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THE MACROECONOMIC EFFECTS OF TAX NEWS

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DISSERTATION

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ABSTRACT OF DISSERTATION

THE MACROECONOMIC EFFECTS OF TAX NEWS

This dissertation explores the effect of tax news on national and state-level economic activity.

In the first chapter, I explore the effect of tax news on state economic activity. I estimate a factor-augmented vector autoregression (FAVAR) model, which allows us to consider the possibility that unobserved regional factors --such as credit and fiscal conditions-- might be relevant for modelling the dynamic response of aggregate and state-level economic activity. Tax news is identified 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. My 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. I find that the variation in the responsiveness of economic activity across states is mostly explained by differences in industrial composition as well as by some demographic characteristics such as education attainment and median age.

In the second chapter, I examine the impact and transmission of the effect of tax news on U.S. economic activity. I find that news related to higher federal income taxes raise the real GDP over the anticipation period. In addition, aggregate and disaggregate industrial production, employment per worker, hours worked per worker and capacity utilization rate respond positively to tax news in the short run. An historical decomposition shows that tax news and federal funds rate shocks have been the main source of fluctuations in real GDP. In particular, tax news associated with legislation in 1986, 1993, and 2001 contributed to the movements in the real GDP.

In the third chapter, I investigate whether the effect of tax news shocks differs across periods of recession and expansion. I follow Jorda's (2005) local projection method to estimate tax news effects on the economy. I find that news about future tax cuts reduces economic activity for about four quarters and has a significant effect on the U.S. economy in the short run. The behavior of output following tax news shocks is similar in both recession and expansion phases of the business cycle and indicates that news about future tax cuts are contractionary. However, the rebound in economic activity four quarters after the news shock is higher in the recessionary phase than in the expansionary phase. Finally, the state dependent model shows that news shocks have a stronger positive impact on consumption expenditures and residential investment in the recession phase than in the expansion phase.

KEYWORDS: Fiscal Policy, Policy Foresight, FAVAR, Tax Policy, State Business Cycles

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To my parents, Srinivasa Rao and Rama Devi, and my sister Hima Bindu, all of whom I am greatly indebted towards

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1 Introduction

Over the past several years, the discussion regarding macroeconomic effects of tax policy changes has gained interest among researchers and policy makers. In general, U.S. tax policy changes goes through legislative and implementation lags. 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. A large body of literature has underlined the necessity of accounting for tax foresight when analyzing the effects of tax policy changes (see e.g., Yang (2005), Leeper, Richter and Walker (2012), Mertens and Ravn (2011, 2012), and Leeper, Walker, and Yang (2013)). Understanding how U.S. states and national economy respond to tax news is of interest to policy makers and researchers alike. Given the presence of long delays in tax policy changes, this dissertation investigates the dynamic effects of tax news shocks in the United States. The first and second chapters examine the impact of tax new on U.S. state and national economy respectively, while the third chapter estimates the effect of anticipated tax cuts on the economy conditioning on business cycle dynamics.

In the first chapter, I build upon the macroeconomic literature on tax foresight to inquire about the effects of news regarding federal taxes on state level employment growth and personal income growth. In particular, I investigate whether news about future tax increases depress or stimulate state-level economic activity? The estimated impulse response functions reveal a statistically significant increase in personal income and employment for most of the states. While tax foresight generates a response that is similar in shape for all states, the magnitude of the effect differs greatly across them. For instance, one year after the shock, an increase of one percentage point in the implicit tax rate results in an increase of personal income that ranges between -0.02% for North Dakota and 0.78% for Massachusetts. The effect on employment ranges from 0.20% and 1.97% for

West Virginia and California, respectively.

Further, this chapter examines what drives the large differences in the magnitude of the responses across states? Theoretical models on the effect of income taxes suggest that dissimilarities in the elasticity of labor supply, in the magnitude of adjustment costs, and variable capacity utilization might lead to differences in the effect of tax changes across economies (Auerbach, 1989; House and Shapiro, 2006; Mertens and Ravn, 2011). To further inquire into this issue I regress the one-year cumulative responses for the 48 states in the sample on a set of state-level characteristics. I find a larger impact of tax news on personal income for states where the share of agriculture is low and that of manufacturing and retail are high, and where the median age is lower. As for the response of employment, I find the effect to be greater for states where the shares of manufacturing and retail are high, where the proportion of highly educated individuals is larger and that of whites is lower.

While the first chapter focuses on the response of U.S. states to tax news, there has been little empirical analysis in the macroeconomic literature to understand the propagation mechanism of tax news at the national level. The main focus of the second chapter is to study how changes in expectations about future tax rates contribute to fluctuations in macroeconomic aggregate and disaggregate variables during the period 1960-2003. Analyzing the responses at disaggregated level data will enable us to understand the transmission mechanism of tax news on the U.S. economy.

The second chapter also helps to understand how much of fluctuations in the real GDP are driven by the shocks to tax news, government spending, tax revenues, and the federal funds rate. I find that tax news associated with legislation in 1969, 1975, 1986, 1993, and 2001 contributed to the historical fluctuations in real GDP. In addition, I investigate how much of the anticipatory effects of tax news shock persists after policy realization? I conduct a counterfactual analysis for the full sample to investigate whether adding a tax policy realization shock diminishes the effect of the news shock on the economy. I find that adding a tax realization shock tapered off the anticipatory effects on the macroeconomic variables.

The third chapter examines the role of news about future tax policy, in particular anticipation of future tax cuts, on the economy in both a linear and a nonlinear framework. A large set of empirical macro literature that evaluates the effect of tax policy changes on the economy generally follows a linear structural vector autoregression (VAR) model. While a linear model has numerous advantages (e.g., ease of computation and inference), it imposes the restriction that the economy's response to tax news shocks is identical during different phases of the business cycle. Hence, this chapter contributes to empirical macro literature by departing from using standard VAR models to use a local projection technique to estimate the effects of news shock on the economy. Precisely, I investigate whether the news about future tax cuts has a different effect depending on the state of the economy.

Using Jorda's (2005) local projection method, I find that news about future tax cuts has a contractionary effect on the economy for about four quarters. The behavior of output and investment following tax news shocks is similar in both high unemployment and low unemployment states of the economy. Additionally, the state dependent model shows that news shocks have a stronger positive impact on consumption expenditures and residential investment in the recession phase than in the expansion phase.

Together, all three dissertation chapters seek to better understand the anticipatory tax effects on the U.S. economy. The first two chapters seek to understand the effect of tax news shocks on national and state level economy. In addition, these two chapters provide evidence for channels of tax news shocks. While, the third chapter questions whether the effect of tax news shocks is identical during different phases of the business cycle. Overall, the results from three chapters show a strong evidence of anticipatory effects on U.S. economy.

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

2.1 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 et al., 2012; Mertens and Ravn, 2011, 2012; Leeper et al., 2013) has underlined the necessity of 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 et al., 2007; Mullen and Williams, 1994; 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 tax news. In particular, does news about future tax increases depress or stimulate state-level economic activity? Are the effects of this shock similar across regions in the United States? Should we expect regions with differing geographical concentrations of industries to exhibit similar changes in personal income and employment patterns when it is well known that there exists variation in the way states adjust to other aggregate shocks such as monetary policy shocks (Carlino and DeFina, 1998) or government spending shocks (Owyang and Zubairy, 2013; Nakamura and Steinsson, 2014)? To grasp the importance of these questions, consider the recent debate regarding the economic effects of raising the top tax rates (Porter, 2012; Piketty et al., 2014; Mankiw, 2013). The income distribution in the U.S. has worsen 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 varies greatly across states and, thus, changes in federal taxes are not likely to affect all states equally. Can we obtain some useful information from analyzing the differences in the states-level responses to news regarding federal taxes, in addition to tracking the response of aggregate GDP? How should policy makers in states with very dissimilar income levels react to the debates on lowering federal income tax rates that typically follow an economic recession?

This chapter takes a step toward addressing these questions. Economic theory suggests a number of ways in which foresight regarding federal tax policy could affect states differently. First, real frictions –such as investment adjustment cost, 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., Leeper et al. (2012); Mertens and Ravn (2011); Leeper et al. (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 et al. (2012)). Consider, for instance, the effect of news regarding a tax increase on labor income. Such news would give firms and workers an incentive to shift production to the anticipation period where taxes are lower. However, the ability to intertemporally substitute 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 et al. (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 –or be less well understood– for residents of some states.

In addition, Gruber and Saez (2002) find that the elasticity of taxable income differs

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

significantly between high income tax payers who itemize deductions and other income groups. Thus, if high income tax payers are regionally concentrated, the effects of changes in federal taxes may vary systematically across states. Similarly, differences in fiscal burden and on whether a state imposes or not personal income taxes may lead to variation in the magnitude and timing on the responses. 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 et al. (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 growth. Our results suggest that a 1 percentage point increase in the implicit tax rate leads to higher GDP growth 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.

To probe deeper into the differential response of state-level economic activity, we then turn to disentangle the channels whereby news of a federal tax increase affect personal income and employment. To this end, we first compute the one-year cumulative response of personal income growth and employment growth for each of the states. Next, we

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

project the cumulative responses on a set of state-level covariates (i.e., state GDP composition, demographic and fiscal characteristics). The results reveal a larger effect of tax news on personal income growth for states that have a low agriculture share in GDP, high manufacturing and retail shares, a lower median age, and those states with higher per-capita federal tax burden. Regarding the response of employment growth to news of a federal tax increase, we find that the magnitude of the effect increases with the share of manufacturing and retail, the degree of education and it decreases with the proportion of white population.

Our finding of a positive response of aggregate economic activity to tax news is not new (see e.g., Leeper et al. (2012, 2013); Mertens and Ravn (2012); Kueng (2014)). What is novel is that our study provides 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, tax news appear to have a larger effect in economies with a larger percentage of educated individuals who are likely to save more and, thus, 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 and capital-labor ratios-play a crucial role in how responsive personal income and employment are to tax news. Third, the larger the per-capita federal tax burden, the greater the response of state economic activity. This result suggests that the initial tax burden faced by a state is key in gauging the effect of anticipated tax changes.

The remainder of this chapter unfolds as follows. Section 2.2 discusses the identification of tax foresight. Section 2.3 describes the factor augmented vector autoregression (FAVAR) model, the data set and the estimation method. In section 2.4, we describe the responses of aggregate and state-level economic activity to tax news. We investigate the drivers of the state-level responses in section 2.5. Section 2.6 summarizes and concludes.

2.2 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 changes 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 4 and 17 months for the period under analysis. 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 implemented. 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.

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 et al. (2013).[3] The two leading methodologies used to tackle the issue of endogeneity are: (a) the narrative approach, and

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

(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. 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)).[4] 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, 2013). 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 (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.[5] Leeper et al. (2013) and Leeper et al. (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.

[4]Alternatively, Mountford and Uhlig (2009) attain identification via sign restrictions.
[5]See also Fernández-Villaverde and Watson (2007)

We follow Leeper et al. (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 a number of questions. First, does the implicit tax rate have predictive content for the standard VAR tax shocks? In other words, 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? Finally, who is the marginal investor? 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 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 2.1 reports the test results. Clearly, whereas the implicit tax rate Granger-causes the VAR shocks, the VAR shocks do not Grange-cause the implicit tax rate.[6] In other words, it would seem that what the usual VAR analysis identifies as

[6] 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.

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 2.1 plots the implicit tax rate, the top 1% marginal tax rate, the average marginal tax rate, and the average personal income tax rate 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. Furthermore, changes in the implicit tax rate appear to precede changes in the average personal income tax rates.

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. Panel B of Table 2.1 reports the test results for the bi-variate Granger causality tests between the implicit tax rate and the log growth of real per-capita net taxes (Blanchard and Perotti, 2002). We find that the implicit tax rate helps to forecast changes in real net per-capita taxes, whereas we cannot reject the null hypothesis that the log growth in real net per-capita taxes does not Granger-cause the implicit rate at a 5% level.

Instead of using net taxes as the tax measure, other researchers have used a personal income tax rates. For instance, Barro and Redlick (2011) use the average marginal tax rate, whereas Mertens and Ravn (2013) use the average personal income tax rate. To formally test the hypothesis that the implicit tax rate is useful in predicting the personal income tax rates, we perform bi-variate Granger causality tests between the implicit tax rate and the average personal income tax rate (Table 2.1, Panel C), and between the implicit tax rate and the average marginal federal income tax rate (Table 2.1, Panel D). The test results indicate that while the implicit tax rate Granger-causes the average personal income tax rate and the average marginal federal income tax rate, neither the average personal income tax rate nor the average marginal federal income tax rate help to forecast the implicit tax rate. Therefore, the implicit tax rate has predictive content for the individual income tax rate for the period under analysis. The reader might wonder 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. To answer this question we conduct a Wald test for Granger-Causality where we evaluate the null-hypothesis of no Granger-causality from the implicit tax rate to net taxes. The results reported in Panel E of Table 2.1 indicate that we can reject the null in a 1% level test, 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 (2014) 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 2.2). Moreover, Figure 2.1 reveals that the path followed by the implicit tax rate resembles that of the marginal tax rate faced by the top 1% of the income distribution.

Identifying shocks to tax policy as innovations in the implicit tax rate has a number of 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. Second, it does not require the researcher to fix the length of the anticipation period a-priori, nor to assume that taxes are exogenous. This point is important as the legislative and implementation lags can vary considerably from one tax change to another (see, Yang (2007), Figure 2.1, and Table 3.1). Modeling tax foresight via the implicit tax rate has the benefit of capturing these changes whereas fixing the anticipation lag a-priori does not.

Nevertheless, 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 et al. (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 (2014) 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 et al. (2012)). However, we will show in section 2.4.4.2 that our results are robust to computing the implicit tax rate using a longer maturity: the 5-year yield spread. Second, one may argue that the marginal investor is not representative of the average tax payer as he or she belongs to the higher tax bracket. Indeed, Kueng (2014) shows that the marginal tax rate implied by the municipal yield spread is close to the rate faced by the top 1% of the income distribution. Nevertheless, identification of the response of state-level employment and personal income relies on changes in the path of the expected tax rate and not on the level. Therefore, as long as the marginal investor's tax rate moves close enough to the true tax rate, using the tax rate implied by the municipal yield spread does not pose a problem for our identification strategy.

2.3 The FAVAR Model

This section motivates the use of the factor-augmented VAR model, describes the model, presents the estimation procedure, and discusses the identification of the common factors and the impulse response functions.

2.3.1 Motivation

The main objective of this chapter is to investigate the effect of tax foresight on state-level economic activity. To do so we could proceed by estimating a structural VAR (VAR) including a macro block and then rotating the state level variables of interest, state by state, after the macro block. In particular, let Y_t be a 5×1 vector of observable macroeconomic variables assumed to have an impact on economic activity throughout the U.S. states. More specifically, suppose Y_t contains the log growth of real per-capita net taxes (Δt_t), the log growth of real per-capita federal government spending (Δg_t), the log growth of real per- capita GDP (Δy_t), the federal funds rate (ff_t), and the implicit tax rate (τ_t). Then, estimating a VAR with the macroeconomic block ordered first, followed by a state block containing the log growth of real per-capita personal income for state i (Δpi_{it}) and the log growth of per-capita employment for state i (Δemp_{it}) would allow us to estimate the impact of news regarding federal taxes on state level economic activity. However, to ensure that the responses of the macroeconomic variables do not change when different states are rotated in the VAR, we would have to assume that state-level economic activity does not enter in the macroeconomic block.[7]

[7] See Owyang and Zubairy (2013) for an excellent discussion on alternative VAR specifications.

Instead, we consider the possibility that unobserved factors such as regional economic, credit and fiscal conditions –not fully captured by Y_t– are relevant for modeling the dynamic response of aggregate and state-level economic activity to tax foresight. Furthermore, we assume that this additional economic information can be summarized by a $k \times 1$ vector of unobserved factors, F_t, where k is small. Then, a factor-augmented vector autoregression (FAVAR) constitutes a suitable methodology to exploit this additional economic information. We assume that the joint dynamics of Y_t and F_t are given by

$$C_t = B(L)C_{t-1} + u_t \tag{2.1}$$

where

$$C_t = \begin{bmatrix} Y_t \\ F_t \end{bmatrix},$$

Y_t is a 5×1 vector of macroeconomic variables listed above,
$Y_t = \begin{bmatrix} \Delta t_t & \Delta g_t & \Delta y_t & ff_t & \tau_t \end{bmatrix}'$, F_t is a vector of $k \times 1$ unobserved common factors, and $B(L)$ is a conformable lag polynomial of order $p = 4$.[8] The error term u_t is an i.i.d. $(k+5) \times 1$ vector of zero mean disturbances such that $E(u_t u_t') = \Omega$.

The system in (2.1) is a VAR in C_t where there is an additional complication relative the standard VAR: the common regional factors F_t are unobserved. We assume that these factors 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, Δpi_{it}, where $i = 1, 2, ..., 48$,[9] and (b) the log growth of per-capita employment for each of the 48 contiguous states, Δemp_{it}, where $i = 1, 2, ..., 48$. Moreover, we assume that this vector of state-level variables is

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

[9]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 region-specific factors.

related to the common factors according to

$$X_t = \Lambda C_t + e_t \tag{2.2}$$

where Λ is a $N \times (k+5)$ matrix of factor loadings with $N = 96$ and is k to be determined as explained in the following section. The $N \times 1$ vector e_t contains series-specific components that are uncorrelated with the common regional factors C_t.

Our motivation for using the FAVAR methodology is threefold. 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). For instance, historically, oil price shocks have had a stronger recessionary effect on states located in the Energy Belt. (See Table 2.2 for a description of the states in each economic region). 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, 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 regional 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 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.

2.3.2 Estimation and Identification

We consider the number of factors k in F_t to be unknown but fixed as in Bai and Ng (2002). To determine the number of factors we start with an arbitrary number $k_{max} = 8 * int[(\frac{min(N,T)}{100})^{1/4}]$, given by Schwert (2002) rule, where $N = 96$ and $T = 200$.[10] Then, for a given k, we obtain estimates of Λ^k and F^k by solving the minimization problem

$$V\left(k, F^k\right) = \min_{\Lambda} \frac{1}{NT} \sum_{i=1}^{N} \sum_{t=1}^{T} \left(X_{it} - \lambda_i^{k\prime} F_t^k\right)^2 \qquad (2.3)$$

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 unobserved factors $\hat{k}$ that minimizes the information criterion suggested by Bai and Ng (2002):

$$IC_{p2}(k) = log[V(k, F^k)] + k * \frac{N+T}{NT} * log[min(N,T)]. \qquad (2.4)$$

Minimization of $IC_{p2}(k)$ with respect to k results in an estimate of $\hat{k} = 8$. That leaves us with the 5 observed factors in Y_t and 3 unobserved factors in f_t.

Having determined the number of unobserved factors, we then proceed to estimate the FAVAR model in (2.1)-(2.2) using a two-step procedure (see Bernanke et al. (2005)). In

[10] 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.

the first step, we use Bai and Ng (2013) method to estimate the 3 unobserved factors and the factor loadings from the large data set X_t. The estimated three factors are denoted as $F_t = [f_{1,t}, f_{2,t}, f_{3,t}]$ and can be interpreted as regional economic factors, which recover the common aspects of U.S. state level economy that are not captured by the macroeconomic variables in Y_t. In the second step, the estimated regional factors $\widehat{F}_t$ are used in conjunction with the macroeconomic variables Y_t to estimate equation (2.1) using standard VAR techniques.

To compute the impulse response functions we employ the standard short-run restrictions imposed in the VAR literature similar to Blanchard and Perotti (2002) and Mertens and Ravn (2012). That is, we use Choleski decomposition with the variables ordered as described above. Thus, we impose the restriction that the log growth in net per capita taxes (Δt_t) does not respond contemporaneously to changes in Δg_t, Δy_t, ff_t, τ_t, $f_{1,t}$, $f_{2,t}$, $f_{3,t}$; the log growth of real per-capita federal government spending (Δg_t) does not respond contemporaneously to changes in Δy_t, ff_t,τ_t, $f_{1,t}$, $f_{2,t}$, $f_{3,t}$, and so on. Note that our ordering implies that there is contemporaneous feedback from the macroeconomic variables to the implicit tax rate, which allows the implicit tax rate to respond to monetary policy shocks affecting the T-bill rate within the quarter. In addition, our identification assumptions imply that the monetary authority responds contemporaneously to movements in net per capita taxes, government spending and output (i.e., Δt_t, Δg_t, Δy_t), that the regional factors respond contemporaneously to innovations in the macroeconomic aggregates, but that the latter only respond with a lag to innovations in the regional factors. Hence, recessions or expansions that start in a particular region may affect the aggregate variables only with a lag. These identification restrictions have two advantages. First, they are in line with the short-run identification restrictions imposed in the existing VAR literature on fiscal policy (see, e.g. Blanchard and Perotti 2002 and Leeper, Walker and Yang 2013). Second, because the implicit tax rate and all macroeconomic variables are ordered before the unobserved factors, the estimated impulse responses are robust to using alternative identification schemes for the regional factors.

Point-wise confidence intervals for the impulse response functions are computed using a residual based wild bootstrap (Gonçalves and Kilian, 2004; Yamamoto, 2012). We use 10,000 replications and report 68% and 95% confidence intervals.

2.3.3 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 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) 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. These three variables are transformed into growth rates by taking first differences of the logs to obtain Δt_t, Δg_t, and Δy_t. 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. Tables A.1.1 and A.1.2 provide details on the data and the construction of variables used in the FAVAR model and in the cross-state analysis, respectively. All variables are standardized prior to estimating the factors.

2.4 The Dynamic Effects of Tax News

This section discusses the effect of a one percentage point increase in the implicit tax rate.

2.4.1 Macroeconomic Aggregates

Figure 2.3 plots the response of the macroeconomic variables and the estimated regional factors to a one percentage point increase in the implicit tax rate. 68% and 95% confidence intervals computed with a residual based wild bootstrap are denoted by dashed and dashed dotted lines, respectively. Our estimation results indicate that a rise in the implicit tax rate immediately results in a faster real per-capita GDP growth, which reaches its peak value of 0.29% four quarters after the shock (see Table 2.3). The expansionary effect lasts about a year. In fact, news of a tax liability increase results in a cumulative rise of 0.88% in real per-capita GDP four quarters after the shock. This response falls in line with the classical view where an anticipated rise in personal income taxes leads to 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.

Not surprisingly, real per-capita net taxes follow a similar pattern as real per-capita GDP growth: they increase on impact and reach a peak response of 0.62% one quarter after the shock. Higher income results in greater tax returns during the anticipation period but, as it is the case for real GDP, the positive effect becomes statistically insignificant after the fifth quarter. 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.

Our results suggest anticipation of a tax liability increase sets off a boom in the economy that lasts slightly over a year. This expansion then results in tighter monetary policy, which is reflected in a higher federal funds rate. This pattern is consistent with the Fed acting to control possible inflationary pressures stemming from heightened economic activity.The finding of a positive relation between tax news and economic activity is consistent with work by 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 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.

2.4.2 State Personal Income

Figures 2.4, 2.5, and 2.6 display the impulse response functions for real per-capita personal income growth –hereafter personal income growth–, as well as 68% and 95% confidence intervals. For most states, the estimated responses reveal a statistically significant increase in real state personal income growth in anticipation of higher personal income taxes. The state responses reach a peak three or four quarters after the shock; that is, a quarter before or at the same time as GDP growth (see Table 2.3).

Although the shape of the impulse responses is very similar across states, they differ greatly in magnitude. For instance, one year after the shock, an anticipated increase in the implicit tax rate results in a cumulative change in real personal income growth that ranges between -0.02% and 0.78 % for North Dakota and Massachusetts, respectively (see Table 2.3). Given that the average growth rate for state personal income was 0.6% between 1957 and 2006, the effect appears to be economically significant. In fact, on average, one year after the shock, an additional one percentage point in the implicit tax rate would result in an increase of 0.23% in state personal income.

Differences in the dynamics of the personal income response across states appear to follow a regional pattern. Figure 2.10 plots the evolution of the cumulative responses across U.S. states for a few representative horizons. Darker shades of red indicate larger positive responses to an innovation in the implicit tax rate. On impact (see Figure 2.10a), the effect on real personal income is somewhat smaller for states in the Northern Plains (e.g., Montana, Southern Dakota and Northern Dakota) and Plains (e.g., Kansas, Iowa 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. A year after the shock, personal income growth has increased, on average, by 0.56%, 0.56%, and 0.60% in the Great

Lakes, New England and the South East regions, respectively (see Figure 2.10b). Two years after the news of a tax increase, most states in the Great Lakes, New England, the Energy Belt and the Far West have experienced an expansion in personal income growth (see Figure 2.10d). One year later, the effect starts to decline for most states. Throughout the four-year horizon the response of personal income is moderate for states that are in the Mountains/Northern region. In contrast, states in New England and the South East show a strong positive effect both in the short and the long run.

Summarizing, whereas the impulse responses of personal income growth exhibit a similar 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 2.5, we will advance two possible hypotheses based on the patterns observed in Figure 2.10. First, shocks to the implicit tax rate appear to have a considerably larger effect in states with higher education attainment and higher income levels. For instance, compare the pattern followed by most states in the New England and Mideast regions (e.g.,Connecticut, New Hampshire, Massachusetts, and New Jersey) with that of West Virginia and Mississippi, two of the states with the lowest percentage of population with at least a bachelor's degree and with low 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. Second, states where agriculture represents a large percentage of GDP such as North Dakota, South Dakota and Montana are less responsive to tax news. Note how these states are represented in lighter tones of red throughout the depicted horizons. This evidence is suggestive of a lesser ability of firms and individuals to exploit tax news in economies with high capital-labor ratios such as those that rely more heavily on agriculture.

2.4.3 State Employment

Figures 2.7, 2.8, and 2.9 plot the 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% and 95% confidence intervals. As the figures illustrate, an implicit tax rate shock results in a statistically significant increase in state employment growth. For most states, the response of employment growth reaches a peak three 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 0.20% and 1.97% for West Virginia and California, respectively (see Table 2.4). 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%. On average, the one-year cumulative impact of a one percentage point increase in the implicit tax rate is estimated to be a 1.15% increase in state employment growth. Hence, the effect is not only statistically but also economically significant.

Figure 2.11 displays the cumulative change in real employment growth across the 48 contiguous states for a few representative horizons. On impact, the difference in the response of employment across states appears to be greater than in the response of personal income (Figure 2.11a). Regional patterns are observable four and six quarters after the shock (see Figures 2.11b and c, respectively). Increases in employment are considerably larger for states in the South East and New England. Interestingly, in contrast with the patterns observed for personal income growth, the effect on employment growth for the Great Lakes region (0.95%) is not larger than the average effect across states (1.15%). The effect of a shock to the implicit tax rate appears to spread throughout the U.S. states during the first year and then starts to die out about eight quarters after the shock.

Is the response of employment more moderate or sluggish for states with a high agricultural component? What demographic characteristics explain these diverse employment patterns? Section 2.5 seeks to formally disentangle the drivers of the variation in the response to implicit tax shocks. However, let us point here to two possible sources. First, the patterns observed in Figure 2.11 suggest that employment is somewhat less responsive in states where agriculture comprises a high share of GDP. Note how North Dakota, South Dakota, Idaho, and Montana are depicted in lighter tones of red than most other states throughout the maps in Figure 2.11. Second, a larger employment boom appears to ensue in states that face a higher per-capita federal tax burden (e.g. Connecticut, New Jersey and Massachusetts). To better grasp why this might be the case, it is important to realize that per-capita federal tax burden is highly correlated with demographic characteristics such as education and median income. Hence, such a finding would be consistent with models that imply a larger effect of tax foresight in economies where the percentage of savers is greater (Leeper, Richter and Walker 2012), and smaller in economies with high capital-labor ratios.

2.4.4 Robustness Checks

In this section, we conduct additional checks to examine whether our findings are robust to alternative specifications of the FAVAR model. For the sake of brevity, we will discuss the responses of aggregate GDP and state-level economic activity but will relegate the corresponding figures to the appendix.

2.4.4.1 Alternative measures of taxes: The benchmark specification employed in the previous sections includes the log growth of real per capita net taxes –after the implicit tax rate– as a measure of tax revenues along the lines of Blanchard and Perotti (2002).

However, the reader may wonder whether our results are robust to including a measure of the tax rates faced by the individual instead of a measure of tax revenue. Thus, we experimented by rotating three different variables, one at a time, as the second variable in the benchmark FAVAR. These variables are: (1) the average personal income tax rate, which is measured as the sum of federal personal income taxes and contributions for government social insurance divided by the personal income tax base; (2) the average corporate income tax rate, which is measured as the federal taxes on corporate income divided by corporate profits; and (3) the average marginal tax rate. The first two variables are available from Mertens and Ravn (2013), whereas the third was calculated on an annual basis by Barro and Redlick (2011). Here, we follow Ramey (2011) and impute the same average marginal tax rate to each of the quarters in a given year. Arguably, the implicit tax rate should contain less information regarding future changes in the average corporate income tax rate than in the average personal income tax rate, as individual holdings of municipal bonds dominate the holdings of other corporate entities (Ang et al., 2010). Yet, as innovations in the implicit tax rate might have an effect on corporate taxes via their effect on employment, we opt to carry out this robustness check.

We find the responses of aggregate GDP, state personal income growth and state employment growth to be similar in shape for all three cases and to resemble the benchmark responses (see Figures A.1.1-A.1.7 in the Appendix). The magnitude of the responses when we rotate in the average personal income tax rate or the average marginal tax rate are almost identical. For instance, four quarters after a shock to the implicit tax rate, the cumulative change in average personal income (employment) growth across states equals 0.469% (1.153%) in the benchmark model versus 0.466% (1.148%) when we use the average personal income tax rate. Instead, the responses of both aggregate GDP and state-level economic activity are slightly larger when we rotate in the average corporate income tax rate. In particular, we obtain one-year cumulative changes of 0.52% and 1.30%

percentage points for personal income growth and employment growth, respectively.

