# The Quantitative Effects of Tax Foresight: Not All States Are Equal*

Ana María Herrera[†] Sandeep Kumar Rangaraju[‡]

**Abstract**

This paper explores the effect of federal tax news on state economic activity. We estimate a factor-augmented vector autoregression (FAVAR) model, which allows us to consider the possibility that unobserved factors –such as credit and fiscal conditions– might be relevant for modelling the dynamic response of aggregate and state-level economic activity. We identify tax foresight as a shock to the implicit tax rate, measured by the yield spread between the one-year tax-exempt municipal bond and the one-year taxable Treasury bond. Our results suggest that an increase in the implicit tax rate raises national output over much of the anticipation period. In addition, anticipated tax increases give rise to expansions in state personal income and employment. We find that the variation in the responsiveness of economic activity across states is mostly explained by differences in industrial composition and income distribution, as well as by some demographic characteristics such as median income and education. Finally, using a proxy for exogenous changes in federal tax revenues, we investigate the dynamics of state-level personal income and employment. Our results point to considerable heterogeneity in the response across U.S. states. Moreover, they reveal that the long-run multiplier for an anticipated increase in tax revenues is about a tenth of the short-run multiplier for an unanticipated increase in taxes.

*Key words:* Policy Foresight, FAVAR, Tax Policy, State Business Cycles
*JEL codes:* C32, E62, H24, H25

## 1 Introduction

The discussion regarding the macroeconomic effects of tax changes has gained momentum in academic and policy circles since the tax cuts of the 2000s and, especially, following the large stimulus package implemented to stave off the Great Recession. This discussion has bolstered a line of research into the economic effects of anticipated and unanticipated tax changes. On the one hand, work by Yang (2005), Leeper, Richter and Walker (2012), Mertens and Ravn (2011, 2012), and Leeper, Walker, and Yang (2013) has underlined the necessity of

*We thank William Hoyt, Michael Owyang, Elena Pesavento, David Wildasin, Sarah Zubairy and two anonymous referees for helpful comments and suggestions. We have also benefited from the many helpful comments provided by participants at various economic conferences and seminars. All remaining errors are ours.

†Corresponding Author: Department of Economics, Gatton College of Business and Economics, University of Kentucky, Lexington 40206-0034; phone: (859) 257-1119; e-mail: amherrera@uky.edu

‡Department of Economics, Goddard School of Business & Economics, Weber State University, Ogden, UT 84408; email: srangaraju@weber.edu.

accounting for tax foresight when analyzing the effects of tax policy changes. This literature has provided key insights into the importance of modeling information flows, the relevance of identifying the fiscal shock correctly in VAR models, and the incidence of ignoring fiscal news in estimated impulse response functions. On the other hand, public economics has long been interested in the effect of state level taxes on the economic activity of neighboring states (see, Wildasin 2011), as well as on the effect of tax changes on state income growth (Reed 2008, Bania, Gray and Stone 2007, Mullen and Williams 1994, and Helms 1985). This literature has underscored the importance of modeling subnational and national governments as interconnected jurisdictions that compete for resources and has revealed a robust negative relationship between taxes used to fund general expenditures and income growth.

Despite this rich theoretical and empirical literature, and in contrast with the growing evidence on the effect of tax changes on macroeconomic aggregates, much less is known about the dynamic response of state-level economic activity to federal tax news. Does news about future federal tax increases depress or stimulate state-level economic activity? Are the effects of this shock similar across states or do they differ as it is the case for monetary policy (Carlino and DeFina, 1998) and government spending shocks (Owyang and Zubairy 2013, Nakamura and Steinsson 2014)? More importantly, what drives the variation in the response of state-level economic activity to tax news? To grasp the importance of these questions, consider the recent debate regarding the economic effects of raising the top tax rates (Porter 2012ab, Buenker and Pizzigati 2014, The Economist 2012, Piketty, Saez, and Stantcheva 2014, Mankiw 2013). The income distribution in the U.S. has become more uneven since the mid-1970s, with the very top earners obtaining most of the productivity gains and recovering faster from the Great Recession (Piketty and Saez 2003, Saez 2013). This has fueled a heated debate regarding the need of a more progressive tax system. Yet, the percentage of top earners, industry mix, and other demographics varies greatly across states. Thus, should policy makers in states with dissimilar characteristics (e.g. different percentage of high-income earners) expect a differential response of state economic activity when a decrease in the federal income tax rate is announced following a national recession? What economic and demographic characteristics explain these differences? This paper takes a step towards answering these questions.

Economic theory suggests several ways in which foresight regarding federal tax policy could affect states differently. First, real frictions –such as investment adjustment costs, imperfect competition in goods and input markets, and variable capital utilization– smooth the response of agents to news about fiscal policy changes (see, e.g., Mertens and Ravn 2011, Leeper, Richter and Walker 2012, Leeper, Walker, and Yang 2013). For instance, capital adjustment costs stemming from disruptions during installation, costly learning, delivery lags, or time to install/build new equipment imply a sluggish and muted response of investment, and thus of production, to shocks. Similarly, monopolistic distortions in factor markets drive a wedge between the real returns to factors and their marginal product. Monopolistically competitive producers are unable to completely adjust prices in response to a news shock and the response of economic activity will be slower than in a perfectly competitive economy. Yet, not all industries face the same degree of capital adjustment costs[1], nor the same degree of monopolistic competition, and not all states have the same industrial composition. All else equal, states with a higher concentration of industries that face larger real rigidities should exhibit a slower and smaller response of economic activity to tax news. Conversely, the lack of significant frictions should be reflected in a faster response to tax news, which dissipates earlier.

Second, the proportion of non-savers in the economy affects how responsive economic activity is to fiscal foresight (see, e.g., House and Shapiro 2006, Leeper, Richter and Walker 2012). Consider, for instance, the effect of news regarding a tax increase on labor income. Such news would give firms and individuals an incentive to shift production to the anticipation period where taxes are lower. However, the ability to intertemporally substitute consumption is limited for households that operate hand-to-mouth and, thus, cannot take advantage of the news of an impending tax increase. All else equal, economic activity in states with a higher proportion of non-savers should be less responsive to tax news.

Third, Leeper, Richter and Walker (2012) show that the degree of foresight plays an important role in determining how responsive economic activity is to fiscal news. For instance, foresight can amplify the effect of a raise in capital taxes on investment and output. The higher the degree of foresight, the greater the incentive for firms to accumulate capital and increase production before the tax raise is implemented. It is conceivable to think that the degree of fiscal foresight might not only vary across time but also across states as federal tax changes might be more of a surprise for residents of some states (e.g., states with a less liquid municipal bond market).

In addition, Gruber and Saez (2002) find that the elasticity of taxable income differs significantly between high-income taxpayers who itemize deductions and other income groups. Thus, if high-income taxpayers are regionally concentrated, the effects of changes in federal taxes may vary systematically across states. Similarly, states differ in their tax treatment of personal income. Thus, a 1% increase in the federal personal income tax rate will result in a differential increase in the effective marginal tax rate and the tax burden across states, which may lead to disparities in the response of firms and households.

To measure tax foresight, we adopt the methodology of Leeper, Walker and Yang (2013) who use the implicit tax rate –measured by the yield spread between the one year tax-exempt municipal bond and the one-year taxable Treasury bond– to isolate news about changes in future taxes. This tax rate represents the rate at which investors are indifferent between the tax-exempt municipal bond and the taxable Treasury bond. Hence, if bond traders are forward looking, this rate predicts future changes in personal income tax rates as an anticipated increase in individual tax rates will induce investors to reduce their demand for taxable bonds, thus driving up the yield on taxable bonds.[2] We then estimate a factor vector autoregressive (FAVAR) model to trace out the dynamic response of state personal income and employment

[1] Hall's (2004) estimates of capital adjustment costs reflect a great degree of dispersion across the industries included in the NIPA data.

[2] As we will discuss in section 2, using this measure of tax shocks has several advantages over using other measures of anticipated (or unanticipated) tax changes.

growth. Our results suggest that a 1 percentage point increase in the implicit tax rate leads to higher real per-capita GDP and increased state economic activity during the anticipation period. Although all states exhibit a similar humped shaped response, the timing and magnitude of the effect varies greatly across states.

What drives the state variation in the response to tax news? To answer this question, we compute the states' one-year cumulative responses of personal income growth and employment growth and project them on a set of state-level covariates (i.e., state GDP composition, demographic and fiscal characteristics). The regression results reveal that state variation in the response to tax news is related to differences in industry mix, income level, income concentration and average federal marginal tax rates. More specifically, we find a larger effect of tax news on personal income growth for states that have a lower FIRE (finance, insurance and real estate) share in GDP, higher median income, higher average federal marginal tax rates, higher education, and more concentrated income distribution as measured by the income share of the top 1%. As for employment growth, the magnitude of the response increases with the share of retail, median income, the average federal marginal tax rate, and concentration of income distribution, whereas it decreases with the share of FIRE in GDP.

Our finding of an expansionary response of aggregate economic activity to tax news in the short-run (and contractionary as taxes are implemented) is not new (see e.g., Leeper, Richter and Walker 2012, Leeper, Walker and Yang 2013, Mertens and Ravn 2012, Kueng 2016). What is novel is that our study provides new insights into how the response of economic activity diverges across states and, more importantly, on the sources of these differences. Our results point to the importance of three mechanisms in the transmission of tax news. First, tax news appears to have a greater impact in states that have a larger median income and face higher average federal marginal tax rates. Second, the larger the percentage of the state's income accrued to the top 1%, the greater the response of state economic activity to tax news. These results indicate that the expansionary effect of tax news is larger in economies with a larger percentage of high-income earner who are likely to itemize deductions and to save more. That is, states with a higher percentage of individuals with the ability to re-optimize by changing their employment and investment decisions. Third, our results suggest that the magnitude of the effect is somewhat related to the state's industry mix. In particular, the impact of tax news is smaller in states where the FIRE economy plays a bigger role.

Our results are also consistent with recent work by Zidar (2015) that finds heterogeneity in the response of employment to tax cuts. Zidar (2015) constructs a novel measure of regional tax shocks by exploiting the fact that differences in income distribution across U.S. states leads to variation in the impact of federal tax changes. He shows that actual tax cuts (not tax news shocks) exert a larger stimulus on employment growth in states where the share of the top 1% is lower (i.e., states with a higher proportion of low-income earners).

Finally, we investigate the state-level dynamics of tax revenue shocks. To do this, we obtain state-level responses of personal income and employment growth to an unanticipated increase in federal tax revenues using a method that is similar to the proxy-SVAR of Mertens and Ravn (2014). Along the lines of our findings for a tax news shock, we find a similar hump-shaped response to an unexpected increase in federal tax revenues, but important divergences in the timing and magnitude of the effect across states. Our results indicate that the long-run multiplier for an anticipated increase in tax revenues is about a tenth of the short-run multiplier for an unanticipated increase in taxes.

The remainder of this paper unfolds as follows. Section 2 discusses the identification of tax foresight. Section 3 describes the factor augmented vector autoregression (FAVAR) model, the data set and the estimation method. In section 4, we describe the responses of aggregate and state-level economic activity to tax news. Section 5 explores the contribution of tax news shocks to economic activity during the period that preceded the Tax Reform Act of 1986. The next section explores the dynamic effect of unanticipated tax revenue shocks. Section 8 summarizes and concludes.

## 2 Identifying Tax Foresight

A crucial issue in quantifying the effect of changes in federal taxes on economic activity is that changes in taxes occur for different reasons. Some tax changes are implemented in order to finance a war, others because the economy is weak, or because the budget deficit is considered too high. Other tax changes take place automatically because the tax base varies with the income level or with other variables that affect the tax base, such as inflation or movements in the stock market. Therefore, an important difficulty in quantifying the effect of tax changes is disentangling the macroeconomic effect of exogenous and endogenous variations in tax changes.

Another key issue in estimating the macroeconomic effect of changes in tax policy is that what is considered a shock to federal taxes might be anticipated by economic agents. Indeed, a review of the tax events that took place in the United States during the 1957-2006 period suggests a long lag between the time the tax law was proposed and the time it was enacted. This legislative lag ranged between 2 and 17 months for the period under analysis.[3] Furthermore, the process of changing taxes also involves an implementation lag: there is a delay between the moment when a tax change is signed into law and when it is executed. Hence, news about future changes in tax policies reach the individual well before the change is effected, which implies that forward looking individuals will adjust their consumption and work patterns before the tax change has been implemented (see Leeper, Walker, and Yang 2013).

Recent research on the macroeconomic effects of tax policies has, thus, underlined the importance of identifying exogenous variations in tax policy and of accounting for tax foresight (see Mertens and Ravn 2011, 2012 and Leeper, Walker and Yang 2013).[4] The two leading methodologies used to tackle the issue of endogeneity are: (a) the narrative approach, and (b) the structural VAR approach. Romer and Romer (2010) have perhaps the most careful and comprehensive investigation on the effect of tax changes using the narrative approach.

[3] For a list of tax events and corresponding legislative lags see Table B.1 in the on-line, available at http://gattonweb.uky.edu/faculty/herrera/documents/HRAppendix.pdf

[4] A similar issue, the identification of government spending shocks, has been studied by Ramey (2011).

Based on congressional reports and other sources, they construct an "exogenous" tax change variable that evaluates each tax modification by its size and the timing of the intended effect on federal tax revenues during the first year when the tax change was implemented. Moreover, for a legislated tax change to be classified as exogenous it had to be intended to reduce a large inherited budget deficit or to increase long-run growth. Romer and Romer (2010) find a negative effect of exogenous tax increases on GDP. While this variable enables the researcher to disentangle the effect of exogenous tax variations, by construction, it measures changes that have been already legislated and, thus, is not well suited to capture anticipation of future tax modifications.

Instead, in most vector autoregressive (VAR) models identification of the tax shock is attained by assuming that tax returns are predetermined within the quarter with respect to the other macroeconomic variables (e.g., Blanchard and Perotti 2002).[5] Even though these studies also find a contractionary effect of tax increases, there is considerable disagreement as to the relative size of the tax multiplier associated with a shock to federal tax revenues (Mertens and Ravn 2014). Furthermore, an issue with this identification strategy is that what the usual VAR analysis identifies as innovations in taxes might have been forecasted by the economic agents. Hansen and Sargent (1980, 1991) first discussed how foresight poses a potential problem for interpreting VARs as it could result in time series with a non-fundamental moving average component.[6] Leeper, Walker and Yang (2013) and Leeper, Richter and Walker (2012) study the drawbacks of using the standard VAR approach to identify the effect of tax changes when there is foresight about taxes. Furthermore, they propose a line of attack for dealing with tax foresight: adding asset prices to the VAR in order to better align the information sets of the agent and the econometrician.

We follow Leeper, Walker and Yang's (2013) lead and use the yield spread between the one-year municipal bond and the one-year Treasury bill to capture foresight regarding future tax changes. More specifically, we compute the implicit tax rate as $\tau_t^I = 1 - \frac{r_t^M}{r_t^T}$, where $r_t^M$ represents the one year tax exempt municipal bond rate, and $r_t^T$ the one-year taxable Treasury bond rate at time $t$. Because municipal bonds in the United States are exempted from federal taxes, whereas Treasury bonds are taxable, the implicit tax rate can be used to identify news about future tax changes. In fact, this rate can be interpreted as the tax rate at which investors are indifferent between yields on municipal and Treasury bonds.

Using the implicit tax rate to capture tax news raises several questions. First, could the standard VAR tax shocks have been forecasted using the implicit tax rate? Second, is the implicit tax rate informative regarding future tax changes? Third, who is the marginal investor? Finally, are shocks to this national measure of tax news representative of anticipated changes in taxes at the state level? To answer the first question, we formally test the hypothesis that the usual VAR tax shocks can be predicted using the implicit tax rate. To do so we first compute the VAR shocks that would have resulted from estimating a VAR model in the spirit

[5] Alternatively, Mountford and Uhlig (2009) attain identification via sign restrictions.

[6] See also Fernández-Villaverde, Rubio-Ramírez, Sargent and Watson (2007).

of Blanchard and Perotti (2002). That is, we regress real per-capita net taxes on four lags of itself and of each of the following variables: the log growth of real per-capita government spending, the log growth of real per-capita GDP, and the federal funds rate. The residuals of this regression constitute the VAR tax shocks obtained by estimating the VAR equation-by-equation via OLS and imposing the identification assumption that real per-capita net taxes are predetermined relative to the other macroeconomic variables. We then carry out a Granger causality test between these VAR tax shocks and the implicit tax rate. Panel A of Table 1 reports the test results.[7] Clearly, whereas the implicit tax rate Granger-causes the VAR shocks, the VAR shocks do not Granger-cause the implicit tax rate.[8] In other words, it would seem that what the usual VAR analysis identifies as innovations in taxes might have been forecasted using the implicit tax rate.

As to the second question, does the implicit tax rate have any predictive content for future tax changes, the answer is yes. To illustrate the relationship between the implicit tax rate and a few measures of personal tax rates, Figure 1 plots the implicit tax rate, the top 1% marginal income tax rate, the average marginal federal income-tax rate (AMTR), the average personal income tax rate (APITR), and the average corporate income tax rate (ACITR) over the sample period. In addition, the shaded areas depict the time between the initial policy proposal and its enactment. Note that the Revenue Act of 1964, the Revenue Act of 1975, the Tax Reform Act of 1986 and the Economic Growth and Tax Reconciliation Act (EGTRA) of 2001 appear to have led to significant variation in the personal income tax rates and in the implicit tax rate. The Revenue Act of 1964, Tax Reform Act of 1986, and the EGTRA of 2001 reduced the marginal tax rates on individual income; whereas the Revenue Act of 1975 provided a temporary tax rebate. The figure shows evidence of movements in the implicit tax rate before the tax changes were actually enacted.

To formally test the hypothesis that the implicit tax rate is useful in predicting different tax measures, we perform a set of bi-variate Granger causality tests between the implicit tax rate and alternative tax measures previously used in the literature on the macroeconomic effects of tax changes. The test results are reported in Panels B-E of Table 1. We find that the implicit tax rate helps to forecast changes in real net per-capita taxes used by Blanchard and Perotti (2002), the average marginal income tax rate used by Barro and Redlick (2011), and the average personal income tax rate employed by Mertens and Ravn (2013). In contrast, none of these measures help predict the implicit tax rate (see Panels B-D). As for the average corporate income tax rate used by Mertens and Ravn (2013) we find no statistical evidence of Granger causality (see Panel E). To evaluate whether the implicit tax rate has any predictive content for the log growth of real per-capita net taxes once we condition on all the information contained in the Factor Augmented VAR that we describe and estimate in the following sections, we conduct a Wald test for of no Granger-causality from the implicit tax rate to net taxes. The results reported in Panel F of Table 1 indicate that we can reject the null in a 1% level test,

[7] All the Granger-Causality tests reported in Table 1 include four lags as indicated by the AIC.

[8] A similar exercise is performed by Ramey (2011) to show that the usual VAR innovations in government spending could have been forecasted by war dates.

given further evidence of how lags of the implicit tax rate have explanatory power for net taxes.

The third question that arises is: who is the marginal investor? Kueng (2016) provides convincing evidence that, since the 1970s, the marginal investor is a household near the top of the income distribution. His conclusions are based on two sources of data: the Federal Reserve's Flow of Funds and the Survey of Consumer Finances. In fact, data from the Federal Reserve's Flow of Funds Accounts suggest the percentage of municipal debt owned by households –either directly or through mutual funds– increased since the 1970s and has fluctuated around 74% since the 1990s (see Figure 2). Moreover, Figure 1 reveals that the path followed by the implicit tax rate resembles that of the average marginal income tax rate faced by the top 1% of the income distribution.

Finally, the implicit tax rate constitutes a measure of tax news at the national level. Thus, to the extent that the percentage of individuals in the top 1% varies across states and that these high-income earners are more likely to itemize and claim different deductions than low or medium-income earners, the effect of shocks to the implicit tax rate is likely to vary across states. In fact, as we will show in section 6, the greater the percentage of the state's income accrued by the top 1%, the larger the effect of tax news on the state's economic activity.

Identifying shocks to tax policy as innovations in the implicit tax rate has several advantages over other measures of tax shocks. First, as shown above, it does a better job at capturing news regarding tax changes than the VAR shocks. Hence, it improves the alignment between the information set of the agent and the econometrician. Indeed, Leeper, Walker and Yang (2013), and references therein, provide a convincing theoretical motivation as to why the implicit tax rate is helpful in predicting future tax changes. Evidently, the inclusion of the implicit tax rate per se does not identify the structural shocks to future taxes. In order to do so, we impose short-run identification restrictions to be discussed in the next section.

There are some possible limitations to using municipal bonds. First, one concern is that the yield spread may react to changes in factors other than tax news, such as callability, liquidity and default risks. However, as Leeper, Richter and Walker (2012) show the risk-adjustment for AAA-rated municipal bonds is not considerable. We thus use only AAA-rated municipal bonds to construct the implicit tax rate. In addition, Kueng (2016) provides evidence that at shorter maturities the municipal yield spread moves closer to the top marginal rate than at longer maturities (i.e., 2 versus 15 years). Thus, we estimate our benchmark model using the yield spread between the one-year municipal bond and the one-year Treasury bill, which corresponds to the one year forward tax rate (see Leeper, Richter and Walker 2012).

Second, one may argue that the marginal investor is not representative of the average taxpayer as he or she belongs to the higher tax bracket. As Kueng (2016) shows and we illustrated in Figure 1 the marginal tax rate implied by the municipal yield spread is close to the rate faced by the top 1% of the income distribution. Indeed, the correlation between these two rates is high, 0.78, but so is the correlation between the implicit tax rate (ITR1Y) and the average marginal income tax rate (AMTR) employed by Barro and Redlick (2011), 0.63.[9] Moreover, we have shown that the ITR1Y has predictive content for the (AMTR) and the average marginal federal income tax rate. Nevertheless, two caveats are warranted here. First, changes in ownership of municipal debt during the 1970s –from banks to households– suggest in the earlier period the ITR1Y might reflect a mix of movements in the marginal corporate income tax rate –when banks held a larger debt share– and the marginal personal income tax rate, especially for the top income levels. Second, because the ITR1Y constitutes a reduced form measure of expected future tax changes it might compound the effect of tax reforms that increased the top tax rates but decreased tax rates for the lower brackets or vice versa.

Finally, as Leeper, Walker and Yang (2013) point out, municipal bonds respond only to changes in individual income taxes, yet they are informative regarding when corporate taxes will change. In addition, the implicit tax rate does not allow for the distinction made in the theoretical literature between capital and labor income tax foresight. In particular, in standard neoclassical growth and New Keynesian models capital and labor tax foresight have the opposite effect on output during the anticipation period: anticipation of higher future capital income tax rates can be contractionary whereas the effect of anticipated higher labor income tax rates can be expansionary (Yang, 2005; Leeper, Walker, and Yang, 2013). Nevertheless, as we will see later, our study finds ample empirical evidence of an expansionary effect during the anticipation period, thus suggesting that tax foresight isolated from the spread between municipal bonds and the Treasury bill is mostly related to anticipation of future increases in labor income tax rates.

# 3 The FAVAR Model

## 3.1 Specification and Motivation

The main objective of this paper is to investigate the effect of tax foresight on state-level economic activity. To do so we estimate a $FAVAR$ model where the joint dynamics of the observed, $Y_t$, and unobserved factors, $F_t$, are given by

$$C_t = B(L)C_{t-1} + u_t. \tag{1}$$

$C_t = \begin{bmatrix} t_t & g_t & y_t & ff_t & F_t & \tau_t \end{bmatrix}'$ is a $(r+5) \times 1$ vector. $F_t$ is $r \times 1$ vector of unobserved factors, where $r$ is small. $Y_t$ contains the log of real per-capita net taxes ($t_t$), the log of real per-capita federal government spending ($g_t$), the log of real per- capita GDP ($y_t$), the federal funds rate ($ff_t$), and the implicit tax rate ($\tau_t$). $B(L)$ is a conformable lag polynomial of order $p = 4$.[10]. We allow for a deterministic trend by including a linear and a quadratic term in

[9] The correlation between the implicit tax rate and the average marginal income tax rate decreases with the income level (0.70, 0.56, 0.44, and 0.31 for the top 5%, top 10%, bottom 90% and bottom 99% respectively), but is statistically significant for all income levels.

[10] The lag length is set to 4 quarters as in Blanchard and Perotti (2002), Ramey (2011), and Mertens and Ravn (2013b), among others.

equation (1). The error term $u_t$ is an i.i.d. $(r+5)\times 1$ vector of zero mean disturbances such that $E(u_t u_t') = \Omega$.

