample period between 1953 and 2012.
(see below for more discussions on this). Moreover, the long-run effect of an output shock on tax rates is small and insignificant. This suggests that most of the variations in the legislated tax rates are exogenous to output shocks and hence provides further justifications for the recursive identification assumptions of our VAR model.

The last column of the right panel of Table 1 show the long-run effects of a government spending shock. We can see that a positive one-standard-deviation shock to the deficit ratio has a positive and significant effect on the level of output (the third row). This positive income effect can mitigate some of the negative effects of government spending on fiscal deficits as we find in the variance decomposition below. The long-run effect of government spending shocks on the tax rates seems large and negative, but neither is statistically significant at any considerable level. This is mainly driven by the long-run trend of declining tax rates and rising government spending since the 1950s (see Figure 1).

### 3.2 Impulse Response Functions

Figure (3) shows the impulse response functions (IRFs) in deviations from the mean along with two-standard-deviation confidence bands. These functions are derived from a first period, unit shock to each of the variables. The solid line represents the estimated IRFs whereas the shaded regions correspond to the confidence intervals.

The top two rows of this figure show how the various shocks affect the individual tax rates. We find that the tax rates themselves do not respond to shocks to other variables in general. However, we do find that the rates are positively correlated. It would seem rather intuitive that the tax rates, due to implementation and bureaucratic lags, would be generally exogenous, which is what we find.

When looking at output growth, we find differing reactions to each of the tax rate shocks as Table 1 suggested. Raising the top tax rate has a non-significant effect on output growth, though the estimate is mostly positive. On the other hand, a positive innovation to the lower-income tax rate has a significantly negative contemporaneous impact on output growth. As discussed above, the shock to the lower-income tax rate (holding the higher-income tax rate constant) may capture the effect of a compression of tax rates across different income brackets. To check this, we combine all the tax brackets and run a single principal component analysis. We find that the first two principal components together account for almost all of the variations in the tax rates. Moreover, the first component is strongly correlated with the movements in the level of the tax rates and the second component is strongly correlated with the spread (or distribution) of the rates across the income brackets. Figure (4) presents the impulse responses of private spending growth to both an average tax rate shock (left) and a shock to the tax spread (right).\footnote{Here we simply replace our two representative tax rates from the base model with the new measures}
of tax policy.
that the impulse response function for the average tax rate (first principal component) is nearly identical to the impulse response function of the higher-income tax rate (third row, first column) in Figure 3, and the impulse response function for an increase in the tax rate spread (second principal component) is almost the mirror image of the impulse response function of the lower-income tax rate (third row, second column), which could represent a reduction in this spread. This confirms that a positive shock to the lower-income rate (while holding the higher-income rate constant) captures the effect of a decrease of the spread of tax rates across income brackets (or a tax rate compression). Our empirical results suggest that increasing the average tax rate has little effect on the growth rate of output. But if we increase the spread of the tax rates across the income brackets, we find a positive and significant effect on the growth rate. A more progressive tax code seems beneficial to the economy due its potential redistribution effects. These results are consistent with the finding of Easterly and Rebelo (1993) that level changes in tax rates do not effect output significantly. Our study indicates that the composition of the income tax rates can have an important effect on the economy.

3.3 Variance Decomposition

Table (2) shows the forecast error variance decomposition of the model. Since the statistics for the tax rates are trivial, we show only the results for output growth and the deficit ratio. Considering the variance decomposition for output growth, we find that the tax rates on the highest-earning Americans does little to induce variations in output. The lower tax rates contribute to much more of the variations and grows stronger in the long run. In the end, however, private spending accounts for the majority of its own variations, with public spending doing less than the lower tax rate. In the second set of columns, we see that the tax rates account for less than 10% of deficit ratio variations, combined, but innovations to the top tax rates seem to have more of an impact (6%) than the lower rates (3%), almost assuredly due to the lower rates' significant impact on output growth. A somewhat surprising result is the fact that output growth accounts for over 65% of the variations in the deficit ratio for a large portion of our examination. Changes of government spending account for more than 68% of the variations in the deficit ratio in the short-run. In the long-run, however, government spending accounts for only 23% of the variations in the deficit ratio. This could be due to the positive effects of increasing public spending on the growth rate of private spending (third row, fourth column of Figure 3) which helps mitigate the negative effect of government spending on fiscal deficit. These results, coupled with the impulse response functions above, suggest that output growth has the most influence on the deficit ratio in the long run. As far as personal income tax rates are concerned, our results indicate that changes in the high-income tax rate have a much larger effect on fiscal deficits than do changes in the low-income tax rate. This is due to the fact that these income tax rates have different effects on the aggregate income.
Table 2: Variance Decomposition – Base Model$^a$