2.4.4.2 Longer Bond Maturities: The reader might also wonder whether using bonds with longer maturities to compute the implicit tax rate affects our results. For instance, Kueng (2014) finds that the 2-year break even tax rate (BERT) –computed using the municipal bond spread– follows the marginal tax rate of the top 1% of the income distribution closer than the 15 year BERT. Clearly, the longer the maturity of the bonds, the longer the horizon over which expectations of future tax changes are computed. To evaluate the effect of considering longer bond maturities, we re-estimated our FAVAR model using the implicit tax rate derived from the yield data of U.S. municipal and Treasury bonds with five year maturity. Figure A.1.8 of the Appendix illustrates that, regardless of the maturity dates on municipal and Treasury bonds, GDP increases in response to a tax news shock. In fact, differences between the two impulse response functions are minimal.

As for the estimated impulse response for state-level personal income and employment, they are also robust to considering longer maturities (see Figures A.1.9-A.1.14 in the Appendix). Overall, we observe a similar shape in the response of personal income with a peak around 4 quarters for most states and a significant variation in the magnitude of the response across states. For employment, states exhibited similar shaped responses with a peak around 1 quarter after the shock. As it is the case for aggregate economic activity, the estimated effect on state-level economic activity is very similar. For instance, the mean of the 4-quarter cumulative response across states for personal income is 0.41% when we use the 5-year bonds versus 0.47% for the benchmark. This result is consistent with forward looking agents incorporating information about the future path of the income tax rate as soon as news become available.

2.4.4.3 Monetary Policy: Work by Rossi and Zubairy (2011) finds that considering fiscal and monetary policy in conjunction is key when analyzing the effect of government spending in VARs. This is also likely to be the case when estimating the effect of tax news. Thus, to formally evaluate the importance of accounting for monetary policy, we re-estimated the FAVAR excluding the federal funds rate. The estimated responses are similar in shape and magnitude to our benchmark model where the implicit tax rate is ordered after the federal funds rate. For instance, in the model that excludes the fed funds rate, 1% increase in the implicit tax rate leads to one-year cumulative increases of 0.74%, 0.44%, and 1.22% in real per-capita GDP, average state personal income, and average state employment, respectively. Contrast this with our benchmark model where, four quarters after the shock, the increase in real per-capita GDP, state personal income, and state employment growth equaled 0.88%, 0.47%, and 1.15%, respectively.[11].

We also investigated the robustness of our results to two alternative specifications of monetary policy. First, we augmented our benchmark model by including the log growth of nonborrowed reserves. This alternative specification is motivated by arguments discussed in Christiano et al. (1999) whereby the Federal Reserve targeted non-borrowed reserves during some years, in particular between 1979 and 1982. The results were qualitatively unchanged (see Figures A.1.16-A.1.21 in the Appendix). The only difference in the impulse responses is a smaller impact of tax news on aggregate and state-level economic activity. For instance, if we include nonborrowed reserves in the model, we estimate increases of 0.37% and 0.79% in the cumulative responses of personal income and employment growth, respectively, a year after the shock.

Then, we experimented with using the term spread, measured as the difference between the 10-year Treasury bond rate and the 3-month Treasury bill rate, as an alternative

[11]Unreported results, available from the authors upon request, suggest that the effect of an unanticipated tax change is overestimated when monetary policy is ignored under an alternative identification scheme where the implicit tax rate is ordered first (see Figure A.1.15)

indicator of the monetary policy stance. In particular, it has been argued that this term spread contains relevant information for the conduct of monetary policy as it captures expectations regarding inflation and output growth (see Ang and Piazzesi (2003), among others). The estimated impulse response functions for aggregate and state-level economic activity are very similar to the benchmark model. The only difference is a slightly larger effect of the implicit tax rate shock on economic activity. More specifically, the average response of personal income and employment growth across states equal 0.48% and 1.24%, respectively.

2.5 What Drives the Variation in the State-Level Responses?

This section investigates the reasons for the differential responses to an implicit tax rate shock across states.

2.5.1 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.

2.5.1.1 Adjustment Costs: It is well known that industries differ in the nature of the labor and capital adjustment costs they face (see Caballero et al. (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, 2006). 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 across states. As Figure 2.12 illustrates, industry composition varies greatly across regions. For instance, for agriculture –an industry with a capital share of about 40%– the share of GDP ranged between 2.5% and 10% for states in the Northern Plains whereas it represented less than 1% for most states in the New England region. In contrast, states in the Great Lakes and in the Southeast regions are mostly characterized by a high manufacturing share in GDP, an industry with a capital share of about 30%. In addition to these divergences, interregional input-output relationships may aid in differentiating the response of federal tax shocks across regions.

2.5.1.2 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 (2014) demonstrates that households who are less educated, have 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 tax payers 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.

2.5.1.3 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.

2.5.2 Empirical Methodology and Estimation Results

The analysis in section 2.4 uncovered important differences in the magnitude of the state-level response of economic activity to tax news. In this section we explore which state-level characteristics drive these differences. To do so we regress the one-year cumulative responses of personal income and employment growth for the 48 contiguous states on a number of state-level covariates. That is, we estimate by OLS the following cross-state equation

$$y_i = \beta x_i + \epsilon_i \tag{2.5}$$

where y_i is defined as the estimated one-year cumulative response of state-level personal income or employment growth for state i, computed from the estimated FAVAR model. ϵ_i is an error term. The vector x_i includes state-level measures of industry mix (i.e., the average ratio of a sector's output to the total state GDP), demographic characteristics (population density, median income, median age, white, black, female, education) and a measure of per-capita state federal tax burden.[12] In addition, we include a dummy that takes the value of one for the eight states where most municipal bonds are traded (California, New York, Florida, Texas, New Jersey, Michigan, Ohio, and Pennsylvania), and a dummy for the seven states that do not levy income taxes on individuals (Florida, Nevada, South Dakota, Texas, Washington, and Wyoming).

[12] See Table A.1.2 in the appendix for a detailed description of the data construction.

Most of the covariates in x_i are computed as annual averages over the period where the data are obtainable. In some cases, due to data availability, we measured the variable in the year where the data were reported. In particular, to control for sectorial composition in the state, we computed the annual average output shares of the one-digit SIC sectors in a state's GDP between 1963 and 2006. These shares are calculated using data from the Bureau of Economic Analysis (BEA)[13] and defined as the ratio of each sector's output to the total GDP for the state. The variable 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 U.S. Census Bureau. Fiscal characteristics 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 the dummy that controls for whether the state levies taxes on personal income. These data are collected from the Tax Foundation. A detailed description of the definitions, computations and sources for the data is provided in the Appendix.

2.5.2.1 State Personal Income: Table 2.7 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. The results suggest that the response of personal income growth is significantly lower in states with large agriculture

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

shares and higher in states where manufacturing and retail represent a high percentage of state GDP. For instance, in the regression with only the statistically significant demographics and industry shares (column 5) the estimated coefficient on agriculture implies that state with a 1% higher share would have experienced a 0.03% smaller increase in response of personal income a year after the implicit tax rate shock. Examples of states with a high agricultural component are South Dakota, North Dakota, Nebraska and Montana. In contrast, a state with a 1% greater share of manufacturing would have exhibited a 0.02% larger increase in personal income. For instance, Indiana and Michigan exhibited manufacturing shares well above the average for the nation.

All in all, the results are consistent with the hypothesis that systematic differences in the industry mix 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. In particular, 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 are less able to take advantage of these news.

Although the first two regression in Table 2.7 reveal a larger increase in personal income for the eight states (CA, NY, FL, TX, NJ, MI, OH, and PA) where most municipal bonds are traded, this effect is statistically insignificant. These results suggest that news regarding a future increase in federal personal income taxes has similar effects on states where residents face a more liquid municipal bonds market than in states where this market is less liquid (Ang et al., 2010).

As noted, demographics vary greatly across states. In turn, tax burden varies significantly by income, age, etc. We thus included a number of demographic covariates in our regression: population density, median income, median age, the percentages of white and

African American population, the percentage of females, and a measure of the education level. Only median age appears to be a statistically significant determinant of how responsive state personal income growth is to news of an increase in federal taxes. In particular, an increase of one year in the median age of the state's population results in a reduction of 0.03% in the response of personal income (see column 5 of Table 2.7). This result is consistent with the fact that occupational mobility decreases with age, thus systematic differences in the degree of state labor mobility could result in differential responses of personal income growth.

We conclude this section by noting that there is no significant difference in the responsiveness of state personal income between states that levy taxes on personal income and those that do not. Nor do we find the per-capita federal tax burden to have any explanatory power, once we have controlled for education.

2.5.2.2 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 2.8. As it is the case with personal income, employment growth appears to be more responsive to tax news in states where the share of manufacturing is high. Similarly, states with a high retail component are more able to take advantage of the tax news and exhibit a larger increase in employment growth. (Examples of states with a high retail share are Maine and Florida.) These results are consistent with House and Shapiro's (2006) finding of 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.

Regarding the demographic characteristics, both the percentage of the population with at least a bachelor's degree and the percentage of white population partially explain the variation in the response of employment growth across states. Examples of states where over 20% of the population has at least a bachelor's degree are Colorado, Connecticut, Massachusetts and Maryland. It is worth noting that most of the highly educated states are located in New England, a region where we estimated the dynamic response of employment growth to implicit tax rate shocks to be not only stronger but faster (see Figure 2.11). This finding points towards the ability of individuals with higher education attainment to take advantage of tax news (Kueng 2014). All else equal, states with a greater percentage of the population that is white[14] exhibit a smaller increase in employment growth when faced with news of a federal tax increase. Most of these states are located 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 2.11).

Similar to what we found for personal income, the magnitude of the employment response is not statistically different between the eight states where most municipal bonds are traded and the rest of the states. On the other hand, states that face a higher federal tax burden do exhibit a greater response of employment to tax news. This result points toward a higher incentive to reoptimize for households and firms located in states where the federal tax burden is greater.

2.5.3 Robustness Checks

2.5.3.1 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 median for the peak response of personal income 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

[14] Notice that the omitted group is other race. Thus a negative coefficient on white indicates that employment growth is less responsive relative to states where the percentage of the population of other race (non-white, non-black) is higher.

to news regarding a federal tax increase occurs before a year has passed (see Table 2.3). 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 column (2) and (3) of Table 2.9 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, $\Delta pi4$, in regression (2.5), enter significantly and exhibit the same sign when we use the cumulative response after two, $\Delta pi2$, or six quarters, $\Delta pi6$. The only significant difference at the two-quarter horizon is a reduction in the magnitude of the coefficients, which is due to the smaller magnitude of the state-level cumulative responses. In contrast, the differences in the magnitudes of the coefficients between the benchmark (4-quarters) and the longer horizon (6-quarters) is minimal. We do observe a slight decrease in statistical significance for federal tax burden and median age

A similar pattern is apparent for employment growth. That is, the sign of the coefficient is unchanged, albeit their magnitude tends to be smaller when we consider the cumulative response after two quarters, $\Delta emp2$ (see column (2) and (3) of Table 2.10). In fact, at this horizon the share of manufacturing in GDP becomes insignificant. Instead, when we consider a six-quarter horizon, $\Delta emp6$, the results are similar to that of benchmark specification except for the coefficient on the share of manufacturing in GDP, which becomes statistically insignificant.

2.5.3.2 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 earning the greater the pressure to approve redistributive income tax policies. Yet, there is a trade-off between the possibility 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 column (5) and (6) of Table 2.9 and 2.10. The estimated coefficients on the control variables are in line with that of benchmark specification and column (4) of Table 2.9 and 2.10. Yet, none of the political controls have explanatory power for the cross-state variation in the responsiveness to tax news.

2.6 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. Although all states exhibited a similar humped shaped response, with the anticipation period lasting about four quarters, the timing and the magnitude of the effect varied greatly across states.

Which state-level characteristics explain these differences in the 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 share of agriculture is low and that of manufacturing and retail are high, and where the median age is lower. As for the response of employment, we found the effect to be greater for states where the shares of manufacturing and retail are high, where the proportion of highly educated individuals is larger and that of whites is lower.

Whereas the finding of a positive response of aggregate economic activity to tax news is not new (Yang, 2005; Leeper et al., 2012; Mertens and Ravn, 2011, 2012; Leeper et al., 2013; Kueng, 2014), 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 a number of studies, tax news appear to have a larger effect in economies with a larger percentage of highly educated individuals –most likely 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 and capital-labor ratios- play a key role in how responsive personal income and employment are to tax news. Third, the larger the tax burden faced in an economy the greater the response of economic activity to tax news. Then, 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.

Our results have implications regarding the recent debates on increasing the federal income tax rates for the top 1% of the income distribution. The existence of disparate responses to an implicit tax rate shock 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 agreement 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 in regards to the quantitative impact of tax foresight.

Table 2.1: Granger Causality Tests

Null Hypothesis		
Panel A: VAR Tax Shocks	**F-test**	**p-value**
VAR tax shocks do not Granger-cause the implicit tax rate	1.094	0.360
Implicit tax rate does not Granger-cause the VAR tax shocks	5.016	0.000
Panel B: Log Growth of Real Per-Capita Net Taxes	**F-test**	**p-value**
Log growth of real per-capita net taxes does not Granger-cause the implicit tax rate	2.014	0.094
Implicit tax rate does not Granger-cause the log growth of real per-capita net taxes	7.816	0.000
Panel C: Average Personal Income Tax Rate	**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 D: Average Marginal Federal Income Tax Rate	**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 E: Log Growth of Real Per-Capita Net Taxes in FAVAR	**χ^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 2.2: U.S. States by Economic Regions

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

The table lists the states corresponding to each of the eight economic regions identified by Crone (2005). Only the 48 contiguous states are included as the classification is based on similarities in business cycles.

Table 2.3: State Level Cumulative Personal Income Responses and Quarter of Peak Effect

State	4-quarter cumulative effect	Peak response	Peak quarter
Alabama	0.710	0.277	3
Arizona	0.411	0.255	4
Arkansas	0.491	0.186	3
California	0.453	0.273	4
Colorado	0.516	0.288	4
Connecticut	0.575	0.234	4
Delaware	0.300	0.210	4
Florida	0.345	0.264	4
Georgia	0.636	0.290	4
Idaho	0.429	0.149	3
Illinois	0.581	0.238	3
Indiana	0.637	0.276	3
Iowa	0.292	0.253	3
Kansas	0.307	0.187	3
Kentucky	0.554	0.283	3
Louisiana	0.365	0.178	4
Maine	0.478	0.131	4
Maryland	0.365	0.267	4
Massachusetts	0.780	0.268	4
Michigan	0.750	0.263	3
Minnesota	0.539	0.212	4
Mississippi	0.509	0.211	3
Missouri	0.555	0.191	4
Montana	-0.051	0.149	3
Nebraska	0.218	0.196	3
Nevada	0.275	0.247	4
New Hampshire	0.630	0.285	4
New Jersey	0.627	0.265	4
New Mexico	0.356	0.210	4
New York	0.525	0.206	4
North Carolina	0.630	0.259	4
North Dakota	-0.018	0.113	3
Ohio	0.774	0.305	3

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Table 2.3- Continued from previous page

State	4-quarter cumulative effect	Peak response	Peak quarter
Oklahoma	0.460	0.161	4
Oregon	0.576	0.242	4
Pennsylvania	0.555	0.313	3
Rhode Island	0.406	0.230	4
South Carolina	0.848	0.290	4
South Dakota	0.063	0.147	3
Tennessee	0.705	0.257	4
Texas	0.569	0.282	4
Utah	0.501	0.266	4
Vermont	0.496	0.242	4
Virginia	0.605	0.281	4
Washington	0.363	0.243	4
West Virginia	0.049	0.213	3
Wisconsin	0.552	0.208	4
Wyoming	0.216	0.216	3
State average	0.469	0.234	4
Aggregate GDP	0.883	0.288	4

Table 2.4: State Level Cumulative Employment Responses and Quarter of Peak Effect

State	4-quarter cumulative effect	Peak response	Peak quarter
Alabama	1.339	0.429	3
Arizona	1.546	0.393	3
Arkansas	1.297	0.358	3
California	1.972	0.443	3
Colorado	1.523	0.390	3
Connecticut	1.630	0.408	3
Delaware	0.870	0.280	3
Florida	1.634	0.382	3
Georgia	1.580	0.435	3
Idaho	0.510	0.238	3
Illinois	0.987	0.330	2
Indiana	1.066	0.366	2
Iowa	0.989	0.312	2
Kansas	1.085	0.342	3
Kentucky	0.926	0.335	3
Louisiana	0.873	0.266	3
Maine	1.192	0.334	3
Maryland	1.335	0.326	3
Massachusetts	1.699	0.416	3
Michigan	0.977	0.357	2
Minnesota	1.178	0.363	3
Mississippi	1.354	0.363	3
Missouri	1.171	0.363	2
Montana	0.209	0.175	3
Nebraska	0.868	0.297	3
Nevada	1.463	0.324	3
New Hampshire	1.592	0.406	3
New Jersey	0.627	0.265	4
New Mexico	1.160	0.318	3
New York	1.284	0.355	3
North Carolina	1.509	0.397	3
North Dakota	0.801	0.200	3
Ohio	1.040	0.379	2

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Table 2.4- Continued from previous page

State	4-quarter cumulative effect	Peak response	Peak quarter
Oklahoma	1.155	0.350	3
Oregon	1.293	0.365	2
Pennsylvania	0.820	0.333	3
Rhode Island	1.149	0.308	2
South Carolina	1.437	0.399	3
South Dakota	0.519	0.216	3
Tennessee	1.277	0.396	3
Texas	1.517	0.427	3
Utah	0.947	0.309	3
Vermont	1.294	0.359	3
Virginia	1.555	0.366	3
Washington	1.060	0.305	3
West Virginia	0.204	0.190	3
Wisconsin	1.173	0.380	2
Wyoming	0.674	0.193	3
State average	1.153	0.338	3

Table 2.5: Summary Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
$\Delta pi4$	0.611	0.250	0.015	1.041
$\Delta emp4$	1.200	0.358	0.242	1.865
Agriculture	2.372	2.305	0.368	10.000
Oil	1.557	3.796	0.000	18.344
Construction	4.733	0.854	3.289	8.489
Manufacturing	16.618	5.970	4.119	30.198
Retail	8.334	0.881	5.944	10.442
FIRE	16.812	4.777	9.048	35.396
Female	51.118	0.707	49.200	52.580
White	85.960	9.111	63.070	98.420
Black	9.650	9.359	0.290	35.740
Education	15.421	2.791	9.900	21.700
Population density	179.36	244.39	4.90	1097.60
Median income	51029.40	7400.12	37516.00	67235.00
Median age	35.588	1.886	27.100	38.900
Per-capita federal tax burden	6774.458	1509.137	4287.00	11563.00
Municipal bond issuer	0.167	0.377	0.00	1.000
Exempt State	0.125	0.334	0.000	1.000
House	0.549	0.173	0.000	0.870
Senate	0.558	0.170	0.000	0.860
N = 48				

The table reports the summary statistics for the variables included in the cross-state regressions. $\Delta pi4$ denotes the 4-quarter cumulative response of real per-capita personal income growth. $\Delta emp4$ 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. 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. 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.

Table 2.6: Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1)	1																	
(2)	0.02	1																
(3)	-0.08	0.05	1															
(4)	-0.18	-0.33	-0.50	1														
(5)	0.20	-0.23	0.33	-0.00	1													
(6)	-0.23	-0.45	-0.15	-0.11	-0.42	1												
(7)	-0.28	-0.29	-0.61	0.54	-0.12	0.22	1											
(8)	0.33	-0.13	0.02	-0.06	0.10	0.04	-0.29	1										
(9)	-0.32	0.03	-0.08	0.27	-0.07	-0.08	0.45	-0.90	1									
(10)	-0.26	-0.06	0.05	-0.40	-0.35	0.56	-0.18	0.09	-0.24	1								
(11)	-0.43	-0.22	-0.27	0.03	-0.39	0.56	0.46	-0.12	0.13	0.39	1							
(12)	-0.38	-0.28	0.03	-0.11	-0.43	0.64	-0.05	0.13	-0.15	0.80	0.57	1						
(13)	-0.00	-0.16	-0.18	0.06	0.048	0.13	0.34	0.24	-0.12	-0.14	0.24	-0.03	1					
(14)	-0.35	-0.16	-0.024	-0.27	-0.50	0.68	0.00	0.09	-0.15	0.71	0.65	0.85	0.24	1				
(15)	-0.26	-0.04	-0.16	0.02	-0.10	0.18	0.18	-0.18	0.09	0.071	0.30	0.16	0.05	0.24	1			
(16)	0.11	0.28	0.40	-0.45	0.054	-0.05	-0.43	0.05	-0.14	-0.02	-0.15	-0.03	-0.01	0.17	0.16	1		
(17)	-0.46	0.01	-0.13	0.24	0.01	-0.10	0.50	-0.52	0.54	-0.21	0.29	-0.19	0.17	-0.07	-0.01	-0.15	1	
(18)	-0.38	0.04	-0.10	0.21	0.01	-0.07	0.43	-0.51	0.54	-0.20	0.25	-0.19	0.15	-0.11	-0.12	-0.14	0.93	1

Where 1-18 denote: Agriculture (1), Oil (2), Construction (3), Manufacturing (4), Retail (5), FIRE (6), Female (7), White (8), Black (9), Education (10), Population density (11), Median income (12), Median age(13), Per-capita federal tax burden (14), Municipal bond issuer (15), Tax exempt state (16), House (17) Senate (18). Agriculture, manufacturing, retail, FIRE (finance, insurance and real estate), oil, and construction are the shares of each industry in the state GDP. 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. 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.

Table 2.7: Estimated Equations Explaining Cross-State Variation of Personal Income to Implicit tax rate

Variables	(1) cupi4	(2) cupi4	(3) cupi4	(4) cupi4	(5) cupi4
agriculture	-0.0201	-0.0197	-0.0322***	-0.0327***	-0.0332***
	(0.0160)	(0.0129)	(0.00820)	(0.00797)	(0.00786)
manufacturing	0.0269***	0.0253***	0.0248***	0.0239***	0.0235***
	(0.00781)	(0.00514)	(0.00342)	(0.00326)	(0.00311)
retail	0.0382	0.0404	0.0410**	0.0427**	0.0457**
	(0.0328)	(0.0242)	(0.0166)	(0.0162)	(0.0198)
fire	-0.00940*	-0.00929**	-0.00688**	-0.00595*	
	(0.00543)	(0.00360)	(0.00334)	(0.00308)	
oil	-0.00156				
	(0.00900)				
construction	0.0340	0.0216			
	(0.0442)	(0.0359)			
muni	0.0626	0.0472			
	(0.0441)	(0.0364)			
npitax	-0.0380				
	(0.0784)				
ftbp	8.78e-05*	5.25e-05**	5.15e-05***	6.26e-05***	4.98e-05**
	(4.33e-05)	(2.19e-05)	(1.89e-05)	(2.18e-05)	(2.01e-05)
popdensity	-6.49e-05				
	(8.48e-05)				
medianincome	-8.11e-06				
	(8.25e-06)				
medianage	-0.0308**	-0.0244**	-0.0270**	-0.0313**	-0.0309**
	(0.0129)	(0.00995)	(0.0120)	(0.0130)	(0.0133)
white	-8.67e-05	-0.00189			
	(0.00497)	(0.00407)			
black	0.00312	0.00177			
	(0.00483)	(0.00423)			
female	0.0389	0.0335			
	(0.0542)	(0.0488)			
education	0.0242	0.0175	0.00944		
	(0.0156)	(0.0110)	(0.00822)		
Constant	-1.710	-1.524	0.373	0.584*	0.539
	(2.750)	(2.424)	(0.340)	(0.341)	(0.362)
Observations	48	48	48	48	48
R-squared	0.811	0.800	0.760	0.755	0.744

The table reports 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 ordinary least squares. *, **, and *** denote statistical significance at 10%, 5%, and 1% level, respectively.

Table 2.8: Estimated Equations Explaining Cross-State Variation of Employment to Implicit tax rate

Variables	(1) cuemp4	(2) cuemp4	(3) cuemp4	(4) cuemp4	(5) cuemp4
agriculture	-0.00796				
	(0.0360)				
manufacturing	0.0355**	0.0223***	0.0248***	0.0194**	0.0186*
	(0.0158)	(0.00725)	(0.00775)	(0.00811)	(0.0102)
retail	0.161**	0.148***	0.133***	0.167***	0.120**
	(0.0712)	(0.0518)	(0.0490)	(0.0427)	(0.0453)
fire	0.00327				
	(0.0142)				
oil	0.00502				
	(0.0184)				
construction	0.149	0.0941	0.0975		
	(0.101)	(0.0718)	(0.0717)		
muni	-0.0649				
	(0.149)				
npitax	-0.0527				
	(0.246)				
ftbp	0.000290***	0.000191***	0.000160***	9.02e-05	
	(0.000102)	(6.84e-05)	(5.58e-05)	(5.72e-05)	
popdensity	-0.000760	-0.000755	-0.000715		
	(0.000492)	(0.000488)	(0.000480)		
medianincome	-2.39e-05				
	(2.02e-05)				
medianage	-0.0508	-0.0327			
	(0.0350)	(0.0313)			
white	-0.0314**	-0.0176***	-0.0198***	-0.0192***	-0.0181***
	(0.0136)	(0.00546)	(0.00549)	(0.00443)	(0.00424)
black	-0.0185				
	(0.0123)				
female	0.214*	0.171	0.124		
	(0.116)	(0.113)	(0.110)		
education	0.0537	0.0434*	0.0562***	0.0529**	0.0815***
	(0.0406)	(0.0218)	(0.0178)	(0.0243)	(0.0212)
Constant	-9.219	-8.795	-7.306	-0.334	0.144
	(5.947)	(5.857)	(5.819)	(0.518)	(0.688)
Observations	48	48	48	48	48
R-squared	0.619	0.564	0.550	0.451	0.397

The table reports 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 ordinary least squares. *, **, and *** denote statistical significance at 10%, 5%, and 1% level, respectively.

Table 2.9: Robustness Checks: Shorter and Longer Horizons and Political Controls-Personal Income

Variables	(1) cupi4	(2) cupi2	(3) cupi6	(4) cupi4	(5) cupi2	(6) cupi6
agriculture	-0.0332***	-0.0240***	-0.0329***	-0.0300***	-0.0213***	-0.0274**
	(0.00786)	(0.00467)	(0.00836)	(0.00937)	(0.00569)	(0.0106)
manufacturing	0.0235***	0.0118***	0.0237***	0.0234***	0.0117***	0.0235***
	(0.00311)	(0.00229)	(0.00384)	(0.00316)	(0.00236)	(0.00396)
retail	0.0457**	0.0471***	0.0331	0.0449**	0.0480***	0.0329
	(0.0198)	(0.0134)	(0.0266)	(0.0173)	(0.0142)	(0.0229)
ftbp	4.98e-05**	3.26e-05**	4.41e-05*	5.11e-05**	3.53e-05**	4.74e-05**
	(2.01e-05)	(1.29e-05)	(2.19e-05)	(2.07e-05)	(1.40e-05)	(2.32e-05)
medianage	-0.0309**	-0.0241***	-0.0296*	-0.0322**	-0.0257***	-0.0321**
	(0.0133)	(0.00836)	(0.0147)	(0.0129)	(0.00818)	(0.0142)
house				0.240	0.0518	0.306
				(0.273)	(0.183)	(0.362)
senate				-0.192	0.0117	-0.207
				(0.270)	(0.178)	(0.351)
Constant	0.539	0.278	0.651	0.553	0.266	0.658
	(0.362)	(0.264)	(0.412)	(0.361)	(0.268)	(0.397)
Observations	48	48	48	48	48	48
R-squared	0.744	0.685	0.668	0.749	0.690	0.677

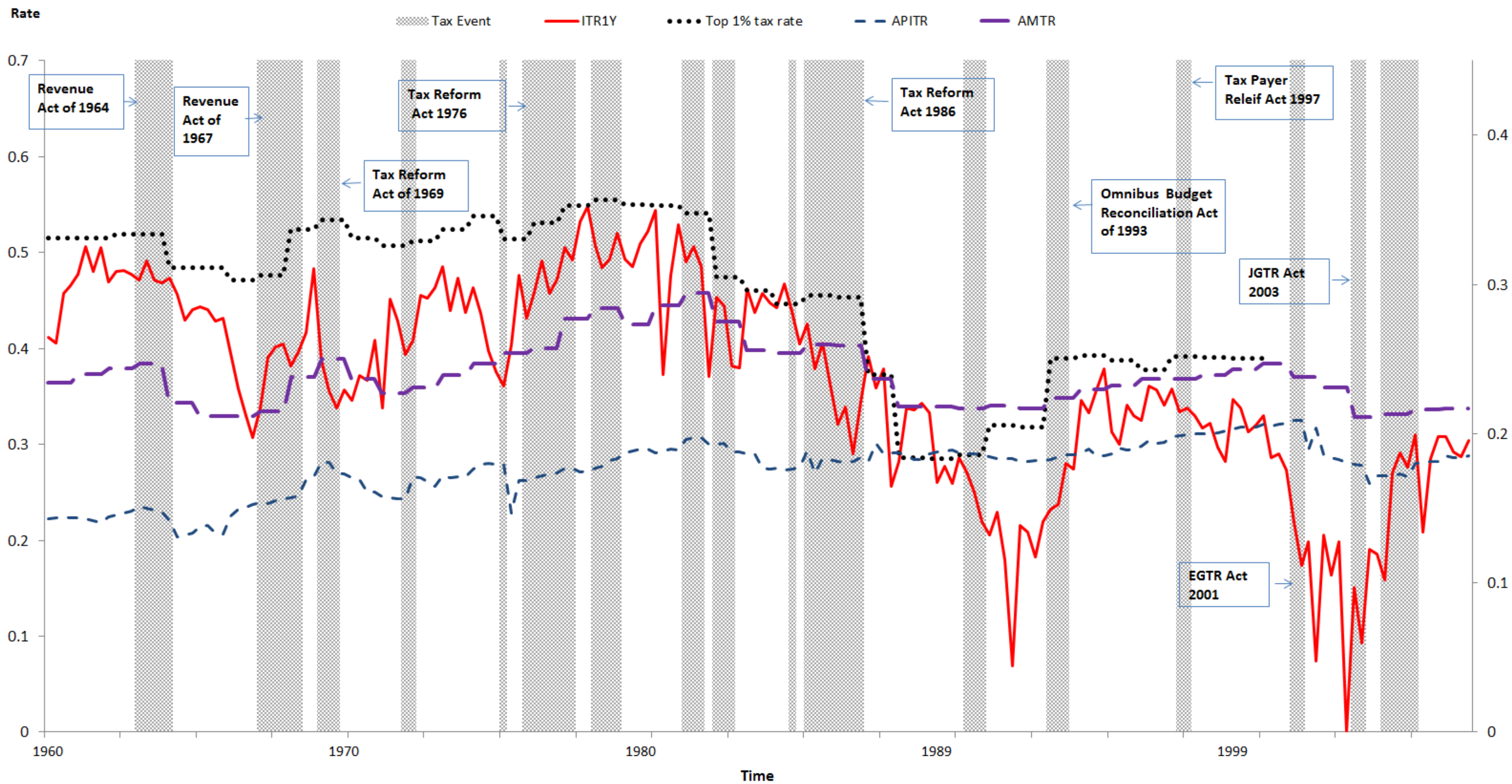
The table reports regressions coefficients and robust standard errors (in parentheses) for the cross-state regressions of the 4-quarter cumulative response of per-capita employment growth on state-level characteristics. The regressions are estimated by ordinary least squares. *, **, and *** denote statistical significance at 10%, 5%, and 1% level, respectively.

