

Marginal Income Tax Rates, Economic Growth, and Primary Fiscal Deficits*

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Abstract

Economic theory suggests that variations in marginal tax rates are more important for consumption and investment decisions than the average rates commonly studied. This paper analyzes the aggregate implications of the statutory tax code, using a new times series on annual marginal tax rates that decomposes the federal income tax code into its “level” and “progressive” (or spread) components. Robust results from a vector autoregression model show that increasing the spread of the marginal income tax rates has a positive impact on private spending growth, leading to an indirect, negative impact on the primary deficit ratio. Contrary to the political narrative, the general level of these tax rates does not significantly impact growth rates or the primary deficit ratio.

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1 Introduction

A broad cut in tax rates was part of the recent pro-cyclical experiment in US fiscal policy. As with every tax cut, two opposing views emerge. On one side, some argue that broad tax cuts like these will boost economic growth and generate enough revenue to avoid a large surge in fiscal debt. This side of the debate would expect robust economic growth in both the short and long-run with mild increases in fiscal deficits. The more common take among economists, however, says that the level of economic growth needed is unobtainable. This argument predicts strong short-run growth, but tempered growth in the long-run due to fiscal drag. The question, then, is quite straightforward: what will these new tax rates do for the economy and/or the borrowing capacity of the federal government?

When discussing the general effects of tax policy, however, one has to consider a growing litany of approaches. Some of the first works focused on fiscal revenues, in general (i.e. Blanchard and Perotti, 2002; Mountford and Uhlig, 2009); or on average, or effective, tax rates (i.e. Easterly and Rebelo, 1993; Mendoza *et al.*, 1994; Stokey and Rebelo, 1995). However, these approaches can be plagued by changes in the tax base, distribution of income sources, and other non-policy forces. Newer approaches aimed at avoiding these hurdles include the narrative and proxy identification schemes (i.e. Romer and Romer, 2010; Mertens and Ravn, 2012, 2013). Whether it be measurement error or bias in the confidence bands (Lunsford and Jentsch, 2016); these, too, have their own assortment of drawbacks. Considering all of these approaches and theories, Valerie Ramey (2016, pg. 129) claims that, “ideally, one would use statutory rates, since the actual rate paid is partly endogenous [...]”

We argue that the structure of the federal income tax code itself can shed light on the macroeconomic impact of marginal tax rates. Specifically, we find that the spread of the income tax rates is a more effective policy tool than their general level.¹ Increasing this spread drives private economic growth up in the short term and seems to have an indirect, negative effect on the primary deficit-GDP ratio. Changes to the tax level have no significant impact on either the rate of economic growth or the primary deficit ratio. The success of our approach stems from our ability to extract level and spread variations in the statutory marginal rates from the tax brackets themselves via a principle component decomposition, removing most of the endogenous influences seen in effective tax rates.

Why do we focus on the statutory marginal rates when the tax code can be summarized with an effective rate? First, the standard theory says that economic agents make decisions at the margin. That is, households make their decisions based on the tax rate applied to their next dollar of income, not the average tax rate on all their income. Second, even if marginal tax rates are considered, they are, to our knowledge, derived from an effective tax approach, which leaves them susceptible to the multiple non-policy influences mentioned earlier. Third, our approach takes the general political debate into consideration. While most debates include other aspects of the tax code initially, they frequently seem to erode down to a discussion about the statutory tax rates themselves. Finally, this approach allows a straight-forward look at the first- and second-order characteristics of the tax code simultaneously. Principle component analysis reduces this high-dimensional, ever-evolving structure into two principle components: one describing movements in the general levels of the tax rates, and one describing movements in the spread of the marginal tax rates. Together, these points

¹ When talking about the “spread” of the tax rates, we are talking about a subset of the greater “progressive” notion. The progressive nature of the tax code not only includes this spread characteristic, but also the number of tax brackets, which is something we do not examine explicitly.

form the basis of our motivation to explore the statutory marginal tax rates.

We then explore the nuances of the tax spread and its effectiveness as a fiscal tool. First, we find that the positive correlation between the tax spread and economic growth is independent of the source of spread fluctuations (rising top marginal rates, falling lower marginal rates, or both). We explore this by splitting the tax code by income level in order to forcibly create movements in the level and spread of the tax code. We also show that, despite finding a general positive relationship between the tax spread and economic growth, additional tests suggests that the causation likely runs from the tax spread to economic growth, not vice versa. This result is intuitive when you consider that our tax variables come from the statutory rates rather than effective rates.² Lastly, we find that our results are robust to alterations not only in the identification scheme, but also to the modeling methodology. Together, these outcomes and the analyses that follow provide a novel, well-rounded, and robust view of the economic impact of these statutory tax rates.

Our results are appealing with regards to the existing literature and important with respect to the recent political trends nationwide. In terms of the literature, our findings confirm and expand upon Piketty, Saez and Stantcheva's (2014) result that the top marginal rate has little economic impact. The derived tax variable representing variations in the level of the code relies heavily on the movements in the top marginal rates. So our results suggest that, not only are the top marginal rates relatively ineffective policy tools, but the general level is also a rather ineffective tool. From a policy perspective, our distributional look at the tax code suggests that a more progressive structure fosters economic growth. This contradicts the recent trends in many State-level policies towards flat tax codes along with the similar proposals recently seen at the federal level. Combined, these two elements provide the basis for a substantial contribution to the policy debate.

A key historical insight that arises from of our methodology is the extent to which policymakers have taken a narrow approach to income tax policy since its inception in 1913. Specifically, the decomposition of the federal income tax code reveals that the vast majority of policy has focused on shifting the general level of the tax code, while these results suggest that the spread would have been a more effective approach. Thus, future policy changes could put more emphasis on changes to the spread of the tax code than simply increases or decreasing rates across the board.

Our paper builds on the long literature pertaining to the macroeconomic effects of tax policy, and is particularly relatable to the work of Mertens and Olea (2018). They too, focus on marginal rates, finding that they are more important to economic dynamics than average rates – a key motivation for our approach. A prominent difference in our methodologies, though, lies in the derivation of the tax variables. Their marginal rates are derived from an income-weighted average of various income tax rates and are comparable across income percentiles. While not to the extent of the effective rates used in the literature, holding the income percentiles constant still leaves the tax variables susceptible to changes in non-policy factors. As a further attempt to address the concern of Ramey (2016) that these rates derived from average incomes may have endogeneity issues, our tax variables are constructed by holding real income levels constant and only considering the statutory rates of one (though very important) aspect of the tax code. Despite this narrow focus, our results are robust to the introduction of other tax rates, matching Mertens and Olea's robustness to the removal of social security tax rates from their study. Our novel approach to identifying both the movements in the statutory rates as well as the spread between these rates

² It should be mentioned that, while statutory tax rates are held constant outside of legislative adjustments in real terms, the federal income tax code was not indexed to inflation until 1985, meaning that there was an endogenous channel of economic growth to the tax code without legislation.

adds another perspective to the tax policy discussion.

The remainder of this paper unfolds in a straightforward manner. Section 2 explains the methodology behind the derivation of our tax variables and the model in which they are implemented. Section 3 presents and analyzes the baseline results, including impulse response functions and variance decompositions. Section 4 expands upon these results with a series of robustness checks. Section 5 concludes the paper with a look at some of the implications of our results.