The system in (1) is a VAR in $C_t$ where there is an additional complication relative to a standard VAR: the $r$ factors in the vector $F_t$ are unobserved. We assume that the factors in $C_t$ summarize the information contained in a large number of state-level variables, $X_t$. More precisely, $X_t$ is a $N\times 1$ vector containing: (a) the log growth of real per-capita personal income for each of the 48 contiguous states, $\Delta pi_{it}$, where $i = 1, 2, ..., 48$,[11] and (b) the log growth of real per-capita employment for each of the 48 contiguous states, $\Delta emp_{it}$, where $i = 1, 2, ...$ , 48. As in Bernanke, Boivin and Eliazs (2005) we assume that this vector of informational time series is related to the common components, $C_t$, according to

$$X_t = \Lambda C_t + e_t \tag{2}$$

where $\Lambda$ is a $N \times (r+5)$ matrix of factor loadings with $N = 96$ and $r$ is to be determined as explained in the following section. The $N \times 1$ vector $e_t$ contains mean zero series-specific error terms that are uncorrelated with the elements of $C_t$. Equation (2) reflects the idea that both the observed, $Y_t$, and the unobserved factors, $F_t$, constitute common factors that drive the behavior of the state variables in $X_t$. Estimation and identification of the FAVAR model are discussed in detail in the following section.

Our motivation for using the FAVAR methodology is fourfold. First, states enter and exit recessions at different moments in time and some regions experience separate recessions from the rest of the U.S. (Hamilton and Owyang, 2012). However, economic spillovers across neighboring states occur due to free factor mobility and the ability of households and firms to purchase goods across states (Carlino and Inman 2013). By using the FAVAR, we are able to capture these regional cycles, which we would neglect if we used a VAR. Second, a $FAVAR$ model allows these common factors to affect the macroeconomic variables while avoiding technical and conceptual issues that arise when the number of variables in a $VAR$ increases and so do the unrestricted parameters in the system (Stock and Watson, 2002). Third, work by Rossi and Zubairy (2011) underlines the importance of accounting for monetary and fiscal policy simultaneously when studying the effects of government spending shocks in VARs. Furthermore, Carlino and DeFina (1998) show that the response of economic activity to monetary policy shocks differs across some U.S. regions. The FAVAR enables us to control for monetary policy when studying the effect of tax news, while at the same time allowing for common factors. Finally, the sparse information set typically used in VARs could lead to a potential problem: policy makers and the private sector might have information not reflected in the VAR. Expanding the econometrician's information set via the FAVAR, in addition to measuring tax foresight through the implicit tax rate, provides a potential solution to this limited information problem.

One concern with factor models is that they require strong identifying assumptions and, thus, they might muddle the effort to identify economically meaningful shocks. However, to

[11] We follow the common practice in the literature on regional cycles of excluding Alaska and Hawaii as they do not border with any other U.S. state and their economic activity might not be driven by the common factors.

the extent that our identification assumptions are akin to those used in the VAR literature on fiscal shocks –as we will discuss in the following section– and because we identify tax news with shocks to the implicit tax rate, the identification of anticipated tax changes is straightforward.

### 3.2 Estimation and Identification

We consider the number of common factors to be unknown but fixed as in Bai and Ng (2002). To determine the number of factors that drives the vector of state variables $X_t$, we start with an arbitrary number $k_{max} = 8 * int[(\frac{min(N,T)}{100})^{1/4}]$, given by Schwert's (1989) rule, where $N = 96$ and $T = 200$.[12] Then, for a given $k$, we obtain estimates of $\Lambda^k$ and $F^k$ by solving the minimization problem

$$V\left(k, F^k\right) = \min_{\Lambda} \frac{1}{NT} \sum_{i=1}^{N} \sum_{t=1}^{T} \left(X_{it} - \lambda_i^{k\prime} F_t^k\right)^2 \tag{3}$$

subject to the normalization that $\Lambda^{k\prime}\Lambda^k = I_k$. Having obtained the minimized sum of squared residuals $V\left(k, F^k\right)$ for $k = 0, 1, \ldots, k_{max}$, we then select the number of common factors $\hat{k}$ that minimizes the information criterion suggested by Bai and Ng (2002):

$$IC_{p2}(k) = log[V(k, F^k)] + k * \frac{N+T}{NT} * log[min(N,T)]. \tag{4}$$

Minimization of $IC_{p2}(k)$ with respect to $k$ results in an estimate of $\hat{k} = 8$. As discussed above, five of the factors are observed ($t_t$ $g_t$, $y_t$, $ff_t$, $\tau_t$); thus we only need to estimate $r = 3$ unobserved factors.[13]

Having determined the number of unobserved factors, we proceed to estimate the FAVAR model in (1)-(2) using a two-step procedure as in Bernanke, Boivin and Eliasz (2005) and Boivin, Giannoni and Mihov (2009). In the first step, we estimate the three unobserved factors and their loadings from the large data set $X_t$ using an iterative procedure that purges the factors from the effects of the observed variables $Y_t$. Hence, these estimated unobserved factors $\widehat{F}_t$ can be interpreted as common economic factors, which recover shared aspects of the U.S. state level economy that are not captured by the observed components in $Y_t$.[14] In the second step, the estimated common factors, $\widehat{f}_{1,t}$, $\widehat{f}_{2,t}$, $\widehat{f}_{3,t}$, are used in conjunction with the observed macroeconomic variables in $C_t = \left[\begin{array}{cccccccc} t_t & g_t & y_t & ff_t & \widehat{f}_{1,t} & \widehat{f}_{2,t} & \widehat{f}_{3,t} & \tau_t \end{array}\right]'$ to estimate equation (1) using standard VAR techniques.

[12] We have 201 quarterly observations between 1956:IV and 2006:IV but we lose one data point when we take first differences of the logs in order to compute rates of growth.

[13] Results reported in the on-line appendix show that the FAVAR estimates are robust to using two, five, and eight factors.

[14] The procedure is implemented as follows. (i) Estimate the initial factors $F_t^{(0)}$ by principal components as in Bai and Ng (2013). (ii) Regress $X_t$ on $Y_t$ and $F_t^{(0)}$ to obtain the coefficients on $Y_t$, which we denote by $\lambda_y^{(0)}$; (iii) Compute $\widetilde{X}_t^{(0)} = X_t - \lambda_y^{(0)} Y_t$; (iv) Estimate the factors $F_t^{(1)} = [\ f_{1,t}^{(1)},\ f_{2,t,}^{(1)}\ f_{3,t}^{(1)}]$ as the first three principal components of $\widetilde{X}_t^{(0)}$; (v) Repeat the above three steps multiple times until the difference between the elements of two subsequent vector of factors $F_t^{(k)} = [\ f_{1,t}^{(k)},\ f_{2,t,}^{(k)}\ f_{3,t}^{(k)}]$ and $F_t^{(k-1)} = [\ f_{1,t}^{(k-1)},\ f_{2,t,}^{(k-1)}\ f_{3,t}^{(k-1)}]$ is not greater than $1E^{-4}$.

In order to identify the effect of news shocks on the variables of interest we follow Leeper, Walker, and Yang (2013) and impose the restriction that the implicit tax rate does not have a contemporaneous effect on the other observed macroeconomic variables (i.e., $t_t$, $g_t$, $y_t$, $ff_t$).[15] A similar restriction is imposed on the relation between the implicit tax rate and the factors, which implies that there is no contemporaneous effect of tax news shocks on state employment and personal income growth. Further, note that our identification scheme allows the implicit tax rate to respond to monetary policy shocks affecting the T-bill rate within the quarter. It is worth noting here that, as Christiano, Eichenbaum and Evans (1999) proved, all that is needed to partially identify the effect of the tax news shock is for all macroeconomic variables and the common factors to be predetermined with respect to the municipal bonds spread.

Because we are not interested in identifying shocks to the estimated factors, we do not attach a direct economic interpretation to them. Furthermore, it is important to note that we do not impose restrictions on the factor loadings in a manner that would allow us to classify them as regional factors (see e.g., Kose, Otrok and Whitman 2003). However, Table B.3 of the online appendix reveals that the first factor is highly correlated with economic activity in the Great Lakes, New England, the Mideast and Southeast regions; the second factor exhibits the largest correlation with the Southwest and Far West regions; and the third factor commoves mostly with personal consumption in the Plains (see Table 2 for a list of states in each economic region). Indeed, we have found that comovement among the state-level variables is well captured by five observable and three unobservable common factors[16]**;** yet, our results are robust to allowing for a larger number of factors (e.g., five or eight unobserved factors).

Point-wise confidence intervals for the impulse response functions are computed using a bootstrap method that accounts for the uncertainty in estimating the factors (Gonçalves and Kilian, 2004 and Yamamoto, 2019). We use 10,000 replications and report 68% confidence intervals as is commonly done in the literature (see Blanchard and Perotti 2002, Leeper, Walker and Yang 2013, among others).

### 3.3 Data

The data set used to estimate the FAVAR model comprises both aggregate and state-level quarterly data spanning the period between 1957:I and 2006:IV. We opt to exclude the period of the Great Recession as the introduction of unconventional monetary policy measures and the financial crisis are likely to have resulted in structural changes in the monetary policy rule and in the response of macroeconomic aggregates to changes in the interest rate (Trichet, 2013).

Regarding the macroeconomic aggregates, as mentioned, we compute the implicit tax rate as the yield spread between the one year tax exempt municipal bond rate, $r_t^M$, and the one-year taxable Treasury bond rate, $r_t^T$, at time $t$, so that $\tau_t^I = 1 - \frac{r_t^M}{r_t^T}$. The yields on tax-exempt

[15]See the supplement to Leeper, Walker, and Yang (2013).

[16]In fact $\widehat{f}_{1,t}$, $\widehat{f}_{2,t}$, $\widehat{f}_{3,t}$ explain the 38%, 16% and 6%, respectively, of the variance in the latent factors.

prime graded general-obligation municipal bonds and the taxable U.S. Treasury bonds data are obtained from Leeper, Richter, and Walker (2012). We follow Blanchard and Perotti (2002) –hereafter BP– and measure: (a) government spending as federal government consumption expenditures and gross investment, and (b) net taxes as the sum of federal, state and local tax receipts, less federal grants in aid, federal, state and local transfer payments to persons and interest payment to persons. The source of the data for government spending, net taxes, and real GDP is the National Income and Product Accounts (NIPA). We compute real per-capita measures by deflating government spending, net taxes, and real GDP using the GDP deflator and then dividing the real variables by the U.S. civilian non-institutional population over 16 years of age. The data for Federal Funds rate, $ff_t$, is obtained from the Federal Reserve of St. Louis database, FRED.

The state-level variables consist of log growth rates of real per-capita personal income and per-capita employment for the 48 contiguous U.S. states. The data for employment is obtained from Hamilton and Owyang (2012) whereas the personal income data is available from the Bureau of Economic Analysis (BEA). Rates of growth for state-level employment and personal income are computed by taking the first difference of the logarithm of the respective variables. Table B.2 in the on-line appendix provides details on the data and the construction of variables used in the FAVAR model. Following Stock and Watson (2002) and Bai and Ng (2013) all variables are demeaned and standardized prior to estimating the factors.

The reader may wonder why other state-level variables are not included $X_t$. The main reason is that data for the variables that might arguably align better with the theory put forward in the earlier sections (e.g., demographics, capital-intensity, adjustment costs) are only available at an annual or lower frequency. Furthermore, using annual data would invalidate not only our, but most identification strategies used in the literature. However, we will tackle the role of these state-level characteristics in section 6.

# 4 The Dynamic Effects of Tax News

## 4.1 Macroeconomic Aggregates

The red solid line in Figure 3 depicts the response of the macroeconomic variables and the estimated factors to a one percentage point increase in the implicit tax rate as implied by the $FAVAR$. 68% confidence intervals computed with a residual based wild bootstrap are denoted by dotted lines. In addition, to reassure the reader that our purged factors recover common aspects of the U.S. economy that are not captured by the observable macro variables in $Y_t$, the green dashed line depicts the response of the aggregate variables in a simple VAR without factors. Throughout the paper the impulse response coefficients for GDP represent tax multipliers, i.e., dollar changes in GDP as ratio of the dollar changes in tax revenues (see Figures 4 and 17). Our estimation results indicate that a shock to the implicit tax rate leads to faster real per-capita GDP, which reaches a peak increase of 0.022% five quarters after the shock. The expansionary effect lasts slightly over a year. This response falls in line with the classical view where an anticipated rise in personal income taxes causes an increase in output because individuals and firms have an incentive to switch production to the anticipation period where income taxes are expected to be lower. Furthermore, news of a future tax increase has a negative and immediate wealth effect, which gives agents an incentive to work harder and produce more.

Not surprisingly, real per-capita net taxes follow a similar pattern as real per-capita GDP: they increase on impact and reach a peak response of 0.21% six quarters after the shock.[17] Higher income results in greater tax returns during the anticipation period but, as it is the case for real GDP, the positive effect only becomes significant in the short run. In contrast, a positive shock to the implicit tax rate results in a slightly lower but statistically insignificant decrease in real per-capita government spending. The expansionary effect of the anticipated tax increase results in tighter monetary policy, which is reflected in a higher federal funds rate. This pattern suggests the Fed acts to control possible inflationary pressures stemming from heightened economic activity.

Figure 3 provides clear evidence that the $FAVAR$ responses are qualitatively indistinguishable from those obtained using a simple VAR. Note how the difference between the solid red and the dashed green lines is minimal. This result gives credence to our identification and estimation strategy, as our purged factors do not appear to capture fiscal shocks.

The estimated output multiplier associated with a one-dollar innovation in tax revenue due to an anticipated increase in tax rates is depicted in Figure 4.[18] The effect is slightly positive (0.01) but insignificant on impact but positive and significant in the short run. The multiplier reaches a peak of 0.198 five quarters after the shock; it then declines and turns negative two and a half years after the anticipated tax increase. Contrast these estimates with the output multipliers obtained by BP, Mountford and Uhlig (2009) and Leeper, Walker and Yang (2013). The two former studies estimate the effect of an unanticipated one-dollar increase in tax revenue to equal -0.74 and -0.79, respectively, four quarters after the shock. In contrast, Leeper, Walker and Yang (2013) estimate that higher anticipated taxes lead to a 0.19 increase in GDP four quarters after the shock. Our estimates mirror those obtained by Leeper, Walker and Yang (2013) by including the implicit tax rate in BP's VAR specification: an anticipated tax increase leads to higher GDP during the anticipation period and a decline once the tax increase is implemented.

The finding of a positive relation between tax news and economic activity is also consistent with the work of Mertens and Ravn (2011, 2012) and House and Shapiro (2006). The theoretical model constructed by Mertens and Ravn (2011) simulates the response of various macroeconomic variables to anticipated and unanticipated tax shocks for a range of different adjustment costs, labor supply elasticity, and variable capacity utilization. They find that

[17] Our estimates are consistent with Leeper, Walker and Yang (2013) who find that net taxes respond more than GDP to a shock in the implicit tax rate (see Figure S.1 of their Supplementary Material).

[18] Following Mountford and Uhlig (2009), we compute the multiplier for GDP as $\frac{\left(\frac{\text{GDP response}}{\text{Anticipated tax revenue shock}}\right)}{(\text{Average Tax Revenue share of GDP})}$. This definition of the multiplier is also used by BP and Leeper, Walker and Yang (2013).

announcements of future tax cuts result in curtailed output, investment and hours worked until the tax cut is implemented. Mertens and Ravn (2012) estimate a VAR model, which provides empirical evidence in support of the contractionary effect of pre-announced –but not yet implemented– tax cuts on output, investment, and hours worked. House and Shapiro (2006) find that the phased-in-tax reductions enacted by the 2001 Economic Growth and Tax Relief Reconciliation Act (EGTRRA) resulted in a 0.37% decline in aggregate employment. In fact, under the assumption that the implemented tax cut was permanent, the authors find a larger decrease of 0.78% in aggregate employment. Similarly, our estimates suggest a positive relationship between tax news and aggregate economic activity.

### 4.2 State Personal Income

Figures 5-8 display the accumulated impulse response functions for real per-capita personal income growth –hereafter personal income growth–, as well as 68% confidence intervals. For most states, the estimated responses reveal an increase in personal income growth that reaches a peak four or five quarters after the shock; that is, at the same time as GDP (see Panel A of Table 3).

Although the shape of the impulse responses is very similar across states, they differ greatly in magnitude. For instance, among the 37 states that exhibit a statistically significant expansionary response, an anticipated increase in the implicit tax rate results in a four-quarter cumulative change in personal income growth that ranges between 0.33% and 1.39% for Alabama and Wyoming, respectively (see panel A on Table 3). Given that the average growth rate for state personal income was 0.6% between 1957 and 2006, the effect appears to be economically significant (see Table B.4 in the on-line appendix). On average, one year after the shock, a one percentage point increase in the implicit tax rate would result in a 0.63 percentage points rise in state personal income growth.

Differences in the dynamics of the personal income growth response across states appear to follow a regional pattern. Figure 9 plots the personal income multiplier associated with a dollar innovation in tax revenues arising from an anticipated increase in tax rates across U.S. states for a few representative horizons.[19] Darker shades of red indicate larger positive responses to an innovation in the implicit tax rate. On impact (see Figure 9a), the effect on real personal income growth is somewhat smaller for states in the Northern Plains (e.g., Montana, South Dakota and North Dakota) and Plains (e.g., Kansas and Nebraska) regions. As it is represented by the increase in the number of states in dark red as the horizon increases, the impact spreads across states overtime and gradually rises in the Energy Belt, the South East and New England (see Figure 9d). Two years later, the effect starts to decline for most states. Throughout the three-year horizon the response of personal income is moderate for states that are in the Mountains/Northern region (see Figure 9).

Summarizing, whereas the impulse responses of personal income growth exhibit a similar

[19] We compute the personal income multiplier as $\frac{\left(\frac{\text{Personal Income response}}{\text{Anticipated tax revenue shock}}\right)}{(\text{Average Tax Revenue share of Personal Income})}$.

humped shape across states, the magnitude and timing varies. What drives these differences in the responses? Although we explore this issue in depth in section 6, we will advance a possible source of variation based on the patterns observed in Figure 9. Shocks to the implicit tax rate appear to have a considerably larger effect in states with higher income. For instance, compare the pattern followed by most states in the New England and Mideast regions (e.g., Connecticut, New Hampshire, Massachusetts, New York and New Jersey) with that of West Virginia and Mississippi, two of the states with the lowest median income. As denoted by the faster onset of a darker red in the map, the shock to the implicit tax rate generates a faster and greater expansion in personal income for the former group of states. This evidence is suggestive of a stronger response to tax news in states where there are more individuals who have the ability to save.

### 4.3 State Employment

Figures 10-13 plot the accumulated impulse response functions for per-capita employment growth –hereafter employment growth– to a one percentage point increase in the implicit tax rate, and the corresponding 68% confidence intervals. As the figures illustrate, an implicit tax rate shock results in a statistically significant increase in state employment growth for all but two (South Dakota and West Virginia) of the 48 contiguous states. For most states, the response of employment growth reaches a peak four to six quarters after the shock and declines subsequently. As it is the case with real personal income growth, the impulse response functions show a similar shape across states, but the magnitude of the effect differs considerably. For instance, four quarters after the shock, the change in employment growth ranges between 0.10% and 1.84% for Montana and Nevada, respectively (see Panel B on Table 3). To gain some insight as to the economic significance of these results, consider that the average rate of state employment growth during the 1957-2006 period equaled 0.56% (see Table B.4 in the on-line appendix). On average, the one-year cumulative impact of a one percentage point increase in the implicit tax rate is estimated to be a 0.72 percentage points increase in state employment growth. Hence, the effect is not only statistically but also economically significant.

Figure 14 illustrates the responses of real employment to one-dollar increase in anticipated tax revenue arising from a shock to the implicit tax rate.[20] These responses are measured in employment numbers across the 48 contiguous states for a few representative horizons. On impact, the difference in the response of employment growth across states appears to be similar to that in the response of personal income growth. Regional patterns are observable four and six quarters after the shock (see Figures 14b and c, respectively). Increases in employment growth are considerably larger for California, Texas, Florida and New York. Interestingly, in contrast with the patterns observed for personal income growth, the effect on employment growth for the Great Lakes region (0.46%) is not larger than the average effect across states (0.7%). The effect of a shock to the implicit tax rate appears to spread throughout the U.S.

[20] We compute the impact responses of state-level employment as $\frac{\left(\frac{\text{Employment response}}{\text{anticipated tax revenue shock}}\right)}{(\text{Average Tax Revenue share of Employment})}$.

states during the first year and then starts to die out about eight quarters after the shock.

Is the response of employment growth stronger or faster for states with a particular industry component? What demographic characteristics explain the diversity in employment patterns? Section 6 seeks to formally disentangle the drivers of the variation in the state responses to tax news shocks. However, let us point here that the patterns observed in Figure 14 suggest a larger employment boom ensues in states with higher income inequality (e.g. Nevada, New York and Florida).

We conclude this section by noting that while this paper does not distinguish between labor and capital income tax foresight, it provides ample empirical evidence that the tax news isolated from an innovation in the implicit tax rate has an expansionary effect on state-level personal income and employment. Given that in standard neoclassical growth and New Keynesian models anticipation of a capital income tax increase is contractionary whereas anticipation of a labor tax increase is expansionary, our results suggest that tax foresight isolated from the bond spread between municipal bonds and the Treasury bill is mainly related to anticipation of higher labor income tax rates. We further note that our finding of an expansionary effect is robust to a number of alternative specifications; namely using: (a) alternative measures of taxes (i.e. the average personal income tax rate, the average corporate income tax rate, and the average marginal tax rate); (b) bonds with longer maturities to compute the implicit tax rate; (c) alternative monetary policy specifications and exclusion of the federal funds rate (as in Blanchard and Perotti, 2002); and (d) a larger (five or eight) or a smaller (two) number of factors. For the sake of brevity, we report the results of these robustness checks in Figures B.1-B.36 of the on-line appendix.[21]

# 5 Historical Decomposition: The Tax Reform Act of 1986

Our interest in this section centers on the time period around the Tax Reform Act of 1986. This period is particularly appealing for two reasons. First, as can be seen in Figure 1, this episode contains a significant amount of tax news reflected in changes in the implicit tax rate, whereas other times are less rich in tax news (Romer and Romer 2010, and Leeper, Richter and Walker, 2012). Second, the period of foresight around this tax reform was considerably long. President Reagan first signaled a change in tax policy when he called for a simplification of the federal tax system in his State of the Union address on January 25, 1984. Yet, it took almost two years –until December 17, 1985– for the Tax Reform Act to be passed by the House of Representatives and six additional months until it was passed by the Senate in June 24, 1985. Enactment took place on October 22, 1986.

The impulse response functions described in the previous section measure the average effect of tax news over the estimation sample. Another useful summary statistic is the cumulative

[21] We estimate an alternative specification where the trend is assumed to be stochastic (unit root with drift) and the VAR model in equation (1) is defined in first differences. The results for this stochastic trend model are reported in Figures B.37-B.45 of the online appendix. As in Leeper, Walker and Yang (2013) such specification produces a longer-lasting expansionary effect of anticipated tax increases.

change in economic activity (i.e., GDP, employment growth and personal income growth) caused by a tax news shocks during the time that transcurred between the announcement of the tax reform in 1984:I and its enactment in 1986:IV. Such statistic may be computed starting from the historical decomposition

$$\widehat{C}_t \approx \sum_{i=0}^{t-1} \widehat{\Theta}_i \widehat{v}_{t-i} \tag{5}$$

where $\widehat{C}_t$ denotes the $8 \times 1$ vector of fitted aggregate variables and estimated factors of the $FAVAR$, $\widehat{\Theta}_i$ denotes the matrix of estimated structural impulse responses at lags $i = 0, 1, 2, ...$ and $\widehat{v}_{t-i}$ is a vector of estimated structural shocks.[22] We then compute the cumulative change in GDP growth $(\Delta\widehat{y})$ between the dates $t$ and $T$ due to each of the structural shocks $j = 1, ...,$ 8 as $\widehat{\Delta y}_T^j - \widehat{\Delta y}_t^j$. For the sake of brevity, and because we are not interested in separately identifying the shocks to the estimated factors, we report the sum of their contributions. In addition, we compute the contribution of tax news shocks to state personal income and employment growth by multiplying the estimated tax news contribution by the corresponding factor loadings.

The bars in Figure 15a illustrate the cumulative contributions to GDP growth of the structural shocks between the announcement of the tax reform in 1984:I and its enactment in 1986:IV. The figure shows that news of a tax reduction contributed to a decline of 0.04% in GDP growth. Figure 15b and Figure 15c depict the cumulative contributions of tax news shocks to state personal income growth and state employment growth, respectively. Between the announcement and the enactment of the 1986 Tax Reform Act, tax news accounted for a contraction in personal income and employment across the vast majority of states. The states that experienced the largest decline were Colorado, Connecticut, Florida, Texas and Wyoming. Only North Dakota experienced an increase in personal income growth. Interestingly, this was the only contiguous U.S. state that entered a recessionary period close to the announcement of the of the tax cut (in 1984:II according to Owyang, Piger and Wall 2005).

As for state employment, tax news accounted for a drop ranging between -0.64 percentage points for Nevada and -0.55 percentage points for California (see Figure 15c). All in all, tax news shocks explain a considerably part of the reduction in state economic activity during the anticipation period that preceded the implementation of the Tax Reform Act of 1986.