Table 2.10: Robustness Checks: Shorter and Longer Horizons and Political Controls-Employment

VARIABLES	(1) cuemp4	(2) cuemp2	(3) cuemp6	(4) cuemp4	(5) cuemp2	(6) cuemp6
manufacturing	0.0186*	0.0104	0.0155	0.0160	0.00873	0.0125
	(0.0102)	(0.00733)	(0.0122)	(0.0108)	(0.00780)	(0.0131)
retail	0.120**	0.0778**	0.145**	0.116***	0.0753**	0.141**
	(0.0453)	(0.0303)	(0.0589)	(0.0430)	(0.0299)	(0.0570)
white	-0.0181***	-0.0119***	-0.0224***	-0.0137**	-0.00915**	-0.0170**
	(0.00424)	(0.00295)	(0.00536)	(0.00562)	(0.00403)	(0.00708)
education	0.0815***	0.0499***	0.102***	0.0834***	0.0512***	0.104***
	(0.0212)	(0.0156)	(0.0263)	(0.0213)	(0.0157)	(0.0269)
house				0.783	0.488	0.729
				(0.592)	(0.424)	(0.774)
senate				-0.344	-0.211	-0.180
				(0.569)	(0.411)	(0.736)
Constant	0.144	0.0968	0.195	-0.427	-0.263	-0.520
	(0.688)	(0.485)	(0.821)	(0.698)	(0.503)	(0.880)
Observations	48	48	48	48	48	48
R-squared	0.397	0.346	0.385	0.432	0.376	0.415

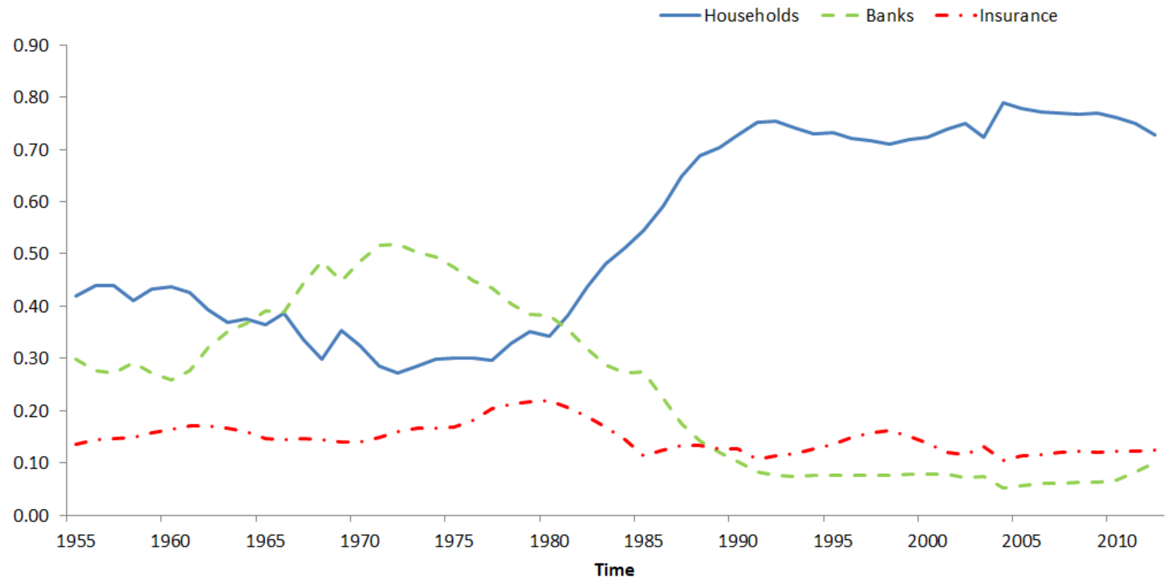
The table reports regressions coefficients and robust standard errors (in parentheses) for the cross-state regressions of the 4-quarter cumulative response of per-capita employment growth on state-level characteristics. The regressions are estimated by ordinary least squares. *, **, and *** denote statistical significance at 10%, 5%, and 1% level, respectively.

Figure 2.1: Tax Rates and Tax Events, 1960-2006



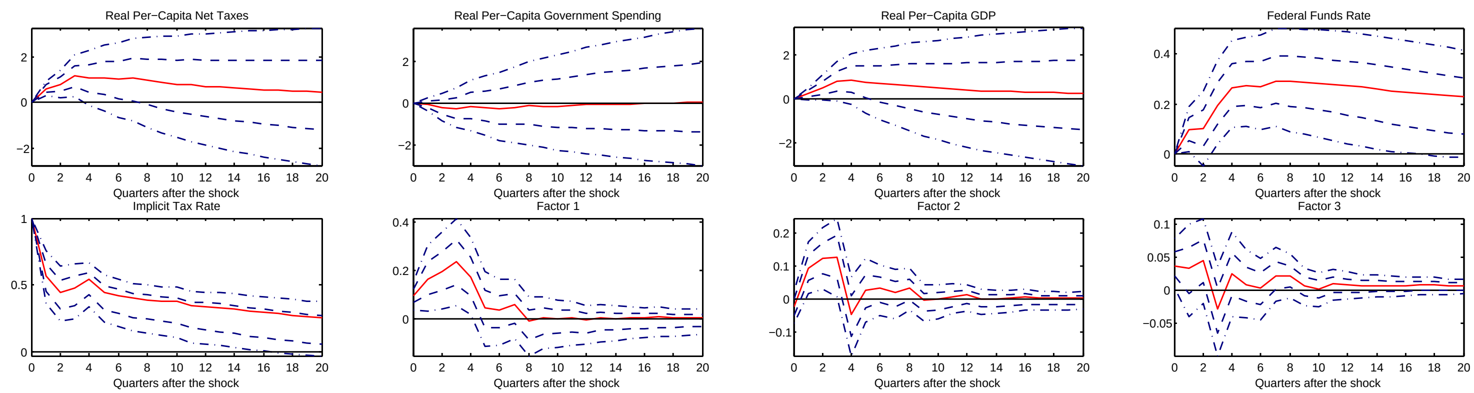
*Notes:*The figure plots the implicit tax rate, top 1 % marginal tax rate, average personal income tax rate, and average marginal federal individual income tax rate for the United States. The solid line is the implicit tax rate (ITR1Y) which is yield spread between the one year tax exempt municipal bond rate and 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 Table 3.1). The documented tax events is taken from Yang (2007).

Figure 2.2: Ownership of Municipal Bonds



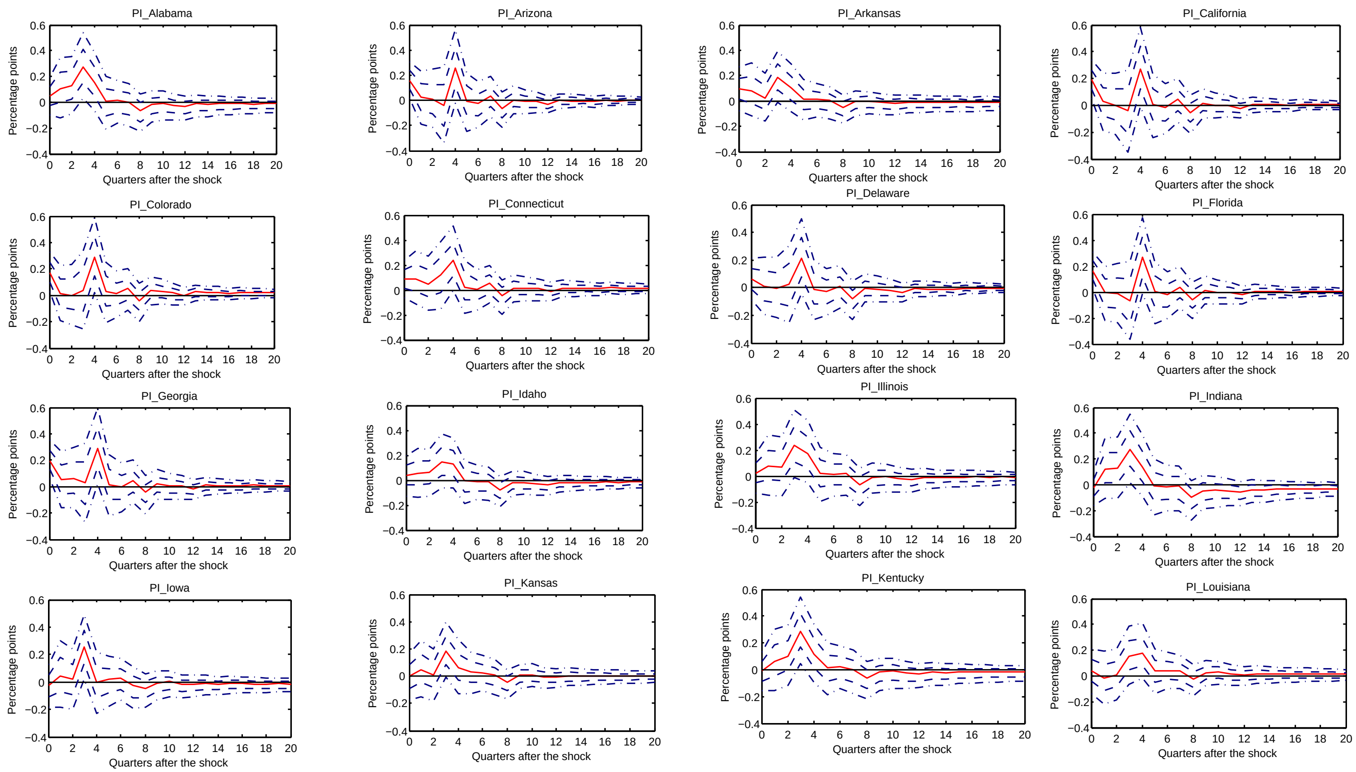
*Notes:*The figure plots the ownership of municipal bonds held by households, banks, and insurance companies. The data is collected from the Flow of Funds Accounts provided by the Board of Governors. The percentage of municipal bonds held by: (a) households includes direct and indirect ownership through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

Figure 2.3: Impulse responses for aggregate variables and estimated factors



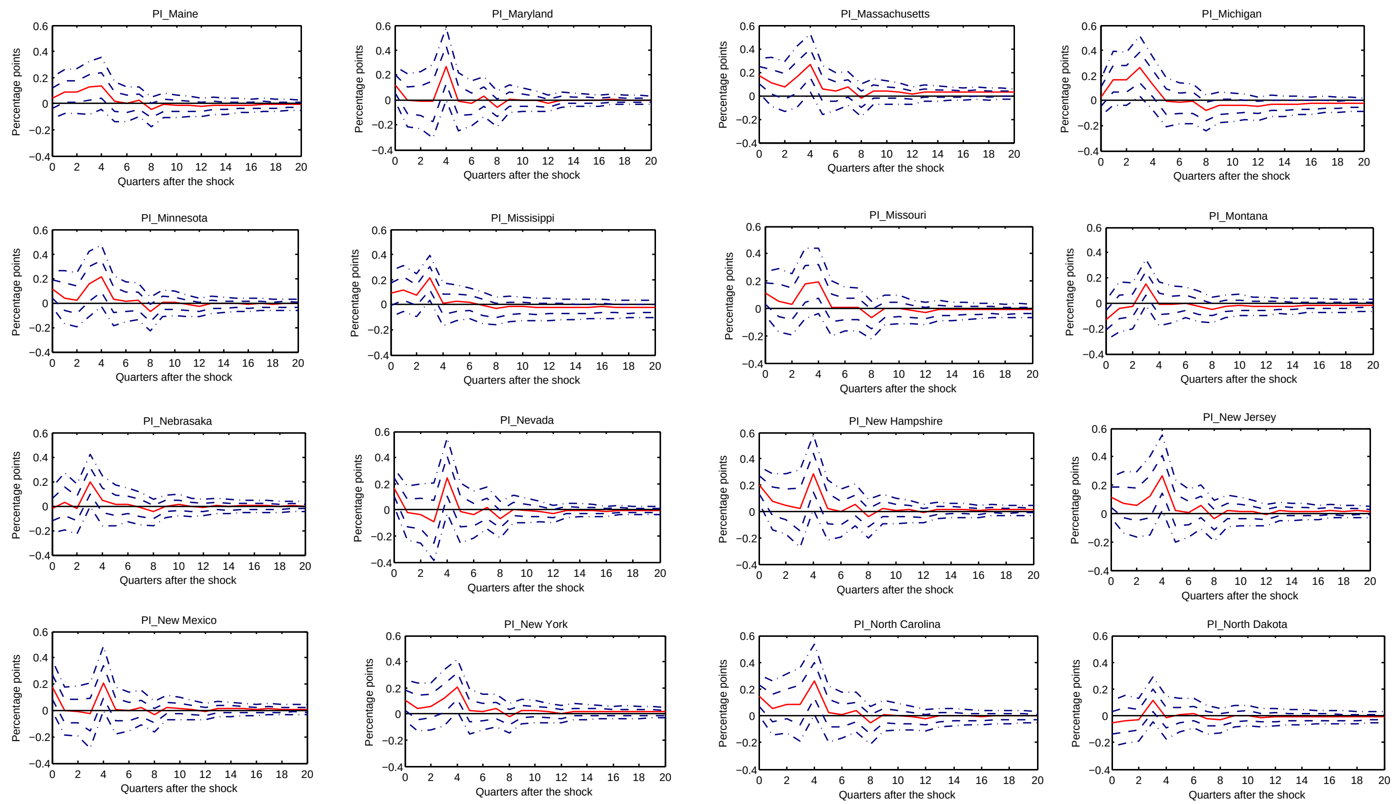
*Notes:*The figure shows the response of the aggregate variables and the regional factors to a one percentage point increase in the implicit tax rate. All responses are reported in percentages. Full lines are point estimates; dashed and dash-dot lines indicate the 68 and 95 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian (2004)).

Figure 2.4: Impulse responses of state-level personal income



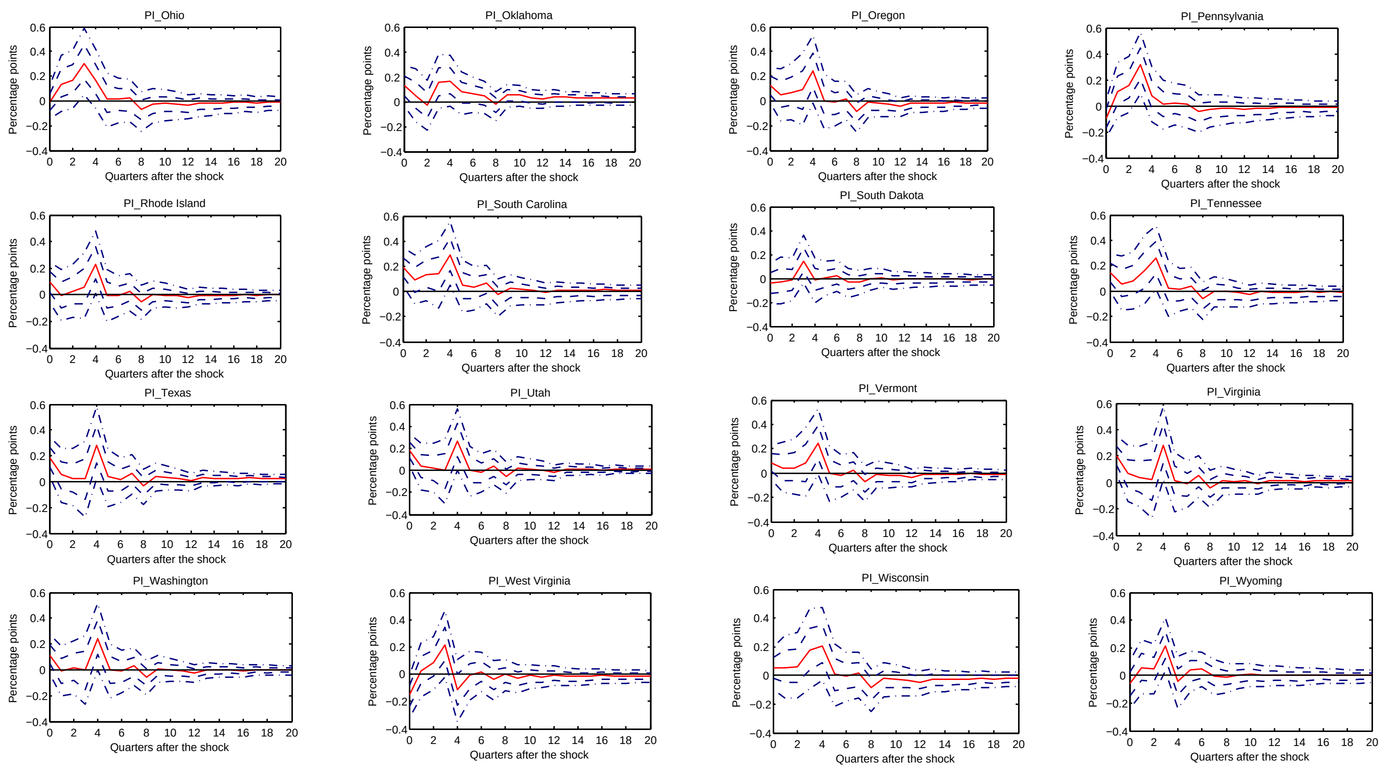
Notes: The figure shows the response of real per-capita personal income growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates; dashed and dash-dot lines indicate the 68 and 95 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian (2004)).

Figure 2.5: Impulse responses of state-level personal income



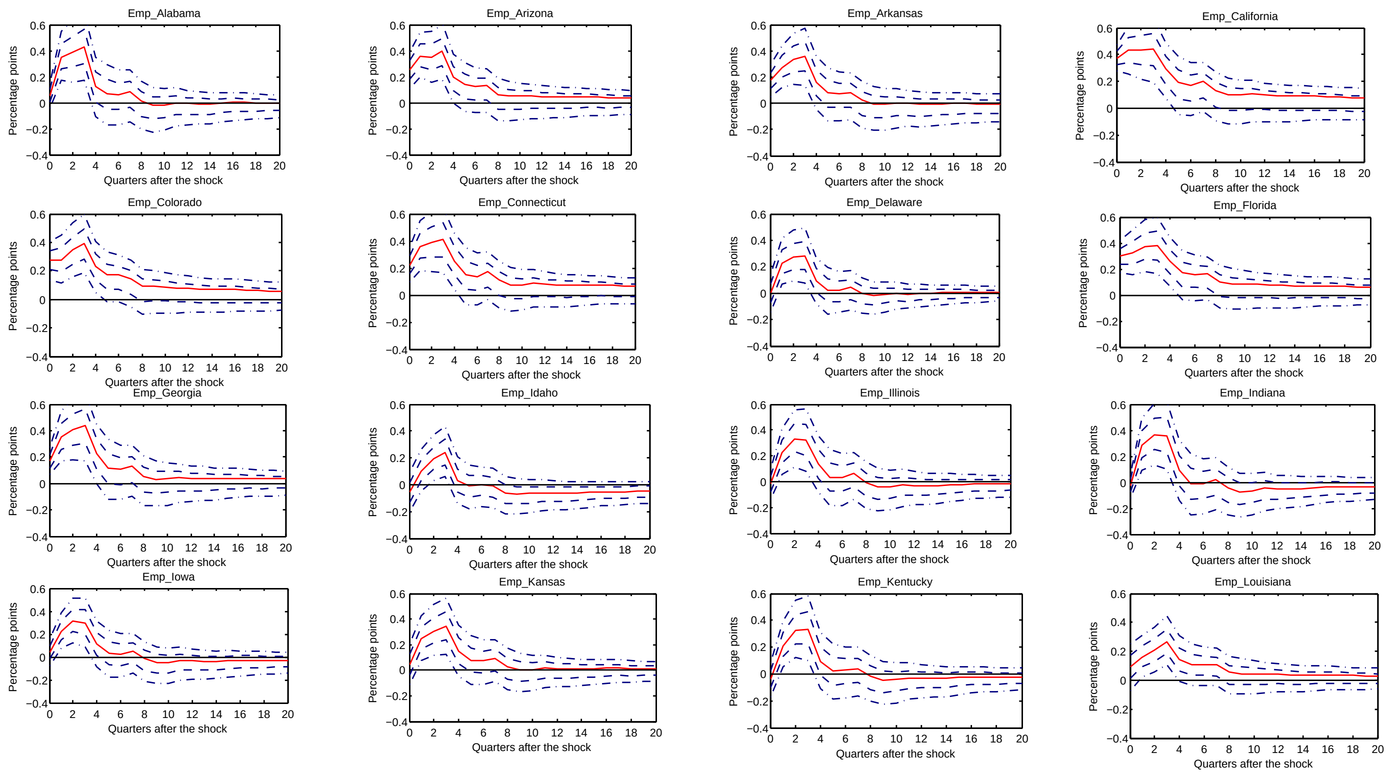
Notes: The figure shows the response of real per-capita personal income growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates; dashed and dash-dot lines indicate the 68 and 95 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian (2004)).

Figure 2.6: Impulse responses of state-level personal income



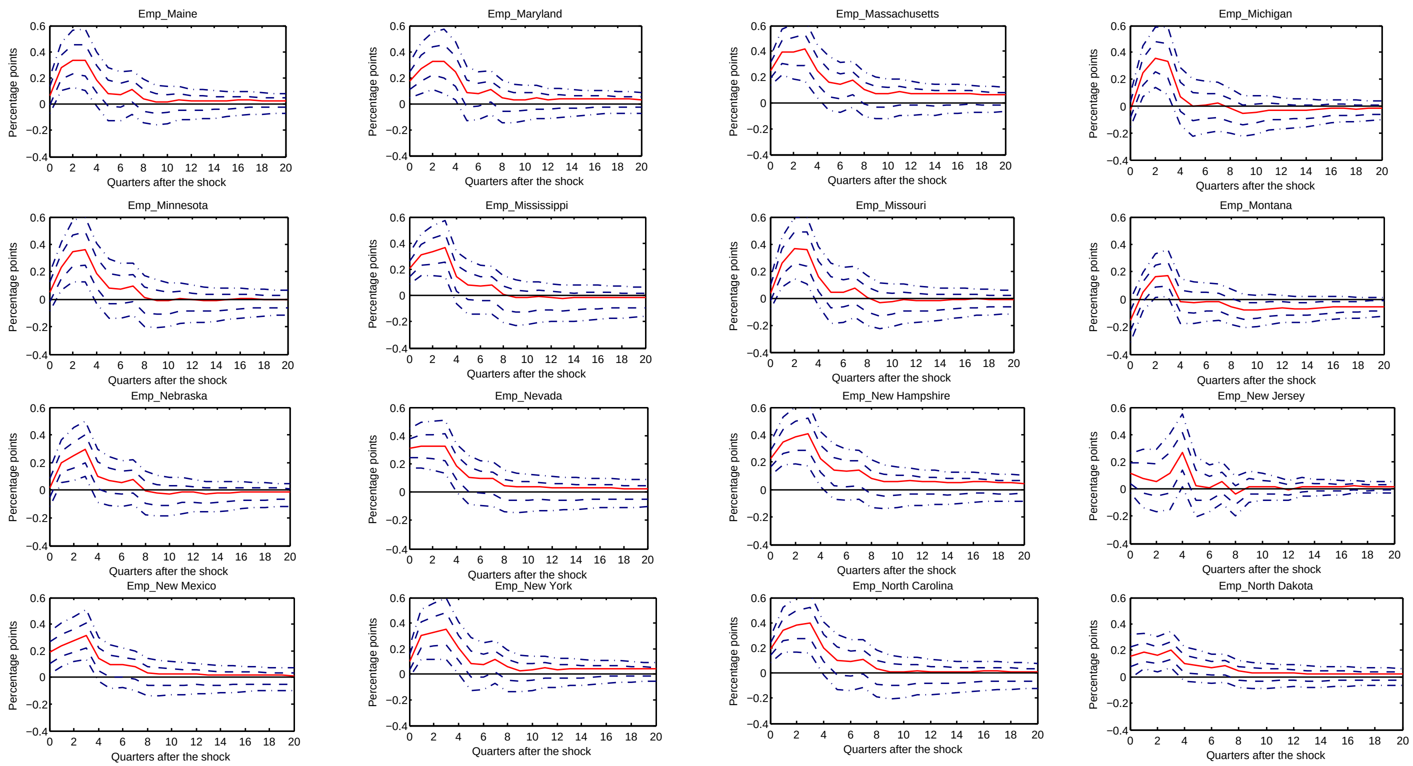
Notes: The figure shows the response of real per-capita personal income growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates; dashed and dash-dot lines indicate the 68 and 95 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian (2004)).

Figure 2.7: Impulse responses of state-level employment



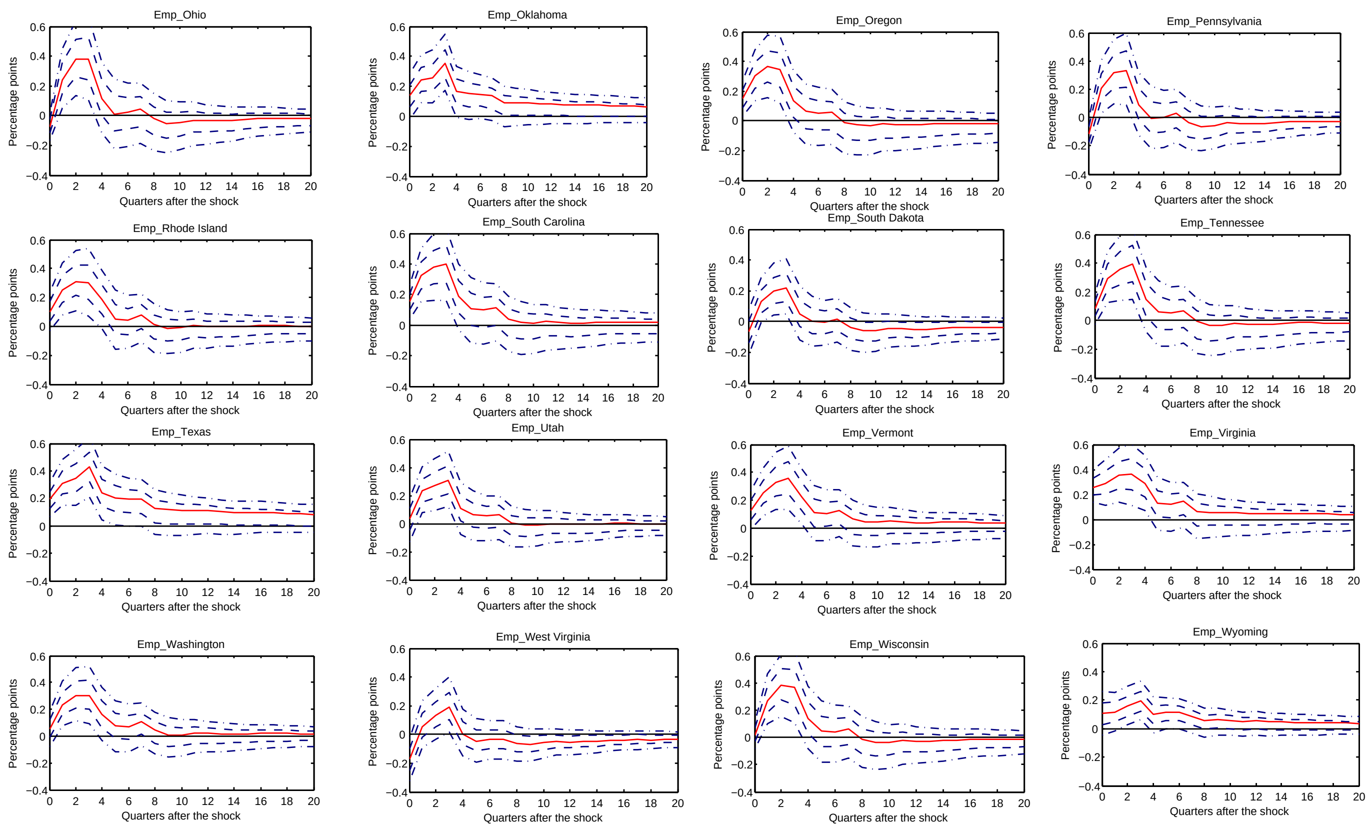
Notes: The figure shows the response of real per-capita employment growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates; dashed and dash-dot lines indicate the 68 and 95 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian (2004)).