<table>
<thead>
<tr>
<th>Period</th>
<th>Output Growth</th>
<th>Deficit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\varepsilon_{r1}$</td>
<td>$\varepsilon_{r2}$</td>
</tr>
<tr>
<td>1</td>
<td>0.47</td>
<td>10.47</td>
</tr>
<tr>
<td>2</td>
<td>1.65</td>
<td>10.42</td>
</tr>
<tr>
<td>3</td>
<td>1.87</td>
<td>11.54</td>
</tr>
<tr>
<td>4</td>
<td>2.05</td>
<td>13.58</td>
</tr>
<tr>
<td>5</td>
<td>2.40</td>
<td>14.31</td>
</tr>
<tr>
<td>6</td>
<td>2.56</td>
<td>14.39</td>
</tr>
<tr>
<td>7</td>
<td>2.61</td>
<td>14.37</td>
</tr>
<tr>
<td>8</td>
<td>2.62</td>
<td>14.35</td>
</tr>
<tr>
<td>9</td>
<td>2.62</td>
<td>14.34</td>
</tr>
<tr>
<td>10</td>
<td>2.62</td>
<td>14.33</td>
</tr>
<tr>
<td>11</td>
<td>2.63</td>
<td>14.33</td>
</tr>
<tr>
<td>12</td>
<td>2.63</td>
<td>14.34</td>
</tr>
<tr>
<td>13</td>
<td>2.63</td>
<td>14.35</td>
</tr>
<tr>
<td>14</td>
<td>2.63</td>
<td>14.36</td>
</tr>
<tr>
<td>15</td>
<td>2.64</td>
<td>14.36</td>
</tr>
<tr>
<td>16</td>
<td>2.64</td>
<td>14.37</td>
</tr>
<tr>
<td>17</td>
<td>2.64</td>
<td>14.37</td>
</tr>
<tr>
<td>18</td>
<td>2.64</td>
<td>14.38</td>
</tr>
<tr>
<td>19</td>
<td>2.64</td>
<td>14.38</td>
</tr>
<tr>
<td>20</td>
<td>2.65</td>
<td>14.38</td>
</tr>
</tbody>
</table>

$^a$ Results are expressed as a percent of variation.

4 Robustness

Here we consider some alternative models to check for robustness. Included in these are alternative identification schemes and the addition of anticipated fiscal policy.

4.1 Alternative Identification Schemes and Other Taxes

As with any model, the identification scheme is always subject to challenge. In our baseline model, we order the tax rates first, then output growth and deficit ratio. We mentioned earlier that swapping the order on the tax rates yields essentially the same results, while further alterations to the ordering also provide similar findings. Thus, we find the ordering of our identification assumptions to be robust. On the other hand, we also considered the possibility that a shock to the top tax rate in our base model was also capturing shocks
to the lower tax rate as well. Thus we conducted a number of additional tests, including setting the lower tax rate as an exogenous variable on the right side of the regression, and obtained similar results. Besides personal income taxes, capital gain taxes and corporate taxes are other major sources of government revenue. We also estimated models that include these additional tax rates. While changes in these tax rates also contribute to changes in government deficits, the results about personal income tax rates, in particular the different effects of high- and low-income tax rates on aggregate private spending and government deficits, remain robust. Therefore, the variance decompositions reported in Table 2 in essence represent the upper bound of the effects of personal income tax rates on output and government deficits.\textsuperscript{11}

4.2 Policy Expectations

While our model is robust to multiple identification schemes, we did not explicitly control for anticipation effects as in Mertens and Ravn (2010). To control for this potential effect, we rely on a proxy for news of future tax changes as in Kueng (2012). He uses the rate spread between municipal and federal bonds as a proxy since the most significant difference between these lies in how their returns are taxed. Both types of bonds are fairly riskless, but returns on federal bonds are taxed, while those of municipal bonds are not. As these rates are market driven, we use this as a proxy for expected future tax changes. Specifically, we use the spread between the 10-year Treasury rate and the Bond Buyer 20-Bond GO municipal bond index. When considering the identification of the new model, we keep the general order the same, but place the news proxy in the third position. It, obviously, should be ordered after the tax rates, as it represents shock to future tax rates, meaning that our representative tax rates should not react contemporaneously to this shock, but variables such as private spending should react immediately to expectations.