We conclude by noting that the historical decomposition carried out in this section suggests that the effect of tax news on personal income growth might differ depending on the state's business cycle phase around the time when the federal tax change is announced. After all, North Dakota was the only state to enter a recession shortly after the tax cut was announced and the only state where personal income grew during the anticipation period. This result is consistent with recent studies that estimate a larger fiscal multiplier during recessions than expansions (see e.g., Candelon and Lieb, 2013; Arin, Koray and Spagnolo, 2015; Hussain and Malik, 2016). The linear FAVAR framework used in this paper does not allow us to directly

[22] See Kilian and Lee (2014) for an in-depth description of the methodology applied to VARs.

test whether the effect of tax news differs across expansions and recessions.[23] Nevertheless, the historical decomposition suggests state variation in the response to tax news might partially stem from a combination of differential responses to tax news during recessions and expansions and variation in business cycle phases across states when the tax change is announced.

# 6 What Drives the Variation in the State-Level Responses?

## 6.1 Possible Sources of Variation

The literature on fiscal policy suggests several reasons why the effect of anticipated federal tax changes might vary across states. These include dissimilarities in the degree of labor market frictions and in investment adjustment costs, diverse geographical concentrations of industries, differences in demographics, and variation in the state's fiscal burden and taxes.

### 6.1.1 Industry Composition and Adjustment Costs

It is well known that industries differ in the nature of the labor and capital adjustment costs they face (see Caballero, Engel and Haltiwanger 1997, Hamermesh and Pfann 1996, Hall 2004, Cooper and Haltiwanger, 2006 and references therein), as well as in the output shares of capital and labor (Jones 2003, Acemoglu and Guerrieri 2008). These differences in adjustment costs and capital-labor ratios may, in turn, interact with diverse industry mix across states and offer a source for employment and personal income to exhibit a different response to anticipated tax changes across states. For instance, using a New Keynesian model, Leeper, Walker and Richter (2012) find that the difference between the responses of output and labor with and without foresight to an increase in capital taxes is larger when investment adjustment costs are turned off. In addition, work by Chetty, Friedman, Olsen and Pistaferri (2011) suggests that labor market frictions such as search costs and hours constraints imposed by firms might attenuate the short-run response of workers to tax changes. In brief, discrepancies in the magnitude of adjustment costs across economies (states) related to industrial composition could translate into differences in the response to anticipated changes in tax rates. As Figure 15 illustrates, industry composition varies greatly across regions. In addition, interregional input-output relationships may aid in differentiating the response of federal tax shocks across regions.

### 6.1.2 Demographics

Work by Leeper, Richter and Walker (2012) suggests the response of employment to an increase in labor taxes differs depending on the percentage of non-savers in the economy. Households that operate hand-to-mouth cannot take advantage of foresight regarding a future tax increase, thus such news would have little effect on their labor and consumption decisions. In contrast, households that have the ability to save are able to react in anticipation of a tax increase. Along the same lines, Kueng (2016) demonstrates that households who are less educated, have

[23] We address this question in related research (Herrera and Rangaraju, 2018).

lower income, or are more credit constrained are less responsive to news regarding tax changes. Yet, he also shows that the same households respond one-to-one to large news shocks. Gruber and Saez (2002) find that the elasticity of taxable income differs significantly for high-income taxpayers who itemize deductions and for other income groups. Indeed, marginal tax rates differ across individuals with different income levels (Congressional Budget Office, 2012) and are higher for middle-age workers than for younger workers and retirees (NBER, 2000).

Thus, if households that have high income, are more educated, are less credit constrained or are middle-aged are regionally concentrated, the effects of tax news may vary systematically across states. For instance, one could conjecture that the responsiveness of employment and personal income to tax news is very different for a rich state like New Jersey –the state with the highest median income in the sample– than for Mississippi –the poorest state in the nation. After all, the median income in New Jersey was more than twice that of Mississippi. Similarly, we might expect tax news to have a larger impact on Massachusetts than in West Virginia where the percentage of the population with at least a bachelor's degree was 20.4% and 9.9%, respectively.

Lastly, recall that the implicit tax rate closely tracks the marginal tax rate of the top 1%. Therefore, heterogeneity in income distribution across states should also result in variation in the state-level response of income. In fact, we might expect these differences to be exacerbated if the tax system is progressive.

#### 6.1.3 State Taxes and Federal Tax Burden

The literature on fiscal competition posits that the degree of factor mobility across jurisdictions affects the magnitude of the short and long run response of employment and personal income to local taxes (see, e.g. Wildasin, 2006). Our object of interest here is not the effect of changes in state taxes; yet, to the extent that states differ on their tax treatment of personal income, an increase in federal income taxes will effectively result in a differential increase in effective marginal tax rates across states. In particular, not all states in the union levy income taxes on individuals. Alaska, Florida, Nevada, South Dakota, Texas, Washington, and Wyoming do not impose personal income taxes, whereas Tennessee and New Hampshire impose taxes only on income from dividends and interest. For those states that do impose personal income taxes, the structure of individual and corporate taxes relies heavily on the structure of the federal income tax. In fact, most of these states base the calculation of the state tax on a federal "starting point" such as the federal adjusted gross income (AGI) or the federal taxable income. Similarly, state deductions and exemptions are grounded on the federal deductions and exemptions. Therefore, news of an increase in federal income taxes constitutes news of an increase in the state tax. Furthermore, news of a one percentage point increase in the federal personal income tax represents a different percentage increase in marginal income taxes for each state.

In addition, states also differ on whether –and how much– they tax corporate income, sales, particular items such as gasoline, cigarettes, alcohol, etc. Thus, the federal tax burden borne by an individual varies depending on her state of residence. Indeed, in 2005 the per-capita federal tax burden ranged between \$11,563 and \$4,287 for Connecticut and Mississippi, respectively. Hence, systematic differences in federal tax burdens across states –due in part to differences in demographics– suggest that the same news regarding an increase in federal personal income taxes could lead to diverse responses in employment and personal income.

## 6.2 Empirical Methodology and Estimation Results

The analysis in sections 4 and 5 uncovered important differences in the magnitude of the state-level response of economic activity to tax news. In this section we explore which characteristics drive this state variation. We follow the methodology of Carlino and DeFina (1998, 1999), Davis and Haltiwanger (2001), Bachmeier and Cha (2011), and Owyang and Zubairy (2013), among others, who regress the cumulative impulse response on the historical average of the covariates of interest.

In our case, the dependent variable –the one-year cumulative response of personal income or employment growth– is estimated using the FAVAR model. That is, the dependent variable is a generated from a first stage regression. To account for this estimation uncertainty and control for the fact that sampling uncertainty may not be constant across states, we follow Hanushek (1974), Lewis and Linzer (2005) and Guisinger et. al. (2018) in constructing a two-stage feasible generalized least squares estimator (FGLS) as follows.

Let $y_i$ be a dependent variable that is not directly observable. Instead, we observe an estimate

$$y_i^* = y_i + e_i \tag{6}$$

where $E(e_i) = 0$ and $Var(e_i) = \omega_i^2$ for each state $i$. Our objective is to estimate the cross-state

equation:

$$y_i = \beta x_i + \epsilon_i \tag{7}$$

where $\epsilon_i$ is an homoskedastic error term and $x_i$ is a vector of state-level covariates. The latter comprise measures of industrial composition, demographics, taxation, and income distribution. Since $y_i$ is unobserved it is only feasible to estimate:

$$y_i^* = \beta x_i + \epsilon_i + e_i \tag{8}$$

$$y_i^* = \beta x_i + v_i \tag{9}$$

where $v_i = \epsilon_i + e_i$, $y_i^*$ corresponds to the estimated one-year cumulative response of state-level personal income or employment growth for state $i$, and $Var(e_i) = \omega_i^2$ is obtained from the FAVAR model (see equation(2)). An unbiased estimator of the variance of $\beta$ is computed as

$$\boldsymbol{\sigma}^2 = \frac{\Sigma\widehat{v}_i^2 - \Sigma\omega_i^2 + tr((\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\mathbf{G}\mathbf{X})}{N-K}. \tag{10}$$

where $tr(.)$ is the trace operator, $X$ the $N \times (K+1)$ matrix of covariates, and $G$ is the diagonal matrix with $\omega_i^2$ as the $i^{th}$ diagonal element. We estimate equation (9) by weighted least squares with weights $w_i$ given by

$$w_i = \frac{1}{\sqrt{\widehat{\sigma}^2 + \omega_i^2}}. \tag{11}$$

Because the impulse response functions represent an average response over the sample, computing the covariates as the historical average provides a straightforward measure of the variation across time. In three cases, due to data availability, we measured the covariates in the year where the data were reported.[24] The reader might wonder whether the results change if we measure the covariates at a different point in time given that they have varied over the sample period. Results reported in the on-line appendix (Table B.6) indicate the conclusions are qualitative unchanged; however, statistical significance declines when the covariates are measured at the end of the sample or at the earliest available date.

To control for sectoral composition in the state, we computed the annual average output shares of the one-digit NAICS sectors in a state's GDP between 1963 and 2006. These shares are calculated using data from the Bureau of Economic Analysis (BEA).[25] Regarding demographic controls, median income is calculated as the average median income over the 1984-2006 period. White and black are computed as the annual average of the percentage of the total state population that is white or African American, respectively, over the 1970-2006 period. Similarly, female corresponds to the annual average of the percentage of females in the total state population between 1970 and 2006. Education is defined as the annual average of the percent of total population 25 years and over with bachelor's degree or higher education between 1960 and 2000. Population density is defined as inhabitants per square mile for the year 2000. Median age corresponds to the median age in the state for the year 2000. All the demographic variables are constructed using data from the U.S. Census Bureau. As for the taxation variables, we include per-capita state federal tax burden, which is defined as the ratio of the state's federal tax revenues to the state's personal income for 2005 and reported by the Tax Foundation. Average marginal state income tax rates at federal and state level are computed as the average of the marginal tax rates for each state between 1977 and 2006. These annual rates are calculated by the National Bureau of Economic Research (NBER) using TAXSIM. Regarding income distribution, the variable top 1% is the average income share held by the state's top 1% between 1957 and 2005. Adjusted gross income (AGI) is defined by the IRS as total income less statutory adjustments or deductions. We compute real per-capita measures of AGI and net capital gains using the GDP deflator and then dividing the real variables by the U.S. state civilian noninstitutional population ages 16 years and older. Both real per capita AGI and real per-capita net capital gains correspond to the annual averages for each state in between 1988 and 2005. Capital intensity is computed by multiplying the

[24] See Table B.5 in the on-line appendix for a detailed description of the data construction and sources.

[25] Data prior to 1963 are not available from the BEA.

NAICS capital intensity indexes from the NIPA Industry Database by the corresponding share of the industry in the state's GDP. The capital intensity indexes are reported by the Bureau of Labor Statistics whereas data on GDP by state are provided by the Bureau of Economic Analysis. Capital intensity corresponds to the average of these GDP weighted indexes over the 1986-2006 period. In addition, we include a dummy that takes the value of one for the eight states where most municipal bonds are issued (California, New York, Florida, Texas, New Jersey, Michigan, Ohio, and Pennsylvania).

### 6.2.1 State Personal Income

Table 5 reports coefficient estimates and (in parentheses) associated standard errors for the regression where the dependent variable is the one-year cumulative change in personal income growth, $\Delta pi4$. The results suggest that the response of personal income growth is significantly lower in states where FIRE (finance, insurance, and real estate) represents a high percentage of state GDP. For instance, in the regression with only the statistically significant demographics, income share and industry shares, the estimated coefficient implies that a state with 1% higher share of FIRE would have exhibited a 0.04 percentage points larger decrease in personal income (see column 4).

These results are consistent with the hypothesis that systematic variation in industry mix possibly compounded with differences in costs of adjustments and in factor proportions across sectors (i.e., different shares of capital) result in dissimilar responses to tax foresight across states. News regarding a future increase in federal taxes will give firms and individuals an immediate incentive to increase production. Yet, states where production activities with a higher capital-labor ratio represent a larger percent of GDP might be less able to take advantage of these news. To further explore this hypothesis, we drop the industry shares and instead control for the state's capital intensity ratio. We find little statistical evidence that this ratio explains the variation in the response across states (see Table 5, column 5).

Of the demographic covariates, median income and education appear to be statistically significant determinants of how responsive state personal income growth is to news of an increase in federal taxes. These results are consistent with the idea that higher income and more educated individuals –who face less liquidity constraints– have a greater ability to re-optimize in face of a shock to the implicit tax rate.

Although column 1 of Table 5 reveals a smaller increase in personal income for the eight states (CA, NY, FL, TX, NJ, MI, OH, and PA) where most municipal bonds are issued, the effect is statistically insignificant.[26] That is, news regarding a future increase in federal personal income taxes has similar effects on states where residents face a more liquid municipal bonds market (Ang, Bhansali and Xing, 2010) than in states where this market is less liquid. Furthermore, differences in the average state marginal tax rate do not explain the variation

[26] The results are robust to replacing the municipal bond dummy with a dummy variable that takes the value of one for California and New York, the two states that issue the largest shares of municipal bonds (about 14% and 13%, respectively).

in the response of personal income growth, whereas states that face a higher average federal marginal tax rate exhibit a larger expansion during the anticipation period. These results suggest that the variation in the responses is not driven by the intensity of the signal or the information contained in the municipal bond vs tax exempt Treasury bond, but instead by the differential effect of the same news shock on states with diverging average federal marginal tax rates.

Additionally, we find that states where the income share held by the top 1% is higher exhibit a greater increase in personal income (see columns 4 and 5 of Table 5). This result suggests that shocks to the implicit tax rate will especially affect the top marginal income rates thus creating an incentive for individuals to shift production activity to the period where lower tax rates are anticipated. Our results thus suggest that, conditional on a similar degree of foresight and tax elasticities, variation in state income inequality in conjunction with a progressive tax system leads to differences in the response of state personal income.

We conclude this section by noting that, once we have controlled for median income, education, and average federal marginal tax rate; AGI and capital gains have no explanatory power for the heterogeneity in the response of personal income growth (see columns 6 and 7 of Table 5).[27]

#### 6.2.2 State employment

Similar covariates explain the differences in the magnitude of the response of employment growth to implicit tax rate shocks. Coefficient estimates and standard errors (in parentheses) are reported in Table 6. The response of employment growth to tax news is greater in states with a high retail and a low FIRE component. These results seem to fall along the lines of House and Shapiro (2006) who find a larger effect of labor taxes for economies (i.e., states in our case) where the elasticity of labor supply is larger and the costs of adjustments are smaller. Yet, as we discovered for personal income growth, there is no statistical evidence that capital intensity explains the variation in the response of employment.

Regarding demographic characteristics, the state's median income partially explains the variation in the response of employment growth across states (see columns 1 to 3 of Table 6). Examples of states with income levels that largely exceed the national average are Connecticut, New Hampshire, and New Jersey. It is worth noting that most of the high-income states are in New England, a region where we estimated the dynamic response of employment growth to tax news shocks to be not only stronger but faster (see Figure 14). This finding points towards the ability of individuals with higher income to take advantage of tax news (Kueng 2016). Most of these states are in the Plains and Northern Plains regions (e.g., Iowa, Nebraska, North and South Dakota), which were shown to have a slower response to implicit tax rate shocks (see Figure 14). We also find some evidence that states where the top 1% hold a larger income share exhibit a higher increase in response of employment growth.

[27] This lack of explanatory power is not surprising as state AGI and capital gains are highly correlated with median income and the share of the top 1%.

Similar to personal income growth, states with higher average federal marginal tax rate exhibit higher response in employment growth, whereas neither the average state marginal tax rate not the dummy for the eight states where most municipal bonds are issued explain the variation in the response of employment growth.[28] In contrast, the larger the state's AGI or capital gains, the greater the expansionary effect tax news have on employment during the anticipation period (see columns 6 and 7 of Table 6).

## 6.3 Robustness Checks

### 6.3.1 Alternative measures of income inequality

The reader might wonder how alternative measures of income heterogeneity might correlate with the state personal income and employment responses. In the previous section, we opted for using the income share of the top 1% constructed by Frank (2009) using the IRS data on number of returns and AGI (before taxes). We found the income share of the top 1% to be highly correlated with differences in state personal income and employment responses.

Do alternative measures of state-level income inequality have explanatory power for the variation in state-level responses to tax shocks? As regressions (1) and (2) in Panel A of Table 7 illustrate, similar results are obtained if we use the top 10% income share. The only differences are that when we include the top 10% income share instead of the top 1% income share, white becomes statistically insignificant for the response of personal income. Furthermore, results not reported herein but available from the authors upon request reveal that other income inequality measures (i.e., Gini coefficient, Atkins index, Theil entropy index) have no explanatory power. These results suggest that income heterogeneity matters for the state responses in that households in higher income brackets who do not live hand-to-mouth are more able to respond to tax news.

### 6.3.2 Shorter and Longer Horizons

Our choice to focus on the one-year cumulative response of personal income and employment growth, is driven by the fact that the median peak response of personal income growth and GDP growth is four quarters after the shock. Yet, the reader might wonder whether the variation in the magnitude of the responses at different horizons is explained by the same covariates. On the one hand, exploring the sources of variation at a 2-quarter horizon is of interest as the peak response of employment growth to news regarding a federal tax increase occurs before a year has passed (3 quarters). On the other hand, one might be interested in a longer horizon, say 6 quarters, when the effect of tax foresight on aggregate GDP starts to decline as the anticipation effect fades out.

Thus, we re-estimated our preferred cross-state regressions using as dependent variables the cumulative change in personal income growth and the cumulative change in employment growth computed two and six quarters after the shock. Estimation results reported in Panel

[28] This result is robust to controlling only for California and New York.

B of Table 7 indicate that our results for personal income growth are robust to considering different horizons. Notice that all the covariates that enter significantly in the regression where we use the cumulative response after four quarters, $\Delta pi4$ (see Table 5) exhibit the same sign when we use the cumulative response after two, $\Delta pi2$, or six quarters, $\Delta pi6$. The notable difference at the two-quarter horizon is a reduction in the magnitude of the coefficients and a drop in significance, which is due to the smaller magnitude of the state-level cumulative responses. In contrast, the difference in the magnitudes of the coefficients between the benchmark (4-quarters) and the longer horizon (6-quarters) is minimal.

A similar pattern is apparent for employment growth. That is, the sign of the coefficients is unchanged, albeit their magnitude tends to be smaller when we consider the cumulative response after two quarters, $\Delta emp2$, and larger when we consider a six-quarter horizon, $\Delta emp6$. Moreover, significance remains virtually unchanged.

### 6.3.3 The Political Process

In the U.S., as in most democratic countries, taxes are the result of a political process. The conventional view is that the larger the inequality in pretax earnings the greater the pressure to approve redistributive income tax policies. Yet, there is a trade-off between the likelihood of increased redistribution that stems from higher income taxes and the possible detrimental effect of these taxes on the efficiency of the economy (Agranov and Palfrey 2014). This trade-off constitutes a key source of disagreement in the political and economic debate regarding the effects of income taxes on economic activity. Given the striking rise in income inequality observed in the U.S. (Saez 2013) and the polarization over tax policy, one could conjecture that the effect of tax news might vary depending on the influence exerted by traditional political parties in each state.

As a rough control for differences in the state's political process, we re-estimated the benchmark regressions including two additional variables: (a) the fraction of Democrats in the state house of representatives; and (b) the fraction of Democrats in the state Senate. Both variables are computed as averages over the 1980-2006 period. These data were obtained from the University of Kentucky Center for Poverty Research (UKCPR). Estimation results are reported in Panel C of Table 7. The estimated coefficients on the control variables are in line with those of the benchmark specification. Yet, none of the political controls have explanatory power for the cross-state variation in the responsiveness to tax news.

## 7 The Dynamic Effects of Federal Tax Changes on U.S. States

As shown in the previous sections, tax foresight about a future increase in federal tax rates results in a temporary expansion of aggregate and state-level economic activity. Yet, the response of aggregate economic activity becomes negative in the long-run. How does the long-run negative effect of an anticipated tax increase compare to the short-run impact of an unanticipated taxes change? This question appears to have been at the forefront of the public debate regarding the Tax Cuts and Jobs Act of 2017. After all, the "most sweeping set of tax changes in a generation" according to Barro and Furman (2018) was introduced in Congress on November 2, 2017 –President Trump had released his overall vision for the business tax reform on April 26 of the same year–, signed into law on December 22, 2017 and it went into effect on January 2018. To gain some insight into the effects of anticipated and unanticipated tax changes, we estimate the impact of unanticipated tax revenue shocks on the state-level personal income and employment in this section.

### 7.1 Empirical Methodology

Mertens and Ravn (2014) use a proxy structural VAR method to estimate the impact of tax shocks on the U.S. aggregate output. Their method integrates the Romer and Romer narrative identification approach into the VAR framework, thus allowing the researcher to investigate the impact of unanticipated tax changes. We use a methodology similar to Mertens and Ravn's (2014), which we adapt to FAVAR framework and estimate the effect of tax policy shock on national and state-level economic activity.

Consider the vector moving average representation of the reduced-form VAR in (1), which is given by:

$$C_t = \sum_{i=0}^{\infty} \varphi_i u_{t-i}. \tag{12}$$

Recall that $u_t$ is an i.i.d. $(r+5) \times 1$ vector of zero mean disturbances such that $E(u_t u_t') = \Sigma_u$. Moreover, let $u_t = B_0^{-1} \varepsilon_t$ where $\varepsilon_t$ is a $(r+5) \times 1$ vector of structural innovations. Let us partition $u_t$, $\Sigma_u$, and the first column of $B_0^{-1}$, respectively, as $\begin{bmatrix} \underset{1\times 1}{u_t^T} \\ \underset{7\times 1}{u_t^2} \end{bmatrix} = \begin{bmatrix} \underset{1\times 1}{b_{11}} & \underset{1\times 7}{b_{12}} \\ \underset{7\times 1}{b_{21}} & \underset{7\times 7}{b_{22}} \end{bmatrix} \begin{bmatrix} \underset{1\times 1}{\varepsilon_t^T} \\ \underset{7\times 1}{\varepsilon_t^2} \end{bmatrix}$,
$\Sigma_u = \begin{bmatrix} \underset{1\times 1}{\Sigma_{u,11}} & \underset{1\times 7}{\Sigma_{u,12}} \\ \underset{7\times 1}{\Sigma_{u,21}} & \underset{7\times 7}{\Sigma_{u,22}} \end{bmatrix}$ and $\underset{8\times 1}{b_1} = \begin{bmatrix} \underset{1\times 1}{b_{11}} \\ \underset{7\times 1}{b_{21}} \end{bmatrix}$. Then, we can rewrite

$$\underset{8\times 1}{\varepsilon_t} = [\ \underset{1\times 1}{\varepsilon_t^T}\ \ \underset{7\times 1}{\varepsilon_t^{2\prime}}]' \text{ and } \underset{8\times 1}{u_t} = [\underset{1\times 1}{u_t^T}\ \ \underset{7\times 1}{u_t^{2\prime}}]'$$

where $\varepsilon_t^T$ and $u_t^T$ are the structural shock and the reduced-form residual associated with tax revenues. $\varepsilon_t^2$ and $u_t^2$ are associated with other shocks to the system**.** As in Mertens and Ravn (2014), we use Romer and Romer's narrative tax shock series ($Z_t$) as a proxy to identify unanticipated shocks to tax revenues. Identification requires the following two conditions to hold:

$$\text{Relevance} \qquad E[Z_t \varepsilon_t^T] = \phi \tag{13}$$

$$\text{Exogeneity.......} E[Z_t \varepsilon_t^2] = 0 \tag{14}$$

Two key differences between our setup and the benchmark model of Mertens and Ravn (2014) is that the FAVAR in (1) includes two additional observable variables (the federal funds rate and the implicit tax rate) plus the common factors extracted from the state-level variables. Hence, assumption (14) requires the proxy to be, not only uncorrelated with contemporaneous government spending and aggregate output shocks, but also contemporaneously uncorrelated with shocks to monetary policy, the implicit tax rate and to the common factors. Regarding the federal funds rate and the implicit tax rate, Mertens and Ravn (2014) show in their appendix that larger proxy-VAR systems including monetary policy and tax foresight variables yield similar results to the smaller specification. As for the common factors, given that they are extracted from state-level employment and personal income, it is reasonable to assume that their shocks are contemporaneously uncorrelated with the proxy. Moreover, as we will see later, the fact that our estimates of the tax multiplier are similar to those of Mertens and Ravn (2014), gives credence to this assumption.

We adapt the methodology in Mertens and Ravn (2013, 2014) and Jentsch and Lunsford (2016) to estimate the FAVAR parameters, compute the impulse response functions for the variables in $C_t$, and their 68% confidence intervals[29]. The estimates of $C_t$ are then combined with the estimated factor loadings $\widehat{\Lambda}_i$ to compute the impulse responses for the state-level variables in $X_{it}$.