Figure 2.8: Impulse responses of state-level employment



Notes: The figure shows the response of real per-capita employment growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates; dashed and dash-dot lines indicate the 68 and 95 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian (2004)).

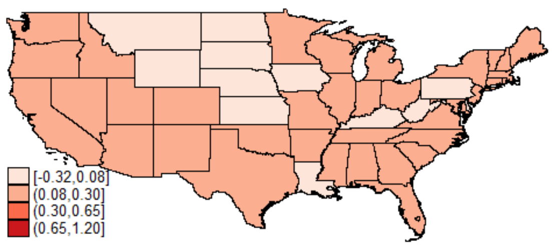
Figure 2.9: Impulse responses of state-level employment



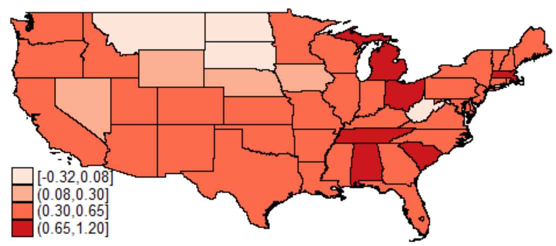
Notes: The figure shows the response of real per-capita employment growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates; dashed and dash-dot lines indicate the 68 and 95 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian (2004)).

Figure 2.10: Cumulative response of state-level personal income

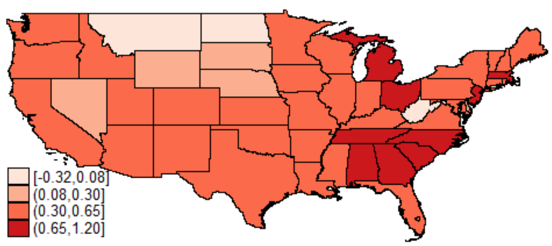
(a) 1 quarter after the implicit tax rate shock



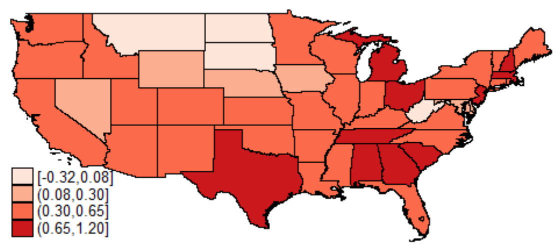
(b) 4 quarters after the implicit tax rate shock



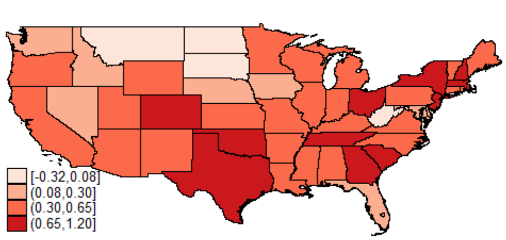
(c) 6 quarters after the implicit tax rate shock



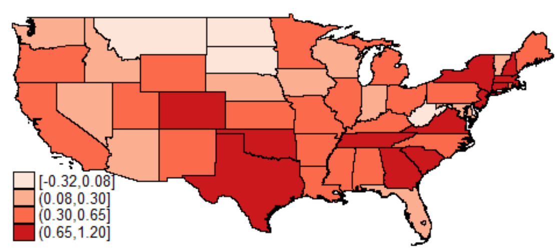
(d) 8 quarters after the implicit tax rate shock



(e) 12 quarters after the implicit tax rate shock



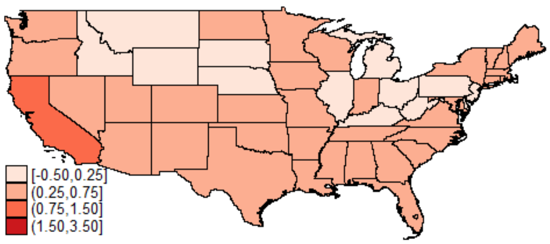
(f) 16 quarters after the implicit tax rate shock



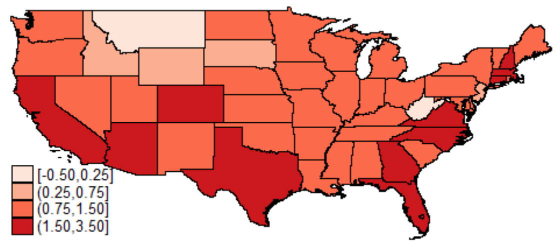
Notes: The figure illustrates the cumulative response of state-level personal income to one percentage point increase in the implicit tax rate. Darker shades of red indicate larger positive responses to the implicit tax rate shock. The lighter shades of red indicate smaller response to the implicit tax rate shock.

Figure 2.11: Cumulative response of state-level employment

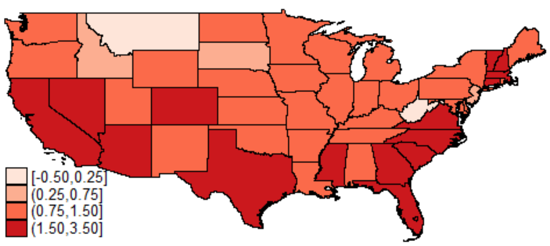
(a) 1 quarter after the implicit tax rate shock



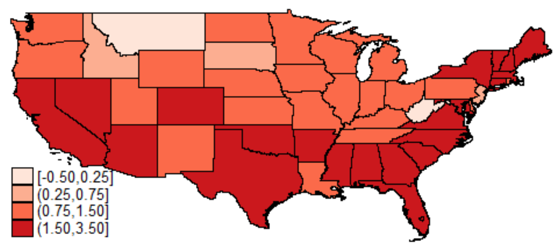
(b) 4 quarters after the implicit tax rate shock



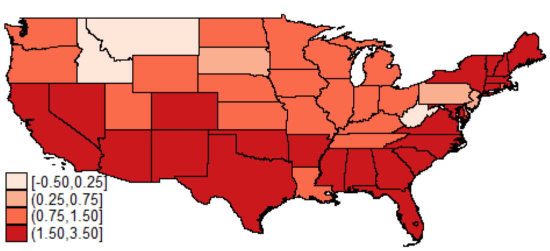
(c) 6 quarters after the implicit tax rate shock



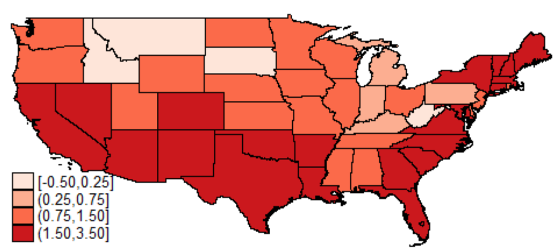
(d) 8 quarters after the implicit tax rate shock



(e) 12 quarters after the implicit tax rate shock



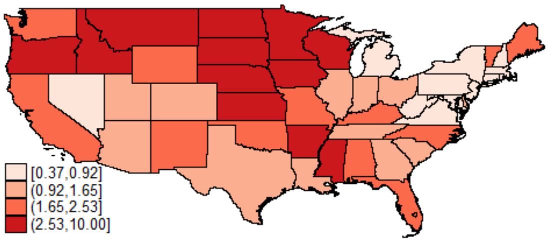
(f) 16 quarters after the implicit tax rate shock



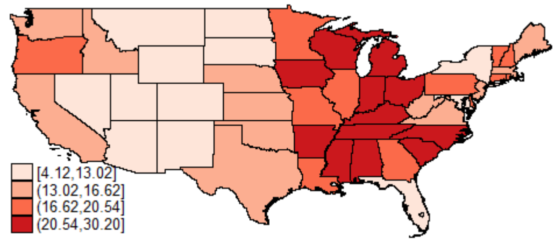
*Notes:*The figure illustrates the cumulative response of state-level employment to one percentage point increase in the implicit tax rate. Darker shades of red indicate larger positive responses to the implicit tax rate shock.The lighter shades of red indicate smaller response to the implicit tax rate shock.

Figure 2.12: U.S. state-level industrial shares

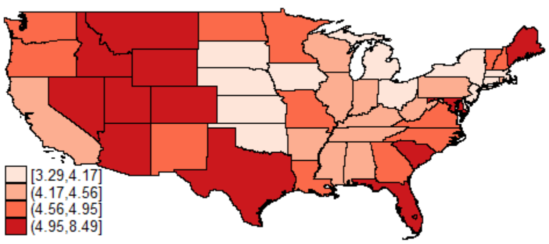
(a) Average agriculture share of total state GDP, 1963-2006



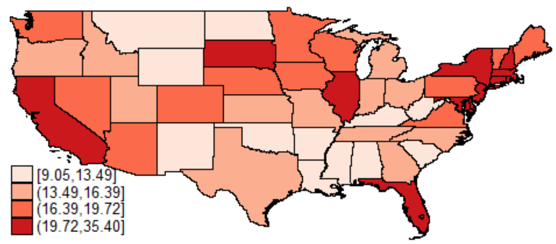
(b) Average manufacturing share of total state GDP, 1963-2006



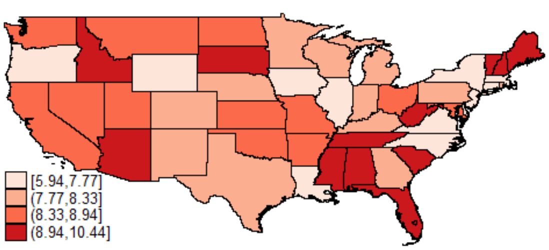
(c) Average construction share of total state GDP, 1963-2006



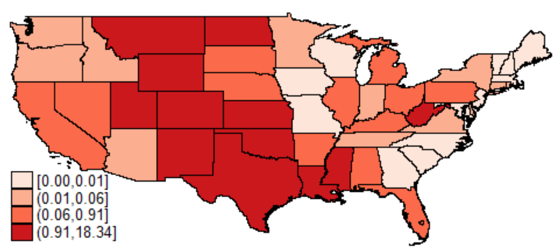
(d) Average finance, insurance and real estate (FIRE) share of total state GDP, 1963-2006



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



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



*Notes:*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).

3 Tax News and Economic Fluctuations: A Factor-Augmented Vector Autoregressive (FAVAR) Approach

3.1 Introduction

How does economic activity respond to tax news? Does tax news stimulate or depress economic activity? Through what transmission mechanism does tax news affect the U.S. economy? More specifically, how does the output response to tax news vary across industrial sectors and market groups that differ in their adjustment costs, output shares of capital and labor, durability of the product and so on? A large body of literature in macroeconomics has provided substantial evidence that predictable changes in the tax rates can alter the economic behavior of firms and workers (see e.g., Barro (1979), Yang (2005), House and Shapiro (2006), Mertens and Ravn (2011), Leeper et al. (2012), Leeper et al. (2013), and Kueng (2014)). This literature has explored the importance of timing in tax changes and their implications on the macroeconomy. The experiences of phased-in tax changes introduced in the early 1980's and 2001 suggest that expectations about future tax cuts may have constrained the economic activity during the anticipation period and that the subsequent implementation of tax cuts helped to boost the economy.[15] The idea that changes in expectations about future tax policy contribute to economic fluctuations has led to an intense research effort into the importance of fiscal foresight, which seeks to quantify the economic effects of anticipated and unanticipated tax changes. The main focus of this chapter is to study how changes in expectations about future tax rates contribute to fluctuations in macroeconomic aggregate and disaggregate variables during the period 1960-2003.

Traditional empirical models that are used to estimate the tax effects on the economy do

[15] House and Shapiro (2006) evaluates the phased-in tax reductions enacted by 2001 Economic Growth and Tax Relief Reconciliation Act and their effects on the economy. They suggest that the phased-in nature of these tax cuts contributed to the slow recovery of U.S. economy from recession. They underline the importance of timing and size of tax cuts assumptions in evaluating the tax policy

make an information assumption that tax policy changes are unanticipated by the economic agents (i.e., no-foresight). In practice a tax reform law usually goes through a legislation lag (i.e., when a new tax law is announced by the President and when the tax bill is passed by Congress) and an implementation lag (i.e., lag between the time when the bill is signed by the President and when it is actually implemented). These lags allow economic agents to anticipate future changes in tax policy and subsequently alter their economic behavior. For instance, a review of the tax events that took place in the United States during the 1960-2003 period suggests a long lag of time arose between the tax law that was first proposed by the President and the time it was enacted. 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 implemented. Table 3.1 summarizes major changes in the U.S. tax legislations during the period 1960-2003. The table provides information related to the initial announcement of tax changes by the President, the enactment date of the tax law, and the provisions in the tax law. The information about each tax law and enactment dates are obtained from the Library of Congress and Yang (2007).[16] All of the tax events have undergone a significant delay in the legislative process. The legislative lag ranged between 4 and 17 months for the period 1960-2003. Thus, the news about future changes in tax policies reached the individual well before the change was effected, which implies that forward looking individuals will adjust their consumption and work patterns before the tax change has been implemented. This re-optimization takes place because news of a tax policy change alters the economic agent expected income (Yang, 2005; House and Shapiro, 2006).

Recent work by Leeper et al. (2013) demonstrates that fiscal foresight poses a serious

[16] The Library of Congress uses the data from the Office of Clerk of House of Representatives, the Office of the Secretary of Senate, the Government Printing Office, Congressional Budget Office, and the Library of Congress Research Service. The precise dates for signaling of tax changes can be found in the Presidential speeches. The source is `http://millercenter.org/president/speeches` The bill records, dates and its provisions during the period 1960-1974 are obtained from Yang (2007). The details of each tax law provisions, enactment date since 1973 is obtained from `https://beta.congress.gov`.

econometric problem in estimating the tax effects on the economy. They suggest that if forward looking economic agents acquire the news about future tax changes and adjust their behavior well before the actual tax changes, then it generates an equilibrium that contains non-invertible moving average representations.[17] They point out that this problem arises because econometricians possess a smaller information set compared to economic agents. Further, they suggest that ignoring fiscal foresight affects the prediction of how tax changes affect the macroeconomic variables such as output, consumption, investment, and employment.

Although the empirical literature has acknowledged the problem of fiscal foresight, there is little consensus among researchers regarding the effect of tax news on the macroeconomy and whether these effects are empirically relevant. In particular, researchers have used different methodologies, data, and instruments to identify news about tax policy changes. Three approaches have been commonly employed in the empirical literature to identify anticipated tax shocks: Blanchard and Perotti (2002) structural vector autoregressive (SVAR) approach -hereafter BP (2002)- Mountford and Uhlig (2009) sign restrictions approach -hereafter MU (2009)- and Mertens and Ravn (2012) timing convention approach. BP(2002) use a VAR model to identify anticipated tax shocks. They assume that the federal government does not respond to current- and last-quarter real GDP shocks. Under this assumption, they find that "there is not much evidence of the effect of anticipated tax changes on output".[18] MU (2009) use sign restrictions on the impulse responses to identify anticipated and unanticipated tax shocks. They find that the announcement of tax policy changes has little effect on output in the short run. In contrast, Mertens and Ravn (2012) use the timing of tax liability changes to differentiate between the anticipated and unanticipated tax shocks. They find evidence of

[17] This problem was first noted by Hansen and Sargent (1991)

[18] Leeper et al. (2013) augments the BP (2002) method with the data on yield spread between municipal and Treasury bonds that captures the expectation of the future tax rates in the VAR framework. They find that an anticipated increase in tax rates has a positive effect on the output in the short run.

strong anticipatory effects on the real GDP in the short run.

While the three approaches recognize the problem of fiscal foresight and identify anticipated tax shocks, their results vary based on the identification strategy. In addition, they are subject to the criticism that the conventional VAR approach does make a strong assumption on the nature of information flows in the model to identify anticipated tax shocks Leeper et al. (2013). In this chapter, I follow the lead ofLeeper et al. (2013) to identify news about future taxes. I use 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 yield spread is also known as the implicit tax rate because it represents the rate at which the investor is indifferent between the tax-exempt municipal bond and the taxable Treasury bond. The advantage of using the implicit tax rate to predict expected future tax rates is that it does not require setting the period of foresight a priori.

Another challenge in estimating the tax effects arises due to the limited information problem attached to vector autoregressive (VAR) models (see Bernanke et al. (2005), and Forni et al. (2011)). The identification of true tax shocks is sensitive to the information included in the model. To conserve degrees of freedom, conventional VAR models use small number of variables (i.e., between five to ten variables). In general, economic agents or the policy makers base their forecasts and analysis on a large panel of information rather than constrain themselves to few variables. Hence, the low dimensional vector autoregressive (VAR) models are very to capture the large panel of information set used by the policy makers. For this reason, the identified structural shocks in VAR models are unlikely to suffer contamination. I attenuate the limited information problem attached to small scale VAR models by using a Factor Augmented VAR (FAVAR) model similar to that estimated by Bernanke et al. (2005). This method allows combining the VAR analysis with a small set of factors extracted from a large data set while imposing minimal short-run identifying restrictions to estimate the response to tax news for large number of variables.

This chapter contributes to the growing empirical literature in three specific ways. First, although previous studies by Leeper et al. (2013) and Kueng (2014) study the impact of tax news on U.S. economy, there has been little empirical analysis to understand the propagation mechanism of tax news. More importantly, I study the impact of tax news on a set of key disaggregate measures of industrial production, employment per-worker, hours worked per worker, short term and long term unemployment rates, capacity utilization rate, purchasing manager index, housing starts, price level, and financial variables. Analyzing the responses of disaggregated data in industrial production and labor inputs will enable us to understand the transmission mechanism of tax news on the U.S. economy.

I find a positive relationship between anticipated tax changes and real economic activity in the short run. Real GDP increases on impact and remains above the mean for about four quarters. The result of a positive response of aggregate economic activity to tax news is in line with the findings of Leeper et al. (2013) and Mertens and Ravn (2012). In addition, I find that tax news has larger impact on the industries related to the manufacturing, and mining. Also, non-durable manufacturing shows a significantly higher response compared to the durable manufacturing sector. Regarding the response of industrial production based on market group, I find that tax news have a larger effect on firms that supply business equipment (i.e., industrial and defense equipment, oil and gas drilling) compared to firms supplying consumer goods and services. Moreover, the response of the capacity utilization rate shows that industrial plants operate at a higher capacity on the arrival of news about higher taxes.

Having found a positive response of aggregate and disaggregate industrial production to tax news, I then focus on the effect of tax news on labor market variables. The results indicate that the employment per-capita and total hours worked per worker increase with news of a future tax increase. These findings are consistent with the positive effect on GDP and industrial production to tax news shock. Leading indicators such as new orders for consumer and manufacturing goods show a positive response to news of higher taxes. I observe regional patterns in the response of the number of private housing units to tax news. The number of housing units increases on impact of the shock and it is considerably larger for northeastern and western regions of the United States. These results fall in line with previous chapter results that anticipatory effects to tax news in northeastern states compared to other regions of the United States. Overall, I find that the anticipation of a higher income tax rate stimulates the economy in the short run.

Second, I ask how much of historical fluctuations in the real GDP is driven by the shocks to the implicit tax rate (i.e., by tax news). Historical decomposition of the real GDP indicates that shocks to the federal funds rate and tax news shocks have contributed largely to the fluctuations in real GDP. In particular, I find that tax news associated with legislation in 1969, 1975, 1986, 1993, and 2001 contributed to the historical fluctuations in real GDP. Also, I find that peaks associated with the fluctuations in real GDP due to the federal funds rate coincide with the tax news in early 1980's, 1990 and 2001.

The results from historical decompositions do not allow us to distinguish the effects from tax new shocks and the effect resulting from the response of monetary policy to tax news. Thus, it leads to another interesting question: What is the role of the systematic monetary policy response in accounting for the expansion that is due to news of a tax increase? To answer this specific question, I conduct a counterfactual analysis that allows a one year delay in the response of monetary policy during three major tax episodes: the Tax Reform Act of 1986 (TRA86), the Omnibus Budget Reconciliation Act of 1993, and the Economic Growth and Tax Reconciliation Reform Act of 2001 (EGTRRA). The results show that the announcement of future tax cuts in TRA86 and EGTRRA constrained the economic activity during the anticipation period. The news of higher income taxes in the Omnibus Budget Reconciliation Act increased the real economic activity during the anticipation period. Moreover, the results show that shutting down the monetary policy response for four quarters produces a higher peak deviation in output during 1993 and a lower peak negative deviation during 1986. However, shutting down the systematic monetary policy for four quarters during the tax announcement in 2001 had no significant effect.

Third, I ask how much of the anticipatory effects of tax news shock persists after policy realization? I conduct a counterfactual analysis for the full sample to investigate whether adding a tax policy realization shock diminishes the effect of the news shock on the economy. I find that adding a tax realization shock tapered off the anticipatory effects on the macroeconomic variables. These results are in line with the findings of those of Yang (2005), and Mertens and Ravn (2012) who find significant pre- and post-implementation effects of income taxes on the economy. Finally, I conduct another counterfactual analysis targeting three tax events to test whether the results vary based on the length of foresight and magnitude of the shock. The counterfactual results provide strong evidence of anticipatory effects in all three tax events, which differ in the length of foresight. However, the results vary based on the size of policy realization shock at the implementation date. The results show strong pre- and post-implementation effects on real GDP for EGTRRA 2001. In contrast, I find a weak effect on real GDP after policy realization for TRA86 and the Omnibus Budget Reconciliation Act of 1993.

The remainder of this chapter is organized as follows. Section 3.2 discusses the measure of tax news and section 3.3 describes the factor augmented vector autoregression (FAVAR) model. Implementation of the empirical methodology, data set, and model specification are presented in section 3.4. Empirical results are discussed in section 3.5. Finally, section 3.6 concludes.

3.2 A Measure of Tax News

As discussed in detail in section 2.2, I follow the lead of Leeper et al. (2013) and use the yield spread between the one-year municipal bond and the one-year Treasury bill to capture expectations about future tax policy changes. More specifically, I 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. Municipal bonds in the United States are exempted from federal taxes and also sometimes from state and local taxes, whereas interest on Treasury bonds are taxed by the federal government. If investors are forward looking and anticipate that federal income taxes will rise (fall) then they will demand higher (lower) interest on taxable bonds until they are indifferent between tax exempt bonds and taxable bonds (Leeper et al., 2013).

In general, municipal bonds are issued by state and local governments, this include counties and municipalities, and school districts. I consider the municipal bonds that are AAA rated General Obligation (GO) bonds. These bonds have full faith, credit, and taxing power pledged by the issuer and who is obligated to make the repayment of the bonds. Usually, the GO bonds are used to fund public goods in the locality and these are free from default risk. To predict news about future tax changes, both the municipal bond and the Treasury bill should have the same maturity date, liquidity and transaction costs, credit risk, call features, and market risk. Further, the US Treasury and municipal bonds should have the same tax treatment of capital gains and losses.

Table 3.2 shows the state taxation on municipal and US Treasury bonds. The interest income on the US Treasury bonds is taxed through federal income tax but it is exempted from state taxes in the US. The interest income on municipal bonds is exempted from federal taxes and almost all states exempt the interest income for in-state investors. Few states such as Alaska, Florida, Nevada, South Dakota, Washington, and Wyoming do not levy state income taxes. Table 3.2 shows that almost all states levy taxes on the individual investors if the interest earned on a municipal bond is paid by an out-of-state issuer. Hence, there is an advantage for the individuals to invest within their own state boundaries to get tax exemption on interest income. Researchers have examined whether state income tax affects the yield on the municipal bond. Fortune (1996) suggests that if out-of-state investors buy the municipal bonds then state income taxes do not affect the yield on municipal bonds. In addition, Kueng (2014) compares the yields on long term municipal bonds for states that have a differential tax treatment on interest income and concludes that state income taxes are not the key determinant on municipal yield spreads.

Using the implicit tax rate to capture tax news raises a key question, whether the implicit tax rate has any predictive content for future tax rate changes. The work by Poterba (1989), Fortune (1996), Leeper et al. (2012), and Kueng (2014) has documented the relationship between the implicit tax rate and expected future tax rates. They conclude that the implicit tax rate contains significant information about future tax rates. To illustrate this relationship between the implicit tax rate and a few measures of personal income tax rates, I plot the average federal marginal tax rate and the marginal tax rate faced by the top 1% of the income distribution with an annualized one year lagged implicit tax rate (see Figure 3.2 and Figure 3.3). Figure 3.2 shows the relationship between the average marginal tax rate and the one year lagged implicit tax rate. The data for the average marginal tax rate is obtained from Barro and Redlick (2011). The correlation coefficient between both series for the full sample is 0.61. However, the correlation coefficient from the 1970's onwards is 0.82. The stronger relationship after the 1970's can be associated with the dramatic rise in the percentage of municipal debt owned by households (see Kueng (2014)). Household ownership - either directly or through mutual funds- has increased since the 1970's and has fluctuated around 74% since the 1990's (see Figure 3.1). Figure 3.3 illustrates the relationship between the one year lagged implicit tax rate and the top one percent marginal tax rate for the period 1960-2003. The data for top one percent marginal tax rate is obtained from Saez (2004). The correlation coefficient for the sample 1960-2003 is 0.79. Figure 3.3 reveals that the path followed by the implicit tax rate resembles that of the marginal tax rate faced by the top 1% of the income distribution for the entire sample.

Figure 3.2 and Figure 3.3 show that the path of implicit tax rate moves very closely with the actual marginal tax rates. Recent evidence by Kueng (2014) suggests that difference in the level of the tax rate between the spread and the actual marginal tax rate is less concern for the identification strategy because the effect of tax news depends upon the path of the implicit tax rate rather than on the level of the tax rate. Kueng (2014) analysis therefore implies that as long as the path of the implicit tax rate moves close enough to the true marginal tax rate, using the spread between the one year municipal and the Treasury bond does not pose a problem for the identification strategy.

Finally, to empirically test the hypothesis that the implicit tax rate is useful in predicting actual tax rates, I perform a set of bi-variate Granger causality tests between the implicit tax rate and marginal tax rates. Table 2.1 reports the results for the bi-variate Granger causality tests between the implicit tax rate and average marginal tax rates. The tests indicate that the implicit tax rate Granger-causes the average marginal federal tax rate and the top 1% percent marginal tax rate, neither the average federal marginal income tax rate nor the top one percent marginal tax rate help to forecast the implicit tax rate. Thus, all the empirical evidence from Figure 3.2, Figure 3.3, and the Granger causality test points out that the implicit tax rate predicts the future tax rate changes.

3.3 The Factor Augmented Vector Autoregressive Model

To study the effect of tax news on macroeconomic variables, I use a factor augmented vector autoregressive (FAVAR) model that builds on Bernanke et al. (2005) and Boivin et al. (2009). Traditionally, empirical studies investigating the effects of fiscal policy shocks on macroeconomy have employed small scale VAR models using a limited number of variables for a single country. The sparse information set used in the VAR models can lead to a limited information problem, whereby the information possessed by the policy makers and private sector is not reflected in the VAR model. Using the FAVAR model allows us to expand the econometrician information set and attenuates the limited information problem. The key assumption in this model is that the dynamics of the large panel of macro variables is captured by some observed and unobserved common factors. The unobserved factors are extracted from a large set of macroeconomic data. The main advantage of this technique is that it allows us to extract the responses of a wide range of macroeconomic variables to structural shocks in the implicit tax rate and other policy variables.

I formalize the model by assuming that the behavior of the U.S. economy can be captured by a vector of observable variables (Y_t) and unobservable factors (F_t). The vector Y_t consists of the log growth of real per-capita net taxes (ΔT_t), the log growth of real per-capita federal government spending (ΔG_t), the log growth of real per- capita GDP (ΔGDP_t), the federal funds rate (R_t), and the implicit tax rate (τ_t). The vector X_t consists of 120 series of variables that capture U.S. economic performance. This vector comprises measures of industrial production, labor market variables, consumption, housing, inventories, price indexes, exchange rates, interest rates, stock prices, and hourly earnings (see appendix Table A2.2 for a detailed list of variables in X_t).

The general form of FAVAR model is represented as

$$\begin{bmatrix} Y_t \\ F_t \end{bmatrix} = A(L) * \begin{bmatrix} Y_{t-1} \\ F_{t-1} \end{bmatrix} + e_t \tag{3.1}$$

where Y_t is 5×1 vector of observed macroeconomic variables. F_t is a vector of $k \times 1$

unobserved factors. $A(L)$ is the matrix of lag polynomials of order $p = 4$. e_t are the reduced form residuals and Ω is the covariance of reduced form residuals. Equation (1) cannot be estimated without knowledge of the unobserved factors. The unobserved factors F_t can be extracted from the vector X_t and they summarize the information contained in the large number of macro-economic variables, X_t, of dimension $N \times 1$.

The observation equation for the system can be written as

$$X_t = \Lambda^y Y_t + \Lambda^f F_t + e_t. \tag{3.2}$$

where Λ^y is a $N \times 5$ matrix of coefficients on the observable variables, Λ^f is a $N \times k$ matrix of factor loadings, and e_t is vector of series-specific components that are uncorrelated with the Y_t and F_t.