As can be seen in Figure 5, the use of a news proxy captures the endogeneity of the tax rates. Interestingly, shocks to both tax rates raise the value of the news variable, signaling further increases in the future. We also see significant increases in this proxy due to shocks to private spending. This matches the upward drift in tax rates during expansions that we see in Figure 1. Thus, including the news proxy seems to capture not only its intended goal, which is to signal a change in future tax rates, but also seems to capture the endogeneity of tax rates in response to output growth. We also capture, though not significant, an increase in expected future taxes as a result of a government spending shock. This could indicate a “Ricardian equivalence” effect, where increases in government spending and deficits must signal future increases of tax liabilities, holding everything else constant. This effect, however, is not statistically significant.

\textsuperscript{11}Results from alternative identification schemes and models are available upon requests.
Table 3 provides the forecast error variance decomposition for this alternative model. Comparing this to Table 2, we see that the values are essentially the same. Including the news shock $\varepsilon_n$ adds little to the analysis, but it is worth noting that most of the variation attributed to the news shock seems to come out of the lower tax rate shock component. This might suggest that our news proxy captures more of the expectations of changes to the lower tax rates and less of the higher tax rates, or changes of the composition of tax rates across different income brackets. The variance decomposition and impulse response functions confirm that the results from our base model are robust with respect to the anticipation effect.
Policy makers face a difficult trade-off when choosing different approaches to reduce government deficits. Both increases in taxes and reductions in government spending may have adverse effects on private spending. The decreases in private spending, and therefore the aggregate income, can make the deficit-reducing policies less effective or even counterproductive. This is part of the reason for the heated debates in the political discourse with regard to the government’s growing debt levels and its fiscal deficits. In this paper we try to quantify the effects on the government deficit-to-GDP ratio from changes in the federal individual income tax rates while taking into account their effects on private spending. We achieve this by using a simple, structural vector autoregressive model (VAR) and a novel tax policy time series that distinguishes between high- and low-income tax rates. Applying this model to post-war data from the United States, we find that innovations to these different tax rates have significantly different effects on private spending and hence gov-

5 Concluding Remarks

Table 3: Variance Decomposition – Model with News Proxy$^a$

<table>
<thead>
<tr>
<th>Period</th>
<th>Output Growth</th>
<th>Deficit Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\varepsilon_{x1}$</td>
<td>$\varepsilon_{x2}$</td>
</tr>
<tr>
<td>1</td>
<td>0.51</td>
<td>10.50</td>
</tr>
<tr>
<td>2</td>
<td>1.35</td>
<td>10.08</td>
</tr>
<tr>
<td>3</td>
<td>1.65</td>
<td>10.44</td>
</tr>
<tr>
<td>4</td>
<td>1.84</td>
<td>11.27</td>
</tr>
<tr>
<td>5</td>
<td>2.02</td>
<td>11.45</td>
</tr>
<tr>
<td>6</td>
<td>2.07</td>
<td>11.43</td>
</tr>
<tr>
<td>7</td>
<td>2.08</td>
<td>11.42</td>
</tr>
<tr>
<td>8</td>
<td>2.08</td>
<td>11.41</td>
</tr>
<tr>
<td>9</td>
<td>2.10</td>
<td>11.40</td>
</tr>
<tr>
<td>10</td>
<td>2.12</td>
<td>11.39</td>
</tr>
<tr>
<td>11</td>
<td>2.14</td>
<td>11.39</td>
</tr>
<tr>
<td>12</td>
<td>2.16</td>
<td>11.38</td>
</tr>
<tr>
<td>13</td>
<td>2.18</td>
<td>11.38</td>
</tr>
<tr>
<td>14</td>
<td>2.20</td>
<td>11.38</td>
</tr>
<tr>
<td>15</td>
<td>2.22</td>
<td>11.38</td>
</tr>
<tr>
<td>16</td>
<td>2.24</td>
<td>11.38</td>
</tr>
<tr>
<td>17</td>
<td>2.25</td>
<td>11.38</td>
</tr>
<tr>
<td>18</td>
<td>2.27</td>
<td>11.38</td>
</tr>
<tr>
<td>19</td>
<td>2.28</td>
<td>11.38</td>
</tr>
<tr>
<td>20</td>
<td>2.29</td>
<td>11.38</td>
</tr>
</tbody>
</table>