2 Methodology

Being interested in the relationship between tax rates, economic growth, and fiscal deficits; the accounting identity defining these fiscal deficits represents a succinct and effective motivation. Fiscal deficits, or the changes in the overall debt level D_t

$$\Delta D_t = G_t - R(\tau_t, Y_t) + i_{t-1}D_{t-1}$$

are composed of non-interest government spending G_t , revenues $R(\cdot)$ derived from the statutory tax rates τ_t and incomes Y_t , and the interest payments on past debt levels $i_{t-1}D_{t-1}$. Since the stock of outstanding debt D_{t-1} and the interest rates i_{t-1} are predetermined, they are omitted from this study. Instead, the primary deficit

$$D_t^p = G_t - R(\tau_t, Y_t),$$

where policymakers have more contemporaneous control, is considered.³

2.1 The Federal Income Tax

This paper focuses exclusively on the structure of the federal income tax code for a number of reasons. First, it has been the single largest contributor to federal government revenues (roughly 40%) since 1950. Second, it is not earmarked for specific programs like the various social insurance taxes, the next-largest contributor to federal revenue. Third, private consumption expenditures constitute about two-thirds of GDP. With income taxes have a direct impact on disposable income, this issues has been at the heart of many policy considerations. Finally, basic economic intuition supported by the recent literature implies that economic agents make their decisions on the margin. Thus, changes to the the marginal tax rate on the next dollar of income is more disruptive than changes to the average tax rate paid on all income. Together, these points suggest that this par of the tax code deserves special attention.

The other aspects of the income tax code; including deductions, credit, etc.; are applied to pre-tax income and are too small to change most households' marginal tax rate. For example, for married filing jointly in 2017, the standard deduction was \$12,700 while the smallest tax bracket (income range) was the 10% bracket spanning incomes of \$0-\$18,650. The other tax brackets have ranges often exceeding \$70,000. Itemization when filing taxes makes the situation that much more complex and idiosyncratic, but the basic result remains for the majority of households: the tax rate applied to the next dollar of labor income often remains the same.⁴ While these additional

³ See Bohn (2008) for an extensive look at the primary deficit in the United States.

⁴ The Tax Cuts and Jobs Act of 2017 increased the standard deduction to \$24,000 beginning in 2018, though it also limits deductions for state and local taxes (SALT) and others.

tax code provisions have impacts on the economy and fiscal debt, they add undue complexity in addressing the specific question at hand. Thus, only taxable incomes and the applied marginal tax rates are considered.

Even the basic structure of the income tax code can be problematic for time series econometric models. Since its inception in 1913, the federal income tax code has not only seen adjustments in its rates, but also expansions and contractions in the number of brackets and alterations to how these brackets handle inflationary bias. For reference, Figure 1 shows how the number of federal income tax brackets has evolved over time. Some of these brackets correspond to lower and middle-income households, while some of these govern the tax rates on a single individual.⁵ With fluctuations across multiple dimensions, we need a procedure that will extract the core features of the tax code's structure.

2.2 Principle Component Analysis

To maintain the general movements in the tax code while keeping the number of variables considered to a minimum, principal component analysis (PCA) is applied. PCA is commonly used in factor-augmented VAR models and allows a reduction in the dimensions of the data while retaining the core variations. An added benefit to this procedure is that the resulting principle components are orthogonal by design. This provides us with a parsimonious look at multiple dimensions of the tax code that is also economically intuitive.

2.2.1 Mapping Taxable Income Levels to the Tax Code

To get a better picture of how the federal income tax code has evolved over time, it is applied to fifty artificially-created real income levels (measured in thousands of 2012 dollars) across the sample period. The natural first thought is to use constant dollar increments between the income levels. However, the structure of the tax code often incorporates narrower brackets at the lower end of the income spectrum and wider brackets at the higher end. Also, these higher end brackets have been applied to very high income levels in the past. This would imply that there either need to be a multitude of smaller brackets with little differentiation in most of them, or a smaller number of large brackets that miss much of the nuance at the lower end of the spectrum. Alternatively, this paper separates income levels by their natural logarithm, measured in thousands of dollars. As an example, Table 1 shows that increments of 0.1 in the logarithmic values of the income levels are used. The tax code is then applied by assigning the tax rates associated with the next marginal dollar of each respective income level.⁶ The use of logarithmic values allows the analysis to cover a wide range of income levels without sacrificing the details at the lower end of the income distribution. These marginal tax rates are shown in Figure 2. 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 compression of the tax code can also be seen in the second round of tax cuts during the Reagan administration, where all income levels were assigned into two marginal rates.

⁵ 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.

⁶ For consistency, the married-filing-jointly specification is used throughout.

This mapping illustrates the evolving complexity of the tax brackets and serves as the base for our principle component analysis to extract the the basic elements from the tax code.⁷

2.2.2 Principle Component Decomposition

Considering an $m \times n$ matrix \mathbf{T} , where m represents the number of real taxable income levels considered and n represents the number of observations, the following steps produce the first principle component $\tau_{1,t}$.

1. create the de-meaned matrix $\tilde{\mathbf{T}} \equiv \mathbf{T} - \bar{\mathbf{T}}$
2. solve for the variance-covariance matrix $\mathbf{\Omega} = \tilde{\mathbf{T}}\tilde{\mathbf{T}}'$
3. eigenvalue/eigenvector decomposition: $\mathbf{\Omega}\mathbf{v} = \lambda\mathbf{v}$
4. choose the largest eigenvalue $\lambda_{\max} \in \lambda$ and corresponding eigenvector $\mathbf{v}_{\max} \in \mathbf{v}$
5. normalize the eigenvector (optional): $\tilde{\mathbf{v}}_{\max,j} \equiv \mathbf{v}_{\max,j} / \sum_i \mathbf{v}_{\max,i} \forall i, j \in [1, m]$
6. apply resulting vector to the vector of tax rates at each observation: $\tau_{1,t} \equiv \tilde{\mathbf{v}}_{\max}\mathbf{T}_t$

The second principle component $\tau_{2,t}$ is derived from taking the second-largest eigenvalue in step 4, and so on. The size of the eigenvalue λ_j relative to the sum of the eigenvalues, represents the relative capture of variation in the underlying data for that particular principle component. The corresponding eigenvectors are the factor loadings for each time series, with larger weights applied to more representative time series. Step 5, while optional, simply normalizes the factor loadings to produce a more intuitive principle component. This is useful when considering the general movements in the level of the tax code, as it scale the resulting variable into a representative marginal tax rate. Each iteration on this procedure produces a component description one dimension of variation in the tax code.

2.2.3 The Principle Components

The principle components considered here are shown in Figure 3. At 88.44% and 9.92%, respectively, the first two components account for the overwhelming majority of the variation in the data. When used in FAVAR models, the principle components cluster a wide variety of data series into useable variables; often making them hard, if not impossible, to interpret. This aspect of principle components is why they are often motivated as a way to eliminate omitted-variable bias with restrictive degrees of freedom. The setup of this PCA exercise, however, uses a variety of constructed data series from the same source, which provides a much easier interpretation.

The interpretation of these components can be derived from their factor loadings in Figures 4(a) and 4(b). With all the factor loadings being positive for the first principle component (and adding to unity via the normalization in Step 4 above), the first principle component is a weighted average of all the marginal tax rates. This makes it a representative tax rate, or a depiction of the general movements in the level of the tax code. What is surprising about these factor loadings is

⁷ For a look at the effective tax rate analog of Figure 2 and further discussion of the bracket creep described above, see Keinsley (2016, Fig. 1)

the sizable weights placed on the top income levels. This suggests that the top-marginal income tax rate would be a relatively good proxy for the general level of the tax rates. The factor loadings for the second component are negative for lower income levels and positive for higher income levels.⁸ Thus, raising (lowering) the lower (higher) marginal rates will cause this variable to decrease. This leads to the interpretation that this component represents the spread of the marginal tax rates. Together, these two variables represent the first- and second-order movements in the structure of the federal income tax code. Though there is a literature outlining how to choose the optimal number of factors (see Bai and Ng, 2002, and others), the capture of over 98% of the variation in the tax code and a lack of intuition for a third principle component suggests that use of the first two components should suffice.