3.4 Empirical Strategy

3.4.1 Data and Model Specification

I use quarterly data from 1960Q1 to 2003Q4 yielding a total (T) of 175 observations. The information series X_t consists of N= 120 variables listed in the appendix.[19] The data are collected from the FRED database of the Federal Reserve Bank of St.Louis.[20] The original series for the variables in X_t are available at monthly frequency, and I have averaged monthly data three at a time to compute quarterly data. The vector X_t includes data on industrial production, labor market, consumption, housing, inflation, money, and interest rates. The observable data series (Y_t) consists of 5 variables described in the previous section. I follow Blanchard and Perotti (2002) to measure two fiscal variables: net tax revenues and government spending. The source of the data for government spending, net

[19] Table A.2.2 lists all 120 variables used in the FAVAR specification

[20] The complete data series can be obtained from FRED database of the Federal Reserve Bank of St.Louis which is based on paper by Stock and Watson (2005). I thank Mwzandile Ginindza for generously providing Bernanke, Boivin, and Eliasz (2005) data set.

taxes, and real GDP is the National Income and Product Accounts (NIPA). I 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. These three variables are transformed into growth rates by taking first differences of the logs to obtain ΔT_t, ΔG_t, and ΔGDP_t. The data for federal funds rate (R_t) is collected from the Federal Reserve of St. Louis database, FRED. I compute the implicit tax rate as the yield spread between the one year tax exempt municipal bond rate (r_t^M) and one year taxable Treasury bond rate (r_t^T). More specifically, $\tau_t = 1 - \frac{r_t^M}{r_t^T}$. The yields on tax-exempt prime graded general-obligation municipal bonds and the taxable U.S. Treasury bonds data are obtained from Leeper et al. (2012). Tables A2.1 and A2.2 provide details on the data, data transformation, and the construction of variables used in the FAVAR model.

The lag length is set to 4 quarters in the VAR specification in equation (1), which is consistent with the previous literature (see Blanchard and Perotti (2002), Ramey (2011), Mertens and Ravn (2013), among others). I follow the common practice in FAVAR models to standardize each of the series in X_t, so that the data are demeaned and have unit variance.

3.4.2 Estimation

The first step in the estimation of the model is to determine the number of unobserved factors. I assume the number of factors to be unknown but constant as in Bai and Ng (2002). I follow Bai and Ng's (2002) IC_{p2} information criteria (see Bai and Ng (2002) for details) to determine the number of factors. The information criteria selects a total of 8 factors i.e., 5 observed factors (Y_t) and 3 unobserved factors (F_t). Having determined the number of observed and unobserved factors for the model, I estimate the FAVAR model in equations (3.1) - (3.2) using the two-step procedure proposed by Boivin et al. (2009). In the first step, I employ the iterative procedure of Boivin et al. (2009). to estimate the unobserved factors. The estimated three factors are denoted as $\hat{F}_t$ = [$f_{1,t}$, $f_{2,t}$, $f_{3,t}$] and can be interpreted as the economic factors, which recover the common dynamics of U.S macro economy that are not captured by the five observed variables.

In the second step, the estimated factors $\hat{F}_t$ are replaced in equation (3.1). Then they are used in conjunction with the macroeconomic variables (Y_t) to estimate the VAR. I use the standard Cholesky decomposition method to identify the impulse response functions with variables are ordered as follows: ΔT_t, ΔG_t, ΔGDP_t, R_t, τ_t, $\hat{F}_t$. This identification scheme is close to that of Leeper et al. (2013). According to these restrictions, the implicit tax rate has no contemporaneous effect on net taxes, government spending, real GDP, and the federal funds rate. However, there is contemporaneous feedback from the observed variables (i.e., net tax revenues, government spending, real GDP, and the federal funds rate) to the implicit tax rate. I allow monetary policy to respond contemporaneously to the net tax revenues, government spending and real GDP. In addition, I assume that the three common factors in $\hat{F}_t$ do not contemporaneously affect the five observed variables (Y_t). I do not attach a particular economic interpretation to the factors but they can be considered as common factors that affect the US economy that are not captured by fiscal, monetary and business cycle shocks. Following the above identifying restrictions, the variables in X_t are allowed to respond contemporaneously to the shocks in the implicit tax rate and all other observable variables.

3.5 Quantifying the Macroeconomic Effect of Tax News

This section discusses the effect of one percentage point increase in the implicit tax rate -hereafter called tax news. The main focus will be on the responses of aggregate GDP and disaggregated variables related to industrial production, employment, new orders, housing starts, prices, and consumer expectations. I present the results for 32 key variables of all

120 variables in the FAVAR model. Point-wise confidence intervals for the impulse response functions are computed using a residual based wild bootstrap (Gonçalves and Kilian, 2004; Yamamoto, 2012). I use 10,000 replications and report 68% and 95% confidence intervals.

Figure 3.4 shows the response of macroeconomic variables to one percentage point increase in the implicit tax rate. The estimated impulse response shows that an unexpected rise in the implicit tax rate immediately results in higher real per-capita GDP. The effect of tax news on real GDP builds to a peak value of 0.77 percent in the fourth quarter and then starts to decline. The response of GDP is statistically significant from two to five quarters after the shock and becomes statistically insignificant thereafter. This behavior of real GDP falls in line with the classical view whereby an anticipated rise in personal income taxes leads to 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.

The response of real per-capita net taxes follows a pattern similar to real per-capita GDP: it increases for six quarters and reaches a peak value of 0.978 percent six quarters after the shock. Higher income results in greater tax returns during the anticipation period but, as it is the case for real GDP, the positive effect becomes statistically insignificant after the fifth quarter. 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. Overall, the results suggest that tax news has an expansionary effect on the economy that lasts slightly over a year. This expansion in the aggregate output then results in tighter monetary policy, which is reflected in a higher federal funds rate. This pattern is consistent with the Federal Reserve acting to control possible inflationary pressures arising from an increase in aggregate demand.

The evidence of an expansionary effect on the economy in the short run draws our attention to the following questions: Through what channels does tax news influence the aggregate economy? How do the responses to tax news vary among industry groups or different market groups? To explore these issues, I study the impact of tax news on disaggregated measures of industrial production. Industrial Production is comprised of two groups: the market group and the industry group. The market group includes final products and materials. More specifically, the final products can be disaggregated into consumer goods (durable and nondurable goods), business equipment, and materials. The industry group includes durable and non-durable manufacturing, mining and utilities.

Figure 3.4 shows the impulse response for total industrial production (IP) and disaggregated measures of production following a one percentage point increase in the implicit tax rate. The response of industrial production (IP) shows a positive and significant effect of tax news. Not surprisingly, the cumulative response of IP shows a similar trajectory to that of the real GDP. IP rises on impact and reaches a peak value of 1.2 percent at fifth quarter. The magnitude of the peak response of IP (1.2 %) is higher than that of the response real GDP (0.77%). Much of the difference between the real GDP and industrial production arises due to the exclusion of the domestic service sector from the index. This difference in the size of the effect shows that tax news has a larger impact on industries related to the manufacturing, mining and electric industry.

Further, I examine the responses of 9 major market groups listed in Table A3.2. To economize space, I display impulse responses for selected groups in Figure 3.4 (i.e., durable consumer goods, nondurable consumer goods, business equipment, and materials).[21] The impulse responses show a similar shape across different market groups but the magnitude of the effect differs considerably. For instance, the peak effect of the industrial production ranges from 0.609 to 1.561 percent for durable consumer goods and business equipment, respectively. This difference in the magnitude of the effect indicates

[21] A full set of impulse responses for market groups and industrial sectors are available upon request from the author

that firms producing business equipments (industrial and defense equipment, oil and gas drilling, information processing) mainly drive the response of aggregate industrial production.

Another interesting result involves the dynamic effect of tax news on different industrial sectors. In response to the tax news, manufacturing and mining show a strong and persistent effect compared to the utilities sector (electric and natural gas). The response of production in the manufacturing and mining sectors rises on impact and reaches a peak value of 1.1 percent and 1.2 percent respectively, which occurs about five quarters after the shock. The energy sector responds very little to tax news. Summarizing, Figure 3.5 illustrates a greater short-run sensitivity of production in the mining and manufacturing sectors to tax news.

To further investigate what market groups drive the response of IP to tax news, I examine the responses of durable and nondurable manufacturing. In response to tax news, nondurable manufacturing rises on impact and subsequently increases to a peak value of 1.439 percent. Durable manufacturing follows similar dynamics but responds slower to tax news and peaks at around 0.729 percent five quarters after the shock. The results suggest that firms in nondurable manufacturing are more able to take advantage of tax news and shift the production to the anticipation period.

The impulse responses for labor market variables are shown in Figure 3.5 and Figure 3.6. The effect of tax news on the labor market operates both at the intensive and extensive margins. A one percentage point increase in the implicit tax rate leads to a statistically significant increase in employment per-capita with a peak value of 0.40 percent at fourth quarter.[22] Hours worked per worker rise by 0.483 percent on impact and remain above the

[22]Employment and hours per-capita series are obtained from Francis and Ramey (2009). The data is available on Valerie Ramey's webpage. Employment per-capita is the logarithm of total employment divided by population over age of 16 years.

mean for the entire forecast horizon. The response of the short-term unemployment rate rises on impact of tax news, but falls one quarter after the shock. Medium and long term unemployment indicators defined as the number of jobless people based on the duration of the unemployment spell (i.e., less than five weeks, between five and 14 weeks, and over 15 weeks) fall sharply on impact. These responses show a significant reduction in the unemployment rate on impact and a gradual fall to reach the trough during the fourth quarter. The rate of growth of civilian unemployment remains negative for most of the time horizon.

The responses of labor market variables are consistent with the results of House and Shapiro (2006), Mertens and Ravn (2012) and Leeper et al. (2013). In a theoretical paper, House and Shapiro (2006) find that the phased-in-tax reductions enacted by the 2001 Economic Growth and Tax Relief Reconciliation Act (EGTRRA) delayed the production decisions of firms and workers and resulted in a 0.37 percent decline in aggregate employment. The authors suggest that the 2003 Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) accelerated the schedule of tax reductions under EGTRRA and gave incentive for firms and workers to alter their behavior immediately. While the study by House and Shapiro (2006) focuses on tax cuts, their analysis on the timing of tax cuts and their effects on the macro economy extends to tax increases as well.

The impulse responses for the capacity utilization rate and the purchasing managers index (PMI) supports my finding that news of higher taxes has an expansionary effect on economic activity in the short run. The capacity utilization rate measures the maximum sustainable output which an industrial plant can produce with the available labor and capital. This measure is aimed to know the operating capacity of manufacturing, mining and utilities industries. The increase in the capacity utilization rate reflects an incentive to increase the industrial production on receiving the news related to higher income tax. Similarly, the Purchasing Managers' Index (PMI) is a useful indicator that basically measures the growth in the manufacturing sector. The PMI rises on impact and shows a sign of expansion for the next three quarters with a peak value at 0.40 in the third quarter. Overall, the responses of industrial production, employment per-worker, hours per worker, capacity utilization rate, and PMI index, and other disaggregated measures of economy reflect that news of higher income taxes has an expansionary effect on the economy during the anticipation period.

Finally, the increase in the real economic activity in the short run results in demand-pull-inflation. This is reflected in the responses of consumer and producer price indices. The response of CPI inflation for all items and PPI inflation for finished goods shows a strong and persistent increase. Moreover, leading indicators, which tend to fluctuate before the overall economy, also respond to tax news. New orders for consumer goods and materials in the manufacturing sector responds positively on impact (see Figure 3.7). This increase in new orders is a signal for firms to increase production and employment. One of the leading index components - new private housing units tends to increase in response to tax news. Interestingly, I find that the rise in the number of housing units is considerably larger in the northeast and western regions of the U.S. The peak response is larger for the northeast region compared to all other regions. These results are consistent with chapter 1 results where news of tax increase has a strong positive effect on personal income and employment in the northeastern states (i.e. Connecticut, New Hampshire, Massachusetts, and New Jersey) compared to other regions.

Three main findings follow from this analysis. First, the anticipation of an increase in the income tax rate stimulates the economy; this stimulus lasts slightly over a year. Further, the expansion then results in tighter monetary policy, reflected in a higher federal funds rate. Third, the effect of tax news appears to be stronger for the manufacturing and energy sectors than for services, with nondurables experiencing a greater expansion. These differences in the responses are possibly driven by the dissimilarities in adjustment costs and capital-labor ratios across sectors. The investigation of what particular characteristics account for this differential response will be addressed in future research.

3.5.1 What Shocks are Responsible for Fluctuations in the Real GDP?

This section focuses on the relative importance of fiscal, monetary, and tax news shocks in explaining the fluctuations in U.S economic activity. More precisely, how much of the historical fluctuations in real GDP was accounted for by innovations in net tax revenues, government spending, the federal funds rate and the implicit tax rate?

To answer this question, I follow (Hamilton, 1994; Lütkepohl, 2007; Kilian, 2009) to construct the historical decompositions of real GDP using the VAR model presented in the earlier section (see equation (1)). For expository purpose, let me denote C_t as vector of observable and factor estimates C_t =[Y_t, $\hat{F}_t$]. Where Y_t is 5$\times$1 vector of observed macroeconomic variables, and F_t is a vector of $k$$\times$1 estimated factors. Hence, the reduced form equation (1) can be represented as:

$$C_t = A(L)\, C_{t-1} + e_t \tag{3.3}$$

where $A(L)$ is lag order polynomial, and e_t is a 8×1 vector of correlated errors. Equivalently, the above reduced form VAR model can be represented by a structural VAR,

$$B_0\, C_t = \sum_{i=0}^{n} B_i\, C_{t-i} + v_t \tag{3.4}$$

where B_0 is a lower triangular matrix with diagonal elements that equal one, B_i denotes the lag coefficient matrices, and v_t denotes the vector of mutually uncorrelated structural shocks. To be precise, v_t = [v_t^T, v_t^G, v_t^{GDP}, v_t^R, v_t^τ, v_t^F]′ is an 8×1 vector of structural disturbances, where v_t^F is 3×1 vector of innovations in factors. Equation (3.4) has the following structural moving average representation:

$$C_t = \sum_{i=0}^{\infty} \Psi_i \, v_{t-i} \approx \sum_{i=0}^{t-1} \Psi_i \, v_{t-i} \tag{3.5}$$

where $\hat{\Psi}_i$ denotes the matrix of structural impulse responses at lag i = $0, 1, 2, ...$[23]

The historical path for real GDP is constructed by following two steps: First, I use the $\hat{A}(L)$ and $\hat{e}_t$ estimates from the VAR described by equation (3.3) to compute $\hat{\Psi}_i$ and v_t. Second, I use the structural moving average representation shown by equation (3.5) to decompose the historical real GDP series into the orthogonal components.

Figure 3.8 plots the cumulative contribution of each structural shock to the real GDP based on the historical decomposition of the data. Panel 1 and Panel 2 show the contribution of net tax revenues and government spending shocks to fluctuations in real GDP. Panel 3 and Panel 4 show the contribution of the federal funds rate and the implicit tax rate to real GDP. The vertical bars in Panel 4 correspond to the dates of announcement of major tax policy changes in the United States (see Table 3.1 for more details). The historical decomposition of real GDP allows us to assess the contribution of each shock at each point in the time since 1960.

Figure 3.8 shows that the structural shocks to the federal funds rate and the implicit tax rate significantly contributed to the fluctuations in real GDP (see the third and fourth panels, respectively). The upward movement of the plotted line reflects the rise in real GDP due to a specific shock and, similarly, the downward pressure in real GDP reflects the fall due to the shock. The response of real GDP in panel 4 indicates a increase (decrease) at various episodes of tax events. For instance, the announcement of a 10% increase in individual and corporate income surtaxes in the Revenue and Expenditure Control Act of 1967 resulted in a decline in real GDP in the year 1967 and 1968. The effect of tax news on real GDP subsided between the period of 1970 and 1975. Indeed, the arrival of news

[23] The deterministic regressors in equation (3.3), and equation (3.4), and equation (3.5) are suppressed for notational convenience.

about the reduction in taxes between 1975 and 1978 had very little effect on real GDP.

In the 1980's, the federal government mainly advocated for structural tax reforms aiming for a fair and simple tax system that would broaden the tax base. The Economic Recovery Tax Act of 1981-hereafter ERTA 1981- was announced by President Regan on February 5, 1981 and signed on August 13, 1981. The length of legislative lag ERTA 1981 was only 2 quarters. The law became effective immediately in August, 1981. The plot shows the implementation of tax cuts introduced in ERTA 1981 stimulated the economy from 1981 to 1982. While the announcement of tax changes in the 1982 Tax Equity and Fiscal Responsibility Act and the 1984 Deficit Reduction Act, which were aimed to close the loopholes in tax structure, caused a significant slowdown in real GDP. Though the announcement of tax cut provisions in the Tax Reform Act (TRA86) came as early as 1984-85 to economic agents, the cuts were actually implemented in phased-in nature (i.e., January, 1987 and January 1988).[24] The initial fall in real GDP can be attributed to an anticipation of tax cuts by economic agents. The plot shows that the implementation of tax cuts stimulated the economy from 1986 onwards.

Panel 4 shows a sharp decline in real GDP in 1993 that can be attributed to news about provisions in the Omnibus Budget Reconciliation Act of 1993. The decline in real GDP is due to a rise in individual and corporate income taxes during the first term of President Clinton. The Omnibus Budget Reconciliation Act of 1993 introduced new tax brackets and raised top marginal tax rate to 36%. Followed by a series of deficit reduction measures under the Clinton administration, the U.S. economy reached a budget surplus in 1998. President Bush entered the office in 2001 and announced his intention to reduce federal taxes. The announcement of phased-in tax cuts in the form of EGTRRA in June 2001 pushed the real GDP below the mean in 2001 and 2002. The slowdown in the real GDP during 2001-2003 shows that the announcement and enactment of phased-in tax cuts did

[24]The economic effects of Tax Reform Act of 1986 is discussed in detail by Auerbach and Slemrod (1997)

not help the economy to bounce back to normal level.

Although, tax news played an important role in explaining the fluctuations in real GDP, one cannot ignore the role of monetary policy. Panel 3 shows a long swing in the real GDP during the 1970's and 1980's that can be associated with unexpected changes in monetary policy. In particular, the upswing in GDP growth during the 1970s can be largely associated with the expansionary monetary policy of the Burns-Mill era. In contrast, the deflationary policy during the Volcker period resulted in lower GDP growth. Figure 8 shows that the impact of federal funds rate shocks fell in the late 1990's during the Greenspan era. Conversely, tax news shocks largely contributed to the fluctuations in 1993-1995 and 2002.

In summary, I conclude that tax news associated with legislations in 1969, 1975, 1982, 1986, 1993, and 2001 contributed to the historical fluctuations in the real GDP. In addition, the peaks associated with the fluctuations in real GDP due to federal funds rate shocks coincide with the tax announcements during the 1970's, 1980's, and 1990's.

3.5.2 Is it Systematic Monetary Policy or Is it Tax News?

In the previous section, I showed that monetary policy and tax news have both contributed to the historical fluctuations in the real GDP. To what extent are fluctuations in the real GDP a result of tax news rather than of the subsequent response of monetary policy?

To answer this question, I follow Bernanke et al. (1997, 2004) and use the parameters estimated in the VAR model (see equation 3.3) to conduct a counterfactual analysis in which the response of monetary policy to the implicit tax rate is temporarily shutdown. To be precise, I conduct a simulation in which a tax news shock (v_t^{τ}) hits the economy at time t =0 − while all the other structural innovations in the system are set to zero − and the federal funds rate is fixed at a historical value observed at t = 0 for four quarters (i.e., the value of $\{C_{R,t+s}\}_{s=1}^{4}$ is assumed to remain unchanged for a year after the shock).[25] I compute the response of the economy to tax shocks with and without shutting off the monetary policy response for three major tax episodes: the Tax Reform Act of 1986 (TRA86), the Omnibus Reconciliation Relief Act of 1993, and the Economic Growth and Tax Reconciliation Relief Act of 2001 (EGTRRA). Thus, in each episode I set the values for C_{t-1}, C_{t-2}, C_{t-3}, C_{t-4} equal to the historical values.

Before I proceed to estimate the responses for these three tax episodes, I need to determine the timing and magnitude of the structural shock of interest. I assume the time of the shock equals the quarter when the President announced the intended tax policy change to the Congress. In other words if the investors are forward looking then announcements of tax policy changes trigger movements in forward looking variables (i.e., yields on similarly rated one year municipal and Treasury bonds) at the moment when the policy change is announced. As for the size of the structural shock for (v_t^{τ}), it is set equal to the difference between the observed implicit tax rate at the announcement date and the value at the previous quarter.

Figure 3.9 shows the behavior of the key aggregate variables (net taxes, government spending, real GDP, federal funds rate, and implicit tax rate) during the years 1984:I-1987:IV, 1993:I-1996:IV, 2000:I-2003:IV. The three panels in the Figure 3.9 are associated with three different episodes of tax policy changes. Each figure illustrates three paths: the dashed lines with square marker indicates the historical value; the solid line (hereafter total effect) represents the predicted response of the variable given a shock to the implicit tax rate while allowing for a monetary policy response;[26] and the bold dashed line (hereafter direct effect) represents the response to the implicit tax rate shock when the

[25] This counterfactual simulation is similar to that used in Hamilton and Herrera (2004), and Herrera and Pesavento (2009) to analyze the contribution of oil prices shock and the role of systematic monetary policy on the economy

[26] The solid lines in the Figure 3.9 for the years 1993:I - 1996:IV represents the response of variables to the news about future tax increases, whereas for tax episodes during the years 1984:I-1987:IV and 2000:I-2003:IV represents the response of variables to news about future tax cuts

monetary policy is temporarily shutdown.

The first scenario in the Figure 3.9 (Panel 1) depicts the contribution of news regarding the Tax Reform Act of 1986 (TRA86). Most researchers agree that the TRA86 introduced sweeping changes in the U.S. federal income tax post World War II. The TRA86 was not signed by the President until late 1986, but one can trace a series of reforms introduced by members of Congress or by the President before the bill was enacted and made public law. The central provisions of TRA86 were initially proposed by Senator Bill Bradley and Representative Richard Gephardt in 1983 (Auerbach and Slemrod, 1997). However, the credible announcement about a policy change came from President Regan during his State of the Union address on January 25, 1984 that commissioned Treasury-I and promised to ‘‘go forward with an historic reform for fairness, simplicity, and economic growth’’.[27] I map this news about TRA86 to the changes in the implicit tax rate. The announcement of lowering personal income taxes reduced the implicit tax rate by 4.282 percentage points. I then simulate the response of the variables of interest to a shock to the implicit tax rate (i.e., v_0^τ = -4.282).

The response of real GDP (solid and bold dashed line) in the Panel 1 shows a strong evidence of anticipatory effects during 1984:I-87:IV. The announcement of future tax cuts in TRA86 constrained the economy during the first four quarters of the forecast horizon. Output fell below its mean on impact and reached a trough value of 3 percent at the end of fourth quarter. One year after the shock, the response of output followed an upward movement but remained negative for an extended period that extended beyond the length of the foresight. I find there was no substantial difference between the total and the direct response of output during the first four quarters after the initial shock. However, the drop in real GDP was much higher for the direct effect (bold dashed line) after five quarters. In

[27] The Library of Congress provides the information about U.S. federal legislative information. The Scripps Library collects the presidential speeches in American History starting from 1789-2014. The precise dates for signaling of tax changes can be found in the Presidential speech. The source is http://millercenter.org/president/speeches

this case, the difference between total and direct effect can be interpreted as the indirect effect of the monetary policy response to tax news. This suggests that if the monetary policy had not responded during the first year of the shock, then output would have experienced a larger drop in its response to tax news in the medium run.

Panel 2 illustrates the news about the Omnibus Budget Reconciliation Act of 1993 and its impact on some key macro variables. In this case, the news about the tax increase was announced by President Clinton in his address to a joint session of Congress on February 15, 1993. In his speech, the President announced the addition of a new tax bracket raising the top marginal tax rate to 36%. The President also recommended 10% surtaxes on income over $250,000 a year. The tax increase proposals were mainly targeted at higher income groups. The announcement of a tax increase on individual and corporate income raised the implicit tax rate by 1.292 percentage points. Panel 2 shows that real GDP increased for four quarters following the shock to the implicit tax rate. The plot shows that output reached a peak value of 3.5 percent at the end of 1994:III and thereafter output gradually declined and moved slowly toward the mean level in the long run. In this scenario, shutting down the response of monetary policy to tax news shock for the first four quarters results in higher peak amplitude in the response of output.

Finally, Panel 3 shows the effect of tax news related to the 2001 EGTRRA. The major provisions in the announcement of EGTRRA were aimed to cut the tax rates for the top four brackets. These tax cuts were initially scheduled to take effect in 2002, 2004, and 2006. The results in Panel 3 show that the announcement of phased-in tax cuts in 2001 had a strong negative effect on the real GDP. Output fell below its trend during the pre-implementation period (i.e. 2001:I-IV), while the implementation of tax cuts at the end of 2002 resulted in a rise in the GDP growth. I find that shutting down the monetary policy response in this case had no effect on the response of output. The paths of both lines (solid and dashed) are almost on top of one another for the entire forecast horizon.

Summarizing, during the three periods under analysis, changes in real GDP and inflation were mainly due to the direct effect of tax news and not to the ensuing monetary policy response. This result might not come as a surprise to the reader as it is unlikely that the monetary authorities would have strongly reacted to a tax news shock before the tax changes were implemented.

3.5.3 Pre-Implementation vs Post-Implementation Tax Effects

How much of the anticipatory effects to tax news shock persists after the policy change was implemented? This section investigates the importance of before and after tax policy changes in explaining U.S. macroeconomic fluctuations. More specifically, I analyze the dynamic responses of the macroeconomic variables of interest to a combination of two shocks. First an increase in the federal tax rate is announced at time t = 0, then a tax increase is implemented at time t = 4. In principle, adding the policy realization shock to the model should taper the anticipatory effects of the news shock.

To conduct this exercise I modify the FAVAR model described in the equation (3.1) - (3.2) by replacing the log growth of net tax revenues (ΔT_t) with the tax liability changes (tax_t) constructed by Romer and Romer (2010). Romer and Romer use *Economic Reports of the President*, reports of Congressional committees, and presidential speeches to construct a series of exogenous changes in the US federal tax liability changes. Tax liability changes are computed as dollar changes in tax liabilities relative to nominal GDP at the time of implementation. Given that net tax revenues are replaced by the tax liability changes, I first re-estimate the FAVAR model using two-step estimation procedure and obtain the alternative FAVAR model:

$$\widetilde{C}_t = E(L)\, \widetilde{C}_{t-1} + u_t \tag{3.6}$$

where $\widetilde{C}_t$ = [tax_t, ΔG_t, ΔGDP_t, R_t, τ_t, $\widetilde{F}_t$] is a vector of endogenous variables; $\widetilde{F}_t$ denotes the new estimated factors; tax_t denotes tax liability changes; and u_t = [u_t^{tax}, u_t^{G},

u_t^{GDP}, u_t^R, u_t^τ, u_t^F]′ is an 8×1 vector of reduced form disturbances, where u_t^F is 3×1 vector of innovations in factors. The above equation may be represented as a structural VAR:

$$D_0 \, \widetilde{C}_t = \sum_{i=1}^{p} D_i \, \widetilde{C}_{t-i} + \epsilon_t \tag{3.7}$$

where D_0 is lower triangular matrix with ones along the principal diagonal. ϵ_t = [ϵ_t^{tax}, ϵ_t^G, ϵ_t^{GDP}, ϵ_t^R, ϵ_t^τ, ϵ_t^F]′ is an 8×1 vector of structural disturbances.

More precisely, I employ the coefficients estimated for equation (3.6) and simulate the response of the economy to a tax news shock of 1% at time t = 0 (i.e., ϵ_0^τ = 1). Then, I assume that at time t = 4, tax liabilities experience an unexpected 1% increase (i.e., ϵ_4^{tax} = 1). This is equivalent to assume that the change in the implicit tax rate does not perfectly capture the subsequent change in tax liabilities. To be more precise, I use the structural VAR described in equation (3.7) to compute the impulse response function ($\widetilde{\Psi_t}$) to a shock in the implicit tax rate for t = 0,1,2,3. Then, at time t = 4, a tax policy shock (ϵ_4^{tax} = 1) hits the economy while we assume no additional shocks occur at that time or in the future. I compute the impulse response functions for $t \geq 4$ in the usual manner but with the exception that I assume the lagged values $\widetilde{C}_{t-1}$ equal the values simulated in the previous steps. This allows me to compute the values $\widetilde{C}_t$ for $t \geq 4$.

Figure 3.10 presents the impulse responses when only the implicit tax rate is shocked at time t = 0 and the responses when an additional 1% increase in tax liabilities takes place at time t = 4 (solid lines). Note that the dashed lines in figure 3.10 correspond to the benchmark results in Figures 3.4, 3.5, and 3.6. Since the dynamic response to a 1% shock in the implicit tax rate have been discussed in the previous sections, I will focus here on what happens when an additional increase in the tax rate takes place later on. At time 0, the arrival of news about an increase in income taxes has a expansionary effect on the economy: real GDP, employment per worker, hours per worker, aggregate and disaggregate industrial production, and new orders rise immediately. Once the tax increase is implemented, a a 1% shock to tax liabilities takes takes place at time $t = 4$, the macro variables follow a path that is consistent with conventional wisdom. That is real GDP, employment per worker, hours per worker, aggregate and disaggregate industrial production, and new orders fall immediately.

These results provide some perspective on why there is no consensus regarding the effect of tax shocks. First, if an increase in the federal tax rate is anticipated, then an expansionary effect is observed. That is firms and workers have an incentive to move production to the anticipation period where taxes are lower. However, once the tax increase is implemented an economic contraction ensues. My results are consistent with those of Yang (2005) and Mertens and Ravn (2012) who find substantial movement in macroeconomic variables prior to policy realization and, once the taxes are realized, actual tax changes offset the anticipatory effects on the macroeconomic variables.

3.5.4 Simulation across Tax Acts

In the previous section, I analyzed on counterfactual scenario without consideration of the magnitude or the anticipation time implied by different historical tax policies. I assumed that economic agents had a one-year foresight over future tax changes and the tax change pre- and post-implementation equaled 1%. However, the length of foresight depends on the legislative lag and the implementation lag, which differ for each tax law. Table 3.1 shows the variation in the length of the legislative lag for various tax events; the lag length ranged between 4 and 17 months.[28] In addition, the size of structural shock for news and actual tax changes vary significantly for each tax law.[29] Therefore it is interesting to examine how the results depend on the length of foresight and the magnitude of the shock.