### 7.2 State-Level Effects of Unanticipated Tax Shocks

As in the previous sections, the impulse responses have the interpretation of tax multipliers; that is, dollar changes in GDP as a ratio of the dollar change in tax revenues. Figure 17 shows that the impact tax multiplier equals -2.25 and it reaches a peak of -2.64 one quarter after the shock. The estimated response is very similar to that reported by Mertens and Ravn (2014) for larger VARs including monetary variables (see their online appendix). This suggests that adding the common factors has very little effect on the aggregate estimates. As one would expect, the confidence intervals become wider as more variables –such as the common factors– are added to the system. Nevertheless, the impulse response functions are statistically significant for the first six quarters. We conclude that adding the common factors has very little effect on the estimated tax multiplier.

Now, how does the long-run multiplier of an anticipated tax increase compare to the short-run multiplier of an unanticipated taxes change? At the peak –one quarter after the shock– an unanticipated increase in tax revenues is estimated to result in a -2.64 dollars reduction in GDP (see Figure 17). In contrast, at the trough –four and a half years after the shock– the equivalent multiplier for an anticipated tax change is only -0.26 (see Figure 4). In other words, in the long-run the contractionary effect of an anticipated tax cut is about a tenth of the short-run contractionary effect resulting from an unanticipated increase in taxes. Moreover, in the long-run, the decline in GDP growth that stems from the anticipated tax increase completely offsets the positive anticipation effect.

[29] We follow recursive design residual based wild bootstrap for 10,000 replications. We estimate the factors and bootstrapped statistics of interest i.e., structural IRF's in the algorithm suggested by Jenstsch and Lunsford (2016).

Table 8 provides summary statistics for the state-level responses of personal income and employment to an unexpected increase in tax revenues of a 1% of GDP. For the sake of brevity, we relegate the impulse response graphs to the online appendix (see Figures B.46 - B.53). As it was the case for a tax news shock, we find a considerable degree of heterogeneity in the state-level responses to an unanticipated increase in federal tax revenues. The one-year cumulative response of personal income ranges between -0.88 for Nevada and -11.35% for Ohio, whereas that of employment varies between -4.26% for Wyoming and -13.02% for Georgia. The effect of an unanticipated tax revenue shock appears to be largest for states in the Great Lakes (Michigan, Indiana, Ohio and Illinois), the South East (Alabama, Kentucky) and Pennsylvania. Regarding the response of state-level employment, we estimate the effect to be largest for states in the South East (Alabama, Georgia) and smallest for states in the Northern Plains such as North Dakota and South Dakota, as well as Wyoming. For most states, economic activity returns to its pre-shock level around a year after the shock.

## 8 Conclusions

Do tax news related to federal income taxes depress or stimulate state-level economic activity? Using a FAVAR model we found that tax news –measured as a 1 percentage point increase in the implicit tax rate– resulted not only on larger aggregate GDP growth, but also on increased personal income and employment growth across most states. The shape of the impulse response functions suggested a somewhat shorter-lived response of employment growth, which peaks at three quarters, and a more persistent response of personal income with a peak about a year after the shock. Significant differences in the magnitude of the responses for both personal income and employment growth were evidenced across states. We confirmed the finding of a positive relation between tax news and economic activity by isolating the period preceding the enactment of the Tax Reform Act of 1986 and estimating the cumulative contribution of the historical innovations in the implicit tax rate to state-level economic activity.

Which state-level characteristics explain the differences in the state-level response of economic activity to tax foresight? We addressed this question by regressing the one-year cumulative response of personal income and employment growth on a set of state-level covariates. We found a larger impact of tax news on personal income for states where the education level, median income, the average federal marginal tax rate, and the income share of the top 1% is larger and the share of FIRE in GDP is lower. As for the response of employment, we found the effect to be greater for states where the share of retail in GDP, median income, the federal marginal tax rate, and the income share of the top 1% is larger and the share of FIRE in GDP is lower.

Whereas the finding of a positive response of aggregate economic activity to tax news is not new (Leeper, Richter and Walker 2012, Leeper, Walker and Yang 2013, Mertens and Ravn 2012, Kueng 2016), our findings provide new insights into how the response of economic activity diverges across states and on the sources of these differences. Our results point to the importance of three mechanisms in the transmission of tax news. First, as posited by several studies, tax news appears to have a larger effect in economies with a larger percentage high earners and savers who have the ability to re-optimize by changing their employment and investment decisions. Second, differences in industry composition –possibly linked with differences in input adjustment costs– play a key role in how responsive personal income and employment are to tax news. Third, the larger the heterogeneity of state income distribution (as measured by the share of the top 1%) the greater the response of economic activity to tax news.

Who gains and who loses when news of an increase in federal income taxes hit the economy? States in the Southeast and New England regions gain as they experience increases in employment and personal income. In contrast, the Northern Plains are the losers as households and firms located in these states are less able to take advantage of tax news. Moreover, to the extent that both neoclassical growth and New Keynesian models imply that anticipation of higher labor income taxes has an expansionary effect whereas anticipation of higher capital labor taxes is contractionary, our results suggest that the impact of tax news isolated from the bond spread between municipal bonds and the Treasury bill is consistent with the theoretical implications of foresight regarding labor income taxes.

Our results have implications regarding the recent debates on increasing the federal income tax rates for the top 1% of the income distribution. First, we showed that the long-run effect of an anticipated increase in federal taxes is about a tenth of the short-run contractionary effect implied by an unanticipated tax shock. However, the existence of disparate responses to an implicit tax rate shock (or to an unanticipated increase in tax revenues) across states underscores the difficulty of agreeing on a national fiscal policy for such a diverse nation as the U.S., and raises issues of cross-state equality. Regardless of how big the effect of implicit tax rate shocks on aggregate GDP growth is, these cross-state differences make it difficult to reach an accord regarding who should be taxed more (or less) by the federal government. Furthermore, although due to the aggregate nature of our data we are not able to differentiate between news regarding a tax increase for high-income earners and news regarding an across the board tax increase, our results suggest that increasing the tax rates of the top 1% of the income distribution would have differential impacts on income and inequality across U.S. states. In brief, not all states are equal regarding the quantitative impact of tax foresight.

## References


[1] Acemoglu, Daron, and Veronica Guerrieri. "Capital Deepening and Nonbalanced Economic Growth." *Journal of Political Economy* 116, no. 3 (2008): 467-498.

[2] Agranov, Marina, and Thomas R. Palfrey. Equilibrium Tax Rates and Income Redistribution: A Laboratory Study. No. w19918. National Bureau of Economic Research, 2014.

[3] Ang, Andrew, Vineer Bhansali, and Yuhang Xing. "Taxes on Tax-Exempt Bonds." *The Journal of Finance* 65, no. 2 (2010): 565-601.

[4] Ang, Andrew, and Monika Piazzesi. "A no-arbitrage vector autoregression of term structure dynamics with macroeconomic and latent variables." *Journal of Monetary Economics* 50, no. 4 (2003): 745-787.

[5] Arin, K. Peren, Faik Koray, and Nicola Spagnolo. "Fiscal multipliers in good times and bad times." *Journal of Macroeconomics* 44 (2015): 303-311.

[6] Bai, Jushan, and Serena Ng. "Determining the number of factors in approximate factor models." *Econometrica* 70, no. 1 (2002): 191-221.

[7] Bai, Jushan, and Serena Ng. "Principal components estimation and identification of static factors." *Journal of Econometrics* 176, no. 1 (2013): 18-29.

[8] Bania, Neil, Jo Anna Gray, and Joe A. Stone. "Growth, taxes, and government expenditures: growth hills for US states." *National Tax Journal* (2007): 193-204.

[9] Barro, Robert J., and Jason Furman. "Macroeconomic effects of the 2017 tax reform." *Brookings Papers on Economic Activity* 2018.1 (2018): 257-345.

[10] Barro, Robert J., and Charles J. Redlick. "Macroeconomic effects from government purchases and taxes." *The Quarterly Journal of Economics* 126, no. 1 (2011): 51-102.

[11] Bernanke, Ben S., Jean Boivin, and Piotr Eliasz. "Measuring the effects of monetary policy: a factor-augmented vector autoregressive (FAVAR) approach." *The Quarterly Journal of Economics* 120, no. 1 (2005): 387-422.

[12] Blanchard, Olivier, and Roberto Perotti. "An empirical characterization of the dynamic effects of changes in government spending and taxes on output." *The Quarterly Journal of Economics* 117, no. 4 (2002): 1329-1368.

[13] Buenker, John and Sam Pizzigati, "IRS at 100: How Income Taxation Built the Middle Class" Reuters, October 2, 2013, http://blogs.reuters.com/great-debate/2013/10/02/irs-at-100-how-income-taxation-built-the-middle-class/.

[14] Caballero, Ricardo J., Eduardo M.R.A. Engel, and John Haltiwanger. "Aggregate Employment Dynamics: Building from Microeconomic Evidence." *The American Economic Review* 87, no. 1 (1997): 115-137.

[15] Candelon, Bertrand, and Lenard Lieb. "Fiscal policy in good and bad times." *Journal of Economic Dynamics and Control* 37, no. 12 (2013): 2679-2694.

[16] Carlino, Gerald, and Robert DeFina. "The differential regional effects of monetary policy." *The Review of Economics and Statistics* 80, no. 4 (1998): 572-587.

[17] Carlino, Gerald A., and Robert P. Inman. "Local deficits and local jobs: Can US states stabilize their own economies?" *Journal of Monetary Economics* 60, no. 5 (2013): 517-530.

[18] Chetty, Raj, John N. Friedman, Tore Olsen, and Luigi Pistaferri. "Adjustment Costs, Firm Responses, and Micro vs. Macro Labor Supply Elasticities: Evidence from Danish Tax Records", *The Quarterly Journal of Economics*, 125, Issue 2 (2011): 749-804.

[19] Christiano, Lawrence J., Martin Eichenbaum, and Charles L. Evans. "Monetary policy shocks: What have we learned and to what end?" *Handbook of Macroeconomics* 1 (1999): 65-148."

[20] Congressional Budget Office. Effective Marginal Tax Rates for Low- and Moderate-Income Workers. CBO 43709, 2012.

[21] Cooper, Russell W., and John C. Haltiwanger. "On the nature of capital adjustment costs." *The Review of Economic Studies* 73, no. 3 (2006): 611-633.

[22] Crone, Theodore M. "An alternative definition of economic regions in the United States based on similarities in state business cycles." *The Review of Economics and Statistics* 87, no. 4 (2005): 617-626.

[23] Davis, Steven J., and John Haltiwanger. "Sectoral job creation and destruction responses to oil price changes." *Journal of Monetary Economics* 48, no. 3 (2001): 465-512.

[24] Fernández-Villaverde, Jesús, Juan F. Rubio-Ramírez, Thomas J. Sargent, and Mark W. Watson. "ABCs (and Ds) of Understanding VARs." *The American Economic Review*, 97 (2007): 1021–1026.

[25] Frank, Mark W. "Inequality and growth in the United States: Evidence from a new state-level panel of income inequality measures." *Economic Inquiry* 47, no. 1 (2009): 55-68.

[26] Gonçalves, Sílvia, and Lutz Kilian. "Bootstrapping autoregressions with conditional heteroskedasticity of unknown form." *Journal of Econometrics* 123, no. 1 (2004): 89-120.

[27] Gruber, Jon, and Emmanuel Saez. "The elasticity of taxable income: evidence and implications." *Journal of Public Economics* 84, no. 1 (2002): 1-32.

[28] Guisinger, Amy Y., Ruben Hernández-Murillo, Michael T. Owyang, and Tara M. Sinclair. "A state-level analysis of Okun's law." *Regional Science and Urban Economics* 68 (2018): 239-248.

[29] Hall, Robert E. "Measuring factor adjustment costs." *The Quarterly Journal of Economics* 119, no. 3 (2004): 899-927.

[30] Hamermesh, Daniel S., and Gerard A. Pfann. "Adjustment costs in factor demand." *Journal of Economic Literature* (1996): 1264-1292.

[31] Hamilton, James D., and Michael T. Owyang. "The propagation of regional recessions." *The Review of Economics and Statistics* 94, no. 4 (2012): 935-947.

[32] Hansen, Lars Peter, and Thomas J. Sargent. "Formulating and estimating dynamic linear rational expectations models." *Journal of Economic Dynamics and Control* 2 (1980): 7-46.

[33] Sargent, Thomas, and Lars P. Hansen. "Two difficulties in interpreting vector autoregressions." *Rational Expectations Econometrics.* Westview Press, 1991.

[34] Hanushek, Eric A. "Efficient estimators for regressing regression coefficients." *The American Statistician* 28, no. 2 (1974): 66-67.

[35] Helms, L. Jay. "The effect of state and local taxes on economic growth: A time series-cross section approach." *The Review of Economics and Statistics* 67, no. 4 (1985): 574-82.

[36] Herrera, Ana María., and Sandeep K. Rangaraju, "Tax News in Recessions and Expansions." Manuscript, University of Kentucky (2018).

[37] House, Christopher L., and Matthew D. Shapiro. "Phased-in tax cuts and economic activity." *The American Economic Review*, (2006): 1835-1849.

[38] Hussain, Syed M., and Samreen Malik. "Asymmetric effects of exogenous tax changes." *Journal of Economic Dynamics and Control* 69 (2016): 268-300.

[39] Jentsch, Carsten, and Kurt Lunsford. "Proxy SVARs: asymptotic theory, bootstrap inference, and the effects of income tax changes in the United States." (2016).

[40] Jones, Charles I. "Growth, capital shares, and a new perspective on production functions." Manuscript, University of California Berkeley (2003).

[41] Kilian, Lutz, and Thomas K. Lee. "Quantifying the speculative component in the real price of oil: The role of global oil inventories." *Journal of International Money and Finance* 42 (2014): 71-87.

[42] Kose, M. Ayhan, Christopher Otrok, and Charles H. Whiteman. "International business cycles: World, region, and country-specific factors." *The American Economic Review* 93, no. 4 (2003): 1216-1239.

[43] Kueng, Lorenz. Tax News: The Response of Household Spending to Changes in Expected Taxes. No. w20437. National Bureau of Economic Research, 2016.

[44] Leeper, Eric M., Alexander W. Richter, and Todd B. Walker. "Quantitative Effects of Fiscal Foresight." *American Economic Journal: Economic Policy* 4, no. 2 (2012): 115-44.

[45] Leeper, Eric M., Todd B. Walker, and Shu-Chun Susan Yang. "Fiscal foresight and information flows." *Econometrica* 81, no. 3 (2013): 1115-1145.

[46] Lewis, Jeffrey B., and Drew A. Linzer. "Estimating regression models in which the dependent variable is based on estimates." *Political Analysis* 13, no. 4 (2005): 345-364.

[47] Mankiw, N. Gregory. "Defending the one percent." *The Journal of Economic Perspectives* 27, no. 3 (2013): 21-34.

[48] Mertens, Karel, and Morten O. Ravn. "Understanding the aggregate effects of anticipated and unanticipated tax policy shocks." *Review of Economic Dynamics* 14, no. 1 (2011): 27-54.

[49] Mertens, Karel, and Morten O. Ravn. "Empirical Evidence on the Aggregate Effects of Anticipated and Unanticipated US Tax Policy Shocks." *American Economic Journal: Economic Policy* 4, no. 2 (2012): 145-181.

[50] Mertens, Karel, and Morten O. Ravn. "The dynamic effects of personal and corporate income tax changes in the United States." *The American Economic Review* 103, no. 4 (2013): 1212-47.

[51] Mertens, Karel, and Morten O. Ravn. "A reconciliation of SVAR and narrative estimates of tax multipliers." *Journal of Monetary Economics* 68 (2014): S1-S19.

[52] Mountford, Andrew, and Harald Uhlig. "What are the effects of fiscal policy shocks?" *Journal of Applied Econometrics* 24, no. 6 (2009): 960-992.

[53] Mullen, John K., and Martin Williams. "Marginal tax rates and state economic growth." *Regional Science and Urban Economics* 24, no. 6 (1994): 687-705.

[54] Nakamura, Emi and Jón Steinsson, "Fiscal Stimulus in a Monetary Union: Evidence from U.S. Regions," *The American Economic Review* 104, no. 3 (2014): 753-792

[55] National Bureau of Economic Research (2000), "Marginal and Average Income Tax Rates by Age," mimeo, available at http://users.nber.org/~taxsim/byage/.

[56] Owyang, Michael T., Jeremy Piger, and Howard J. Wall. "Business cycle phases in US states." *Review of Economics and Statistics* 87.4 (2005): 604-616.

[57] Owyang, Michael T., and Sarah Zubairy. "Who benefits from increased government spending? A state-level analysis." *Regional Science and Urban Economics* 43, no. 3 (2013): 445-464.

[58] Piketty, Thomas, and Emmanuel Saez. "Income inequality in the United States, 1913–1998." *The Quarterly Journal of Economics* 118, no. 1 (2003): 1-41.

[59] Piketty, Thomas, Emmanuel Saez, and Stefanie Stantcheva. "Optimal Taxation of Top Labor Incomes: A Tale of Three Elasticities." *American Economic Journal: Economic Policy* 6, no. 1 (2014): 230-71.

[60] Porter, Eduardo. “The Case for Raising Top Tax Rates”, The New York Times, March 27, 2012a, http://www.nytimes.com/2012/03/28/business/economy/the-case-for-raising-top-tax-rates.html?pagewanted=all&_r=0

[61] Porter, Eduardo. "The Great American Tax Debate," The New York Times, September 18, 2012b, http://www.nytimes.com/2012/09/19/business/the-great-american-tax-debate.html?_r=0.

[62] Ramey, Valerie A. "Identifying government spending shocks: it's all in the timing*." *The Quarterly Journal of Economics* 126, no. 1 (2011): 1-50.

[63] Romer, Christina D., and David H. Romer. 2010. "The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks." *The American Economic Review*, 100(3): 763-801.

[64] Rossi, Barbara, and Sarah Zubairy. "What is the importance of monetary and fiscal shocks in explaining US macroeconomic fluctuations?" *Journal of Money, Credit and Banking* 43, no. 6 (2011): 1247-1270.

[65] Reed, W. Robert. "The robust relationship between taxes and US state income growth." *National Tax Journal* (2008): 57-80.

[66] Saez, Emmanuel. "Reported incomes and marginal tax rates, 1960-2000: evidence and policy implications." In *Tax Policy and the Economy*, Volume 18, pp. 117-174. MIT Press, 2004.

[67] Saez, Emmanuel. "Striking it richer: The evolution of top incomes in the United States" (update with 2012 estimates), (2013), http://eml.berkeley.edu/~saez/saez-UStopincomes-2013.pdf.

[68] Stock, James H., and Mark W. Watson. "Forecasting using principal components from a large number of predictors." *Journal of the American Statistical Association* 97, no. 460 (2002): 1167-1179.

[69] Schwert, G. William. "Tests for unit roots: A Monte Carlo investigation." *Journal of Business & Economic Statistics* 7, (1989): 147-160.

[70] The Economist, "The Politics of Plutocracy," January 21, 2012.

[71] Trichet, Jean-Claude. "Unconventional Monetary Policy Measures: Principles—Conditions—Raison d'être." *International Journal of Central Banking* 9, no. 1 (2013): 229-250.

[72] Wildasin, David E. "Fiscal competition." *The Oxford Handbook of Political Economy* (2006): 502-520.

[73] Wildasin, David E. "Fiscal competition for imperfectly-mobile labor and capital: a comparative dynamic analysis." *Journal of Public Economics* 95, no. 11 (2011): 1312-1321.

[74] Yamamoto, Yohei. "Bootstrap inference for impulse response functions in factor-augmented vector autoregressions." *Journal of Applied Econometric*s 34, no. 2 (2019): 247-267.

[75] Yang, Shu-Chun Susan. "Quantifying tax effects under policy foresight." *Journal of Monetary Economics* 52, no. 8 (2005): 1557-1568.

[76] Yang, Shu-Chun Susan. "A Chronology of Federal Income Tax Policy: 1947–2009," Center for Applied Economics and Policy Research (2007) Working Paper no. 2007-021.

[77] Zidar, Owen M. "Tax Cuts for Whom? Heterogeneous Effects of Income Tax Changes on Growth and Employment", NBER Working Paper No. 21035.

**Table 1**

**Granger-Causality Tests**

The table reports the F statistic and the p-value for bi-variate Granger-causality tests between different tax surprise or tax measures and the implicit tax rate in Panels A-E. Panel F reports the χ2 statistic and p-value for a Wald test of Granger-Causality in the FAVAR. The implicit tax rate is computed as the yield spread between the one-year tax exempt municipal bonds and the one-year Treasury bond. All regressions include four lags of the implicit tax rate and the alternative tax measures. The VAR tax shocks used in Panel A are estimated by regressing the log of real per-capita net taxes on 4 lags of itself, a linear and quadratic trend, the log of real per-capita government spending, the log of real per-capita GDP, and the federal funds rate. Panel B reports the results for the real per-capita net taxes, which is the sum of federal, state, and local tax receipts, less federal grants in aid, federal, state, and local transfer payments to persons and interest payment to persons. Panel C reports the results for the average marginal federal income tax rate, which is taken from Barro-Redlick (2011). Panel D reports the results for the average personal income tax rate, which is computed as the ratio federal personal income taxes and contributions for government social insurance to personal income tax base. Panel E reports the results for average corporate income tax rate, which is computed as the ratio of federal taxes on corporate income excluding Federal Reserve banks to corporate profits excluding Fed profits.

| Panel A: VAR Tax Shocks | | |
|---|---|---|
| Null Hypothesis | F-test | p-value |
| VAR tax shocks do not Granger-cause the implicit tax rate | 2.500 | 0.044 |
| Implicit tax rate does not Granger-cause the VAR tax shocks | 3.341 | 0.011 |
| Panel B: Log of Real Per-Capita Net Taxes | | |
| Null Hypothesis | F-test | p-value |
| Log of real per-capita net taxes does not Granger-cause the implicit tax rate | 3.277 | 0.012 |
| Implicit tax rate does not Granger-cause the log of real per-capita net taxes | 7.749 | 0.000 |
| Panel C: Average Marginal Federal Income Tax Rate | | |
| Null Hypothesis | F-test | p-value |
| Average marginal federal income tax rate does not Granger-cause the implicit tax rate | 0.904 | 0.463 |
| Implicit tax rate does not Granger-cause average marginal federal income tax rate | 4.928 | 0.001 |
| Panel D: Average Personal Income Tax Rate | | |
| Null Hypothesis | F-test | p-value |
| Average personal income tax rate does not Granger-cause the implicit tax rate | 1.656 | 0.161 |
| Implicit tax rate does not Granger-cause average personal income tax rate | 2.307 | 0.059 |
| Panel E: Average Corporate Income Tax Rate | | |
| Null Hypothesis | F-test | p-value |
| Average corporate income tax rate does not Granger-cause the implicit tax rate | 1.774 | 0.136 |
| Implicit tax rate does not Granger-cause average corporate income tax rate | 0.985 | 0.416 |
| Panel F: Log Growth of Real Per-Capita Net Taxes in FAVAR | | |
| Null Hypothesis | $\chi^2$ | p-value |
| Log growth of real per-capita net taxes does not Granger-cause the implicit tax rate | 3.532 | 0.473 |
| Implicit tax rate does not Granger-cause the log growth of real per-capita net taxes | 16.675 | 0.002 |

**Table 2**
**U.S. States by Economic Regions**

The table lists the states corresponding to each of the eight economic regions identified by Bureau of Economic Analysis (BEA).

| New England | Mideast | Great Lakes | Plains | Southeast | Southwest | Rocky Mountain | Far West |
|---|---|---|---|---|---|---|---|
| Connecticut | Delaware | Illinois | Iowa | Alabama | Arizona | Colarado | California |
| Maine | Maryland | Indiana | Kansas | Arkansas | New Mexico | Idaho | Nevada |
| Massachusetts | New Jersey | Michigan | Minnesota | Florida | Oklahoma | Montana | Oregon |
| New Hampshire | New York | Ohio | Missouri | Georgia | Texas | Utah | Washington |
| Rhode Island | Pennsylvania | Wisconsin | Nebraska | Kentucky | | Wyoming | |
| Vermont | | | North Dakota | Louisiana | | | |
| | | | South Dakota | Mississippi | | | |
| | | | | North Carolina | | | |
| | | | | South Carolina | | | |
| | | | | Tennessee | | | |
| | | | | Virginia | | | |
| | | | | West Virginia | | | |

**Table 3**
**State-Level Cumulative Responses and Quarter of Peak Effect**

The table reports the 4-quarter cumulative effect of an implicit tax rate shock, the magnitude of the peak response, and the quarter of the peak effect. Panel A refers to the response of real per-capita personal income growth. Panel B refers to the response of real per-capita employment growth.