2.3 Data

The growth rate of real private spending per capita is considered for the income variable. This is created using nominal gross domestic product and removing the government component. The resulting values were then divided by the population and adjusted for inflation using the derived GDP deflator with 2009 as the base year. For the fiscal side of this analysis, the primary deficit-to-GDP ratio is used. It is derived by adding nominal interest payments back into the standard federal-expenditures-less-revenues calculation of the deficit. This value is then divided by nominal GDP. While the generated tax data is available back to 1913, the remaining data is limited to the post-war era (1947-2016). Therefore, the model only considers that time period.

2.4 Identification and Estimation

A structural vector autoregressive (SVAR) model is used to analyze the connection between the structure of the federal income tax code, economic growth, and fiscal deficits:

$$X_t = B_0 + B(L)X_t + C\varepsilon_t \quad (1)$$

where X_t is a vector of selected variables, $B(L)$ is a lag-polynomial of parameter matrices, C is the impact multiplier matrix, and ε_t is a vector of structural shocks. Since the tax code can be represented with just two variables, the level and the spread, the model can be expressed in four variables. Thus, in reference to (1), the setup $X_t \equiv [\tau_{1,t}, \tau_{2,t}, y_t, d_t]'$ is used as a baseline. These are the tax level, tax spread, growth rate of private spending, and the primary deficit-to-GDP ratio, respectively. Due to the accounting identity discussed above, the four corresponding shocks are identified as shocks to the tax level, tax spread, private spending, and fiscal spending; respectively.⁹ 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.

This model includes a Cholesky-style short-run restriction matrix to identify the structural shocks. Given the history of the federal income tax code, these variables are aligned first because they are more persistent and exogenous than the other variables due to legislative lags or inaction. The tax level variable is ordered first but, due to the orthogonality of the two components, adjusting

⁸ To aid the visual analysis, the second component was multiplied by -1. Doing so does not impact the results, but it allows a positive innovation in the series to represent an increase in the spread, making it more intuitive to analyze.

⁹ Henceforth, the private spending shock is referred to as an output growth shock. This is a result of how the variable is constructed, being non-fiscal GDP.

this order does not effect the results. Output growth and the deficit ratio react contemporaneously to shocks to the tax rates. Ordering the real variables y_t and d_t in this fashion is done for two reasons. The first has to do with legislative and implementation lags. While these lags may not reach a full year in length, their existence would render any annual reaction of private spending growth rather muted. The second motivating factor is the setup of the variables themselves. A structural shock to the primary deficit-to-GDP ratio is identified as a shock to the fiscal spending. Therefore, holding private spending growth constant in the immediate term forces the interpretation that a structural shock to the deficit ratio is a positive innovation to its numerator, not a negative innovation to its denominator. Additionally, since the deficit ratio is a function of all the other variables, it must react contemporaneously to all the shocks.

3 Results

Impulse response functions (IRFs) are shown as one-standard-deviation shocks to each of the variables (Figure 5). Here, each row represents a particular variable’s response to the shocks, which are listed across the top of the figure. Solid lines represent the estimated values, while the shaded areas and dotted lines correspond to one- and two-standard-error confidence bands, respectively. These IRFs, combined with a variance decomposition (Table 2) form the baseline results and are the focal point of the discussion that follows.

The overarching theme of these results is that, when considering possible deficit-reducing policies, economic growth is the primary conduit of the income tax code. First, increasing the overall tax level has no statistically significant impact on the deficit-to-GDP ratio. (Figure 5, Column 1). This result stems from the potential drag of higher taxes on economic growth, which is statistically significant at the one-standard-error confidence level. So while policymakers may look to increased taxes to reduce primary deficits, a potentially negative indirect effect makes this policy ineffective. Second, increasing the spread (or progressiveness) of the income tax code has a positive and statistically significant impact on economic growth (Column 2). This expansionary effect on the tax base puts downward pressure on the deficit ratio, a result that is statistically significant at the one-standard-error confidence level. Though there is no evidence of a direct, statistically significant effect, the results suggest that this type of policy may have an indirect effect on the deficit ratio via this economic growth channel. In the long run, these two tax policies contribute similarly to variations in the deficit ratio. In the short- and medium-run, however, their impacts on output growth lead to distinct effects on the deficit ratio (Table 2, Columns 5-6). Thus, when choosing a deficit-reducing tax policy, these results suggest that increasing the progressive nature of the tax code is more potent than simply raising tax rates.

One drawback to the derivation of our tax variables is that an increase in the spread describes both decreases in the lower marginal tax rates as well as increases in the higher marginal tax rates, holding the other constant. This baseline study treats these two scenarios identically, though it is quite probable that these have differing effects. For example, Mertens and Olea (2018) suggest that there are dynamic differences between tax cuts to the top one percent of earners versus the bottom ninety-nine percent of earners. In order to explore this within our framework, we combine the results of multiple robustness checks in Section 4 to find that economic growth is positively related to the spread regardless of the source of any fluctuations. That is, while quantitatively different, economic growth rises with cuts to marginal tax rates on lower incomes and/or hikes to marginal rates on higher incomes. Thus, the increased economic activity seems to stem from a distribution

effect: moving disposable income from low to high marginal propensities to consume.

Intuitively, the biggest drivers of the fiscal deficit ratio are economic growth and government spending, whose shocks have statistically significant impacts on the primary deficit ratio (Figure 5, Columns 3-4). The importance of economic growth, however, remains. Though government spending shocks contribute the most to variations in the deficit ratio upon impact, the downstream effects on economic growth contribute the most to these variations immediately thereafter (Table 2, Columns 7-8). So, just as the tax code results suggest, economic growth is the largest driver in deficit reduction.

4 Robustness

This section considers a number of robustness checks cover the recursive identification scheme, model specification, and sensitivity to omitted variables. Despite the restrictions of annual data and the smaller sample size, these results are robust to a wide range of alterations and tests.

4.1 Recursive Identification Scheme

As with any model, the identification scheme is always subject to challenge. In the baseline model, the tax code variables are ordered first, then output growth and the deficit ratio. Since they are orthogonal by design, it is unsurprising that changing the ordering of the tax code variables does not alter the results qualitatively. However, adjusting the ordering of the other variables confirms the baseline analysis and provides further insight into the relationships at hand. Below are a number of tests that address potential issues with the recursive identification scheme.

4.1.1 Capturing What is Intended

Despite the intuitive look to the components shown in Figure 3, it is important to ensure that the model above is truly capturing the level and spread fluctuations in the tax code. Referring to the decomposition described in Section 2.2, the original \mathbf{T} is separated into two parts, those tax brackets representing the wealthy, \mathbf{T}_w , and those tax brackets representing the rest, \mathbf{T}_r , giving us $k \times n$ and $(m - k) \times n$ matrices, respectively, where k is the top echelon of tax brackets. The separation point is assigned to the \$400,000 level, which is roughly the split between the top one percent and the bottom ninety-nine percent of households.¹⁰ Applying PCA to each of these sets of marginal tax rates yields one principal component containing over 90 percent of the fluctuations and roughly matching the movements in the levels of each category. These derived variables are then used in the same 4-variable VAR, with the impulse responses shown in Figure 6.

Since these components are not orthogonal, increases in the top marginal rate cause increases in the lower marginal rate as well. On the other hand, due to the Cholesky decomposition, an increase in the lower rate does not cause top rates to rise. Thus, a shock to the top marginal rate acts as a general hike in the tax level overall, while an increase in the lower rate represents a decrease in the tax spread. The growth rate of real private spending per capita is not significantly impacted by

¹⁰ This dividing line has been rather arbitrarily chosen to match the public discussions on income inequality following the financial crisis of 2008-2009. See Mertens and Olea (2018) for another discussion on this type of categorization.

the top rate shock, though it does resemble the reaction to the level shock in Figure 5. Likewise, the response of the growth rate to the lower tax shock is a mirror image of the response in Figure 5 to an increase in the spread. Thus, it seems that the original setup does capture true adjustments in the general level and spread of the income tax code.