[28] See Mertens and Ravn (2012) for detailed summary of implementation lags for each of the tax event for the period 1947-2003

[29] See Poterba (1986) for discussion on magnitude of the change in the implicit tax rate to different tax events.

I investigate the same three tax episodes analyzed in section 3.5.2: Tax Reform Act of 1986 (TRA86), Omnibus Reconciliation Relief Act of 1993, and Economic Growth and Tax Reconciliation Relief Act of 2001 (EGTRRA).

First, I use the parameters estimated in the VAR model (see equation 3.6) and then conduct a counterfactual analysis for three different tax episodes. That is, for each episode I first assume the economy is hit with a tax news shock (ϵ_t^τ) at the time of tax announcement, t = 0. Then, at the implementation date an unexpected innovation to the tax liabilities changes (ϵ_t^{tax}) is observed. The estimation methodology is identical to the method used for the general case in the previous section (see section 3.5.3) with the exception that here I replace net tax revenues with tax liabilities changes to get a better grasp of the historical changes in the latter.[30]

Two modeling choices need to be addressed: First, the timing of tax news and tax liability shocks for each of three tax episodes has to be determined. Second, the size of structural shock for tax news at the announcement date and the size of tax liability changes at the implementation date has to be computed.

As in the previous sections, I assume that the announcement date corresponds to the date at which the President announced his intention to change the taxes. The implementation date is the date at which the tax legislation became effective. In addition, as discussed in section 3.5.3, I measure the size of structural shock for tax news (ϵ_t^τ) as the difference in the value of implicit tax rate between the announcement date and the previous quarter. Regarding the shock to the tax liability changes (ϵ_t^{tax}), I use the Romer and Romer (2010) definition to measure the size of actual tax changes (i.e., dollar change in the tax liabilities relative to the current price GDP at the implementation date). For instance, the tax liability

[30]First, I set $\widetilde{C}_{t-1}$, $\widetilde{C}_{t-1}$, $\widetilde{C}_{t-1}$, $\widetilde{C}_{t-1}$ equal to their historical values for three tax episodes. I then estimate equation (3.7) for $\widetilde{C}_{t+s}$ values by feeding structural shock for news shock at the time of announcement and tax liabilities shock at the implementation date. The impulse response functions are derived by plotting $\widetilde{C}_{t+s}$, where s = 1,2,3...16.

changes related to TRA86 were due in three separate phases i.e. 1986:III, 1987:I, and 1987:III. The change in tax liabilities in 1986:III corresponded to 0.50 percent of the GDP. The latter two have reduced the tax liabilities approximately by 0.58 percent of annual GDP. Similarly, the implementation of the Omnibus Reconciliation Relief Act of 1993 brought changes in tax liabilities in three separate phases (i.e., in 1993:III, 1993:IV, and 1994:I). The size of tax liabilities changes in 1993:III was 1.02 percent to annual GDP, a cut in tax liabilities by 0.59 percent in 1993:IV, and increase in tax liabilities by 0.19 percent in 1994:I. Finally, the phased-in tax cuts introduced in the EGTRRA of 2001 were scheduled initially to be implemented in 2004 and 2006. However, the enactment of the Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) in 2003 allowed the phased-in tax cuts in EGTRRA to be implemented immediately in 2003. The implementation of JGTRRA reduced the tax liabilities changes by 2.8 percent of annual GDP[31].

Figure 3.11 illustrates the simulated response of the key macro variables for three specific tax episodes: 1984:I-1987:IV, 1993:I-96:IV, and 2000:I-2003:IV. The dashed line represents the response to the tax news shock (ϵ_t^{τ}). The solid line depicts the response to the combination of shocks where the news shock (ϵ_t^{τ}) occurs at the time of the tax announcement and, subsequently, a positive innovation in the tax liabilities (ϵ_t^{tax}) occurs at the implementation date $-$hereafter called total effect. The vertical lines in Figure 3.11 mark the phased-in implementation dates for three tax episodes.

The first panel of Figure 3.11 plots the simulation for the Tax Reform Act of 1986 (TRA86), where the length of legislative lag was 17 months. The implementation for the TRA86 was phased-in over three separate stages (i.e., 1986:IV, 1987:I, and 1987:III). As the figure illustrates, during the pre-implementation period, news about lower taxes resulted in a significant decline in output. Output reached a trough one year before the tax cuts were implemented and increased thereafter. Note that starting in 1986:IV the

[31] The source for timing and size of tax liability changes is taken from Romer and Romer (2010)

response of GDP shows upward movement due to the implementation of tax cuts.

Panel 2 of Figure 3.11 plots the results for the 1993:I-1996:IV period. The phased-in implementation of the Omnibus Budget Reconciliation Act of 1993 was scheduled in three separate stages (i.e., 1993:III, 1993:IV, and 1994:I). The 1993:III and 1994:I tax changes correspond to increases in tax liabilities while the 1993:IV corresponds to a decrease. At the beginning of 1993:I, the arrival of news about higher taxes had an expansionary effect on real GDP. The rise in taxes in 1993:III shows no significant effect on output but subsequent implementation of higher taxes in 1994:I resulted a immediate fall in the real GDP, which moved slowly towards the steady state in the long run.

Finally, panel 3 of Figure 3.11 illustrates the simulation for 2000:I-2003:IV. The figure shows that output declined sharply in response to tax news in 2001. Once the tax cuts were implemented in 2003:II, a sharp increase in real GDP ensued. The increase in real GDP can be attributed to the elimination of phased-in nature of tax reductions of EGTRRA 2001. These results are consistent with the findings of House and Shaipro (2006) who find that phased-in tax cuts of EGTRRA 2001 contributed to the slow recovery from recession in 2001 and the implementation of tax cuts in 2003 stimulated the economy.

Overall, the results show strong evidence of anticipatory effects for all three tax events, which is consistent with the benchmark estimate where we used the net tax returns instead of the tax liability changes. Whereas the implementation of the TRA86 and the Omnibus Reconciliation Act of 1993 had a rather weak effect on economic activity, the mid-2003 implementation of the tax cuts proposed in the EGTRRA 2001, did have a positive effect on GDP growth.

3.6 Conclusions

The lack of consensus in explaining the macroeconomic effects of news about tax changes can be associated with the empirical challenge in identifying the tax foresight. Existing studies have used different methodologies, data, and instruments to estimate the quantitative effect of tax policy changes. This chapter identifies tax news 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. I investigate the effect of a tax news on U.S. economy, using a factor-augmented vector autoregressive (FAVAR) approach.

The results suggest that tax news –measured as one percentage point increase in the implicit tax rate– has an expansionary effect on real economic activity in the short run. I find that real GDP increases in response to a tax news shock for about four quarters and reaches a peak value of 0.77 percent in the fourth quarter. The magnitude and direction of response of real GDP is consistent with the classical view where an anticipated rise in personal income taxes leads to an increase in output, aggregate employment, and hours worked per worker.

In addition, I investigate the effect of tax news on disaggregate measures of industrial production, price level, housing units, and new orders in consumer goods. I find that a positive shock to the implicit tax rate leads to large, persistent and positive effects on real economic activity. Overall, the results suggest that that news regarding an increase in future tax rates gives an incentive for firms and workers to switch the production over to the anticipation period where taxes are expected to be lower.

A historical decomposition of the sources of fluctuations in GDP growth reveals that shocks to the federal funds rate and tax news have been the main sources of fluctuations in output during the 1960-2003 period. While monetary policy shocks largely explain the variations in output during the 1975-85 period, tax announcements associated with legislations in 1986, 1993, and 2001 contributed to the fluctuations in real GDP during the past decades. Moreover, had the monetary authority not responded to news of tax changes in 1986 and 1993, then the resulting fluctuations in GDP would have been somewhat larger.

Finally, the counterfactual analysis of the pre- and post-implementation shocks sheds some light on the controversy regarding the effect of tax changes. First, during the anticipation period, news of a tax increase results in an expansion. Yet, once the tax increase is implemented, the expansionary effect is tappered. Moreover, simulations for three key historical tax episodes suggest that it is crucial to account for policy foresight in order to get a better grasp of the true effects of a change in tax policy.

Table 3.1: Major Tax Legislations in the United States over the years 1964-2003.

Announcement	Enactment	Provisions in the Act
January 21, 1963	February 26, 1964	**Revenue Act (H.R.8363)** :Reduction in individual and corporate income tax rates. The top rate for individual tax rates in reduced from 91% to 70 % and top corporate tax rate reduced from 52% to 48 %.
January 26, 1967	June 28, 1968	**Revenue and Expenditure Control Act(H.R.15414)**: The tax law imposed a 10% surtaxes on individual and corporate income for individuals and corporations.
April 21, 1969	December 30, 1969	**Tax Reform Act (H.R. 13270)**: This law extended the income surtaxes at 5% for six months. Also, increased the personal income tax exemption from $600 to $750.
January 13, 1975	March 29, 1975	**Tax Reduction Act (H.R.2166)**: The tax law provided 10% tax rebate up to maximum of $200. Increased the minimum standard deduction to $1900 (joint filers). Also, increased the percentage standard deduction to 16% for the year 1975.
January 26,1976	October 4,1976	**Tax Reform Act(H.R.10612)** : Increased percentage standard deduction to 16 % (maximum $2,800) and minimum standard deduction to $2,100 (joints filers). Increased long-term capital gains holding period from 6 months to 1 year.
January 13, 1977	May 23, 1977	**Tax Reduction and Simplification Act of 1977(H.R. 3477)**: Increased the standard deductions and minimum standard deduction with a single standard deduction $3,200 (joint filers).
January 19, 1978	November 6, 1978	**Revenue Act (H.R. 13511)**: Increase the personal exemption from $750 to $1000. Top corporate tax reduced from 48% to 46%. Increased the standard deduction from $3200 to $3400 (joint filers)
February 5, 1981	August 13, 1981	**Economic Recovery Tax Act(H.R. 4242)**: Amends Internal Revenue Code to reduce individual rates by 5% effective October 1, 1981 to June 30, 1982. Further, 10% effective from July 1, 1982 to June 30, 1983. Finally an additional 10% effective on July 1, 1983. The highest marginal tax rates for all types of income reduced from 70% to 50% . Maximum tax rate on long-term capital gains of 20 % is established.
January 26, 1982	September 3, 1982	**Tax Equity and Fiscal Responsibility(H.R. 4961)**:Increases the wage base for purposes of the Federal unemployment tax from $6000 to $7000, effective in 1983. Increases the unemployment tax rate from 3.4 to 3.5 percent effective in 1983 and to 6.2 percent (a permanent tax of 6.0 percent and an extended benefit tax of 0.2 percent) effective in 1985. Increased excise taxes.
January 25, 1984	July 19, 1984	**Deficit Reduction Act (H.R.4170)**: The act has placed state volume limitation on private purpose tax exempt bonds. The maximum estate tax rate at 55%. Increased excise taxes.

Continued on next page

Table 3.1 – *Continued from previous page*

Announcement	Enactment	Provisions in the Act
January 25, 1984	October 22, 1986	**Tax Reform Act (H.R.3838)**: Reduced the number of tax brackets from fourteen to two: 15% and 28%. Top marginal tax rate is lowered from 50% to 28%. The top corporate marginal tax rate is reduced to 34%. The tax reform act tightened the limitations on states issuing tax exempt bonds for private purposes. Increased the standard deduction fro $5,000 for married couples. Increased the personal exemption to $2,000 and also increased earned income tax credit.
June 26, 1990	November 5, 1990	**Omnibus Budget Reconciliation Act (H.R. 5835)**: Increased the top marginal tax rate from 28 percent to 31 percent. The capital gains tax rate is maintained at 28 percent. Individual alternative minimum tax rate is increased from 21% to 24%.
February 15, 1993	August 10, 1993	**Omnibus Budget Reconciliation Act (H.R. 2264)**: The act has introduced a new tax bracket. The top marginal tax rate increased to 36%. Corporate tax rates were increased. The top corporate tax rate is increased to 35%.
February 5, 2001	June 7, 2001	**Economic Growth and Tax Relief Reconciliation Act- EGTRRA (H.R.1826)**: Amends Internal Revenue Code to replace five individual tax brackets (15%, 28%, 31%, 36%and 39.6%) to six lower bracket s(10%, 15%, 25%, 28%, 33%,and 35%). The phased-in reductions of 28%, 31%, 36%and 39.6% brackets will reduce by one percentage point annually until 2006 and thereafter the tax brackets will end up with 25%, 28%, 33%,and 35%. Finally, these tax brackets will expire or sun set in 2011.
January 7, 2003	May 28, 2003	**Jobs and Growth Tax Relief Reconciliation Act- JGTRRA (H.R.2)**: Accelerated the tax provisions from EFTRRA 2001, so that the 2006 rates become immediate effective in 2003. The law has reduced the tax rates on dividends and capital gains assets that held for more than year. The top rate is reduced to 15%. Provided $20 billion to states for fiscal releif for the period over 2003 and 2004.

Table 3.2: State Taxation of Municipal Bonds and US Treasury Bonds

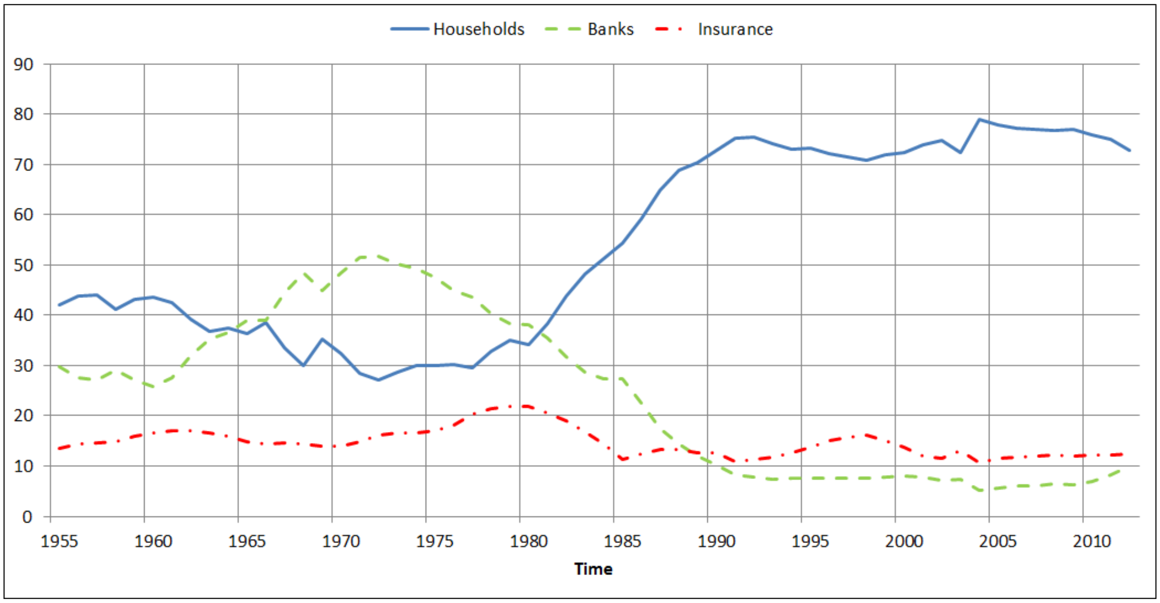
State	In-State Municipal	Out-State Municipal	US Treasury Bonds
Alabama	Exempt	Taxable	Exempt
Alaska	*No Personal Income or Corporate Tax*		
Arizona	Exempt	Taxable	Exempt
Arkansas	Exempt	Taxable	Exempt
California	Exempt	Taxable	Exempt
Colarado	Exempt	Taxable	Exempt
Connecticut	Taxable	Taxable	Taxable
Delaware	Exempt	Taxable	Exempt
District of Columbia	Exempt	Taxable	Exempt
Florida	*No Personal Income or Corporate Tax*		
Georgia	Exempt	Taxable	Exempt
Hawaii	Exempt	Taxable	Exempt
Idaho	Exempt	Taxable	Exempt
Illinois	Taxable	Taxable	Exempt
Indiana	Exempt	Exempt	Exempt
Iowa	Taxable	Taxable	Exempt
Kansas	Exempt	Taxable	Exempt
Kentucky	Exempt	Taxable	Exempt
Louisiana	Exempt	Exempt	Exempt
Maine	Exempt	Taxable	Exempt
Maryland	Exempt	Taxable	Exempt
Massachusetts	Exempt	Taxable	Taxable
Michigan	Exempt	Taxable	Exempt
Minnesota	Taxable	Taxable	Taxable
Mississippi	Exempt	Taxable	Exempt
Missouri	Exempt	Taxable	Exempt
Montana	Taxable	Taxable	Taxable
Nebraska	Exempt	Taxable	Exempt
Nevada	*No Personal Income or Corporate Tax*		
New Hampshire	Exempt	Taxable	Exempt
New Jersey	Exempt	Taxable	Exempt
New Mexico	Exempt	Taxable	Exempt
New York	Taxable	Taxable	Taxable
North Carolina	Exempt	Taxable	Exempt
North Dakota	Exempt	Taxable	Exempt
Ohio	Exempt	Exempt	Exempt

continued on next page

Table 3.2: Continued from previous page

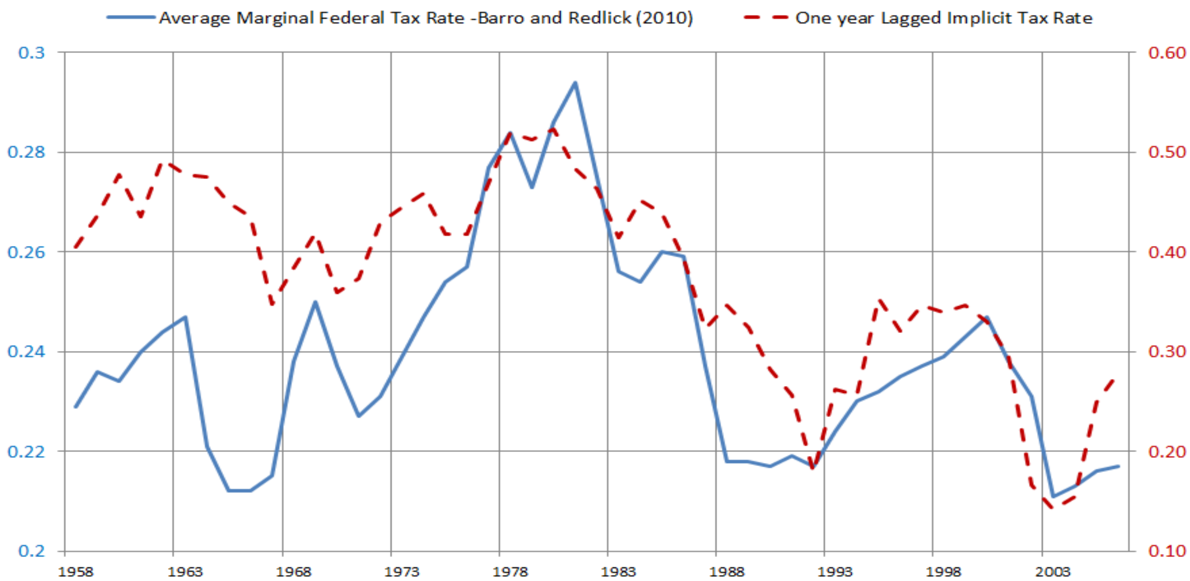
State	In-State Municipal	Out-State Municipal	US Treasury
Okalhoma	Taxable	Taxable	Exempt
Oregon	Exempt	Taxable	Exempt
Pennsylvania	Exempt	Exempt	Exempt
Rhode Island	Exempt	Taxable	Exempt
South Carolina	Exempt	Taxable	Exempt
South Dakota	*No Personal Income or Corporate Tax*		
Tennessee	Taxable	Taxable	Taxable
Texas	Exempt	Exempt	Exempt
Utah	Taxable	Taxable	Taxable
Vermont	Exempt	Taxable	Exempt
Virginia	Exempt	Taxable	Exempt
Washington	*No Personal Income or Corporate Tax*		
West Virginia	Taxable	Taxable	Exempt
Wisconsin	Taxable	Taxable	Exempt
Wyoming	*No Personal Income or Corporate Tax*		

Figure 3.1: Ownership of Municipal Bonds



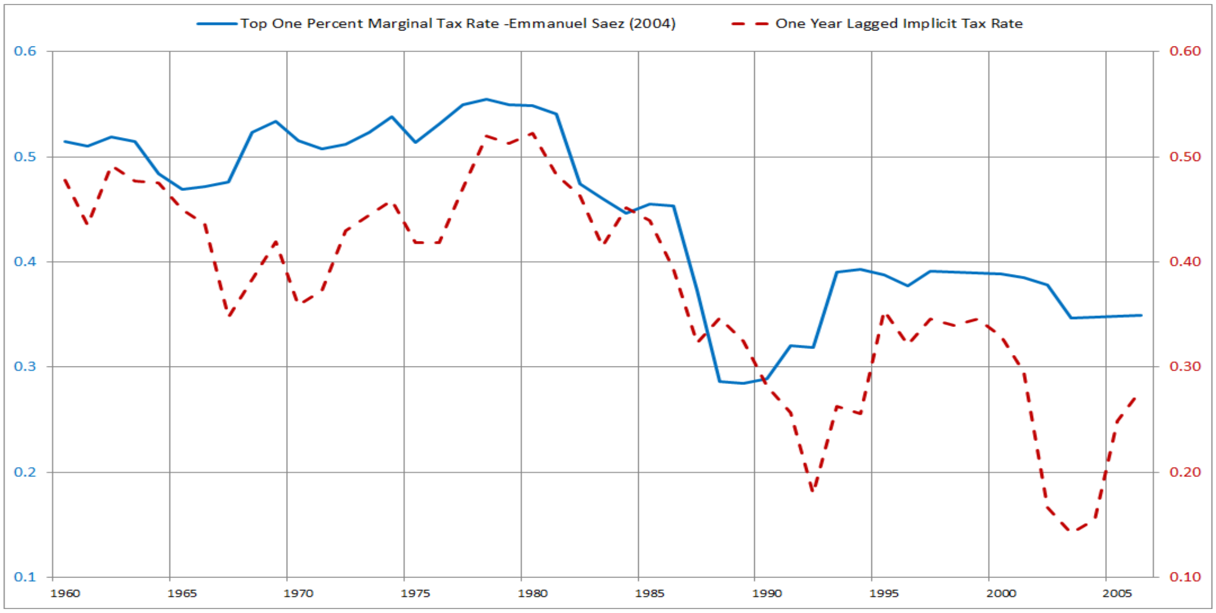
*Notes:*The figure plots the ownership of municipal bonds held by households, banks, and insurance companies. The data is collected from the Flow of Funds Accounts provided by the Board of Governors. The percentage of municipal bonds held by: (a) households includes direct and indirect ownership through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

Figure 3.2: Tax Rates



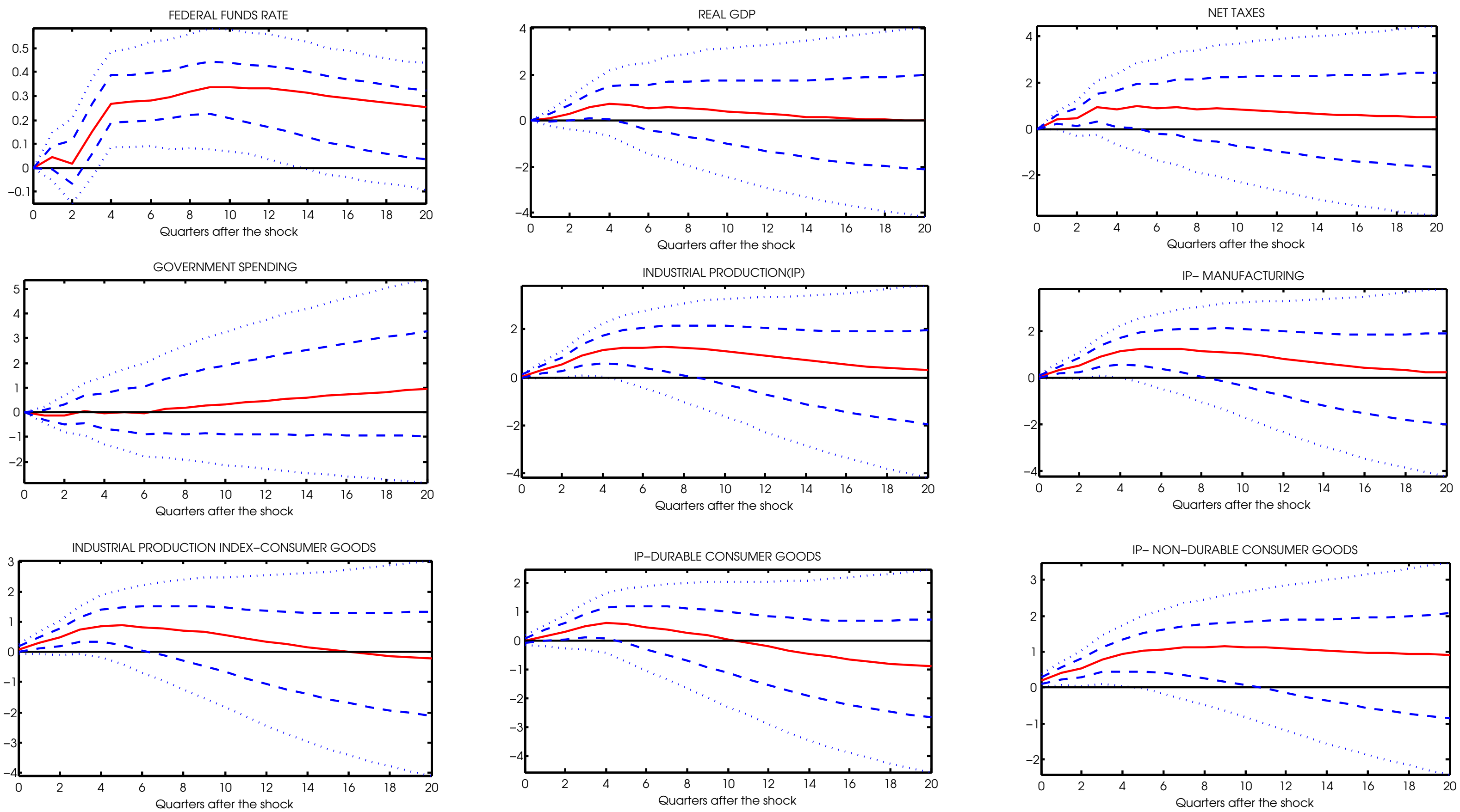
*Notes:*The figure plots the implicit tax rate and average marginal federal individual income tax rate for the United States. The solid line is the average marginal federal individual income tax rate (AMTR) taken from Barro-Redlick (2011). The dashed line is the one year lagged annualized implicit tax rate (ITR1Y) which is yield spread between the one year tax exempt municipal bond rate and 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).

Figure 3.3: Tax Rates



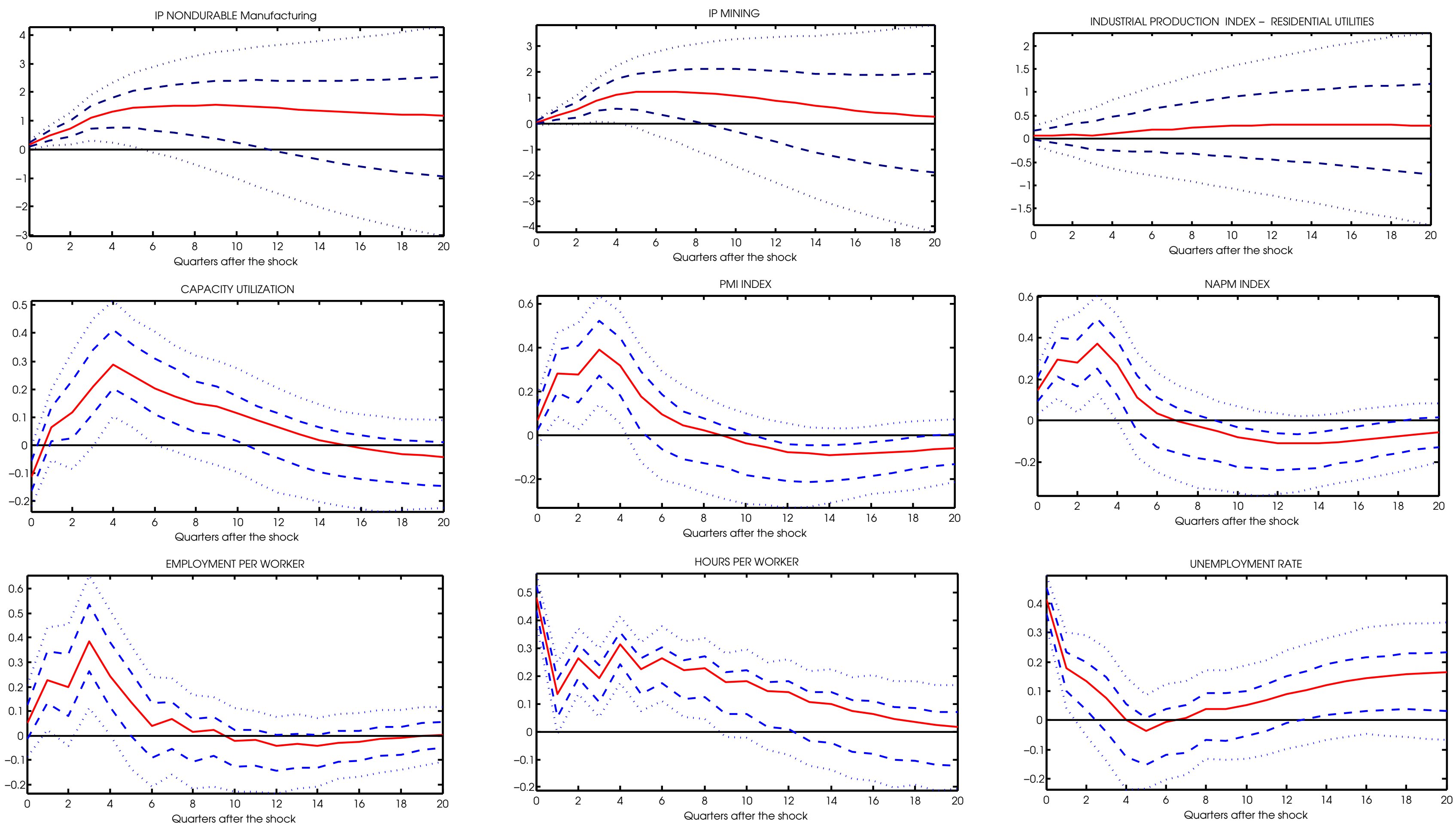
*Notes:*The figure plots the implicit tax rate and marginal tax rate of top one percent for the United States. The solid line is the top 1 % marginal tax rate taken from Saez (2004). The dashed line is the one year lagged implicit tax rate (ITR1Y) which is yield spread between the one year tax exempt municipal bond rate and 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).