| | Panel A: Real Per-Capita Personal Income Growth | | | Panel B: Per-Capita Employment Growth | | |
|---|---|---|---|---|---|---|
| State | 4-quarter cumulative effect (percent) | Peak response | Peak quarter | 4-quarter cumulative effect (percent) | Peak response | Peak quarter |
| Alabama | 0.334 | 0.163 | 4 | 0.548 | 0.231 | 4 |
| Arizona | 1.039 | 0.984 | 5 | 1.101 | 0.321 | 4 |
| Arkansas | 0.206 | 0.145 | 4 | 0.342 | 0.170 | 4 |
| California | 0.990 | 0.799 | 5 | 1.289 | 0.307 | 4 |
| Colorado | 1.189 | 0.684 | 5 | 1.046 | 0.289 | 4 |
| Connecticut | 1.335 | 0.518 | 5 | 1.091 | 0.307 | 4 |
| Delaware | 0.633 | 0.503 | 5 | 0.620 | 0.224 | 4 |
| Florida | 0.830 | 0.960 | 5 | 1.076 | 0.299 | 4 |
| Georgia | 0.670 | 0.492 | 5 | 0.982 | 0.272 | 4 |
| Idaho | 0.811 | 0.231 | 5 | 0.478 | 0.194 | 4 |
| Illinois | 0.763 | 0.232 | 4 | 0.428 | 0.204 | 4 |
| Indiana | 0.447 | 0.267 | 4 | 0.430 | 0.263 | 4 |
| Iowa | 0.846 | 0.435 | 4 | 0.395 | 0.178 | 4 |
| Kansas | 0.358 | 0.222 | 4 | 0.714 | 0.238 | 4 |
| Kentucky | 0.244 | 0.250 | 4 | 0.391 | 0.251 | 4 |
| Louisiana | 0.422 | 0.173 | 4 | 0.420 | 0.224 | 4 |
| Maine | 0.358 | 0.169 | 5 | 0.877 | 0.238 | 4 |
| Maryland | 0.745 | 0.606 | 5 | 0.883 | 0.243 | 4 |
| Massachusetts | 1.136 | 0.348 | 5 | 1.239 | 0.292 | 4 |
| Michigan | 0.875 | 0.283 | 4 | 0.602 | 0.340 | 4 |
| Minnesota | 0.458 | 0.233 | 5 | 0.456 | 0.216 | 4 |
| Mississippi | 0.307 | 0.177 | 4 | 0.416 | 0.180 | 4 |
| Missouri | 0.378 | 0.115 | 2 | 0.525 | 0.193 | 4 |
| Montana | -0.144 | 0.323 | 4 | 0.097 | 0.133 | 4 |
| Nebraska | 0.133 | 0.262 | 4 | 0.269 | 0.154 | 4 |
| Nevada | 1.020 | 1.437 | 5 | 1.847 | 0.496 | 1 |
| New Hampshire | 1.209 | 0.682 | 5 | 1.270 | 0.308 | 3 |
| New Jersey | 1.146 | 0.440 | 5 | 0.833 | 0.233 | 4 |
| New Mexico | 0.366 | 0.287 | 5 | 0.473 | 0.141 | 4 |
| New York | 0.737 | 0.224 | 5 | 0.779 | 0.214 | 4 |
| North Carolina | 0.333 | 0.300 | 5 | 0.730 | 0.223 | 4 |
| North Dakota | -0.371 | 0.464 | 4 | 0.533 | 0.126 | 4 |
| Ohio | 0.747 | 0.288 | 4 | 0.578 | 0.297 | 4 |
| Oklahoma | 0.999 | 0.299 | 5 | 0.939 | 0.307 | 4 |
| Oregon | 0.769 | 0.362 | 5 | 1.102 | 0.275 | 3 |
| Pennsylvania | 0.504 | 0.264 | 4 | 0.495 | 0.232 | 4 |
| Rhode Island | 0.398 | 0.229 | 5 | 0.823 | 0.229 | 3 |
| South Carolina | 0.645 | 0.300 | 5 | 0.770 | 0.258 | 4 |
| South Dakota | 0.404 | 0.443 | 4 | 0.057 | 0.096 | 4 |
| Tennessee | 0.391 | 0.165 | 5 | 0.478 | 0.213 | 4 |
| Texas | 1.079 | 0.625 | 5 | 1.074 | 0.310 | 4 |
| Utah | 0.854 | 0.569 | 5 | 0.490 | 0.191 | 4 |
| Vermont | 0.389 | 0.343 | 5 | 0.863 | 0.251 | 4 |
| Virginia | 0.937 | 0.475 | 5 | 0.872 | 0.212 | 4 |
| Washington | 0.604 | 0.534 | 5 | 0.869 | 0.249 | 4 |
| West Virginia | -0.018 | 0.425 | 4 | 0.247 | 0.254 | 4 |
| Wisconsin | 0.415 | 0.199 | 5 | 0.507 | 0.220 | 4 |
| Wyoming | 1.399 | 0.474 | 4 | 1.235 | 0.319 | 4 |
| *State average* | *0.632* | *0.404* | *5* | *0.720* | *0.242* | *4* |
| *Aggregate GDP* | *0.040* | 0.100 | *5* | | | |

**Table 4**
**Summary Statistics**

The table reports the summary statistics for the variables included in the cross-state regressions in Panel A and the correlation among the covariates in Panel B. Δpi4 denotes the 4-quarter cumulative response of real per-capita personal income growth. Δemp4 denotes the 4-quarter cumulative response of real per-capita employment growth. Both cumulative responses are computed based on the estimated FAVAR impulse response functions. Agriculture, manufacturing, retail, FIRE (finance, insurance and real estate), oil, and construction are the shares of each industry in the state GDP. Capital intensity is computed by multiplying the NAICS capital intensity indexes from the NIPA Industry Database by the corresponding share of the industry in the state's GDP. Capital intensity corresponds to the average of these GDP weighted indexes over the 1986-2006 period. White is the percentage of the total state population that is white. Black is the percentage of the total state population that is African American. Female is the percentage of the total state population that is female. Education is the percentage of the total state population of 25 years and over with at least a bachelor's degree. Population density is the number of state inhabitants per square mile. Median age is the median age of the state population. Median income is the median income of the state. Per-capita federal tax burden is the ratio of per-capita state federal tax revenues to the state personal income. Fed_AMTR and State_AMTR are the average federal and state marginal tax rates over the 1977-2006 period . AGI is the real per-capita adjusted gross income of the state. Capital gain is the real per-capital net capital gains in adjusted gross income for the state. Top1ps and Top10ps are the top 1% and 10% income share of the state, respectively. Tax exempt state is a dummy that takes the value of 1 if the state does not levy income taxes on individuals, 0 otherwise. Municipal bond issuer is a dummy that takes a value of 1 if the state is one of the 8 states (California, New York, Florida, Texas, New Jersey, Michigan, Ohio, and Pennsylvania) where most municipal bonds are traded, 0 otherwise. House is the fraction of democratic state representatives. Senate is the fraction of democratic state senators.

Panel A: Summary Statistics

| Variables | Δpi4 | Δemp4 | Agriculture | Oil | Construction | Manufacturing | Retail | FIRE | Capital intensity | Female | White | Black | Education | Population density | Median income | Median age | Per-capita federal tax burden | Municipal bond issuer | Tax exempt state | Fed_AMTR | State_AMTR | AGI | Net capital tax returns | Top 10 Percent | Top 1 Percent | House | Senate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Observations | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 | 48 |
| Mean | 0.391 | 0.920 | 2.37 | 1.56 | 4.73 | 16.62 | 8.33 | 16.81 | 85.90 | 51.12 | 85.96 | 9.65 | 15.42 | 179.36 | 51029 | 35.59 | 6774 | 0.17 | 0.13 | 17.93 | 4.28 | 0.29 | 0.02 | 36.52 | 12.08 | 0.55 | 0.56 |
| Standard Deviation | 0.163 | 0.361 | 2.30 | 3.80 | 0.85 | 5.97 | 0.88 | 4.78 | 1.30 | 0.71 | 9.11 | 9.36 | 2.79 | 244.40 | 7400 | 1.89 | 1509 | 0.38 | 0.33 | 3.55 | 2.42 | 0.06 | 0.01 | 1.75 | 1.27 | 0.17 | 0.17 |
| Minimum | -0.059 | 0.018 | 0.37 | 0.00 | 3.29 | 4.12 | 5.94 | 9.0 | 84.2 | 49.2 | 63.1 | 0.3 | 9.9 | 4.9 | 37516 | 27.10 | 4287 | 0.00 | 0.00 | 0.21 | 0.00 | 0.20 | 0.01 | 33.20 | 10.28 | 0.00 | 0.00 |
| Maximum | 0.680 | 1.733 | 10.00 | 18.34 | 8.49 | 30.20 | 10.44 | 35.4 | 90.8 | 52.6 | 98.4 | 35.7 | 21.7 | 1097.6 | 67235 | 38.90 | 11563 | 1.00 | 1.00 | 21.38 | 8.98 | 0.48 | 0.04 | 41.09 | 15.54 | 0.87 | 0.86 |

Panel B: Correlation Matrix

| Variables | Agriculture | Oil | Construction | Manufacturing | Retail | FIRE | Capital intensity | Female | White | Black | Education | Population density | Median income | Median age | Per-capita federal tax burden | Municipal bond issuer | Tax exempt state | Fed_AMTR | State_AMTR | AGI | Net capital tax returns | Top 10 Percent | Top 1 Percent | House | Senate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| Oil | 0.02 | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| Construction | -0.08 | 0.06 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| Manufacturing | -0.18 | -0.33 | -0.50 | 1 | | | | | | | | | | | | | | | | | | | | | |
| Retail | 0.20 | -0.23 | 0.34 | 0.00 | 1 | | | | | | | | | | | | | | | | | | | | |
| FIRE | -0.23 | -0.45 | -0.16 | -0.12 | -0.43 | 1 | | | | | | | | | | | | | | | | | | | |
| Capital intensity | 0.14 | 0.88 | 0.18 | -0.50 | -0.15 | -0.4136 | 1 | | | | | | | | | | | | | | | | | | |
| Female | -0.29 | -0.29 | -0.61 | 0.55 | -0.12 | 0.23 | -0.29 | 1 | | | | | | | | | | | | | | | | | |
| White | 0.33 | -0.13 | 0.02 | -0.06 | 0.10 | 0.04 | 0.05 | -0.29 | 1 | | | | | | | | | | | | | | | | |
| Black | -0.33 | 0.03 | -0.09 | 0.27 | -0.08 | -0.08 | -0.16 | 0.46 | -0.91 | 1 | | | | | | | | | | | | | | | |
| Education | -0.26 | -0.07 | 0.06 | -0.40 | -0.36 | 0.57 | -0.01 | -0.19 | 0.09 | -0.25 | 1 | | | | | | | | | | | | | | |
| Population density | -0.43 | -0.22 | -0.27 | 0.04 | -0.39 | 0.57 | -0.17 | 0.47 | -0.13 | 0.14 | 0.40 | 1 | | | | | | | | | | | | | |
| Median income | -0.39 | -0.28 | 0.04 | -0.11 | -0.43 | 0.65 | -0.27 | -0.05 | 0.13 | -0.16 | 0.81 | 0.57 | 1 | | | | | | | | | | | | |
| Median age | 0.00 | -0.16 | -0.18 | 0.07 | 0.05 | 0.14 | -0.01 | 0.34 | 0.25 | -0.13 | -0.14 | 0.25 | -0.03 | 1 | | | | | | | | | | | |
| Per-capita federal tax burden | -0.35 | -0.17 | -0.02 | -0.27 | -0.51 | 0.68 | -0.17 | 0.00 | 0.10 | -0.15 | 0.72 | 0.66 | 0.85 | 0.24 | 1 | | | | | | | | | | |
| Municipal bond issuer | -0.26 | -0.05 | -0.17 | 0.03 | -0.11 | 0.19 | -0.12 | 0.18 | -0.18 | 0.09 | 0.07 | 0.31 | 0.17 | 0.06 | 0.24 | 1 | | | | | | | | | |
| Tax exempt state | 0.12 | 0.29 | 0.40 | -0.46 | 0.05 | -0.05 | 0.20 | -0.43 | 0.06 | -0.15 | -0.03 | -0.16 | -0.03 | -0.01 | 0.18 | 0.17 | 1 | | | | | | | | |
| Fed_AMTR | -0.39 | 0.00 | -0.04 | 0.18 | -0.16 | 0.25 | -0.15 | 0.13 | -0.18 | 0.15 | 0.17 | 0.29 | 0.33 | -0.07 | 0.36 | 0.26 | 0.1442 | 1 | | | | | | | |
| State_AMTR | 0.00 | -0.24 | -0.24 | 0.18 | -0.11 | 0.15 | -0.15 | 0.13 | 0.04 | -0.04 | 0.16 | -0.02 | 0.04 | -0.10 | -0.15 | -0.13 | -0.6752 | -0.2029 | 1 | | | | | | |
| AGI | -0.38 | 0.09 | 0.04 | -0.25 | -0.57 | 0.50 | 0.02 | -0.14 | 0.09 | -0.12 | 0.66 | 0.50 | 0.80 | 0.13 | 0.91 | 0.19 | 0.25 | 0.36 | -0.20 | 1 | | | | | |
| Net Capital Returns | -0.21 | 0.13 | 0.33 | -0.53 | -0.31 | 0.39 | 0.11 | -0.38 | 0.17 | -0.26 | 0.56 | 0.27 | 0.56 | 0.10 | 0.78 | 0.12 | 0.53 | 0.23 | -0.33 | 0.84 | 1 | | | | |
| Top 10 percent | -0.21 | 0.13 | 0.08 | -0.45 | -0.30 | 0.44 | 0.05 | 0.02 | -0.40 | 0.24 | 0.30 | 0.30 | 0.18 | -0.04 | 0.50 | 0.34 | 0.37 | 0.21 | -0.26 | 0.39 | 0.56 | 1 | | | |
| Top 1 percent | -0.29 | 0.13 | 0.14 | -0.36 | -0.35 | 0.47 | 0.00 | -0.03 | -0.23 | 0.14 | 0.17 | 0.26 | 0.18 | 0.00 | 0.51 | 0.33 | 0.47 | 0.24 | -0.33 | 0.47 | 0.65 | 0.90 | 1 | | |
| House | -0.47 | 0.01 | -0.13 | 0.24 | 0.02 | -0.11 | -0.03 | 0.50 | -0.53 | 0.54 | -0.21 | 0.29 | -0.19 | 0.17 | -0.07 | -0.01 | -0.16 | 0.21 | 0.07 | -0.17 | -0.21 | 0.12 | 0.04 | 1 | |
| Senate | -0.39 | 0.04 | -0.11 | 0.22 | 0.01 | -0.07 | 0.00 | 0.44 | -0.51 | 0.54 | -0.21 | 0.25 | -0.20 | 0.16 | -0.11 | -0.12 | -0.15 | 0.21 | 0.11 | -0.20 | -0.26 | 0.09 | 0.00 | 0.93 | 1 |

**Table 5**

**Sources of Cross-State Variation in the Response of Real Per-Capita Personal Income Growth to Tax News**

The table reports FGLS regressions coefficients and robust standard errors (in parentheses) for the cross-state regressions of the 4-quarter cumulative response of per-capita personal income growth on state-level characteristics. The regressions are estimated by FGLS method. The dependent variable is the 4-quarter cumulative response of real per-capita personal income growth to a 1 percentage point shock to the implicit tax rate computed based on the estimated FAVAR impulse response functions. Agriculture, manufacturing, retail, FIRE (finance, insurance and real estate), oil, and construction are the shares of each industry in the state GDP. Capital intensity is computed my multiplying the NAICS capital intensity indexes from the NIPA Industry Database by the corresponding share of the industry in the state's GDP. Capital intensity corresponds to the average of these GDP weighted indexes over the 1986-2006 period. White is the percentage of the total state population that is white. Black is the percentage of the total state population that is African American. Female is the percentage of the total state population that is female. Education is the percentage of the total state population of 25 years and over with at least a bachelor's degree. Population density is the number of state inhabitants per square mile. Median age is the median age of the state population. Median income is the median income of the state. Per-capita federal tax burden is the ratio of per-capita state federal tax revenues to the state personal income. Fed_AMTR and State_AMTR are the average federal and state marginal tax rates over 1977-2006 period. AGI is the real per-capita adjusted gross income of the state. Capital gain is the real per-capital net capital gains in adjusted gross income for the state. Top1ps and Top10ps are the top 1% and 10% income share of the state, respectively. Tax exempt state is a dummy that takes the value of 1 if the state does not levy income taxes on individuals, 0 otherwise. Municipal bond issuer is a dummy that takes a value of 1 if the state is one of the 8 states (California, New York, Florida, Texas, New Jersey, Michigan, Ohio, and Pennsylvania) where most municipal bonds are traded, 0 otherwise. *, **, and *** denote statistical significance at 10%, 5%, and 1% level, respectively.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| VARIABLES | cupi4 | cupi4 | cupi4 | cupi4 | cupi4 | cupi4 | cupi4 |
| Agriculture | 0.000940 | | | | | | |
| | (0.0215) | | | | | | |
| Manufacturing | 0.0132 | | | | | | |
| | (0.00934) | | | | | | |
| Retail | 0.0847 | 0.0412 | | | | | |
| | (0.0788) | (0.0446) | | | | | |
| FIRE | -0.0297 | -0.0592** | -0.0473** | -0.0426*** | | -0.0417*** | -0.0377** |
| | (0.0300) | (0.0237) | (0.0226) | (0.0127) | | (0.0127) | (0.0148) |
| Oil | 0.0254 | | | | | | |
| | (0.0199) | | | | | | |
| Construction | 0.126 | | | | | | |
| | (0.128) | | | | | | |
| Muni | 0.131 | 0.0756 | | | | | |
| | (0.0967) | (0.0624) | | | | | |
| Ftbp | 7.96e-05 | -8.86e-05 | | | | | |
| | (0.000142) | (0.000104) | | | | | |
| Popdensity | -0.000296 | -0.000165 | | | | | |
| | (0.000284) | (0.000229) | | | | | |
| Medianincome | 2.20e-05 | 4.14e-05** | 2.23e-05** | 2.18e-05** | 1.73e-05* | 2.03e-05** | 1.91e-05** |
| | (2.17e-05) | (1.65e-05) | (9.20e-06) | (8.48e-06) | (9.54e-06) | (9.74e-06) | (8.64e-06) |
| Medianage | -0.0399 | 0.00170 | -0.0216 | | | | |
| | (0.0436) | (0.0305) | (0.0157) | | | | |
| White | 0.00450 | 0.00462 | 0.00442 | | | | |
| | (0.00448) | (0.00439) | (0.00433) | | | | |
| Female | 0.146 | 0.113 | 0.0677 | | | | |
| | (0.127) | (0.105) | (0.0842) | | | | |
| Education | 0.0303 | 0.0607** | 0.0521*** | 0.0493*** | 0.0278 | 0.0488** | 0.0437** |
| | (0.0424) | (0.0256) | (0.0173) | (0.0178) | (0.0223) | (0.0181) | (0.0210) |
| Fed_AMTR | 0.0225** | 0.0327*** | 0.0323*** | 0.0335*** | 0.0344*** | 0.0332*** | 0.0339*** |
| | (0.0107) | (0.00899) | (0.00823) | (0.00673) | (0.00770) | (0.00686) | (0.00733) |
| State_AMTR | 0.0108 | -0.000156 | -0.00491 | | | | |
| | (0.0243) | (0.0205) | (0.0207) | | | | |
| Top1ps | 0.101 | 0.188** | 0.134*** | 0.121*** | 0.0801*** | 0.117*** | 0.0946* |
| | (0.0943) | (0.0705) | (0.0482) | (0.0286) | (0.0263) | (0.0334) | (0.0538) |
| Capint | | | | | 0.0383 | | |
| | | | | | (0.0395) | | |
| Agi | | | | | | 0.255 | |
| | | | | | | (0.964) | |
| Capitalgain | | | | | | | 6.651 |
| | | | | | | | (9.070) |
| Constant | -10.82 | -10.35 | -5.832 | -2.648*** | -5.545 | -2.591*** | -2.290*** |
| | (6.668) | (6.230) | (4.753) | (0.356) | (3.478) | (0.411) | (0.659) |
| Observations | 48 | 48 | 48 | 48 | 48 | 48 | 48 |
| R-squared | 0.735 | 0.707 | 0.675 | 0.659 | 0.601 | 0.659 | 0.663 |

**Table 6**

**Sources of Cross-State Variation in the Response of Employment Growth to Tax News**

The table reports FGLS regressions coefficients and robust standard errors (in parentheses) for the cross-state regressions of the 4-quarter cumulative response of per-capita employment growth on state-level characteristics. The regressions are estimated by FGLS method.. The dependent variable is the 4-quarter cumulative response of per-capita employment growth to a 1 percentage point shock to the implicit tax rate computed based on the estimated FAVAR impulse response functions. Agriculture, manufacturing, retail, FIRE (finance, insurance and real estate), oil, and construction are the shares of each industry in the state GDP. Capital intensity is computed my multiplying the NAICS capitalintensity indexes from the NIPA Industry Database by the corresponding share of the industry in the states GDP. Capital intensity corresponds to the average of these GDP weighted indexes over the 1986-2006 period. White is the percentage of the total state population that is white. Black is the percentage of the total state population that is African American. Female is the percentage of the total state population that is female. Education is the percentage of the total state population of 25 years and over with at least a bachelor's degree. Population density is the number of state inhabitants per square mile. Median age is the median age of the state population. Median income is the median income of the state. Per-capita federal tax burden is the ratio of per-capita state federal tax revenues to the state personal income. Fed_AMTR and State_AMTR are the average federal and state marginal tax rates over the 1977-2006 period . AGI is the real per-capita adjusted gross income of the state. Capital gain is the real per-capital net capital gains in adjusted gross income for the state. Top1ps is the top 1% income share of the state. Tax exempt state is a dummy that takes the value of 1 if the state does not levy income taxes on individuals, 0 otherwise. Municipal bond issuer is a dummy that takes a value of 1 if the state is one of the 8 states (California, New York, Florida, Texas, New Jersey, Michigan, Ohio, and Pennsylvania) where most municipal bonds are traded, 0 otherwise. *, **, and *** denote statistical significance at 10%, 5%, and 1% level, respectively.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| VARIABLES | cuemp4 | cuemp4 | cuemp4 | cuemp4 | cuemp4 | cuemp4 | cuemp4 |
| agriculture | -0.0199 | -0.0211 | -0.0224* | | | | |
| | (0.0174) | (0.0171) | (0.0131) | | | | |
| manufacturing | -0.00157 | | | | | | |
| | (0.00751) | | | | | | |
| retail | 0.0899 | 0.129*** | 0.137*** | 0.132*** | | 0.156*** | 0.0895** |
| | (0.0705) | (0.0378) | (0.0433) | (0.0434) | | (0.0555) | (0.0408) |
| FIRE | -0.0578** | -0.0548*** | -0.0548*** | -0.0508*** | | -0.0108 | -0.0187 |
| | (0.0250) | (0.0177) | (0.0142) | (0.0145) | | (0.0111) | (0.0121) |
| oil | -0.00718 | | | | | | |
| | (0.0169) | | | | | | |
| construction | 0.0539 | | | | | | |
| | (0.0778) | | | | | | |
| muni | -0.0320 | -0.0569 | | | | | |
| | (0.102) | (0.0810) | | | | | |
| ftbp | -0.000131 | -0.000140 | | | | | |
| | (0.000119) | (9.28e-05) | | | | | |
| popdensity | 8.01e-05 | 8.96e-05 | | | | | |
| | (0.000350) | (0.000293) | | | | | |
| medianincome | 3.62e-05** | 3.99e-05*** | 2.00e-05* | 2.43e-05** | 9.04e-06 | -8.02e-06 | 7.17e-06 |
| | (1.51e-05) | (1.45e-05) | (1.00e-05) | (9.51e-06) | (1.11e-05) | (9.52e-06) | (7.32e-06) |
| medianage | 0.0743** | 0.0790*** | 0.0272 | | | | |
| | (0.0346) | (0.0283) | (0.0194) | | | | |
| white | -0.00161 | -0.00213 | | | | | |
| | (0.00424) | (0.00385) | | | | | |
| female | -0.0991 | -0.131 | | | | | |
| | (0.119) | (0.0982) | | | | | |
| education | 0.0485 | 0.0466** | 0.0495** | 0.0398** | 0.0306 | 0.0349 | 0.0161 |
| | (0.0360) | (0.0227) | (0.0185) | (0.0180) | (0.0287) | (0.0289) | (0.0240) |
| Fed_AMTR | 0.0303*** | 0.0290*** | 0.0191*** | 0.0225*** | 0.0234*** | 0.0257*** | 0.0273*** |
| | (0.00909) | (0.00735) | (0.00649) | (0.00537) | (0.00767) | (0.00704) | (0.00842) |
| State_AMTR | 0.0222 | 0.0229 | | | | | |
| | (0.0239) | (0.0215) | | | | | |
| top1ps | 0.218*** | 0.228*** | 0.157*** | 0.163*** | 0.0939* | | |
| | (0.0662) | (0.0503) | (0.0418) | (0.0381) | (0.0492) | | |
| capint | | | | | 0.0299 | | |
| | | | | | (0.0302) | | |
| agi | | | | | | 3.962*** | |
| | | | | | | (1.161) | |
| capitalgain | | | | | | | 30.63*** |
| | | | | | | | (8.173) |
| Constant | -1.805 | -0.675 | -4.621*** | -3.934*** | -4.338* | -2.268*** | -1.383*** |
| | (6.108) | (5.466) | (1.056) | (0.734) | (2.578) | (0.597) | (0.412) |
| Observations | 48 | 48 | 48 | 48 | 48 | 48 | 48 |
| R-squared | 0.769 | 0.760 | 0.687 | 0.640 | 0.473 | 0.519 | 0.622 |

**Table 7**

**Robustness Checks: Shorter and Longer Horizons and Political Controls**

The table reports FGLS coefficients and robust standard errors (in parentheses) for the cross-state regressions of economic activity on state-level characteristics. The cumulative response of real per-capita personal income growth at horizon 4 is the dependent variable in regressions (1), (7), at horizon 2 in regressions (3), (8), and at horizon 6 in regressions (4), (9). The cumulative response of real per-capita employment growth at horizon 4 is the dependent variable in regressions (2), (10), at horizon 2 in regressions (5), (11), and at horizon 6 in regressions (6), (12). Retail and FIRE (finance, insurance and real estate) are the shares of each industry in the state GDP. Education is the percentage of the total state population of 25 years and over with at least a bachelor's degree. Median income is the median income of the state. Fed_AMTR is the average federal marginal tax rate over 1977 and 2006 period. Top1ps and Top10ps are the top 1% and 10% income share of the state, respectively. House is the fraction of democratic state representatives. Senate is the fraction of democratic state senators. *, **, and *** denote statistical significance at 10%, 5%, and 1% level, respectively.