$^a$ Results are expressed as a percent of variation. $\varepsilon_n$ represents the news shock.
ernment deficits. Shocks to the high-income tax rate have a much smaller effect on private spending and therefore a much larger effect on the government deficit ratio than shocks to the low-income tax rate do. Overall, shocks to personal income tax rates account for a small fraction of the variations in the government deficit ratio. In contrast, shocks to government spending are a much more important source of government deficits, accounting for approximately 68% and 23% of the short- and long-run variations in the government deficit ratio, respectively. This is partly due to the fact that changes in government spending have a smaller effect on private spending compared to those resulting from tax rate changes. In the long-run, however, it is the exogenous shocks to the growth rate of private spending that account for the largest share (67%) of the variations in the government deficit ratio. These estimates, based on historical data, may provide useful references when considering policy changes that aim at reducing government deficits and debts.
References


A Creation of Our Tax Policy Time Series

A.1 Motivation

Fiscal policy, especially tax code, can be complex and inconsistent. For instance, the graph below shows the number of federal income tax brackets for each year dating back to 1913. Some of these brackets correspond to lower and middle-income households, while some of these govern the tax rates on a single individual.\textsuperscript{12} Not only do the number of tax brackets change, but the corresponding brackets vary in range and level.

Many in the literature consider an average marginal tax rate, which is typically computed using total tax revenues and income, but this statistic can eliminate much of the variations within the tax code and is only available for a short period of time. These variations can have substantial impact on the economy, possibly sacrificing results for simplification. We created a set of 50 time series based on uniform income brackets. These brackets are created using the logarithm of income, measured in thousands of 2012 dollars. We then map the tax rates to their designated brackets. This technique does not come without measurement error, as occasionally our tax brackets do not match those in the tax code or multiple tax rates exist within one of our tax brackets, but the core of the realized tax rate variations remains intact.

A.2 Data

The base data obtained is simply an annual breakdown of the federal income taxes and tax brackets from taxfoundation.org. The data are available in nominal and in 2012 dollars. The availability of the brackets in real dollars allows us to compare the tax burden across years.

\textsuperscript{12} The Wealth Tax Act of 1935 established a marginal tax bracket for those making over $5 million annually, of which there was one: John D. Rockefeller, Jr.
Mapping Technique  In order to map the data into a useful set of time series, we first need to construct the tax brackets. Since tax brackets generally get wider at higher income levels, and some of the tax brackets can reach $40-80 million dollars, we decided to construct the brackets using the logarithm of income levels, measured in thousands of 2012 dollars. Each bracket contains two-tenths of the resulting values, i.e. one tax bracket consists of anything above 2.0, but not over 2.2. These tax brackets and their respective top marginal rates are shown in the top panel of Figure (1). As can be seen, while the top and bottom rates may not change often, there can be considerable variation in the brackets between them. For example, the tax cuts enacted by the Kennedy administration in 1964 cut taxes only for those on the wealthier side of the spectrum, and while the top and bottom rates remained relatively unchanged in the 1970s and 1980s, the rates on middle-income brackets were gradually rising due to bracket creep.

A.3 Principal Component Analysis

In this section we describe the methodology for attaining a single time series out of the 50 we created earlier. For parsimony, we cannot retain all the time series from above, but we would like to consider as much of the variation as we can. Notice as well that, in the top panel of Figure (1), that while there is variation in the tax rates through time, these variations are generally highly correlated, which poses a problem in econometric analysis. Therefore, we chose to consider a principal component analysis (PCA) of the data. This is commonly used when analyzing asset returns and will allow us to reduce the dimensions of the data while retaining the maximum amount of variations. The method is quite simple, considering the $m \times n$ matrix $X$, where $m$ represents the number of tax brackets and $n$ represents the number of observations, we conduct our PCA in the following steps:

1. create the de-meaned matrix $\tilde{X}$
2. solve for the variance-covariance matrix $\Omega = \tilde{X}\tilde{X}'$
3. solve for the eigenvalues of $\Omega$
4. choose the largest eigenvalue and extract its corresponding eigenvector
5. normalize the eigenvector such that the components sum to one
6. apply the resulting vector to the vector of tax rates at each observation

These steps give us a “representative” tax rate what maintains as much of the variations of the original tax rates as possible. For this paper, we separate the original $X$ into two parts, those tax brackets representing the wealthy, $X_{w}$, and those tax brackets representing the rest, $X_{r}$, giving us $k \times n$ and $(m - k) \times n$ matrices, respectively, where $k$ is the top
echelon of tax brackets. The principal objective of this paper is to see what happens when the tax rates on the wealthy are altered, but we also need to control for variations in the remaining tax rates as well. Using this PCA methodology, we can parsimoniously analyze the economy and still include much of the relevant information.