Figure 3.4: Impulse Responses Generated from FAVAR with Three Factors- Tax News Shock



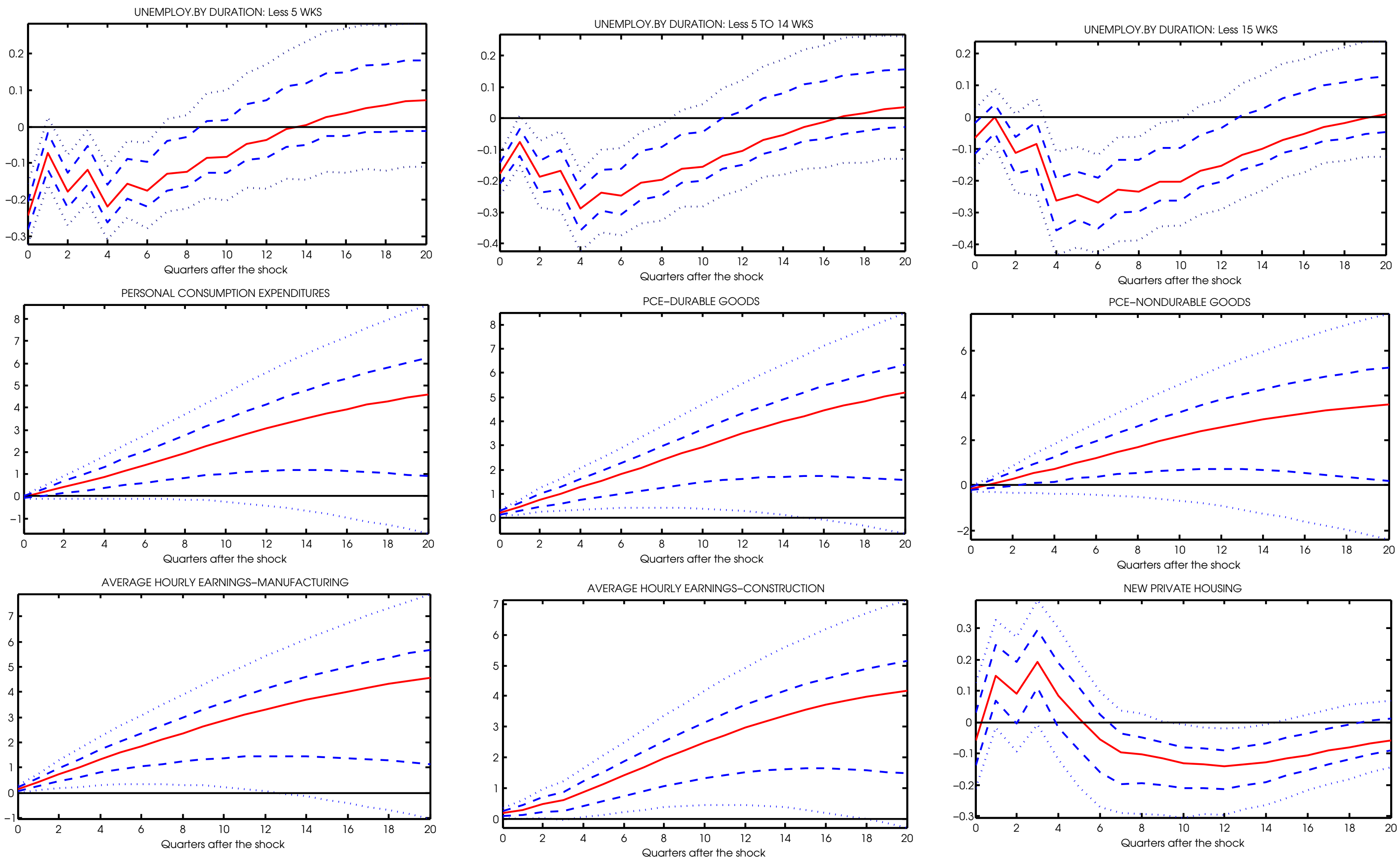
Notes: The figure shows the response of the aggregate variables to a one percentage point increase in the implicit tax rate. Full lines are point estimates; dashed and dotted lines indicate the 68 percent and 95 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian (2004)).

Figure 3.5: Impulse Responses Generated from FAVAR with Three Factors- Tax News Shock



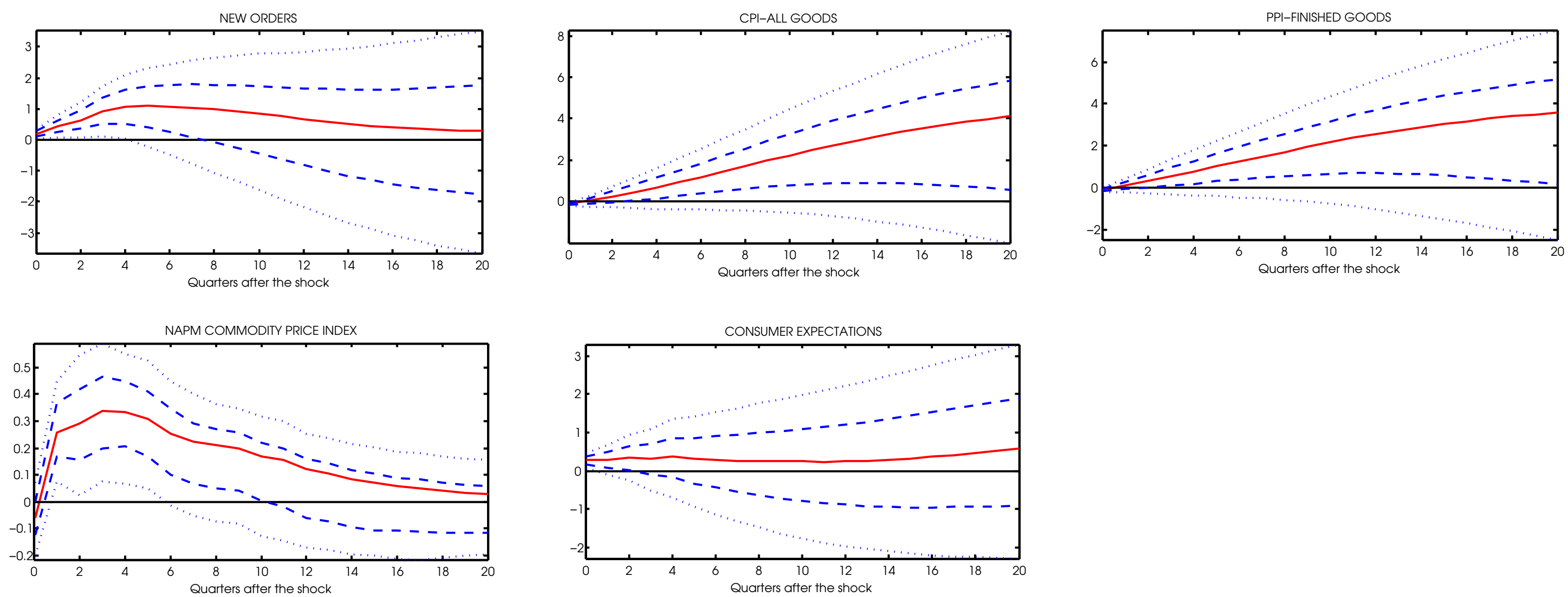
Notes: The figure shows the response of the aggregate variables to a one percentage point increase in the implicit tax rate. Full lines are point estimates; dashed and dotted lines indicate the 68 percent and 95 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian (2004)).

Figure 3.6: Impulse Responses Generated from FAVAR with Three Factors- Tax News Shock



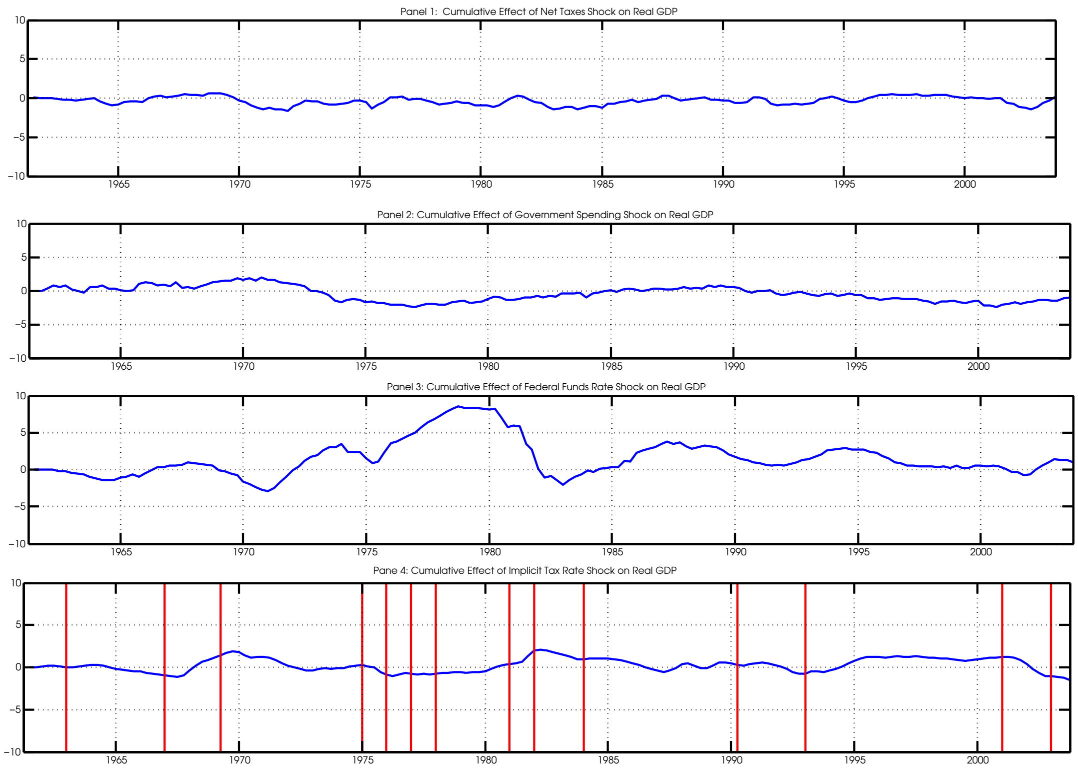
Notes: The figure shows the response of the aggregate variables to a one percentage point increase in the implicit tax rate. Full lines are point estimates; dashed and dotted lines indicate the 68 percent and 95 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian (2004)).

Figure 3.7: Impulse Responses Generated from FAVAR with Three Factors- Tax News Shock



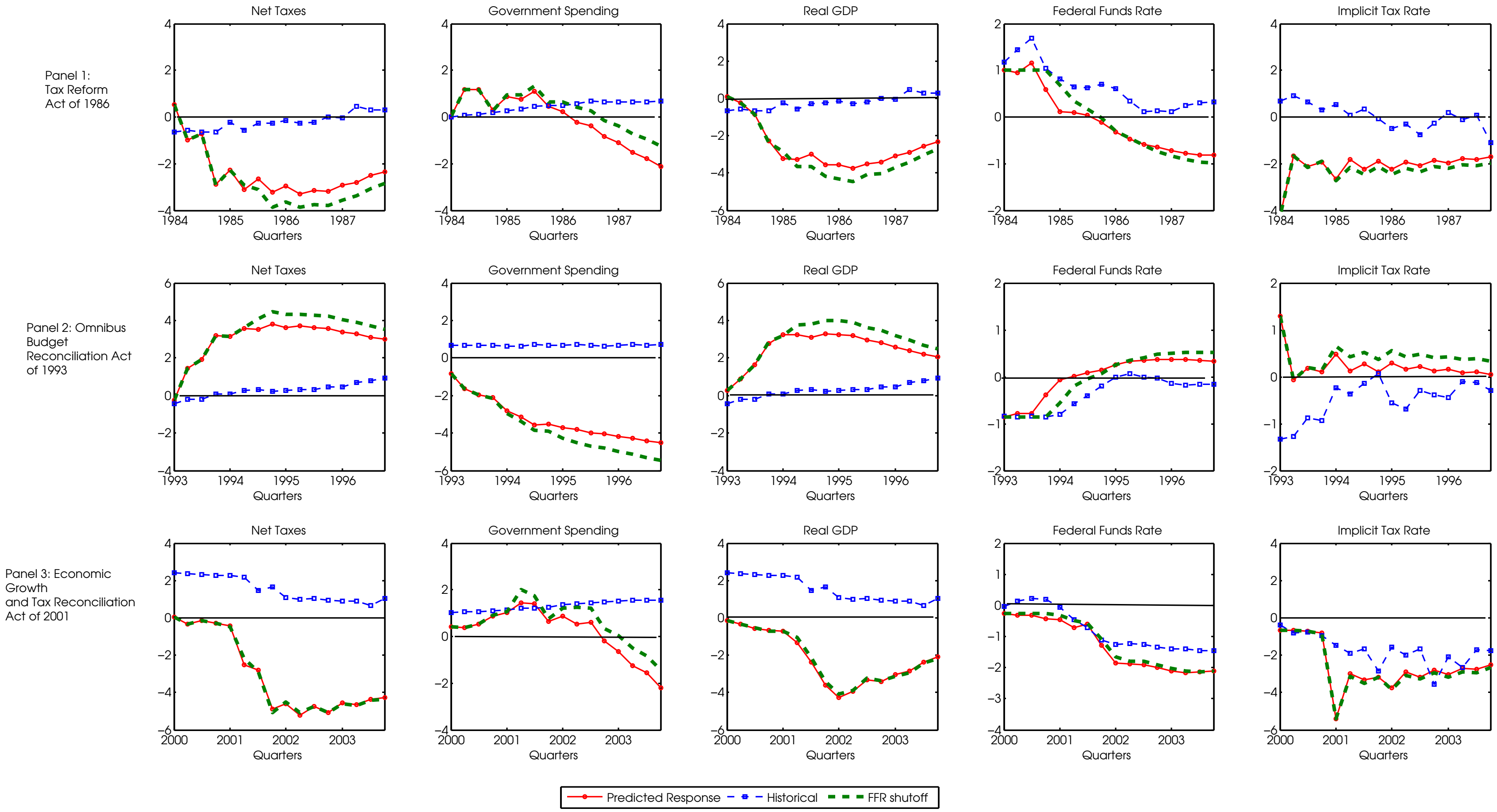
Notes: The figure shows the response of the aggregate variables to a one percentage point increase in the implicit tax rate. Full lines are point estimates; dashed and dotted lines indicate the 68 percent and 95 percent confidence intervals constructed using a recursive wild-bootstrap method with 10,000 replications (Goncalves and Kilian (2004)).

Figure 3.8: Historical Decomposition of Real GDP



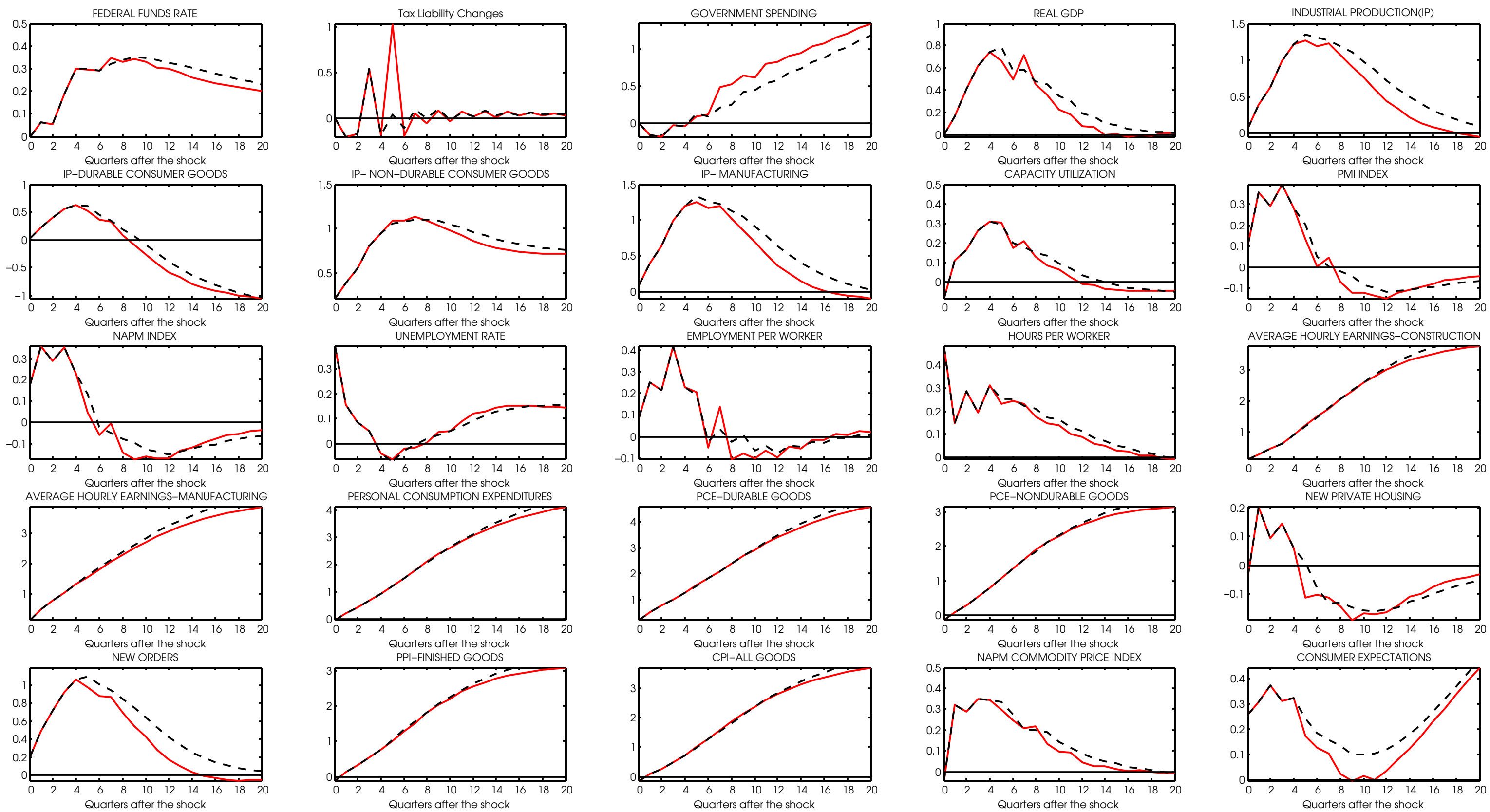
Notes: The vertical bars in panel 4 correspond to the announcement of tax policy changes in the United States. The estimates are derived from structural VAR representation from equation (5).

Figure 3.9: Simulation Exercises: Three Historical Tax News Shock



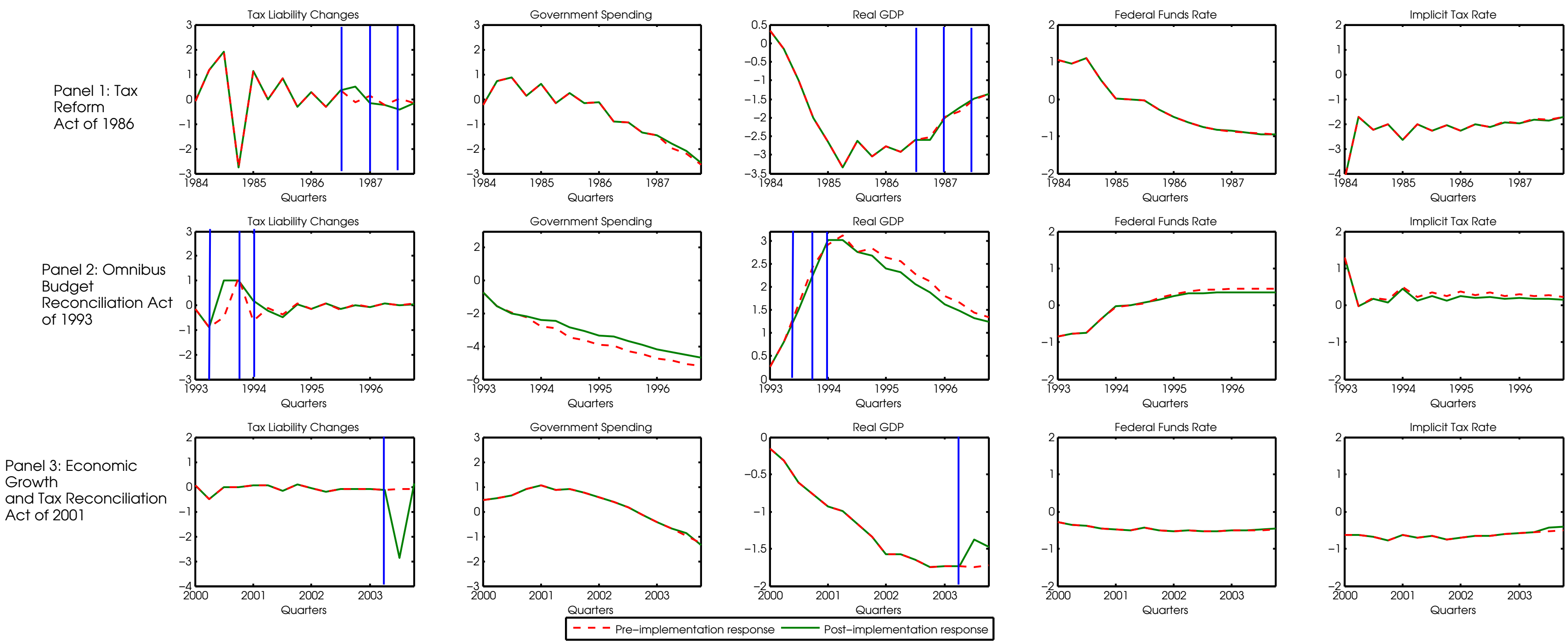
*Notes:*For each of three historical tax episodes, the graphs compare actual behavior of variables with the predicted response. The solid red line represents the predicted response calculated using VAR estimates. Dotted line represents the direct effect of implicit tax rate (shutting down the monetary policy). Dashed blue line represents the actual data. The vertical axis scaling is in levels and measured in percent.

Figure 3.10: Pre-Implementation and Post-Implementation Tax Effects



*Notes:*The figure shows the response of the aggregate variables to a one percentage point increase in the implicit tax rate. Solid lines are point estimates; indicate the responses to one point increase in implicit tax rate at time 0 i.e., $v_0^{\tau} = 1$ and subsequently to 1% increase in tax liabilities at time 4 i.e., $v_0^{tax} = 1$. Dashed lines are benchmark impulse responses to one percentage point increase in the implicit tax rate.

Figure 3.11: Pre-Implementation and Post-Implementation Effects across Three Tax Acts



Notes: For each of three historical tax episodes, the graphs compare actual behavior of variables with the predicted response. The solid green line represents the predicted response of output to tax news and implementation of tax policy changes. Dashed red lines represents the response of output to tax news shock. The vertical blue lines in each panel represents the implementation dates for tax policy changes.

4 Tax News in Recessions and Expansions

4.1 Introduction

Recent macroeconomic literature has shifted its focus from explaining the economic fluctuations through contemporaneous shocks to news shocks. While early studies have focused on news shocks that are driven by future technology or productivity shocks and their impact on the economy[32], there is a recent surge in studying the role of news about future government spending or tax changes and their impact on the economy (see Blanchard and Perotti (2002); Mountford and Uhlig (2009); Ramey (2011); Leeper et al. (2012)). The main idea is that economic agents anticipate future changes in government spending or tax changes and adjust their behavior accordingly (see e.g. Yang (2005), Leeper et al. (2013), Kueng (2014) and Mertens and Ravn (2012)). In this chapter, I investigate whether tax news shocks exhibit a differential impact during recessions and expansions.

A large set of empirical macro literature that evaluates the effect of tax policy changes on the economy generally follows a linear structural vector autoregression (VAR) model. While a linear model has numerous advantages (e.g., ease of computation and inference), it imposes the restriction that the economy's response to tax news shocks is identical during different phases of the business cycle[33]. To overcome this drawback, this chapter analyzes the role of news about future tax policy, in particular anticipation of future tax cuts, on the economy in both a linear and a nonlinear framework. In addition, I investigate whether the news about future tax cuts has a different effect depending on the state of the economy. For this purpose, I employ the Jorda (2005) local projection method that allows for state dependence.

[32] see Cochrane (1994), Beaudry and Portier (2006), and Lorenzoni (2011)

[33] see Parker (2011) for discussion on measuring fiscal policy effects during recessions.

To investigate the effect of news shock conditioning on business cycle dynamics, I need to identify news about future taxes, and measure slackness in the economy so as to differentiate boom and bust periods. I follow the lead of Leeper et al. (2013) to identify news about future taxes. That is, I use 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. The yield spread is known as the implicit tax rate.

Regarding the measure of slack, I follow Ramey and Zubairy's (2015) suggestion to use the unemployment rate as a measure of slack. More specifically, the economy is considered to be in a recession phase when the unemployment rate is above a threshold value and in an expansion phase when the unemployment rate is below a threshold value. The threshold value is set to be 6.5%. Figure 4.1 plots the real GDP growth rate over the sample period. The shaded regions indicate when the unemployment rate is above the threshold value (i.e., 6.5%) and the vertical lines indicate the tax events that are motivated to stimulate the economy or fight recession.[34] I find that during much of the 1970's period, tax changes are used as a discretionary countercyclical policy to counteract poor economic conditions [35] Note that the Revenue Act of 1964, the Revenue Act of 1971, the Tax Reduction Act of 1975, the Tax Reform Act of 1976, and the Tax Reduction and Simplification Act of 1977 were mainly used to confront the recessions and tax cuts were introduced to promote economic growth (Romer and Romer, 2010; Yang, 2007). There were no countercyclical tax policy changes in the1990's. However, I find that phased in tax policy of the Economic Growth and Tax Relief Reconciliation Act of 2001 and the Job Growth and Tax Relief Reconciliation Act of 2003 were used to stimulate the economy following the recession in 2001. As is evident from the above figure, real GDP

[34] The details about each countercyclical tax law, enactment dates and its provisions during the period 1960-2005 are obtained from the Library of Congress, Yang (2007), and Romer and Romer (2010).

[35] see Romer and Romer (2010) for detailed description on post war legislated tax changes. They classify the legislated tax changes as exogenous and endogenous by looking at the motivation of the tax policy. They define endogenous tax changes as those that are motivated to bring output growth to normal. Further, they label the endogenous tax changes that are not related to spending changes as countercyclical tax changes.

predominantly moves upward followed by a realization of tax cuts in the sample.

Figure 4.2 shows the implicit tax rate, log of real per capita tax revenues, and unemployment rate. In the top panel, I plot the implicit tax rate along with shaded regions indicating the time between the initial tax policy proposal and its enactment. As is evident from this figure, the path of the implicit tax rate is followed by the signaling of initial tax policy proposal by the U.S President to the Congress. Recent work by Kueng (2014), and Leeper et al. (2013) has documented the empirical relationship between the implicit tax rate and expected future tax rates. Table 2.1 shows the empirical relationship between the implicit tax rate and actual tax rates. The results from Table 2.1 conclude that lags of the implicit tax rate have predictive content for the average marginal tax rate, and the top one percent marginal tax rate. Their empirical evidence therefore suggests that the implicit tax rate predicts future tax rate changes.

The middle panel shows the logarithm of real per capita net tax revenues along with tax cuts realization dates. The vertical lines show the tax cuts that were implemented to confront recessions. There were a total of 9 tax events in the sample motivated to stimulate the economy. It is clear from the above graph that the Tax Reduction Act of 1975 has caused the largest tax revenue changes in the sample. The bottom panel shows the unemployment series for the sample period and the unemployment rate reached its peak value of 10.1 percent in 1983:IV. Also, the rise in the unemployment rate to 9 percent in May 1975 caused President Ford to announce a large tax rebate to stimulate the economy (Romer and Romer, 2010; Yang, 2007).

This chapter contributes to the previous literature in several ways. First, I depart from using standard VAR models to use a local projection technique to estimate the effects of news shock on the economy. Second, I compute the impulse responses to tax news shocks conditioning on business cycle dynamics (i.e. in boom and bust periods separately). I find that news about future tax cuts has a contractionary effect on the economy for about four quarters. The behavior of output and investment following tax news shocks is similar in both high unemployment and low unemployment states of the economy. Additionally, the state dependent model shows that news shocks have a stronger positive impact on consumption expenditures and residential investment in the recession phase than in the expansion phase.

This chapter is organized as follows. Section 4.2 discusses the data and econometric methodology. In section 4.3, I present the baseline estimates of the local projection method. First, I present the results from a linear model, where the coefficients do not vary with the state of the economy. Second, I present results from a nonlinear framework in which estimates vary according to the slack in the economy. Section 4.4 concludes.