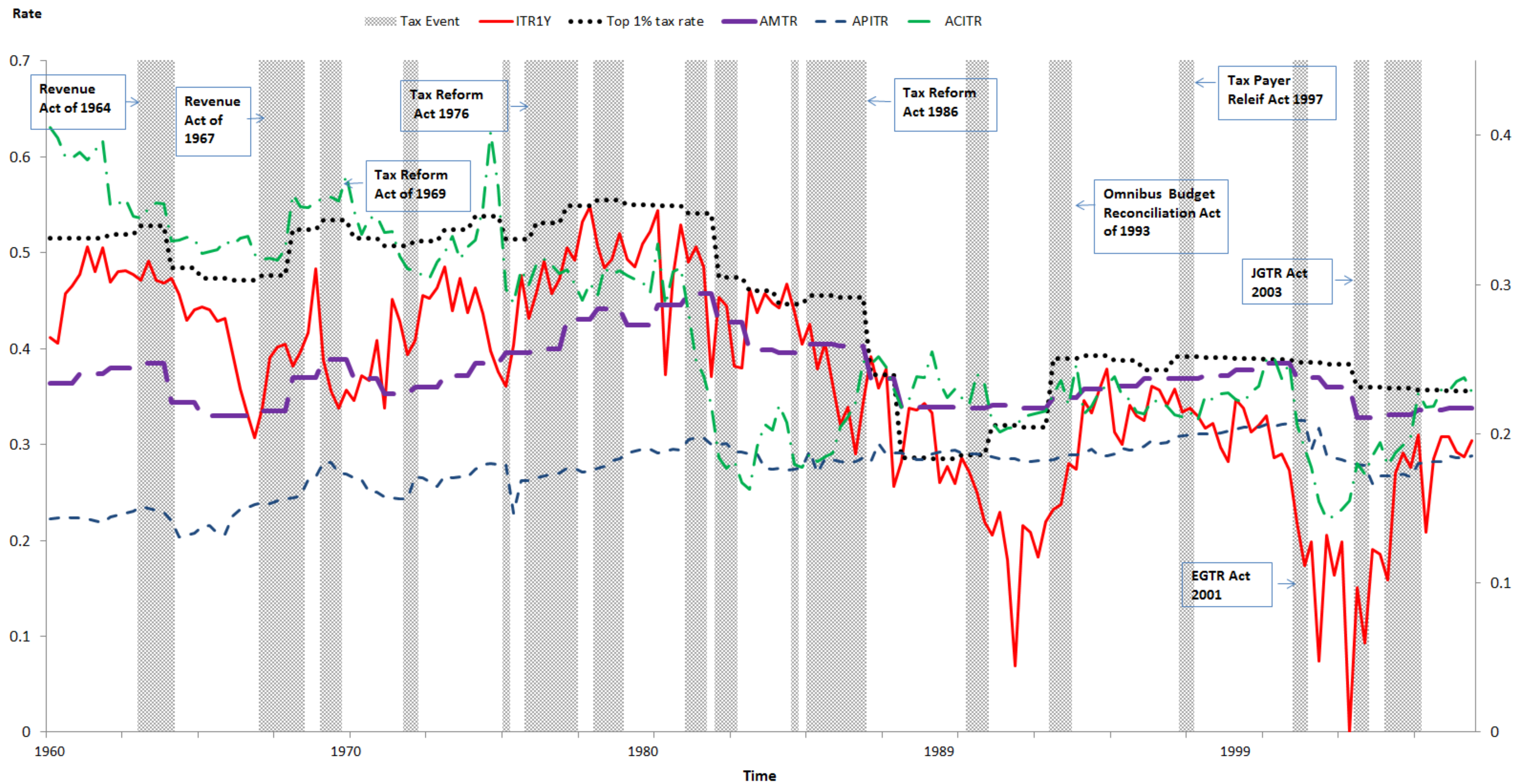
| | Panel A: Alternative Measure of Income Inequality | | Panel B: Shorter and Longer Horizons | | | |
|---|---|---|---|---|---|---|
| | Personal Income | Employment | Personal Income | | Employment | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Explanatory Variables | Δpi4 | Δemp4 | Δpi2 | Δpi6 | Δemp2 | Δemp6 |
| Retail | | 0.112** | | | 0.102*** | 0.134** |
| | | (0.0532) | | | (0.0331) | (0.0543) |
| FIRE | -0.0372*** | -0.0412** | -0.0263** | -0.0563*** | -0.0340*** | -0.0708*** |
| | (0.0136) | (0.0180) | (0.0123) | (0.0200) | (0.0115) | (0.0173) |
| Median income | 2.65e-05*** | 2.81e-05* | 1.26e-05* | 1.60e-05 | 1.47e-05* | 2.44e-05** |
| | (8.85e-06) | (1.44e-05) | (6.67e-06) | (1.13e-05) | (8.26e-06) | (9.56e-06) |
| Education | 0.0277 | 0.0164 | 0.0226 | 0.0954*** | 0.0308* | 0.0779*** |
| | (0.0185) | (0.0296) | (0.0139) | (0.0236) | (0.0154) | (0.0199) |
| Fed_AMTR | 0.0341*** | 0.0237*** | 0.0207*** | 0.0398*** | 0.0118*** | 0.0296*** |
| | (0.00685) | (0.00570) | (0.00717) | (0.00729) | (0.00436) | (0.00637) |
| Top1ps | | | 0.0509* | 0.155*** | 0.110*** | 0.227*** |
| | | | (0.0297) | (0.0464) | (0.0348) | (0.0396) |
| Top10ps | 0.0772*** | 0.0964*** | | | | |
| | (0.0183) | (0.0330) | | | | |
| Constant | -4.005*** | -5.310*** | -1.363*** | -3.388*** | -2.810*** | -5.159*** |
| | (0.633) | (1.427) | (0.358) | (0.553) | (0.663) | (0.767) |
| Observations | 48 | 48 | 48 | 48 | 48 | 48 |
| R-squared | 0.623 | 0.571 | 0.460 | 0.666 | 0.581 | 0.695 |

| | Panel C: Political Controls | | | | | |
|---|---|---|---|---|---|---|
| | Personal income | | | Employment | | |
| | (7) | (8) | (9) | (10) | (11) | (12) |
| Explanatory Variables | Δpi4 | Δpi2 | Δpi6 | Δemp4 | Δemp2 | Δemp6 |
| Retail | | | | 0.132*** | 0.102*** | 0.134** |
| | | | | (0.0456) | (0.0349) | (0.0572) |
| FIRE | -0.0427*** | -0.0259** | -0.0574*** | -0.0514*** | -0.0343*** | -0.0713*** |
| | (0.0118) | (0.0123) | (0.0183) | (0.0151) | (0.0120) | (0.0184) |
| Median income | 2.11e-05** | 1.21e-05* | 1.56e-05 | 2.62e-05** | 1.60e-05* | 2.64e-05** |
| | (8.11e-06) | (6.86e-06) | (1.03e-05) | (1.02e-05) | (8.80e-06) | (1.05e-05) |
| Education | 0.0465** | 0.0223 | 0.0907*** | 0.0400** | 0.0305* | 0.0774*** |
| | (0.0172) | (0.0144) | (0.0225) | (0.0182) | (0.0156) | (0.0201) |
| Fed_AMTR | 0.0374*** | 0.0220** | 0.0449*** | 0.0188*** | 0.00936** | 0.0259*** |
| | (0.00951) | (0.00855) | (0.00997) | (0.00548) | (0.00436) | (0.00722) |
| Top1ps | 0.121*** | 0.0508 | 0.158*** | 0.163*** | 0.111*** | 0.230*** |
| | (0.0275) | (0.0304) | (0.0438) | (0.0393) | (0.0358) | (0.0415) |
| House | -0.316 | 0.0535 | -0.740 | 0.0818 | -0.0230 | -0.122 |
| | (0.448) | (0.347) | (0.515) | (0.434) | (0.326) | (0.517) |
| Senate | 0.0202 | -0.143 | 0.352 | 0.187 | 0.203 | 0.402 |
| | (0.411) | (0.298) | (0.492) | (0.384) | (0.306) | (0.457) |
| Constant | -2.477*** | -1.310*** | -3.194*** | -4.121*** | -2.938*** | -5.358*** |
| | (0.442) | (0.403) | (0.591) | (0.749) | (0.682) | (0.786) |
| Observations | 48 | 48 | 48 | 48 | 48 | 48 |
| R-squared | 0.675 | 0.466 | 0.689 | 0.655 | 0.596 | 0.705 |

**Table 8: State-Level Cumulative Responses and Quarter of Trough Effect**

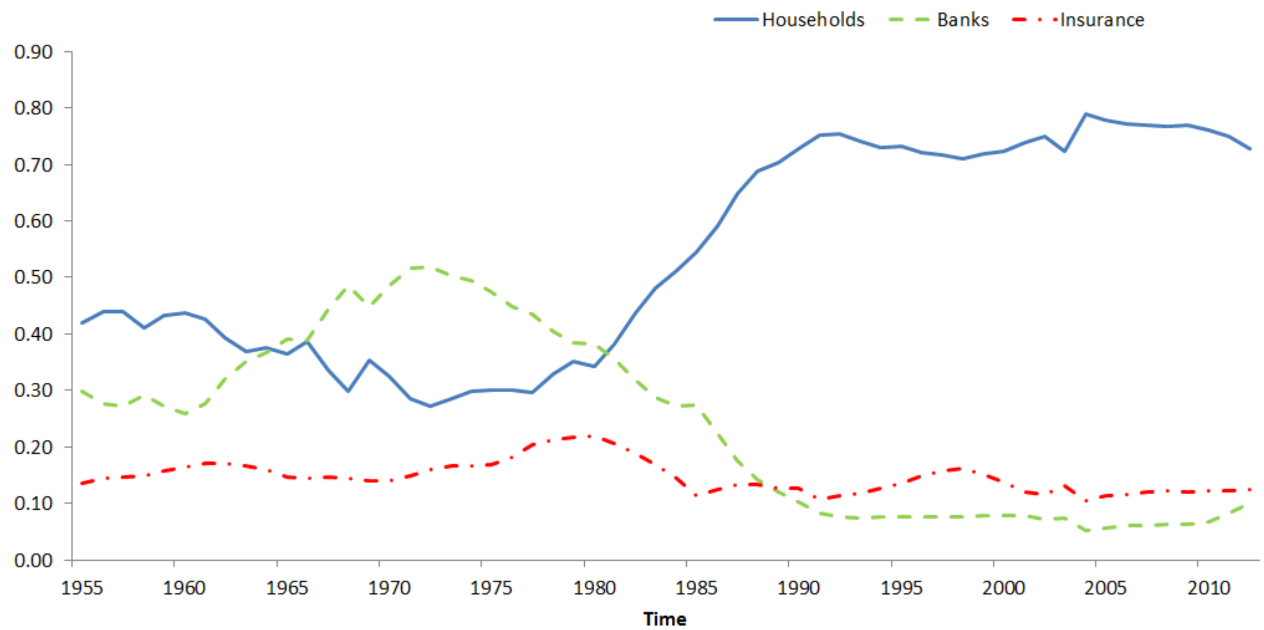
| | Panel A: Real Per-Capita Personal Income Growth | | | | Panel B: Per-Capita Employment Growth | | | |
|---|---|---|---|---|---|---|---|---|
| State | Impact<br>Percent | Cumulative 4 quarters<br>Percent | Trough response<br>Percent | Trough quarter | Impact<br>Percent | Cumulative 4 quarters<br>Percent | Trough response<br>Percent | Trough quarter |
| Alabama | -7.503 | -9.321 | -9.696 | 3 | -3.987 | -12.461 | -12.461 | 4 |
| Arizona | -0.232 | -2.149 | -2.149 | 4 | -3.391 | -9.616 | -9.616 | 4 |
| Arkansas | -5.876 | -5.106 | -6.343 | 1 | -3.650 | -9.962 | -9.962 | 4 |
| California | -0.354 | -2.046 | -2.050 | 2 | -2.229 | -10.350 | -10.422 | 5 |
| Colorado | -2.926 | -4.020 | -4.314 | 2 | -3.916 | -9.563 | -9.563 | 4 |
| Connecticut | -3.608 | -6.285 | -6.285 | 4 | -2.348 | -10.817 | -10.817 | 4 |
| Delaware | -2.647 | -4.089 | -4.195 | 2 | -2.616 | -8.831 | -8.831 | 4 |
| Florida | -0.011 | -1.436 | -1.436 | 2 | -2.360 | -9.090 | -9.090 | 4 |
| Georgia | -1.454 | -3.941 | -3.941 | 4 | -4.519 | -13.024 | -13.024 | 4 |
| Idaho | -4.918 | -6.023 | -6.168 | 2 | -3.995 | -8.391 | -8.391 | 4 |
| Illinois | -7.301 | -9.365 | -9.469 | 3 | -2.149 | -10.795 | -10.795 | 4 |
| Indiana | -7.295 | -10.436 | -10.647 | 3 | -3.293 | -11.693 | -11.693 | 4 |
| Iowa | -8.118 | -6.611 | -8.624 | 1 | -1.957 | -9.299 | -9.299 | 4 |
| Kansas | -5.771 | -5.317 | -6.234 | 1 | -3.207 | -10.642 | -10.642 | 4 |
| Kentucky | -7.467 | -8.988 | -9.591 | 3 | -2.884 | -10.635 | -10.635 | 4 |
| Louisiana | -5.656 | -6.146 | -6.587 | 2 | -2.382 | -6.910 | -6.910 | 4 |
| Maine | -2.445 | -5.158 | -5.158 | 4 | -2.638 | -11.126 | -11.126 | 4 |
| Maryland | -1.625 | -3.301 | -3.301 | 4 | -2.432 | -9.540 | -9.540 | 4 |
| Massachusetts | -4.569 | -6.968 | -6.968 | 4 | -3.107 | -11.558 | -11.558 | 4 |
| Michigan | -6.241 | -9.684 | -9.700 | 3 | -2.805 | -10.509 | -10.509 | 4 |
| Minnesota | -5.796 | -6.423 | -7.141 | 2 | -3.080 | -11.445 | -11.445 | 4 |
| Mississippi | -4.921 | -4.352 | -5.459 | 1 | -3.406 | -9.292 | -9.292 | 4 |
| Missouri | -7.068 | -7.254 | -8.221 | 2 | -3.340 | -12.041 | -12.041 | 4 |
| Montana | -5.484 | -4.963 | -5.917 | 1 | -2.355 | -7.113 | -7.113 | 4 |
| Nebraska | -6.856 | -5.417 | -7.176 | 1 | -2.398 | -8.791 | -8.791 | 4 |
| Nevada | -0.165 | -0.881 | -1.272 | 2 | -3.139 | -8.055 | -8.055 | 4 |
| New Hampshire | -1.265 | -3.826 | -3.826 | 4 | -4.185 | -11.954 | -11.954 | 4 |
| New Jersey | -3.853 | -6.543 | -6.543 | 4 | -2.337 | -10.782 | -10.782 | 4 |
| New Mexico | -1.055 | -1.224 | -1.712 | 2 | -4.127 | -8.572 | -8.572 | 4 |
| New York | -4.094 | -5.631 | -5.631 | 4 | -2.705 | -10.717 | -10.717 | 4 |
| North Carolina | -2.827 | -5.432 | -5.432 | 4 | -3.507 | -11.352 | -11.352 | 4 |
| North Dakota | -4.585 | -2.999 | -4.615 | 1 | -1.585 | -4.558 | -4.579 | 5 |
| Ohio | -7.144 | -11.352 | -11.352 | 4 | -3.345 | -12.605 | -12.605 | 4 |
| Oklahoma | -5.589 | -4.310 | -5.639 | 1 | -3.016 | -8.038 | -8.038 | 4 |
| Oregon | -3.767 | -6.170 | -6.170 | 4 | -3.325 | -10.564 | -10.564 | 4 |
| Pennsylvania | -6.591 | -10.296 | -10.364 | 3 | -3.060 | -11.555 | -11.555 | 4 |
| Rhode Island | -3.349 | -4.987 | -5.086 | 2 | -2.968 | -10.404 | -10.404 | 4 |
| South Carolina | -2.786 | -6.374 | -6.374 | 4 | -3.357 | -11.282 | -11.282 | 4 |
| South Dakota | -5.579 | -3.877 | -5.738 | 1 | -2.490 | -7.903 | -7.903 | 4 |
| Tennessee | -5.447 | -7.487 | -7.655 | 2 | -4.313 | -12.065 | -12.065 | 4 |
| Texas | -1.484 | -3.303 | -3.303 | 4 | -3.472 | -10.798 | -10.798 | 4 |
| Utah | -1.564 | -3.081 | -3.259 | 2 | -3.398 | -9.726 | -9.726 | 4 |
| Vermont | -3.118 | -5.597 | -5.597 | 4 | -3.537 | -11.102 | -11.102 | 4 |
| Virginia | -1.345 | -3.475 | -3.475 | 4 | -3.404 | -10.696 | -10.696 | 4 |
| Washington | -1.434 | -3.341 | -3.341 | 4 | -2.326 | -10.170 | -10.170 | 4 |
| West Virginia | -4.334 | -4.588 | -5.459 | 3 | -3.385 | -7.239 | -7.239 | 4 |
| Wisconsin | -5.848 | -8.086 | -8.153 | 2 | -2.755 | -11.734 | -11.734 | 4 |
| Wyoming | -5.029 | -4.786 | -5.519 | 1 | -1.486 | -4.263 | -4.478 | 6 |
| *State average* | *-4.133* | *-5.468* | *-5.881* | | *-3.035* | *-9.992* | *-9.999* | |
| *Aggregate GDP* | *-2.250* | *-2.638* | -2.638 | *1* | | | | |

Figure 1: Tax Rates and Tax Events, 1960-2006



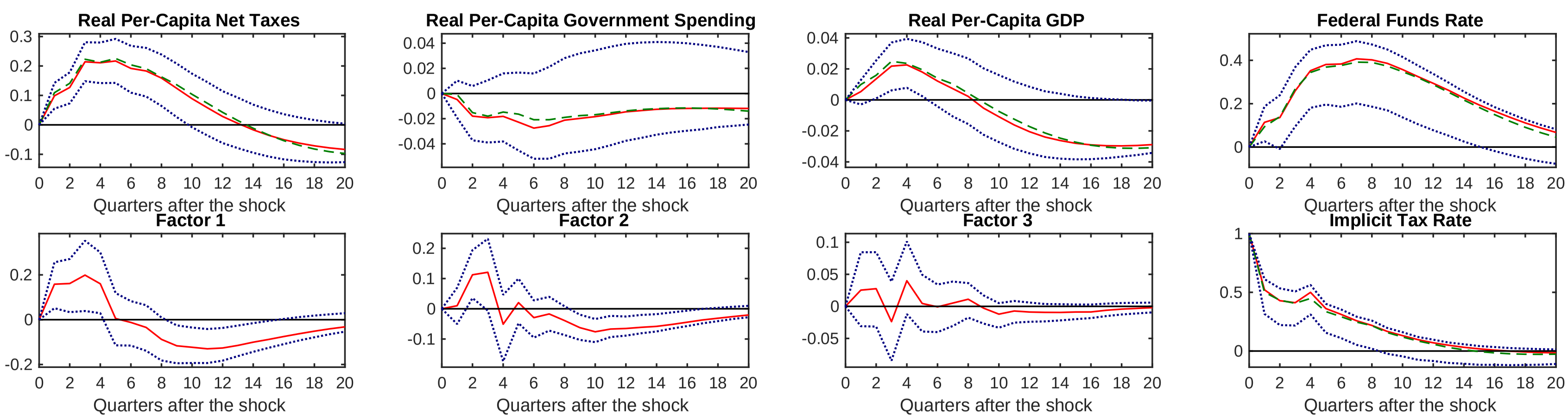

The figure plots the implicit tax rate, the top 1 % marginal tax rate, the average personal income tax rate, the average corporate income tax rate, and the average marginal federal individual income tax rate for the United States. The solid line is the implicit tax rate (ITR1Y) which is yield spread between the one year tax exempt municipal bond rate and the one-year taxable Treasury bond rate. The yields on tax-exempt prime graded general obligation municipal bonds and the taxable U.S. Treasury bonds data are obtained from Leeper, Richter, and Walker (2012).The thin dashed line is the average personal income tax rate (APITR). The dotted line is the top 1 % marginal tax rate taken from Saez (2004). The long dashed line is the average marginal federal individual income tax rate (AMTR) taken from Barro-Redlick (2011). The shaded regions correspond to chronological tax events in the United States (See appendix Table B.1). The documented tax events are taken from Yang (2007).

Figure 2: Ownership of Municipal Bonds



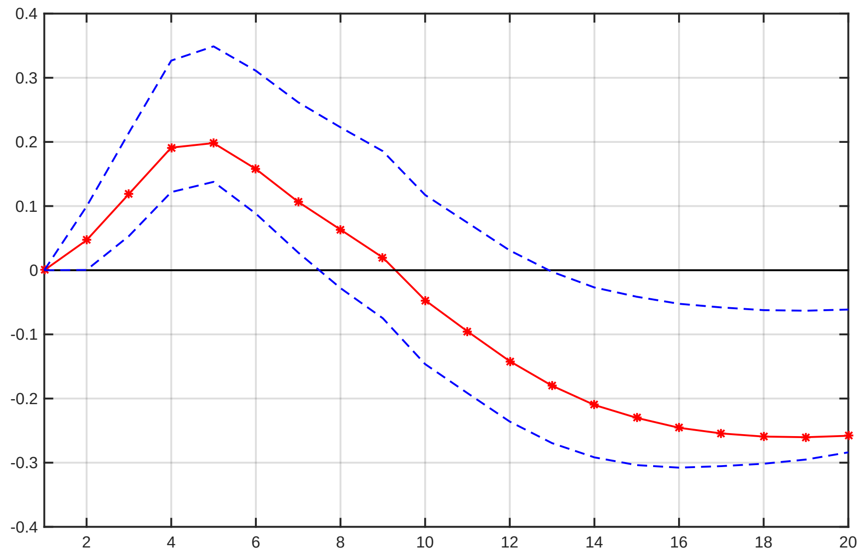

The figure plots the ownership of municipal bonds held by households, banks, and insurance companies. The data are collected from the Flow of Funds Accounts provided by the Board of Governors. The percentage of municipal bonds held by: (a) households include direct and indirect ownership through mutual funds, money market funds, and closed-end funds; (b) banks comprise commercial banks and savings institutions; and (c) insurance companies include life insurance companies and other insurance companies.