4.1.2 Tax Spread and Output Growth

The federal income tax code was first indexed to inflation in 1985 as part of the Economic Recovery Tax Act of 1981. The bracket creep seen in the non-indexed era has been shown to have potentially dramatic impacts on economic dynamics, providing an additional channel for supply-side shocks, in particular (Keinsley, 2016). This implies that there could be a two-way dependency between the tax spread and output growth. Figure 7 shows that swapping the tax spread and output growth variables in the model, such that $X_t^{(1)} \equiv [\tau_{1,t} y_t \tau_{2,t} d_t]'$ reveals that there is a general, positive relationship between these two variables. The variable with the positive reaction, however, depends on which is ordered first.¹¹ The remainder of the results are consistent with Figure 5. The question then becomes one of causality. The easiest way to address this would be to simply run the 1985-2016 subsample with the indexed tax code. The results of this test look qualitatively similar, but with only 32 observations in the subsample this test is not adequately reliable.

To better address this issue, the structural shocks of the tax spread are extracted from both the baseline model and this alternative ordering.¹² These structural shocks are then included in a two-variable VAR with the growth rate of real private spending per capita, where Granger causality tests can be applied.¹³ This test will shed light on whether the innovations to the tax spread are driving the growth rate, or vice versa. The results are shown in Table 3. As can be seen, the null hypothesis that the structural shocks of the tax spread do not granger cause output growth is rejected at the 99% confidence level, while the reverse hypothesis cannot be rejected. This, coupled with the general lack of any other qualitative changes in Figure 7, suggests that the ordering used in the baseline model is preferred.

4.2 Alternative Estimation and Identification Techniques

4.2.1 Proxy-Vector Autoregression

The use of proxy variables to identify structural shocks in vector autoregression models has grown in popularity recently. With this in mind, we replace our tax level variable in Section 2.2 with the average marginal individual income tax rate (AMIITR) and the tax spread variable with spreads between the AMIITRs of various income percentiles, as derived by Mertens and Olea (2018). We then construct the level changes in the principle components (Figure 8) for use as proxy variables. Thus, changes to the first principle component (level) aid in the identification of structural shocks to the overall AMIITR. Likewise, the same is considered of the second principle component. Using the test for a weak proxy developed by Lunsford (2015, Table 2), we find that the F-statistics for the individual proxy variables are 34.88 and 7.40, respectively.¹⁴ These values indicate that,

¹¹ Additional alterations to the ordering does not impact this relationship.

¹² The structural shocks are dependent on the model specification, so both are considered for completeness.

¹³ These two-variable VAR models include four lags, per AIC.

¹⁴ The strongest variable for which the second principle component served as a proxy was the spread between the AMIITR of the top-5% less that of the bottom 90%; all other considerations faired worse. Given the model, this test

while the first principle component is a relatively strong proxy for the AMIITR, the second principle component is a particularly poor proxy for the spread between the AMIITRs. We therefore consider the results of simply substituting the tax level variable, leaving the tax spread variable as in the baseline model. This proxy-VAR specification, however, yields results that are qualitatively unaltered. Thus, we conclude that using these derived variables as proxies does not add any substance to this study, but does marginally contribute to the robustness of the core results.

4.2.2 Jordà Projection Method

The use of annual data and the identification restrictions used in the VAR above naturally lend themselves to criticisms. While this section considers multiple robustness checks of the identification assumptions, measurements, omitted variables, etc. it would be useful to consider an alternative model as well. A simple, yet popular, alternative model to consider is to estimate the impulse responses by local projection methods as in Jordà (2005). For consistency, the same control variables and lag structure are considered. Figure 9 shows that the main results are robust to the modeling technique as well. In fact, while the negative impact of an increase in the spread of the federal income tax code is only significant at the 68% level in the baseline model, Figure 9(c) shows that this result is significant at the 95% level. This only strengthens the “indirect channel” result suggested by the baseline model. In general, the baseline results seem to be robust to the modeling technique.

4.3 Controlling for Other Tax Rates

While the federal income tax has produced around 40 percent of federal revenue on average, the variety of other taxes levied on economic activity need to also be considered.

4.3.1 Corporate Income Taxes

Since the output growth metric used in this analysis is that of real private spending per capita, the impact of taxes on firms needs to be explored. To do so in a parsimonious fashion, the average corporate income tax rate considered by Mertens and Ravn (2013) is added to the VAR model.¹⁵ While this variable is not derived in the same fashion as the income tax variables, this has been a common series used to describe tax rates throughout the literature and should provide a good indication of the robustness of the baseline results. This new tax variable is ordered first in the model, though alternative orderings do not impact the results substantially. Figure 10 shows that, just as in the previous robustness checks, the key relationships of the baseline model (Figure 5) remain. New to this analysis, however, is the Ricardian equivalence effect on both the corporate rate and the personal tax level. This effect was present at the 68 percent significance level in the baseline model, but not at the higher threshold. Also of interest is the statistically significant decrease in fiscal deficits in response to increases in the corporate income tax rate. Further analysis of this result is left to future research.

is conducted with $n = 4$ and a confidence threshold of $\alpha = 0.05$. These results suggest that the asymptotic bias of the first proxy is less than 0.05, but that of the second proxy exceeds 0.10.

¹⁵ The series used in this model is the annual average of their quarterly corporate tax data.

4.3.2 Payroll Taxes

Payroll taxes (FICA) are the second-largest generator of revenue for the US government, though these funds are earmarked for particular purposes. The impact of a tax that generates that much revenue, though, needs to be considered. For this analysis, the social security payroll tax derived by Barro and Redlick (2011) is added in the first position of the VAR. While this is not a narrative or purely-legislative measure of this tax, it is the simplest to implement parsimoniously. The results are provided in Figure 11. Just as in the previous robustness checks, the primary results of Figure 5 hold, though this new setup generates significance to the impact of spending on output growth. It is also interesting to note that shocks to this payroll tax generate negative and significant effect on the income tax level as well as output growth. The first of these results is likely a result of the timing of various tax reforms. For example, as the large income tax cuts of 1981 and 1986 were implemented, payroll taxes were simultaneously rising. The negative impact on output growth is also interesting because payroll taxes act in a similar fashion to income taxes in that they crowd-out both wage rates and corporate profits. The general shape of the output growth's response to both income and payroll taxes are very similar, though the income tax does not yield a statistically significant result.

5 Concluding Remarks

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 counter-productive. 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. This paper attempts to quantify the shifts in the government deficit-to-GDP ratio due to changes in the federal individual income tax rates while taking into account their effects on private spending. A structural vector autoregression model (VAR) and a novel tax policy time series that distinguishes between the level and spread of the federal income tax rates are applied to this question. Innovations to these different tax characteristics have significantly different effects on private spending and hence government deficits. Shocks to the general level of the tax rates have a much smaller effect on private spending as well as the government deficit ratio than shocks to their spread. Overall, changes to the federal 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 primary deficits, accounting for approximately 81 and 38 percent of the short- and long-run variations in the government deficit ratio, respectively. In the long-run, however, it is the exogenous shocks to the growth rate of private spending that account for the largest share (56 percent) of the variations in the government deficit ratio. These estimates, based on historical data, provide useful references when considering policy changes that aim at reducing government deficits and debts.

It should also be noted that, despite the positive growth response to an increase in the spread, the results of the PCA suggest that the vast majority of changes to the tax code are to the general level. At only 9.92% of the variation, the spread of the tax code has been a secondary thought for policymakers over the long history of the federal income tax code. These results suggest that more emphasis could (or should) be put on the spread of these tax rates.