A.4 Results

Following some of the dialogue of the recent political scene, we set the tax bracket cutoff around $400,000 annual income, which is currently around the top 1% of income. This includes the top 27 income brackets in our translation. The limit of our dimensionality reduction depends on how much variation can be captured. Thus, we compare the top eigenvalues for each cohort in Table (4) and consider the percent of variation that is captured by these single values. As can be seen, there is a substantial amount of variation captured in these linear combinations. This ensures that we can reduce the dimensions down to one in each case, giving us a weighted average marginal tax rate for the wealthy and the rest of the population based on the variation of the tax code, not the variation in the tax revenue or income. The resulting tax rates are shown in Figure (2). Notice that, while the overall movements in the two resulting rates are similar, there are considerable differences in their variations. Under this specification, we capture the consistency of the top rates in the 1970s and the subtle rise in the rest of the rates during the same period. We also see that the lower-income rate remains in the same general range from the 1940s onward, while the top rates gradually fall over that span.

B SVAR Setup

To cover the entire methodology simply, we now consider the alternative model which includes the anticipation effect proxy. Recall that the base model abstracts from this. Let \( X_t = (\tau^1_t, \tau^2_t, n_t, \Delta y_t, d_t)' \) be a vector of endogenous variables; where \( \tau^1_t \) is the representative income tax rate on the top-earners, \( \tau^2_t \) is the representative income tax rate on lower-earners, \( n_t \) is a tax news proxy, \( \Delta y_t \) is the growth rate of real private spending per capita, and \( d_t = D_t/Y_t \) is the primary deficit-output ratio. Let \( \varepsilon_t = (\varepsilon^1_{t1}, \varepsilon^2_{t2}, \varepsilon^3_{t3}, \varepsilon^4_{t4}, \varepsilon^5_{t5})' \) represent an vector of exogenous, structural shocks to the representative tax rates, the news proxy,
output per capita, and the government spending, respectively. We identify this last shock as one to government spending because all factors that make up the revenues are considered in \( \varepsilon_{t1}^r, \varepsilon_{t2}^r, \varepsilon_{tn}^r, \) and \( \varepsilon_{ty}^r; \) leaving the only other factor to effect fiscal deficits to be government spending. \( X_t \) is assumed to follow the vector autoregressive process:

\[
X_t = B_0 + B(L)X_t + C\varepsilon_t
\]  

where \( L \) denotes a lag operator such that \( B(z) = B_1 z + B_2 z^2 + \cdots + B_p z^p, \) where \( p \) represents the number of lags in the model. By the Akaike (1974) information criterion, we find that a two-lag vector autoregression best fits the data, which we discuss in the next section. Considering this specification, the moving average representation is given by

\[
X_t = (I - B(1))^{-1} B_0 + (I - B(L))^{-1} C\varepsilon_t.
\]

**Identifying Restrictions** Since our model consists of five variables, in order to identify these errors, we’ll need to make ten additional identifying restrictions in order to recover the matrix \( C.\) Before we begin, we assume that the structural shocks are distributed multivariate \( \mathcal{N}(0, \Sigma) \) with unit variances, which gives us an identity variance-covariance matrix \( \Sigma.\) The unknowns are derived from the following assumptions: 1) neither tax policy responds contemporaneously to exogenous shocks to news of future taxes, output growth or the deficit ratio, 2) the tax rate on the wealthiest households does not respond contemporaneously to the lower-income tax rate as well, and 3) a shock to government spending does not have a contemporaneous effect on private spending. These assumptions imply a Cholesky decomposition of the variance-covariance matrix of reduced-form residuals \( \Omega = \text{Var}(C\varepsilon_t) \) such that \( CC' = \Omega.\)

---


14 In this situation, as it is in any SVAR, we are assuming that the structural shocks are independent of each other, making the off-diagonal elements of \( \Sigma \) zero.