Figure 3: Impulse responses for aggregate variables and estimated factors



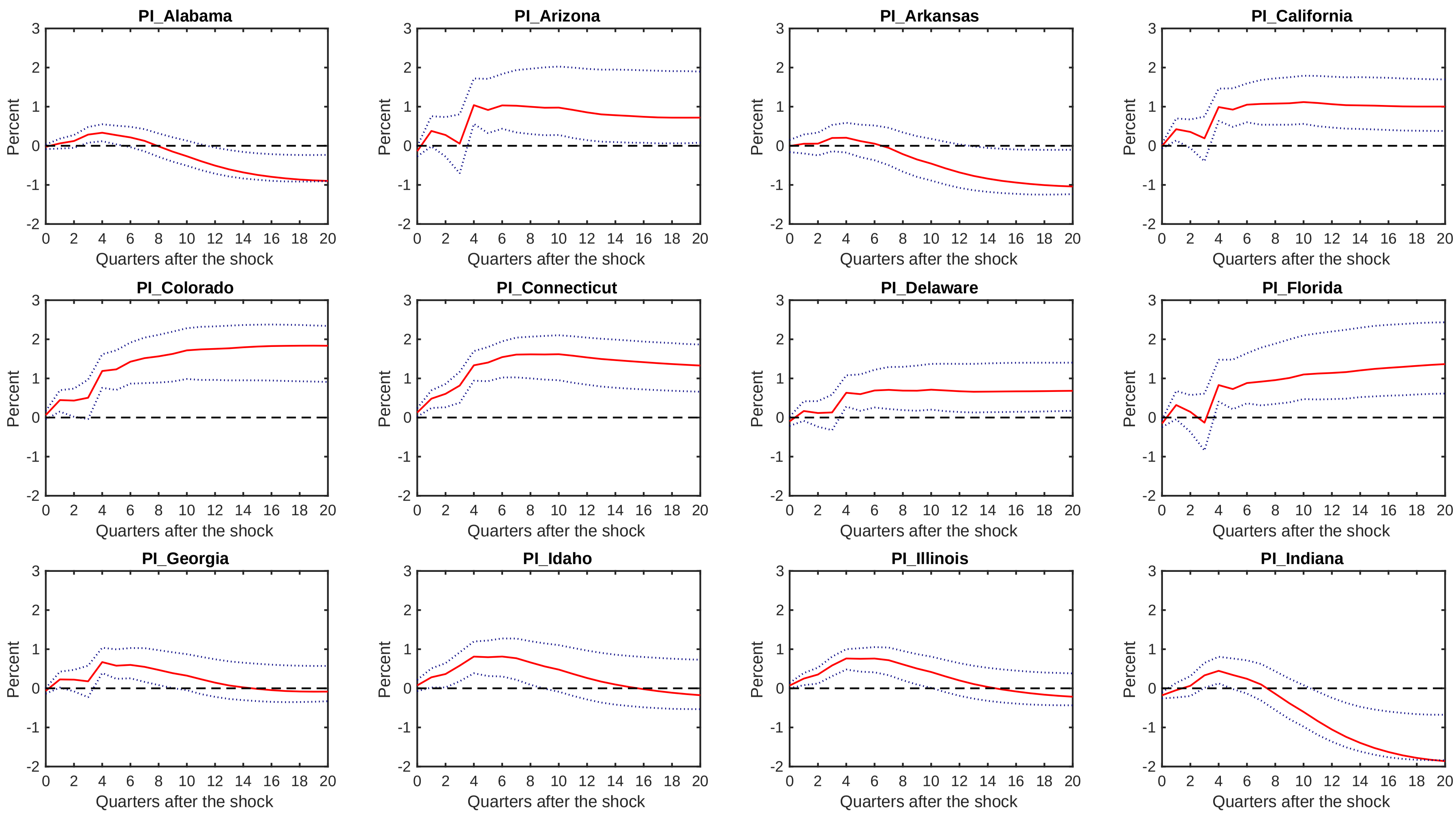

The figure shows estimated impulse responses of the aggregate variables and the regional factors to a one percentage point increase in the implicit tax rate for FAVAR specification. The dashed lines show the response of the aggregate variables with VAR estimation. All responses are reported in percentages. Solid lines are point estimates; dot lines indicate 68 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian, 2004).

Figure 4: Output multiplier for an implicit tax rate shock



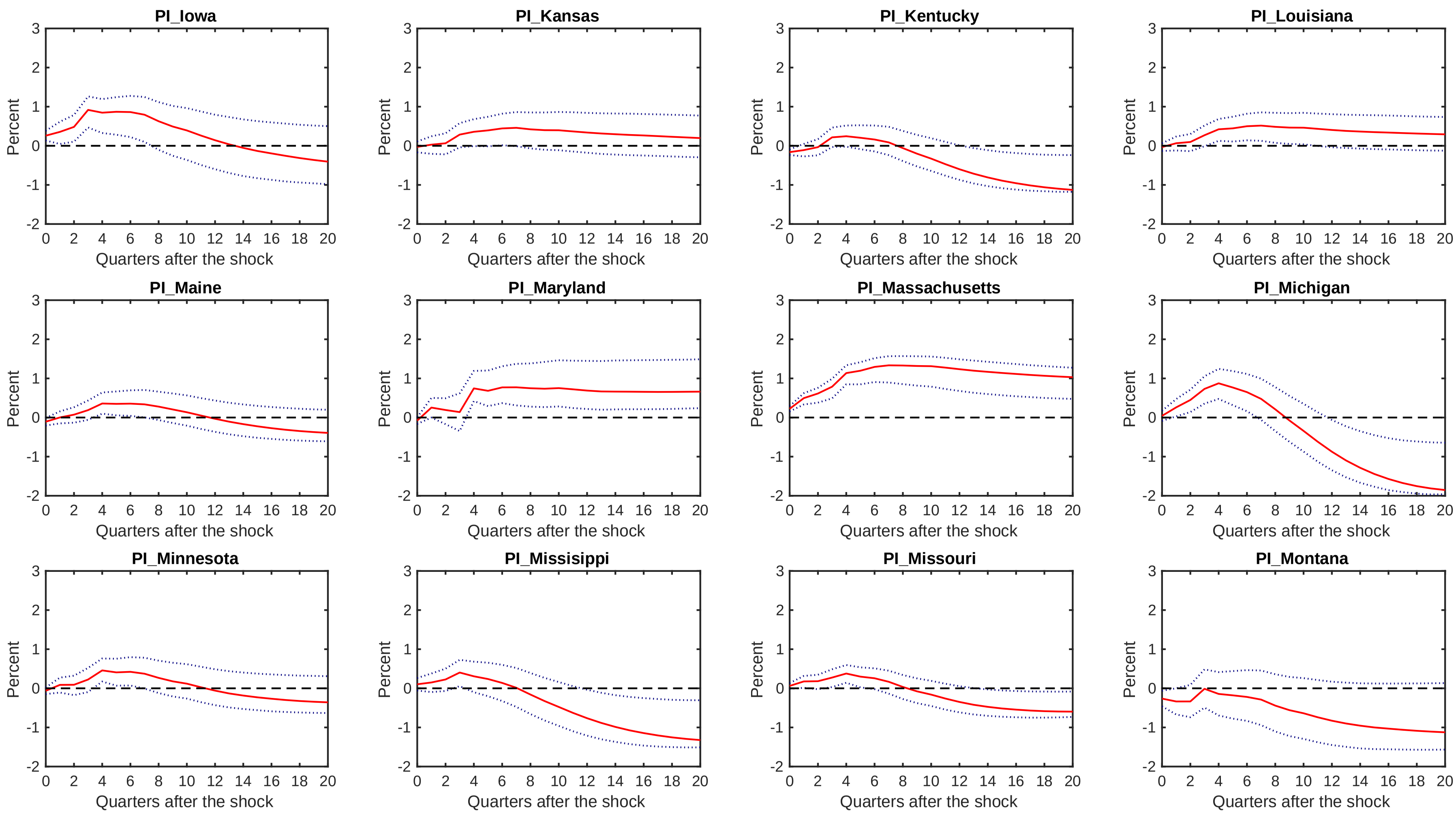

The figure illustrates the output multiplier associated with a dollar innovation in tax revenues arising from an anticipated increase in tax rates. The solid line is the dollar estimate; dashed lines indicate 68 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian, 2004).

Figure 5: Impulse responses of state-level personal income



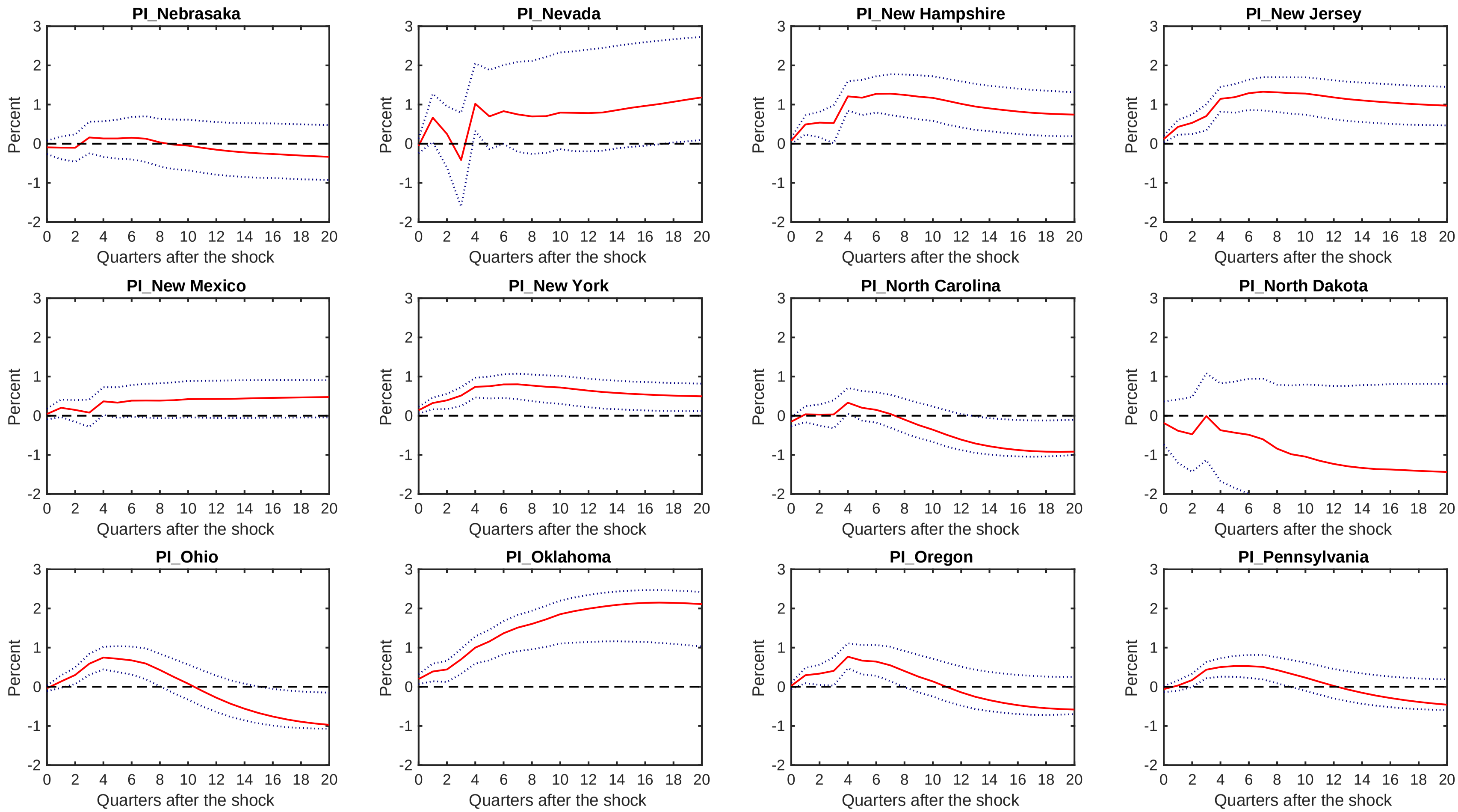

The figure shows the response of real per-capita personal income to a 1 percentage point increase in the implicit tax rate for different states. Solid lines are point estimates; dashed lines indicate 68 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian, 2004).

Figure 6: Impulse responses of state-level personal income



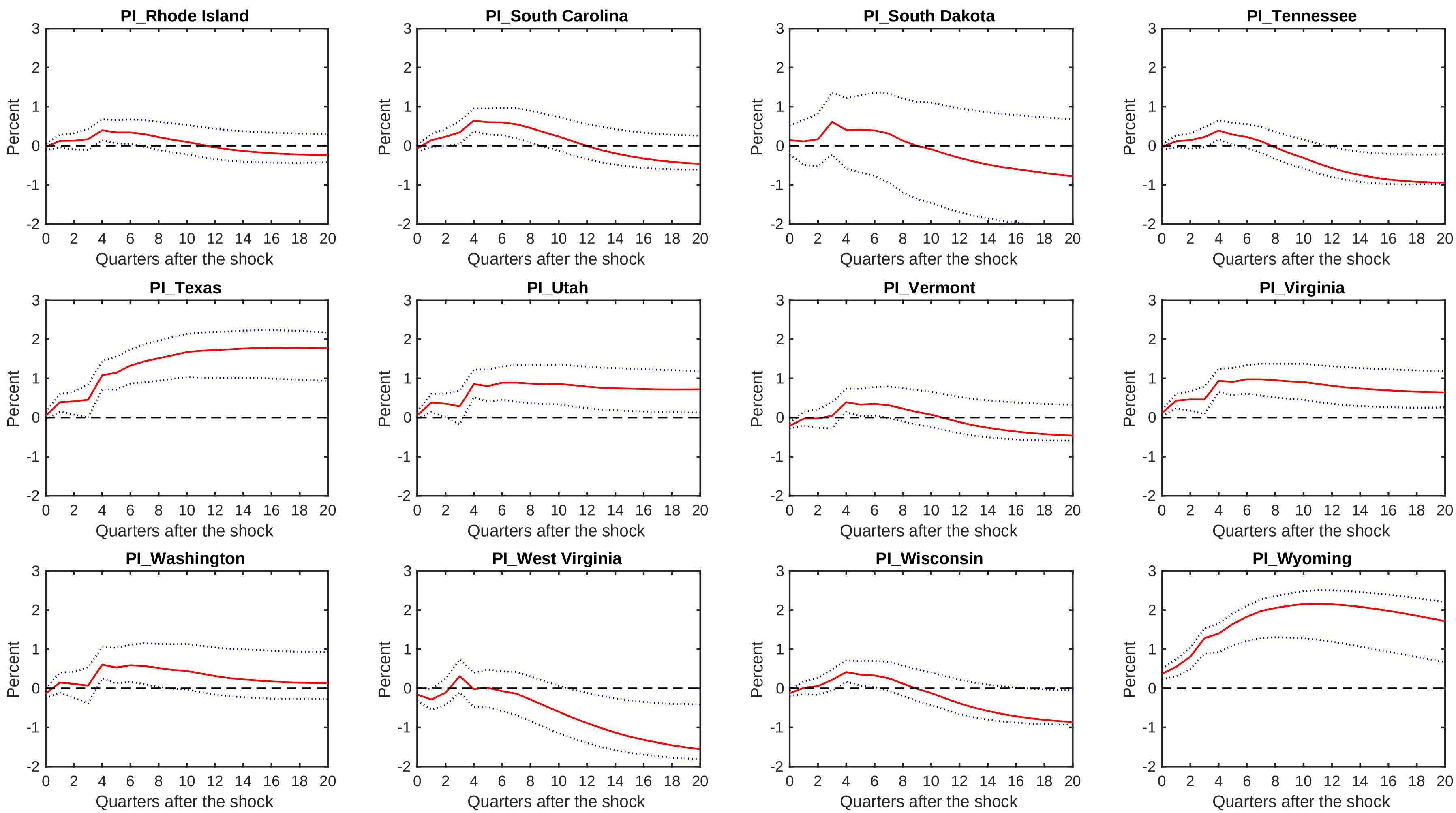

The figure shows the response of real per-capita personal income to a 1 percentage point increase in the implicit tax rate for different states. Solid lines are point estimates; dashed lines indicate 68 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian, 2004).

Figure 7: Impulse responses of state-level personal income



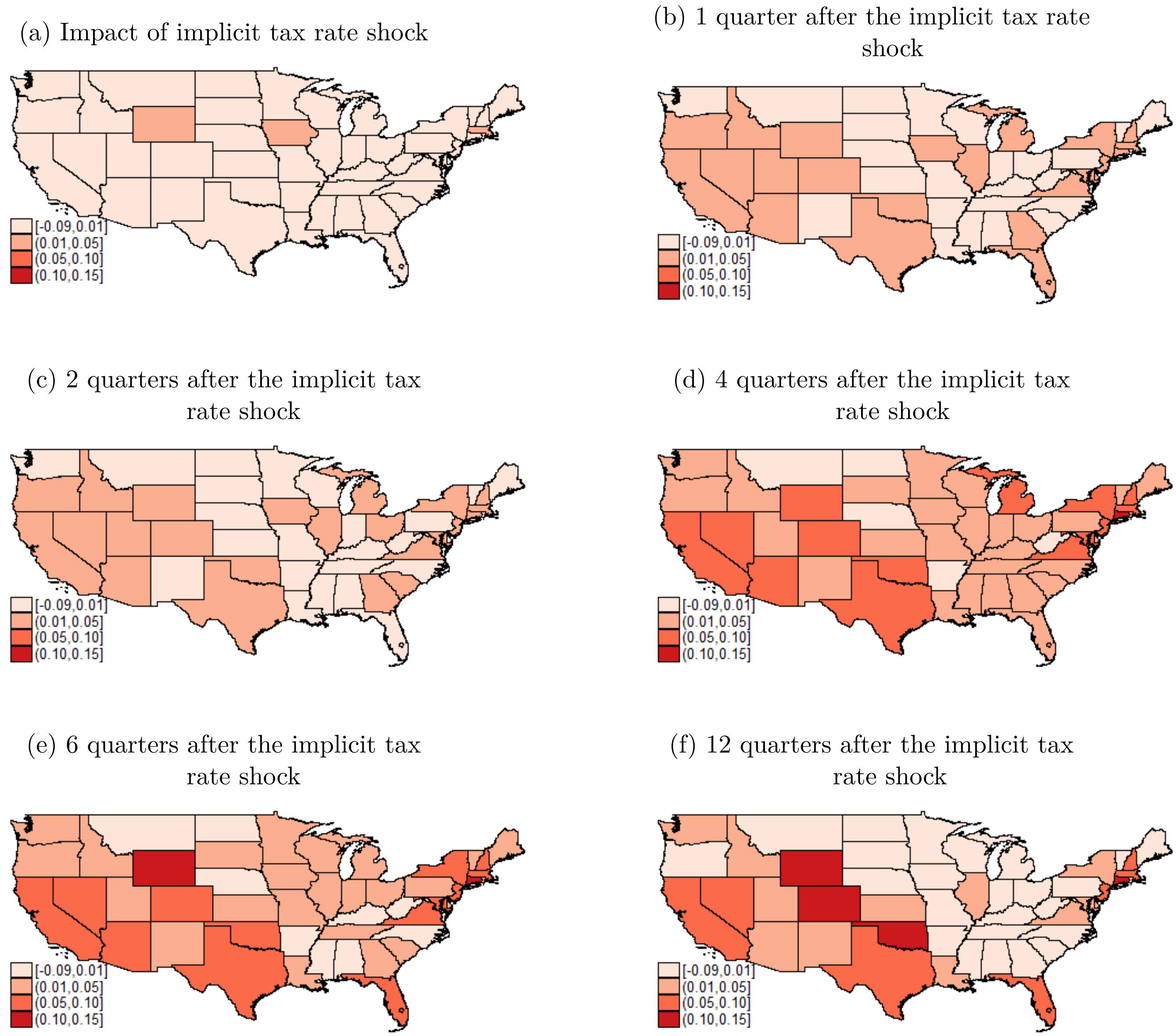

The figure shows the response of real per-capita personal income to a 1 percentage point increase in the implicit tax rate for different states. Solid lines are point estimates; dashed lines indicate 68 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian, 2004).

Figure 8: Impulse responses of state-level personal income




The figure shows the response of real per-capita personal income to a 1 percentage point increase in the implicit tax rate for different states. Solid lines are point estimates; dashed lines indicate 68 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian, 2004).

Figure 9: Personal income multiplier for an implicit tax rate shock




(a) Impact of implicit tax rate shock

(b) 1 quarter after the implicit tax rate shock

(c) 2 quarters after the implicit tax rate shock

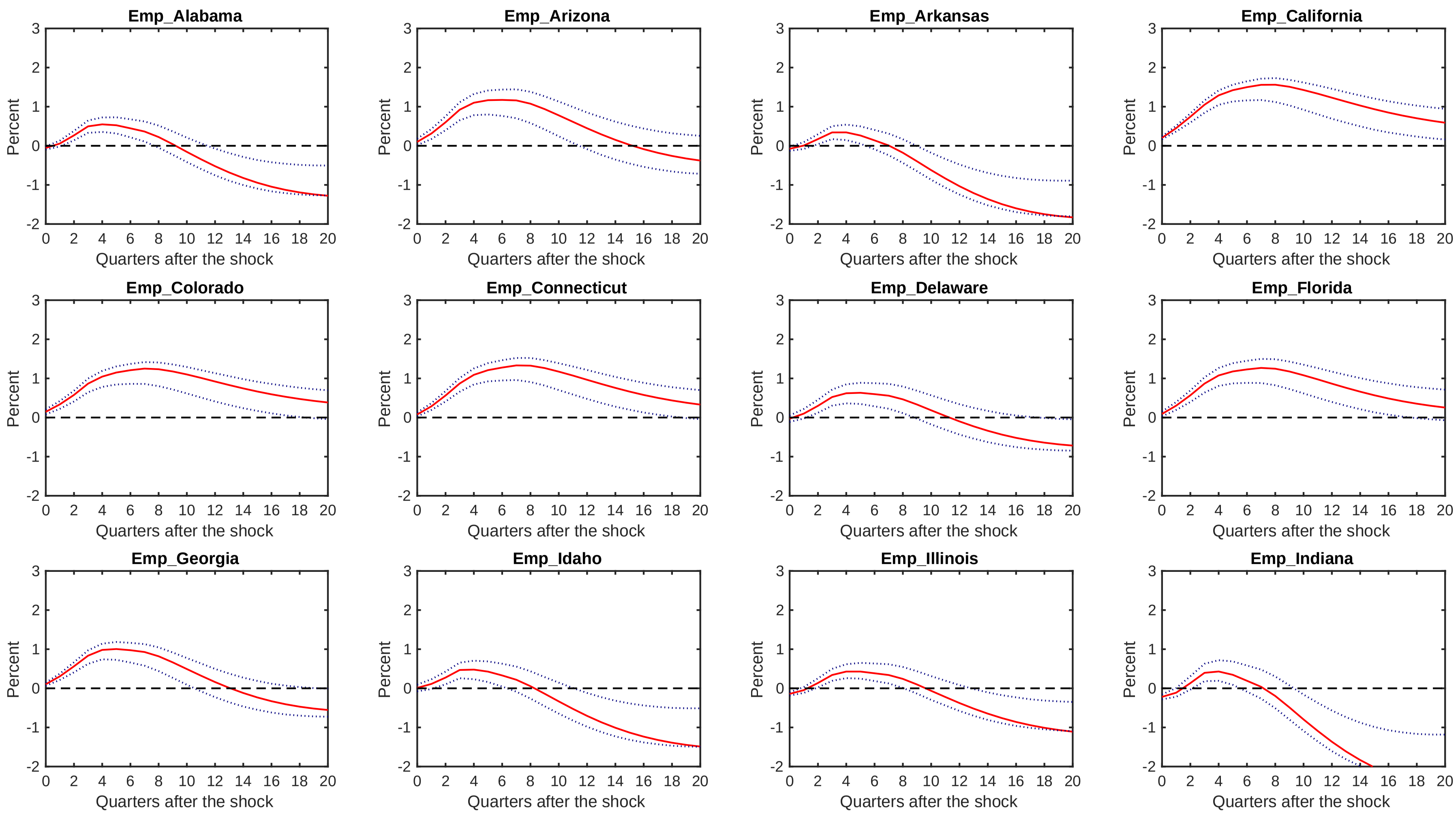
(d) 4 quarters after the implicit tax rate shock

(e) 6 quarters after the implicit tax rate shock

(f) 12 quarters after the implicit tax rate shock

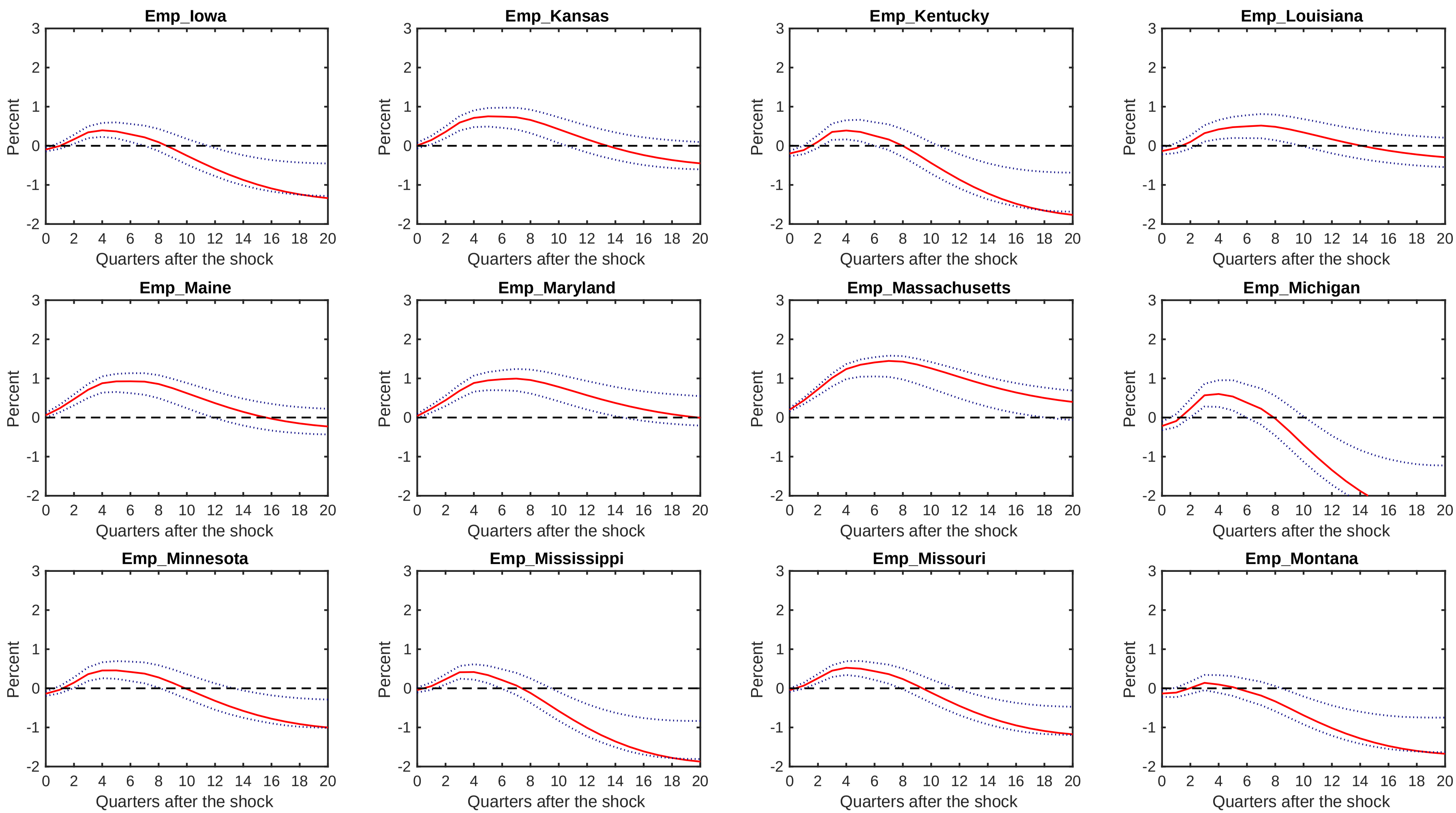
The figure illustrates the state-level personal income multipliers associated with a dollar innovation in tax revenues arising from an anticipated increase in tax rates. Darker shades of red indicate larger responses to dollar shock.