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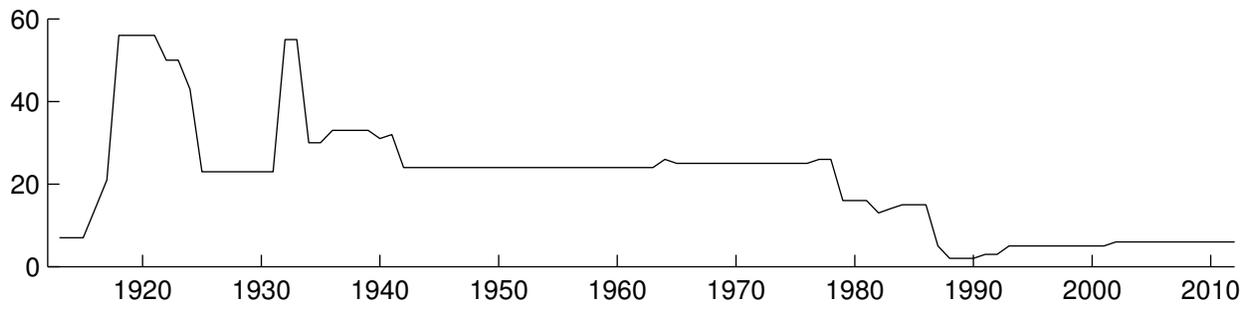


Figure 1: Tax Brackets in the United States (1913–2012)

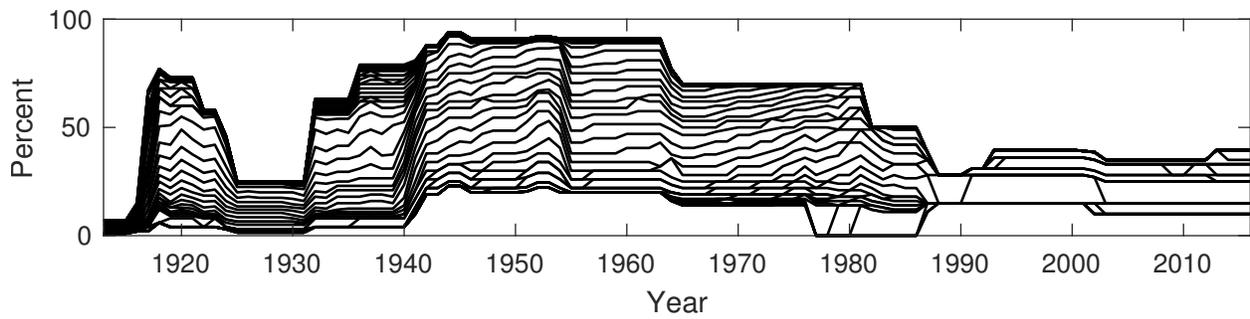


Figure 2: Real Taxable Incomes Applied to the Federal Income Tax Code

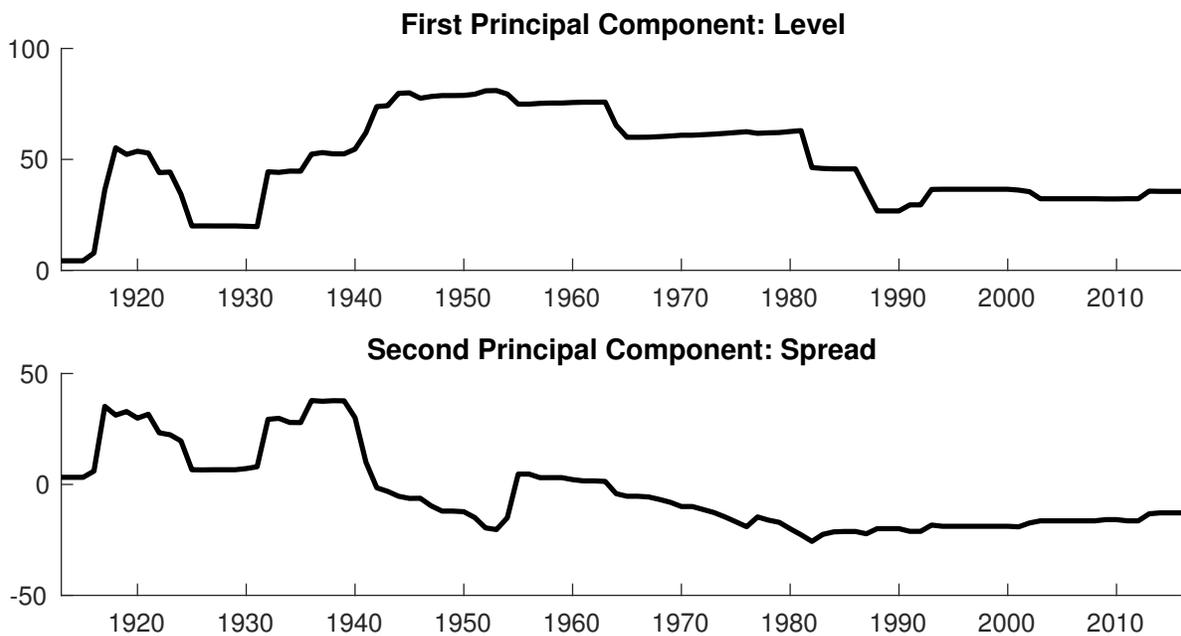
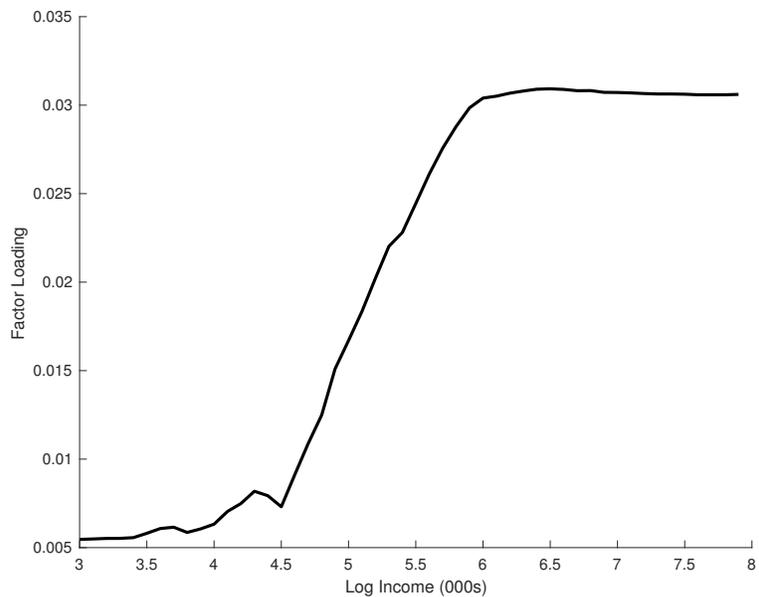
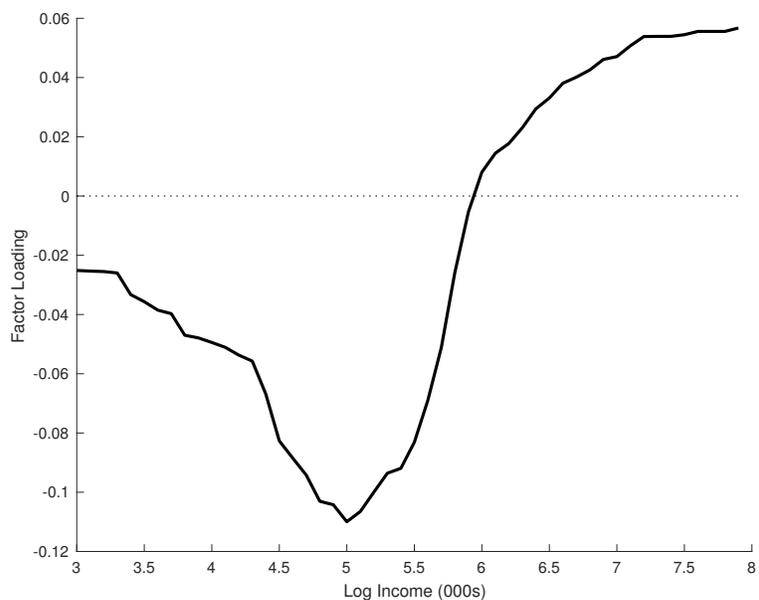


Figure 3: Principal Components of the Tax Code



(a) First Principle Component

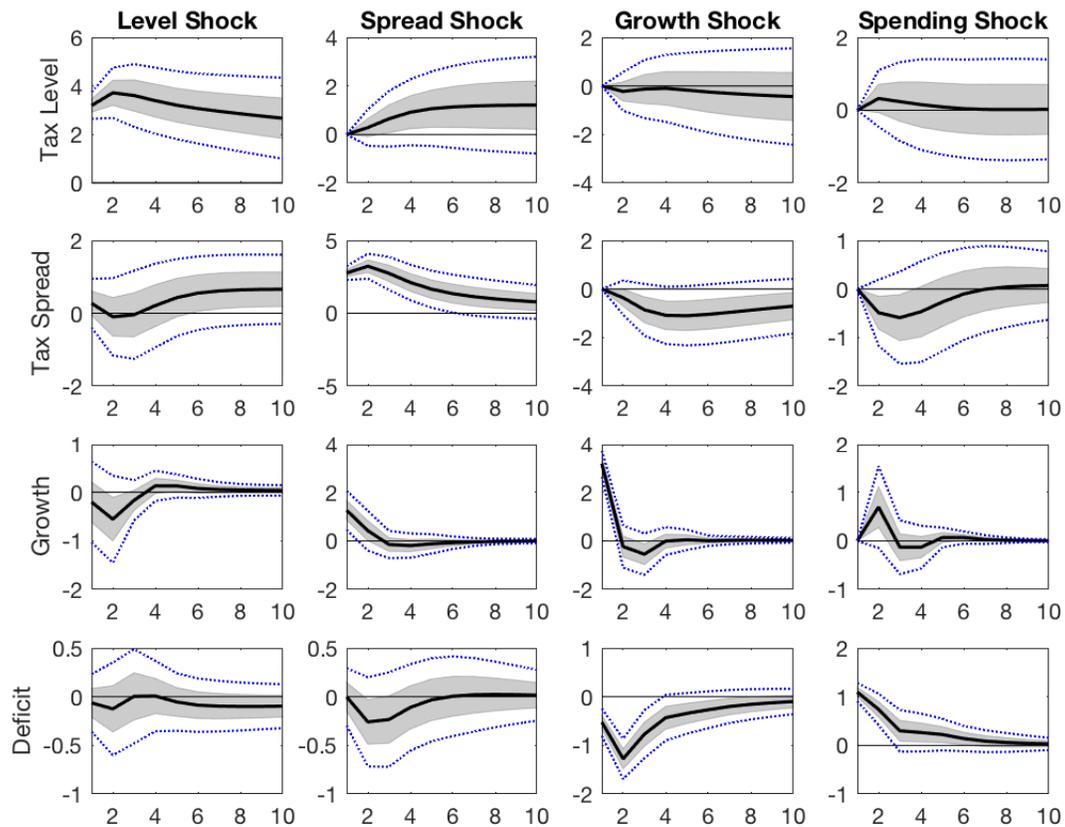


(b) Second Principle Component

Figure 4: Factor Loadings for the Principle Components

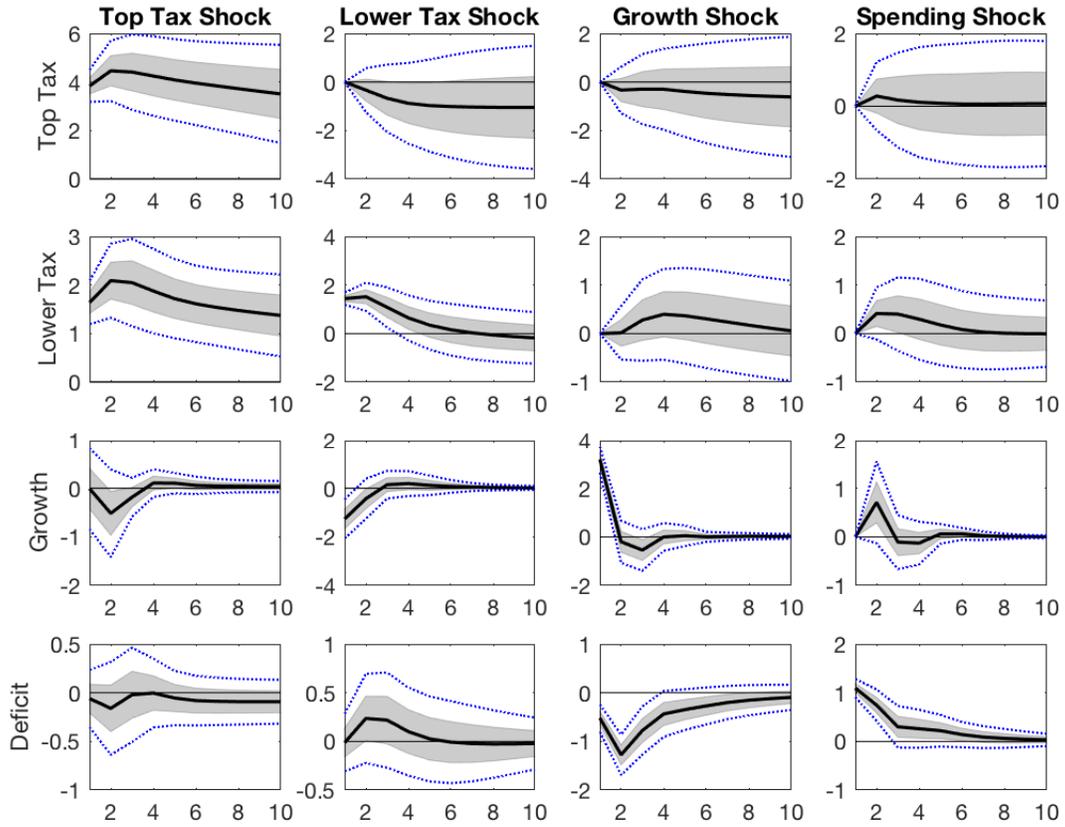
Note: The income levels are expressed in the natural logarithm of thousands of 2012 dollars. This makes the range of incomes from just over \$20,000 to just over \$3 million.

Figure 5: Impulse Response Functions – Baseline Model



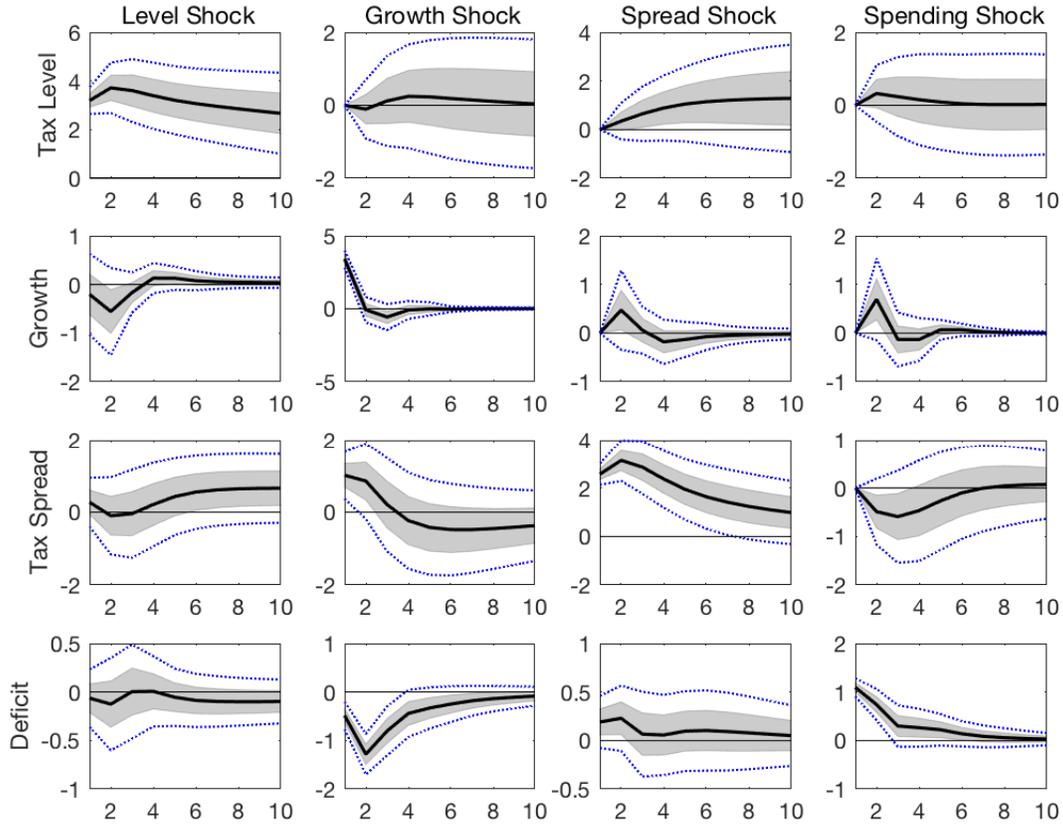
Note: The structural shocks are identified with via Cholesky decomposition. The impulse response functions are denoted by the solid, black lines. Shaded regions represent the one-standard-error confidence intervals, while the blue, dotted lines depict the two-standard-error confidence level.