Figure 10: Impulse responses of state-level employment



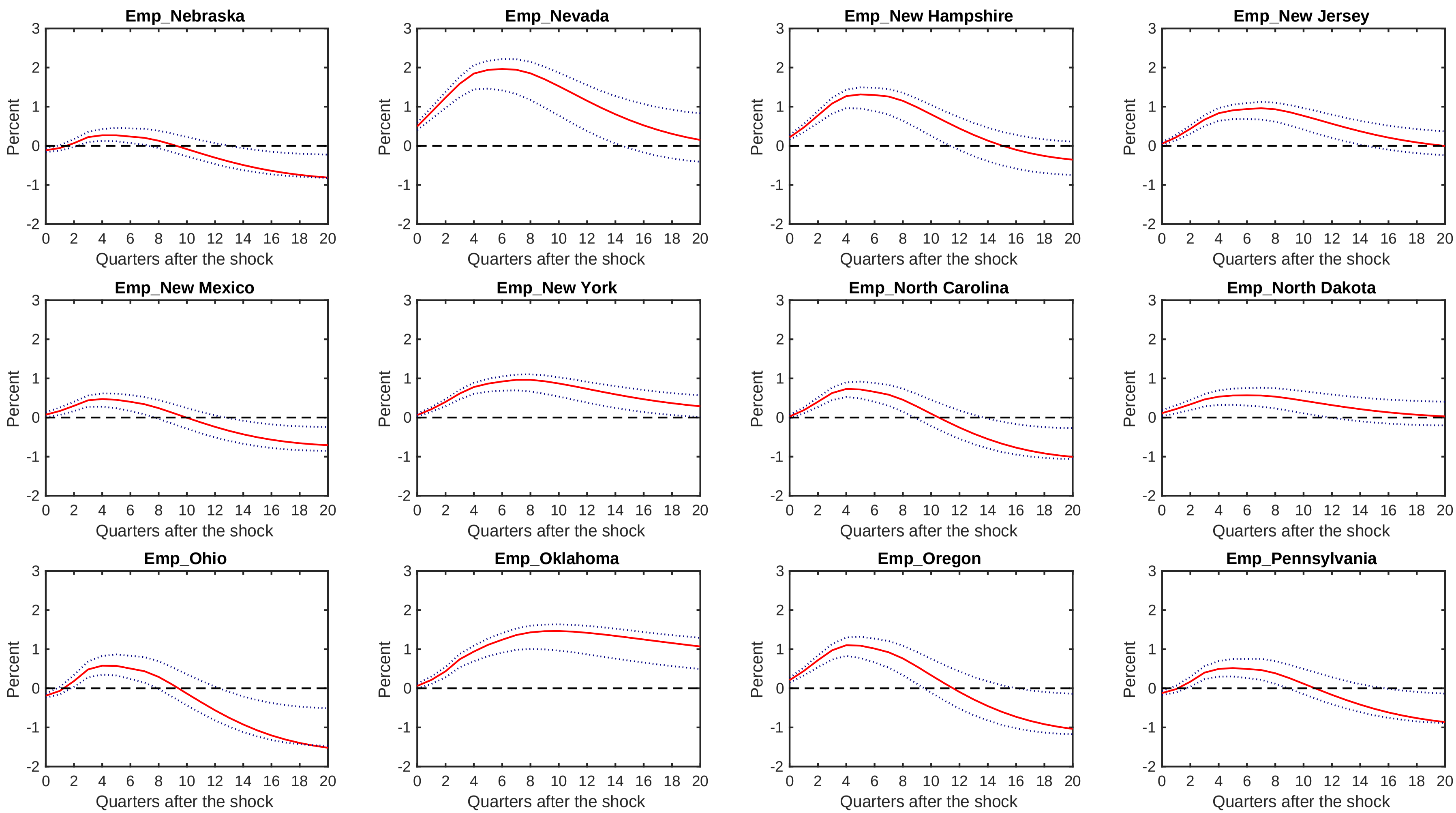

The figure shows the response of real per-capita employment to a 1 percentage point increase in the implicit tax rate for different states. Solid lines are point estimates; dashed lines indicate 68 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian, 2004).

Figure 11: Impulse responses of state-level employment



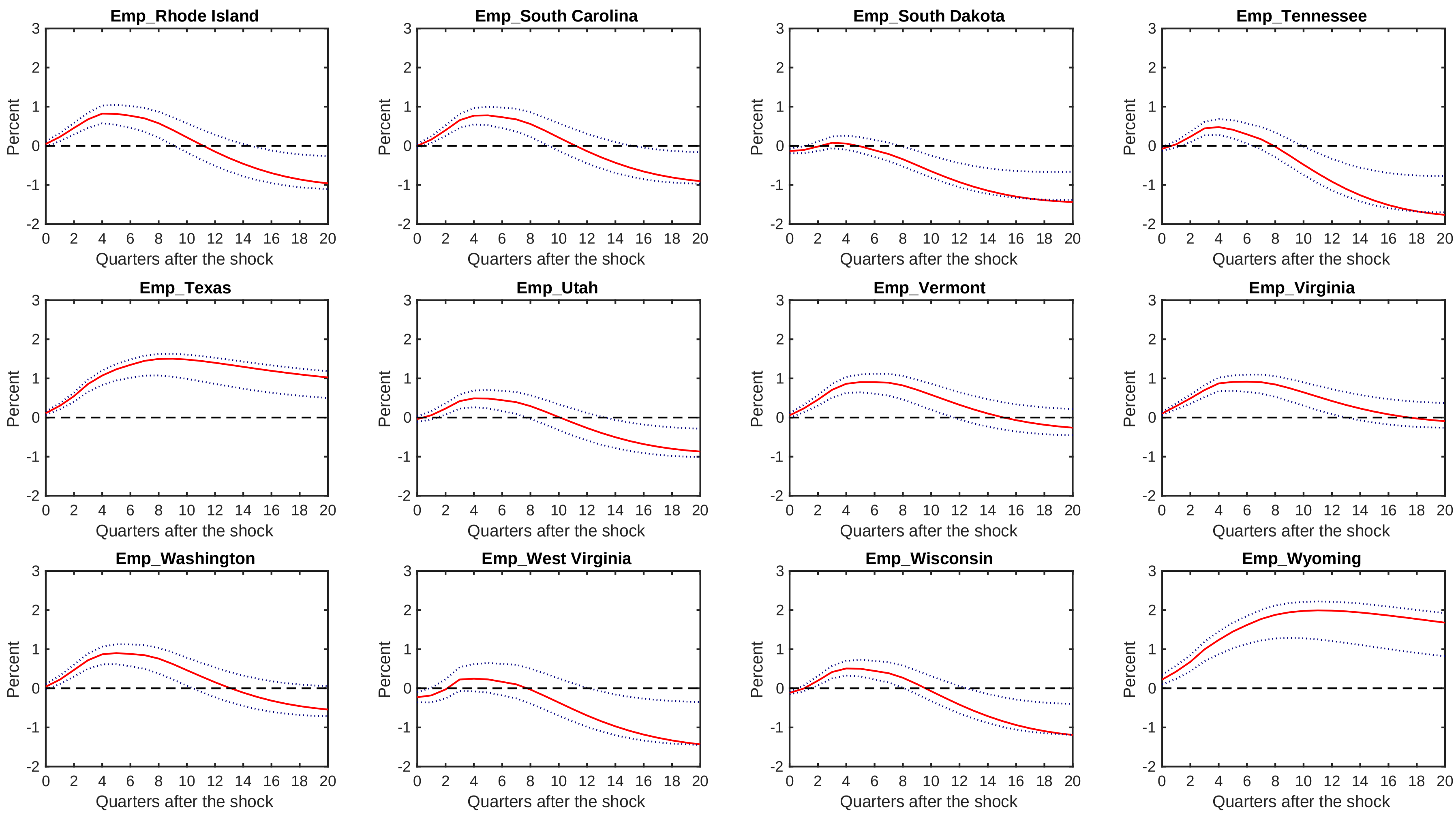

The figure shows the response of real per-capita employment to a 1 percentage point increase in the implicit tax rate for different states. Solid lines are point estimates; dashed lines indicate 68 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian, 2004).

Figure 12: Impulse responses of state-level employment




The figure shows the response of real per-capita employment to a 1 percentage point increase in the implicit tax rate for different states. Solid lines are point estimates; dashed lines indicate 68 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian, 2004).

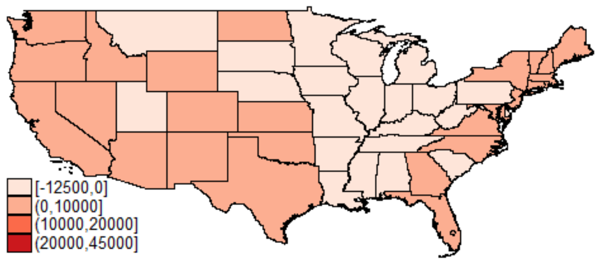
Figure 13: Impulse responses of state-level employment



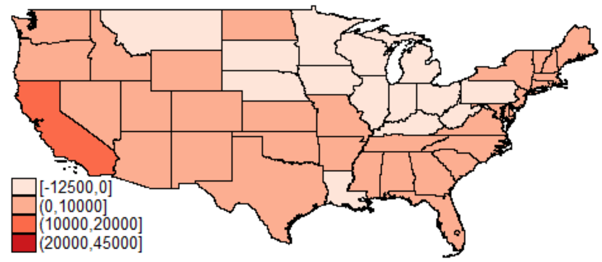

The figure shows the response of real per-capita employment to a 1 percentage point increase in the implicit tax rate for different states.
Solid lines are point estimates; dashed lines indicate 68 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian, 2004).

Figure 14: Employment for an implicit tax rate shock

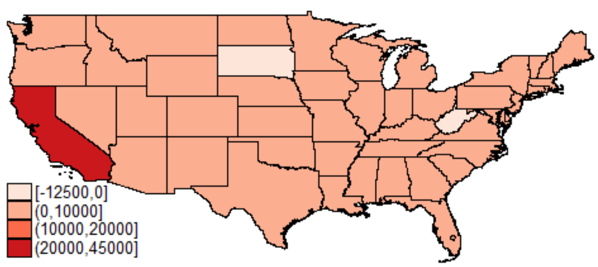
(a) Impact of implicit tax rate shock



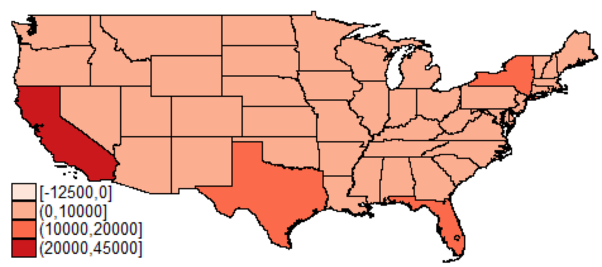

(b) 1 quarter after the implicit tax rate shock



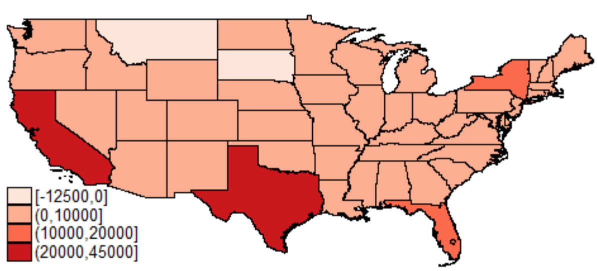

(c) 2 quarters after the implicit tax rate shock



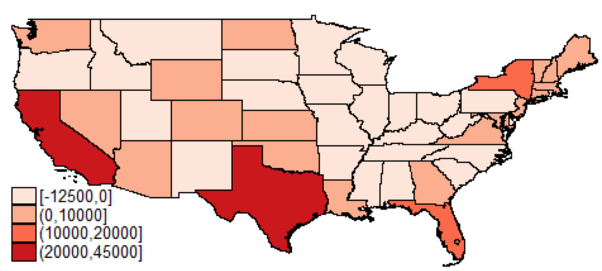

(d) 4 quarters after the implicit tax rate shock




(e) 6 quarters after the implicit tax rate shock



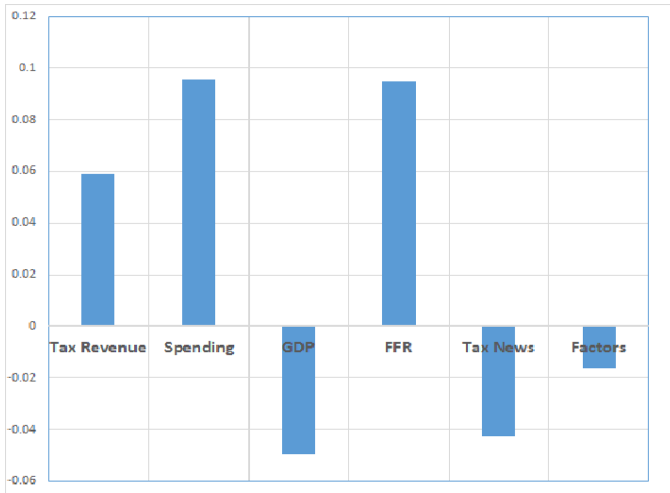

(f) 12 quarters after the implicit tax rate shock



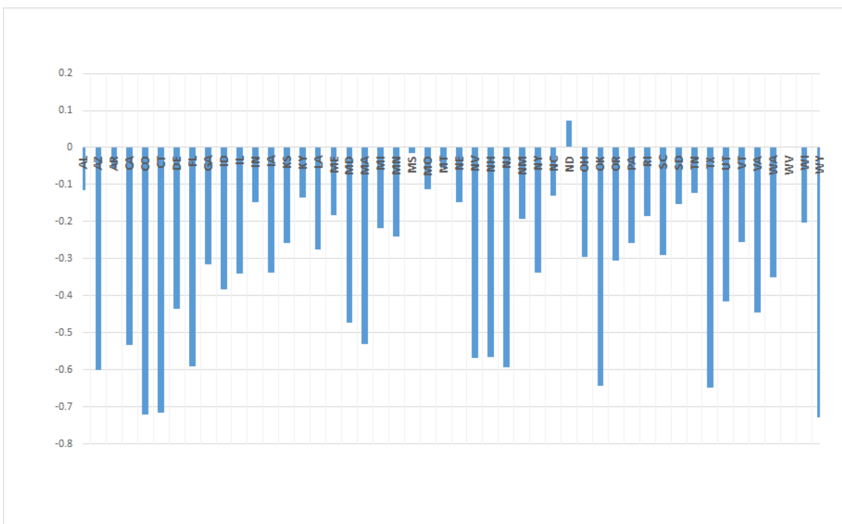

The figure illustrates the state-level employment multipliers associated with a dollar innovation in tax revenues arising from anticipated increase in tax rates. Darker shades of red indicate larger numbers to dollar shock.

Figure 15: Contribution to the Cumulative Change in Economic Activity-Tax Reform Act of 1986

(a) Cumulative Contribution of Structural Shocks to GDP Growth




(b) Cumulative Contribution of Tax News Shocks to State Personal Income Growth




(c) Cumulative Contribution of Tax News Shocks to State Employment Growth

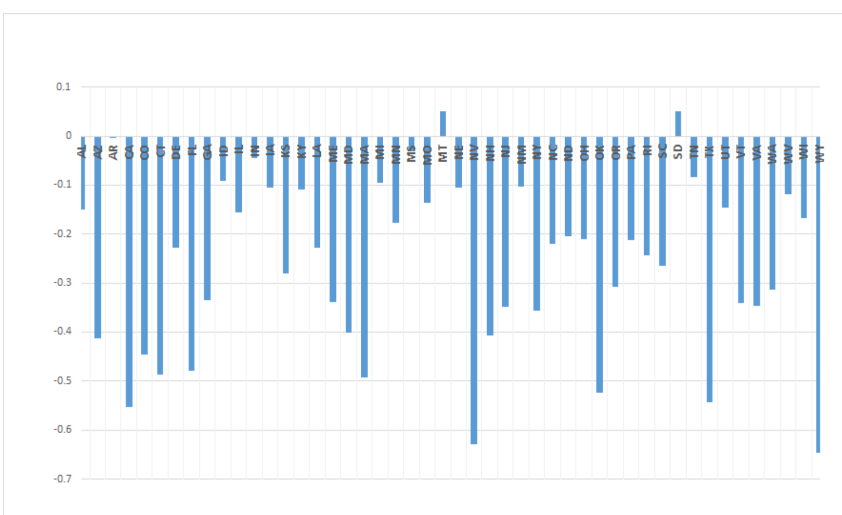
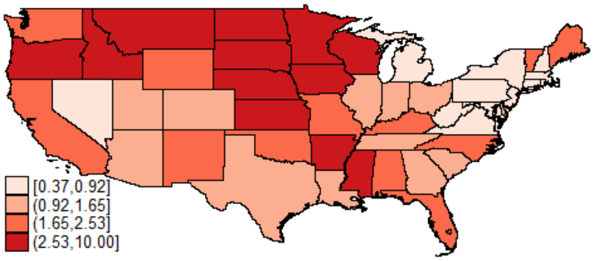
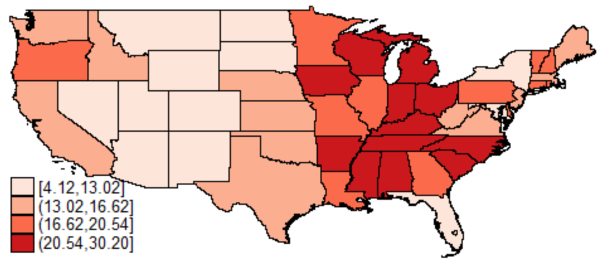


Figure 16: U.S. state-level industrial shares

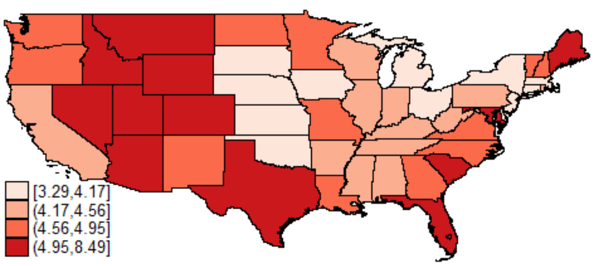
(a) Average agriculture share of total state GDP, 1963-2006



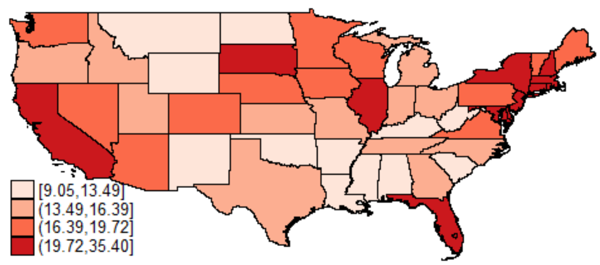

(b) Average manufacturing share of total state GDP, 1963-2006



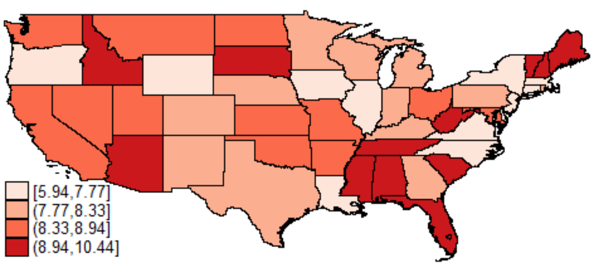

(c) Average construction share of total state GDP, 1963-2006



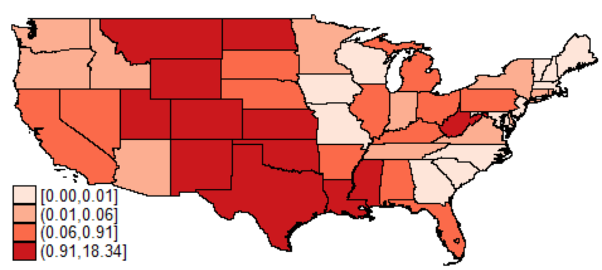

(d) Average finance, insurance and real estate (FIRE) share of total state GDP, 1963-2006




(e) Average retail share of total state GDP, 1963-2006

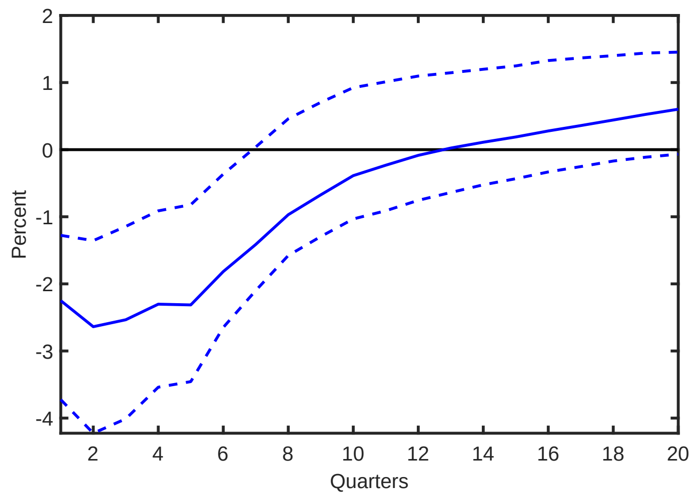



(f) Average oil share of total state GDP, 1963-2006




The figure illustrates industrial composition across 48 contiguous states in the United States. We compute the annual average output shares of the one-digit SIC sectors in a state's GDP between 1963 and 2006. The industrial shares are defined as the ratio of each sector's output to the total GDP for the state. The darker shades of red indicate states with larger shares of industrial sector output and the lighter shades of red indicate the smaller share of the industrial sector output. The industrial shares are calculated using data from the Bureau of Economic Analysis (BEA).

Figure 17: Proxy VAR: Output multiplier to an unanticipated increase in tax revenues




The figure illustrates the output multiplier associated with dollar changes in GDP as ratio of the dollar changes in tax revenues. The solid line is the dollar estimate; dashed lines indicate 68 percent confidence intervals constructed using a residual based wild-bootstrap method with 10,000 replications (Jentsch and Lunsford, 2016).