Figure 6: Impulse Response Functions – Top/Lower Tax Rates



Note: The structural shocks are identified with via Cholesky decomposition. The impulse response functions are denoted by the solid, black lines. Shaded regions represent the one-standard-error confidence intervals, while the blue, dotted lines depict the two-standard-error confidence level.

Figure 7: Impulse Response Functions – Alternate Ordering



Note: The structural shocks are identified via Cholesky decomposition. The impulse response functions are denoted by the solid, black lines. Shaded regions represent the one-standard-error confidence intervals, while the blue, dotted lines depict the two-standard-error confidence level.

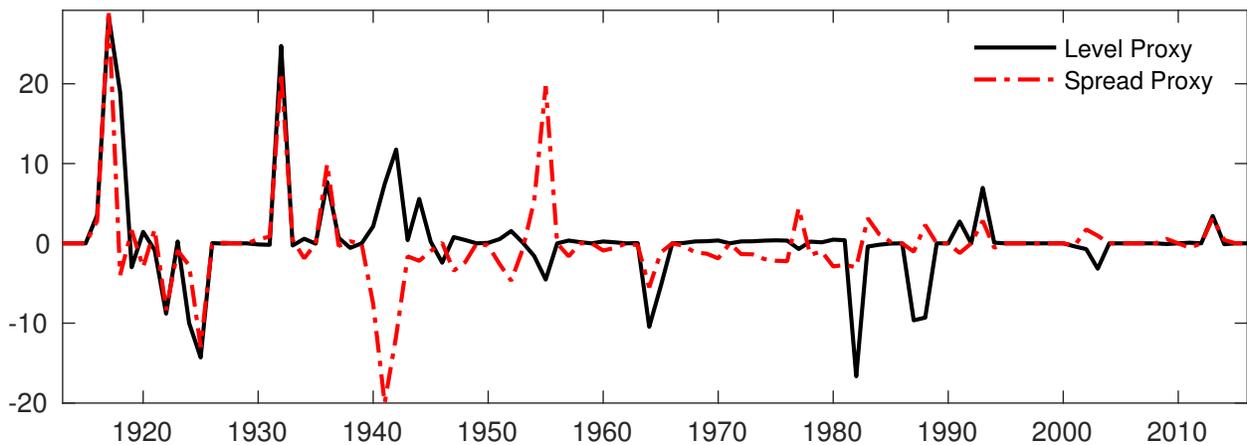
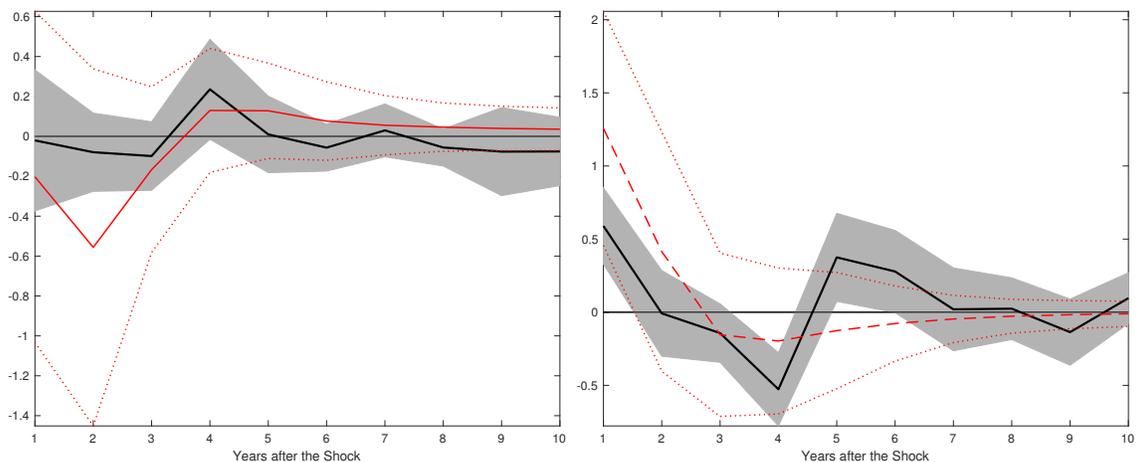
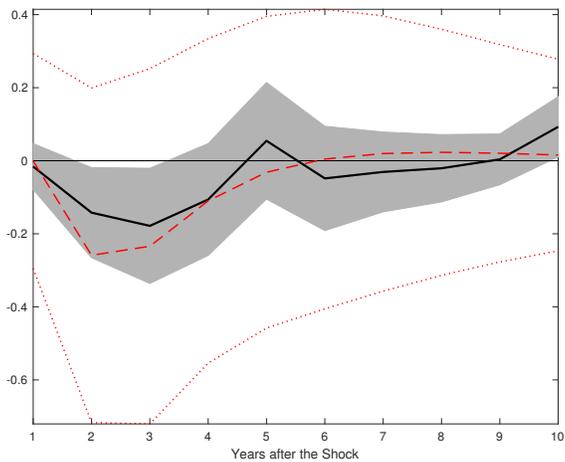


Figure 8: Proxy Variables Considered

Note: Measured in percentage points, these proxy variables are the level changes in their corresponding principal components.



(a) Private Spending Growth to a Tax Level Shock (b) Private Spending Growth to a Tax Spread Shock

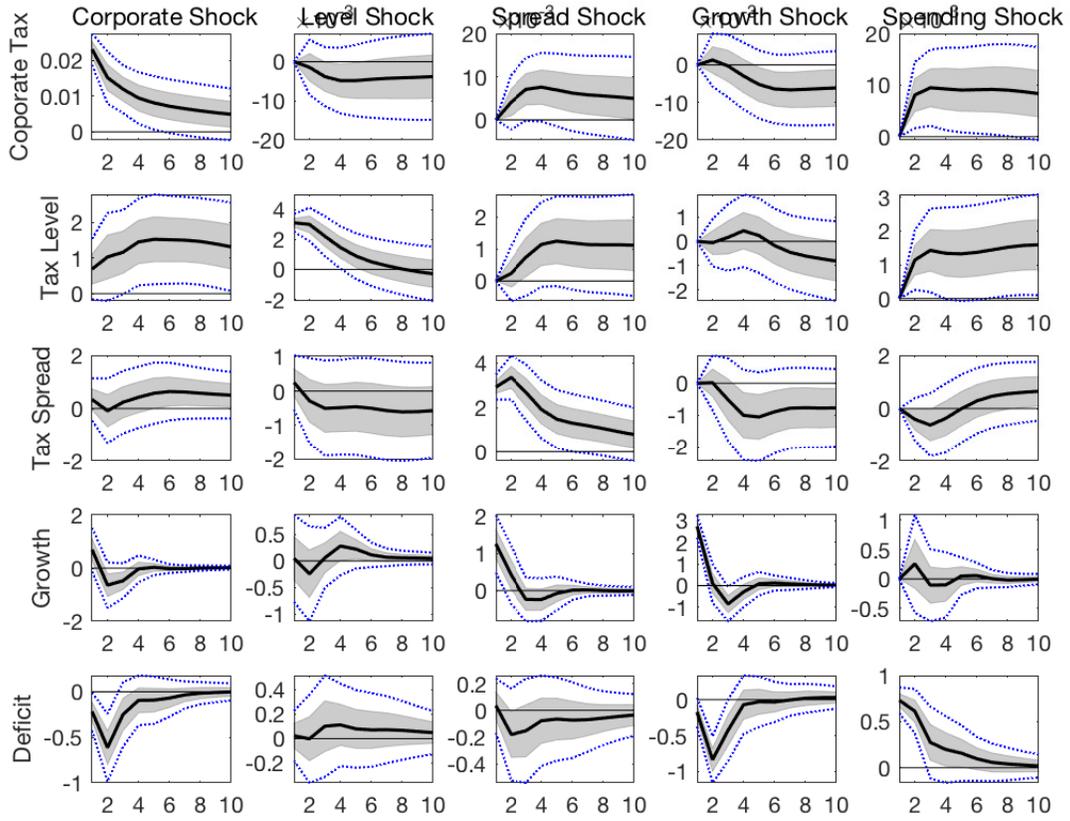


(c) Primary Deficit Ratio to a Tax Spread Shock

Figure 9: Selected Impulse Responses using a Jordà (2005) Projection Method

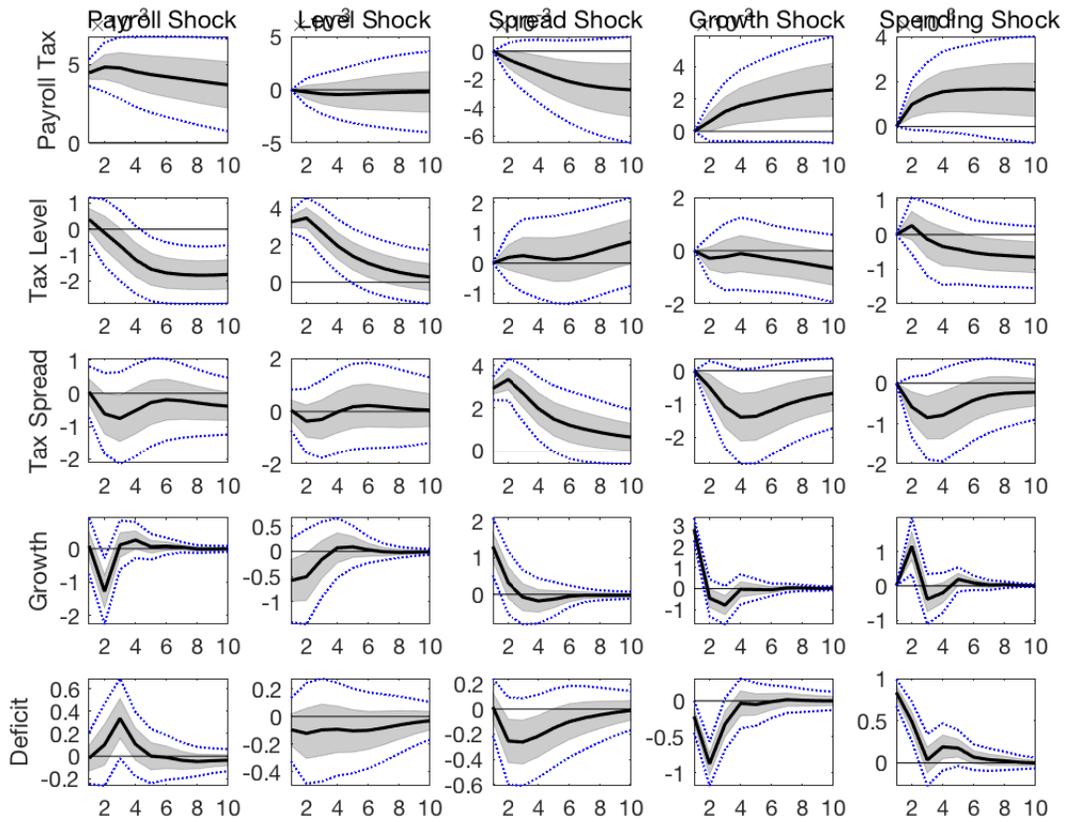
Note: The solid (black) lines and the shaded regions represent the impulse responses and two-standard-error confidence intervals using the Jordà technique, while the dashed (red) and dotted lines are the impulse responses and confidence bands from the baseline SVAR model.

Figure 10: Impulse Response Functions – Corporate Tax Extension



Note: The structural shocks are identified with via Cholesky decomposition. The impulse response functions are denoted by the solid, black lines. Shaded regions represent the one-standard-error confidence intervals, while the blue, dotted lines depict the two-standard-error confidence level.

Figure 11: Impulse Response Functions – Payroll Tax Extension



Note: The structural shocks are identified with via Cholesky decomposition. The impulse response functions are denoted by the solid, black lines. Shaded regions represent the one-standard-error confidence intervals, while the blue, dotted lines depict the two-standard-error confidence level.

Table 1: Mapping Marginal Tax Rates to Income Ranges: 2005

ln(income)	Income Level (000s Dollars)	Marginal Tax Rate	
		2002	2003
⋮	⋮	⋮	⋮
5.0	\$148.413	27%	25%
5.1	\$164.022	27%	25%
5.2	\$181.272	30%	28%
5.3	\$200.337	35%	33%
⋮	⋮	⋮	⋮

Note: The $\ln(\text{income})$ column represents the natural logarithm of the income level measured in thousands of 2012 dollars. Figure 2 depicts these rates, holding the real income level constant.

Table 2: Variance Decomposition – Base Model^a

Period	Output Growth				Deficit Ratio			
	Tax Level	Tax Spread	Private Growth	Fiscal Spending	Tax Level	Tax Spread	Private Growth	Fiscal Spending
1	0.35	13.50	86.15	0.00	0.27	0.00	18.38	81.35
2	2.75	13.77	79.70	3.78	0.52	1.79	50.89	46.80
3	2.89	13.56	79.75	3.80	0.44	2.72	55.75	41.09
4	3.00	13.78	79.31	3.91	0.41	2.82	56.53	40.23
5	3.12	13.86	79.09	3.93	0.46	2.74	56.96	39.84
6	3.16	13.89	78.99	3.96	0.60	2.69	57.27	39.44
7	3.18	13.89	78.96	3.97	0.78	2.67	57.42	39.14
8	3.19	13.90	78.94	3.97	0.97	2.66	57.46	38.91
9	3.21	13.90	78.93	3.97	1.16	2.65	57.45	38.74
10	3.21	13.90	78.92	3.97	1.34	2.65	57.42	38.60
15	3.25	13.89	78.90	3.96	2.05	2.62	57.10	38.22
20	3.27	13.89	78.88	3.96	2.53	2.64	56.81	38.02

^a Results are expressed as a percent of variation.

Table 3: Granger Causality Tests - Spread Shocks and Output Growth

Null Hypothesis	p -value	
	(1)	(2)
ϵ_{τ_2} does not granger cause y	0.0053	0.0034
y does not granger cause ϵ_{τ_2}	0.3170	0.2808

Note: Model (1) denotes that the structural shocks were taken from the baseline model with the tax spread ordered first. Model (2) represents the same process from the alternative ordering.