4.2 Data and Methodology

4.2.1 Data

I follow Leeper et al. (2012) to measure tax news. I use the yield spread between one year municipal bond and one -year Treasury bill to capture the foresight regarding future tax changes. The tax rate derived from the yield spread is called the implicit tax rate. More specifically, the implicit tax rate is constructed 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. I follow Blanchard and Perotti (2002) to measure the government spending and net tax revenues. The data for real GDP, net tax revenues, government spending, and GDP components are obtained from the National Income and Product Accounts (NIPA)-Bureau of Economic Analysis (BEA). I compute real per-capita measures of GDP (y_t) and its components, net tax revenues (T_t), and government spending (G_t) deflating with GDP deflator and dividing by the U.S. civilian non-institutional population ages over 16 years and older. The data for the civilian unemployment rate series is obtained from the Federal

Reserve Bank of St. Louis FRED database. I use quarterly data from 1956Q1 to 2006Q4 yielding a total of 200 observations.

4.2.2 Methodology

I follow the Jorda (2005) local projection method to compute the impulse responses to tax news shock. The advantage of using this single equation local projection method is that it does not impose any dynamic restrictions on the macro variables and it allows us to include nonlinearities in the response function.[36] The linear model can be written as follows:

$$\frac{x_{t+h} - x_{t-1}}{y_{t-1}} = \alpha_h + \delta_h t + \gamma_h t^2 + \Phi_h(L) z_{t-1} + \beta_h \, \tau_t^I + \epsilon_{t+h} \tag{4.1}$$

x_t is our variable of interest, z_t consists of lags of log of real per capita net tax revenues, log of real per capita government spending, log of real per-capita GDP, and the implicit tax rate(τ_t^I). $\Phi_h(L)$ is polynomial of order 4. The estimated coefficient β_h gives the impulse response of x_{t+h} at horizon h to a shock to τ_t^I as suggested by Jorda (2005). More specifically, I estimate a series of regressions for our variable of interest x_{t+h} (i.e.,for each horizon h = 0,1, 2, 3....H) on implicit tax rate (τ_t^I) in period t, as well as four lags of logarithm of real per capita tax revenues, real per capita government spending, real per capita GDP and the implicit tax rate to extract impulse response as a sequence of β_h to news shock. For example, if the variable of interest x_t is real per capita GDP (y_t), then equation (1) reduces to the following form [37] :

$$\frac{y_{t+h} - y_{t-1}}{y_{t-1}} = \alpha_h + \delta_h t + \gamma_h t^2 + \Phi_h(L) z_{t-1} + \beta_h \, \tau_t^I + \epsilon_{t+h} \tag{4.2}$$

Moreover, I obtain the impulse responses for six variables (i.e., components of GDP). These include real per-capita personal consumption expenditures, real per-capita durable

[36] I build this empirical model based on Auerbach and Gorodnichenko (2012) and Ramey and Zubairy (2014).

[37] I follow Hall (2009) and Ramey and Zubairy (2014). to write the variables on the left hand side of equation (4.1), equation (4.2), and equation (4.3) relative to lag of real per capita GDP (y_{t-1})

goods spending, real per-capita non-durable goods spending, real aggregate gross private sector investment, real per-capita residential investment, and real per-capita non-residential investment. I rotate the six variables in x_t and include the corresponding lags in z_{t-1}, one at a time. One advantage of using the Jorda (2005) method is that the control variables are not necessarily required to be the same for each regression (Ramey and Zubairy, 2014).

To investigate whether the tax news shocks exhibit a differential impact during recessions and expansions, I follow the approach taken by Ramey and Zubairy (2014) to modify the above linear model (1) to a state-dependent model. The nonlinear model can be written in a single equation as following:

$$\begin{aligned} \frac{x_{t+h} - x_{t-1}}{y_{t-1}} &= d_{t-1}[\alpha_{R,h} + \Phi_{R,h}(L) z_{t-1} + \beta_{R,h}\, \tau_t^I] + \\ &\quad + (1 - d_{t-1})[\alpha_{E,i} + \Phi_{E,h}(L) z_{t-1} + \beta_{E,h}\, \tau_t^I] + \epsilon_{t+h} \end{aligned} \tag{4.3}$$

As discussed above, x_{t+h} is the variable of interest, y_{t-1} is the lag of output, z_{t-1} consists of control variables, and d is the dummy variable that takes the value of one or zero. The variable d is equal to one when the civilian unemployment rate (U_t) is above the threshold value (c) and zero when the civilian unemployment rate (U_t) is below the threshold value (c). I follow Ramey and Zubairy (2014) criteria to choose the threshold value (c) as 6.5 $\%$ percent in the baseline model. All the coefficient estimates except the constant, linear trend, and quadratic trend terms vary depending on the state of the economy. I label the coefficient estimates with recession state ('R') when $U_t > c$ and expansion state ('E') when $U_t < c$. The impulse responses are constructed for the high unemployment state using the coefficient estimates $\beta_{R,i}$ and the low unemployment state using the coefficient estimates $\beta_{E,i}$.

4.3 Empirical Results

This section discusses the effect of one percentage point decrease in the implicit tax rate-hereafter news about future tax cuts. I focus on the response of real aggregate per capita GDP and real per-capita tax revenues and components of GDP. The 95 percent confidence intervals for the impulse responses are computed based on Newey-West standard errors that correct for the serial correlation. The impulse responses are shown for a horizon of 20 quarters after the shocks. First, I present the impulse responses estimated using the linear model shown in equation (4.1). Second, I examine the impact of news shocks on macroeconomic variables using the nonlinear model represented in equation (4.3).

4.3.1 Linear Model

Figure 4.3 illustrates the benchmark results in a linear framework. The linear model assumes that the point estimates do not vary based on the state of the business cycle. The left panel of Figure 4.3 shows that anticipation of future tax cuts has a negative effect on output in the short run. Notice that tax news shock is persistent for the entire horizon. The effect on output is consistently negative for the entire horizon and significant for about eight quarters. The decline in output occurs gradually over time with the peak decline being reached four quarters after the shock. The maximum effect is a fall in real GDP per capita of -0.118 percent after four quarters (t-stat = -4.0893). Thereafter, output remains below the trend for an extended time period. The right panel of Figure 4.3 shows the path of real per-capita net tax revenues to news shock. Tax revenues fall initially then rises after 5 quarters. The response becomes statistically insignificant after 9 quarters to news shock.

Thus, I find that output responds to current and lagged values of news about future tax cuts, which can be interpreted as an evidence of anticipation effects. The results are in agreement with previous studies in this literature. For example, Mertens and Ravn (2012) show a very strong evidence of anticipation effects to tax cuts, with output declining to 1.5

percent four quarters after the shock. The key difference in their model and the one in this paper is that Mertens and Ravn (2012) control for anticipation horizon; this paper uses the implicit tax rate which does not require setting the period of foresight a priori. Mertens and Ravn (2012) suggest that the response of output is sensitive to length of foresight and conclude that the longer the anticipation horizon the stronger the anticipation effect on the economy. My estimation results are important as they help in understanding the impact of tax news shocks on the economy, when the length of the foresight is unconstrained.

Overall, the evidence of a contractionary effect on output to news shocks indicate that forward looking individuals and firms postpone their production decisions until the tax cuts are actually realized. The anticipation effect is pronounced for four quarters. This effect diminishes gradually and output starts to rise eventually. However, it remains below the trend line for the entire forecast horizon. The response of output suggests that tax cuts that result in large anticipation effects may not be a good countercyclical policy tool. This result is in line with the results of House and Shapiro (2006) and Yang (2005). The theoretical model constructed by House and Shapiro (2006) show that phased in tax cuts enacted in the 2001 Economic Growth and Tax Relief Reconciliation Act lead the economy to contract and resulted in a slower recovery from the 2001 recession.

Further, I examine the response of the GDP components such as personal consumption expenditures, durable goods purchases, nondurable goods purchases, gross private domestic investment, residential investment, and nonresidential investment to news about future tax cuts. Figure 4.4 shows that personal consumption expenditures decline in response to news shocks. The effect of a tax news shock on the personal consumption expenditures and nondurable consumption expenditures is very mild and significant only for three quarters. The response of durable good purchases is not statistically different from zero. According to the Permanent-Income Hypothesis (PIH) theory, households increase the consumption based on long term resources and in the absence of cash or credit constraints, the consumption spending increases to news about tax cuts. In contrast to PIH theory, aggregate consumption responds negatively to news shock and shows no evidence of anticipation effects. The lack of an anticipation effect on consumption is in line with results of Poterba (1989), Reis (2006), and Mertens and Ravn (2012). They suggest that households facing liquidity constraints or some decision costs will find it difficult to adjust their consumption to tax news shocks. In addition, empirical work by Kueng (2014) finds that liquidity constraints do affect the response of nondurable goods consumption to tax news shocks. More specifically, low income households facing liquidity constraint show a weaker response to news shocks. These results suggest that aggregate consumption expenditures and its components react very sluggishly to news shocks.

The bottom panel of Figure 4.4 shows the response of gross private investment, residential investment, and nonresidential investment. The responses of investment and its components are negative and stay below their initial levels after news shocks. Gross private domestic investment declines for about four quarters and then rises for the remaining horizon. The decline in investment and its components to a news shock is due to the forward looking nature of the firms and individuals, which provides an incentive to postpone investment decisions. All in all, the estimates of output, gross private domestic investment, residential, and nonresidential investment in a linear model provide evidence of anticipation effects on the economy.

4.3.2 Nonlinear Model

I now investigate whether the response of output and its components varies with the state of the economy. I estimate the state-dependent model represented in equation 3 to compute the impulse responses for real per capita GDP, real per-capita net tax revenues, and GDP components. The impulse response functions are derived from the estimated coefficient $\beta_{R,h}$ and $\beta_{E,h}$ for real GDP, net tax revenues, and GDP components in equation

4.3. Figure 4.5 illustrates the output response to anticipation about future tax cuts in both recessionary and expansionary phases of the economy. Output declines in the first four quarters and then starts to rise for the remaining time horizon. The effect of news shocks on output is significant for four quarters in the recession phase, whereas the anticipation effect is significant for six quarters in the expansion phase. In addition, the response of output in the recessionary phase diverges from the response in the expansion period by rising steadily and reaching 0.2 percent after 20 quarters. In contrast, the response of output in the expansionary phase consistently remains below zero and never becomes positive. The left panel of Figure 4.5 shows that on the one hand anticipation of a future tax cut shock is more persistent in the long run for the recessionary phase, and on the other hand, it shows a stronger effect on output in the short run in the expansionary phase of the economy. The response of tax revenues follows a similar path to output and declines with a fall in real GDP.

Just as we saw when the response of output differs according to the regime in which a news shock hits the economy, the response of components of GDP to news shocks also diverge depending upon the state of the economy. Figure 4.6 shows that consumption expenditures drop on impact in the recession phase and then rise immediately. Thereafter, they remain positive for the entire horizon. However, the response of consumption expenditures in the expansion phase remains below the initial level and is statistically insignificant. The response of durable and nondurable good purchases in the recession phase of the economy shows a similar shape to that of consumption expenditures and is significant for multiple quarters. Overall, the responses show a strong and persistent effect of news shocks in the recession phase. The rise in consumption indicates that the wealth effect dominates the substitution effect. Surprisingly, the response of consumption expenditures in the recessionary phase is very different to that of the response estimated in the linear model. This indicates that the response of consumption expenditures to news shocks is not appropriately characterized by the linear model.

The bottom panel of Figure 4.6 shows the estimated responses of gross private domestic investment, residential, and nonresidential investment. The impact on gross private domestic investment is uniform across the two states of the economy for about four quarters. The response of private investment declines for about four quarters and then increases for the remaining time horizon in the recessionary phase. Much of this decline in gross private domestic investment is driven by the non-residential investment as can be seen from the above figure. Surprisingly, the residential investment response increases and remains positive in the recessionary phase. The response of residential investment in the expansion is similar to that of private investment. Overall, the news about future tax cuts has a strong impact on gross private and non-residential investment in the short run. The results presented here are consistent with a larger literature. For example, studies by Parker (2011), and House and Shapiro (2006) analyze the impact of tax changes on output and the components of GDP in the recession state of the economy. My results suggest that households experience stronger wealth effects in response to news shocks during recessions than in expansions.

In summary, the results suggest that anticipation about future tax cuts reduces economic activity for about four quarters. However, the response of aggregate GDP, and components of investment rebound to their mean after four quarters. The rebound effect is much stronger in the recessionary phase of the economy. In addition, the results suggest that countercyclical tax news shocks shows a stronger positive wealth effect on personal consumption expenditures in the recessionary phase than in the expansionary phase.

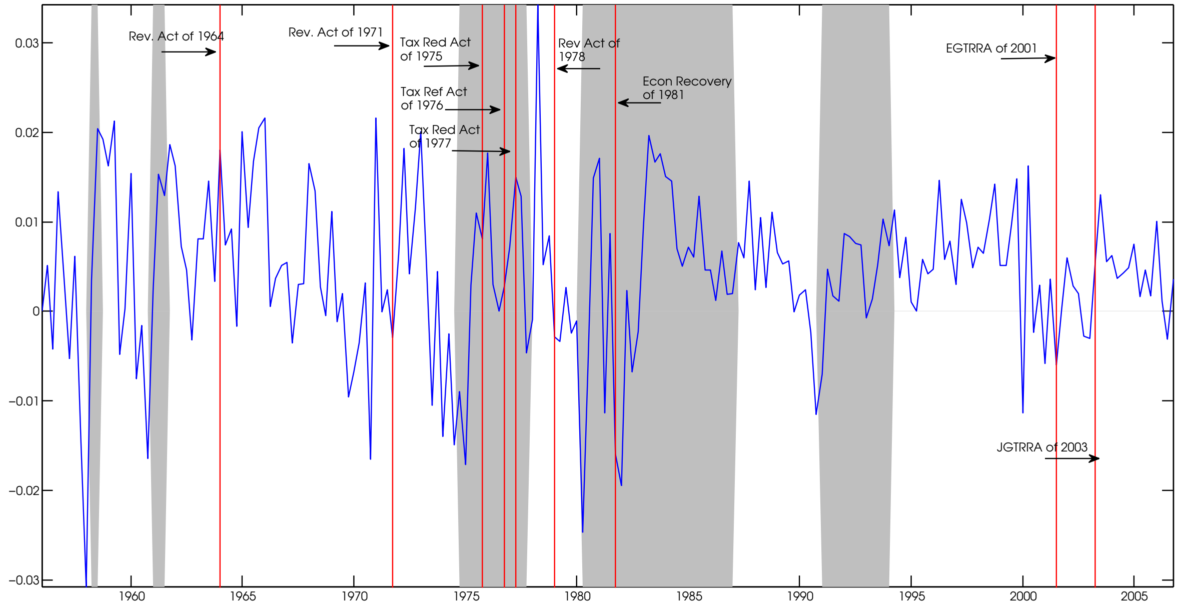
4.4 Conclusions

In this chapter, I analyze the impact of anticipation of future tax cuts on the economy using the local projection model developed by Jorda (2005). The non-linearities are constructed using a single equation state dependent regression model, where the business cycle dynamics are defined by the unemployment rate. I follow Ramey and Zubairy (2014) and use the unemployment rate to measure the slackness in the economy. I use 6.5% as threshold value to define the slackness in the economy.

I find that anticipation of future tax cuts has a negative effect on output for four quarters in both linear and nonlinear models. While this result is consistent with previous literature, my approach generates markedly different results in expansion and recession phases for consumption, durable goods purchases, nondurable good purchases and nonresidential investment. These variables show a strong positive response to news shock in recession time. Additionally, I find that output and gross private domestic investment show stronger rebound effects in a recession phase than in an expansion phase.

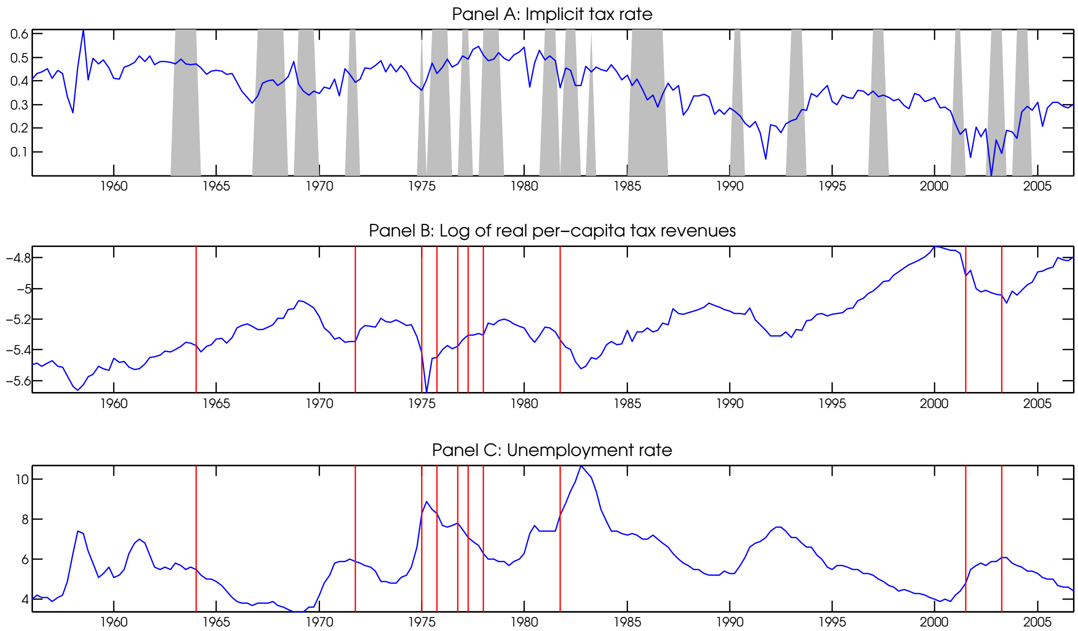
Finally, it would be interesting to compare the results presented here to that of impulse responses computed using traditional VAR model. A recent paper by Kilian and Kim (2011) compares the finite sample performance of impulse response functions computed using Jorda ‘s local projection method and the usual VAR models. They conclude that with a low sample size, the local projection method confidence intervals are less accurate than the bias adjusted- bootstrapped VAR models. Also, it would be interesting to extend this model to estimate news shocks on the economy in good and bad times controlling for monetary, or anticipated productivity shocks.

Figure 4.1: Chronological Tax events motivated by stimulating the U.S. economy



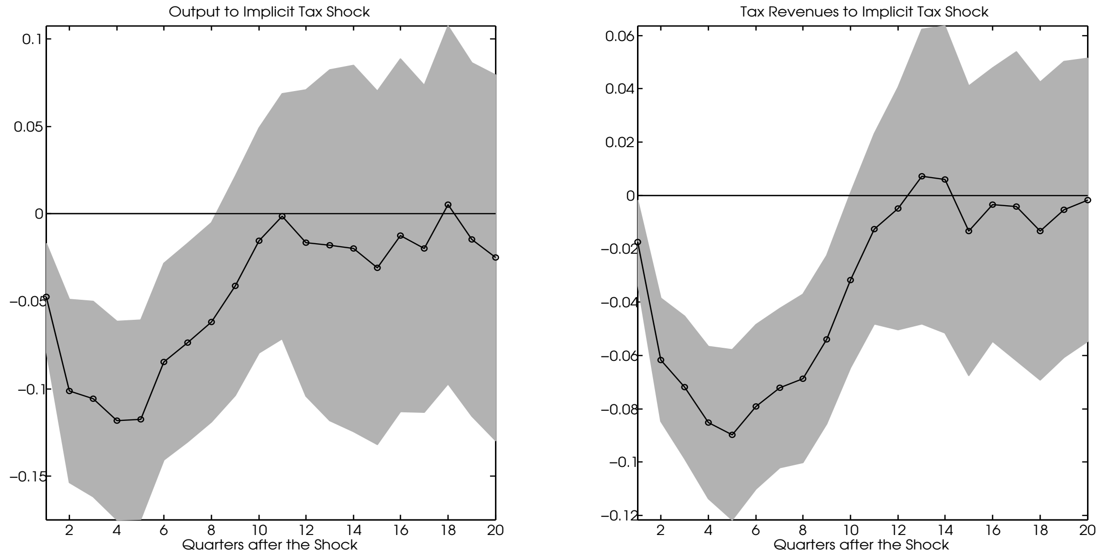
Notes: The figure plots the real per-capita GDP growth rate. The shaded regions reflect the time periods when the unemployment rate is above the threshold value. The vertical line shows the tax events that are motivated to stimulate the economy.

Figure 4.2: Implicit Tax Rate, Tax Revenues, and Unemployment Rate



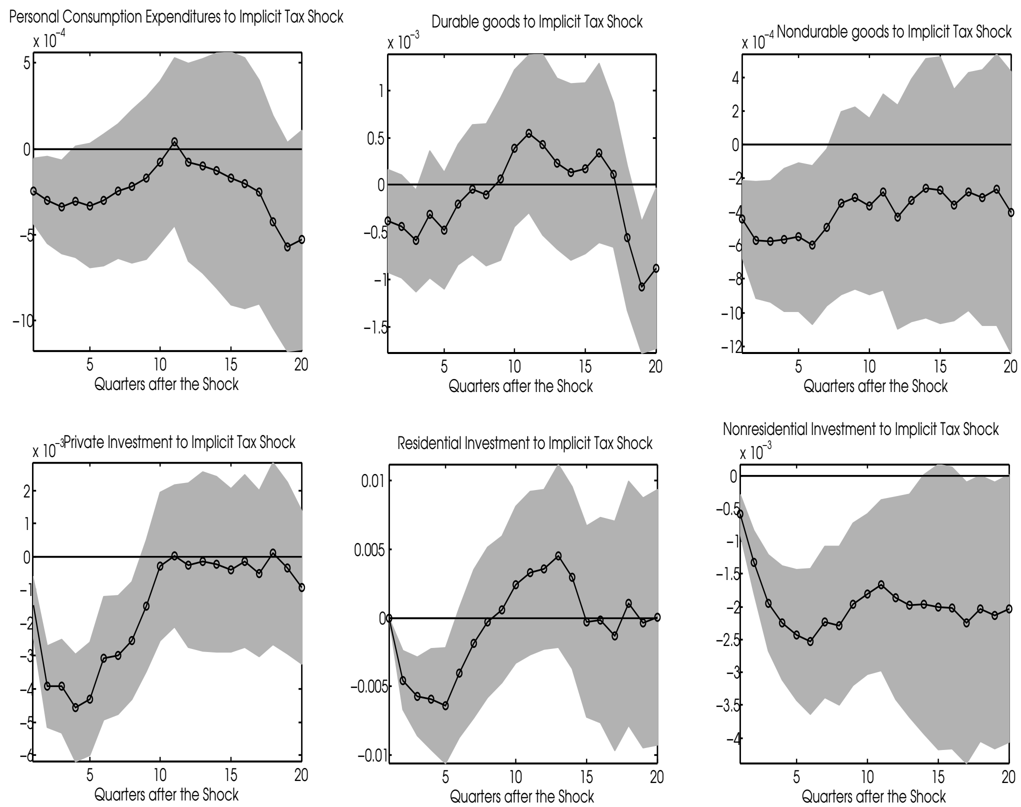
Notes: The figure plots the implicit tax rate, log of real per capita net tax revenues, and unemployment rate. The shaded regions correspond to legislative lags that are documented by Yang (2007). The vertical lines in Panels B and Panel C shows the realized tax cuts dates.

Figure 4.3: Response of GDP and Tax Revenues to Tax News Shock, Linear Model



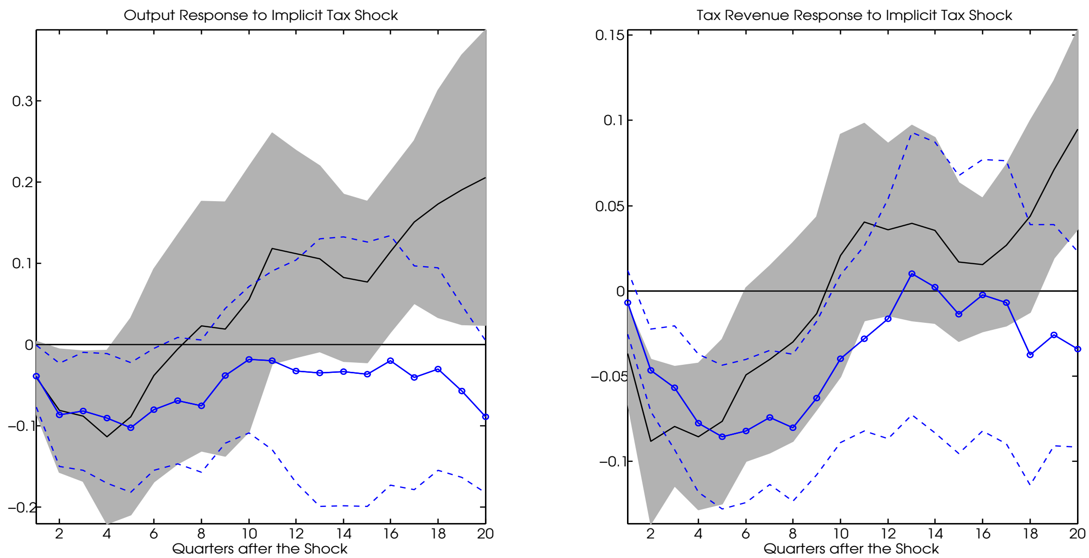
Notes: Solid lines show the point estimates and gray shaded areas are 95 percent confidence intervals.

Figure 4.4: Response of GDP Components to Tax News Shock, Linear Model



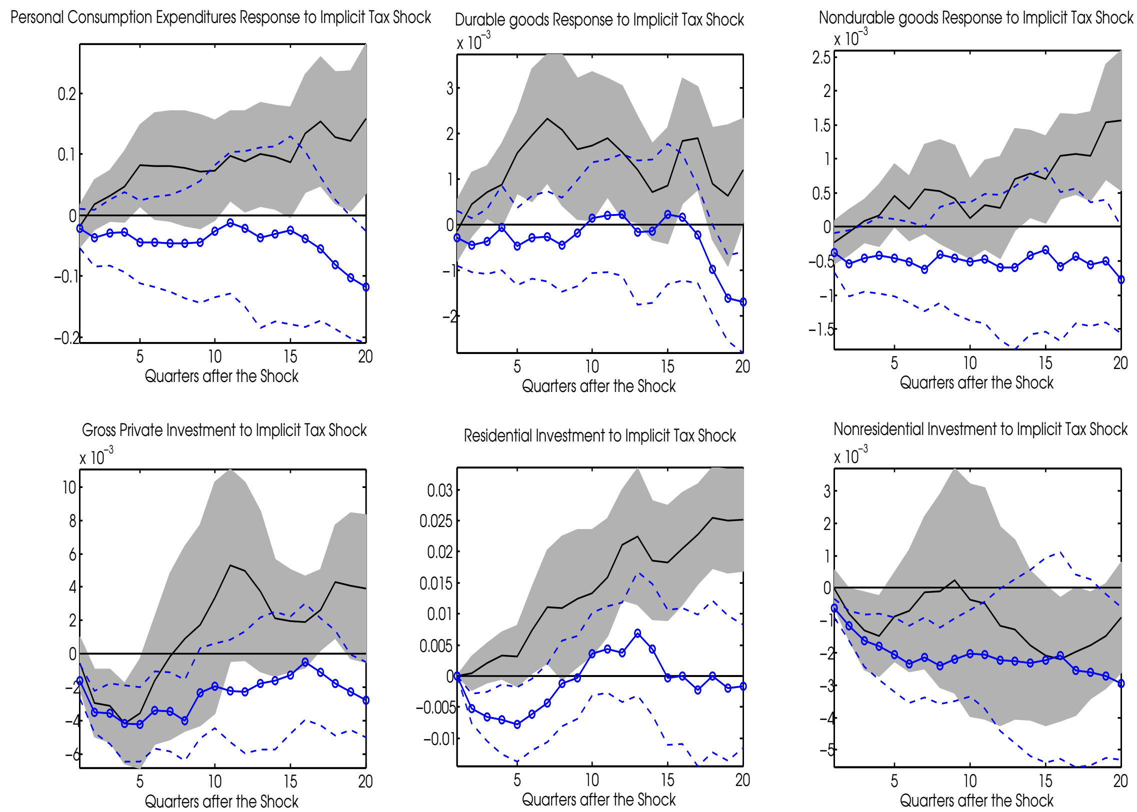
Notes: Solid lines show the point estimates and gray shaded areas are 95 percent confidence intervals.

Figure 4.5: Response of GDP and Tax Revenues to Tax News Shock, Non-Linear Model



Notes: Solid black lines are the point estimates of GDP and tax revenues in the high unemployment state and a blue line with circles are point estimates in the low unemployment state. Gray shaded areas and dashed lines are 95 percent confidence intervals.

Figure 4.6: Response of GDP Components to Tax News Shock, Non-Linear Model



Notes: Solid black lines are the point estimates of GDP components in the high unemployment state and a blue line with circles are point estimates in the low unemployment state. Gray shaded areas and dashed lines are 95 percent confidence intervals.

5 Conclusion

Tax policy changes are well known to public in advance of their implementation. These policy changes may affect the economy prior to their actual implementation. Given the relevance of tax foresight and the lack of consensus among researchers in explaining the macroeconomic effects of news about tax changes, a fundamental question that arises is: Does tax news stimulate or depress economic activity? To address this question, one needs to identify tax news shocks. Here tax news is identified as an unexpected innovation in the implicit tax rate, measured by the yield spread between the one year tax-exempt municipal bond and the one year taxable Treasury bond. In the first two chapters, I have investigated the impact of tax news shocks on the U.S. economy, using a factor augmented vector regression model. While, the third chapter estimates the effect of anticipated tax cuts on the economy conditioning on business cycle dynamics.

The results from three chapters contribute to the discussion regarding the economic effects of anticipated and unanticipated tax changes and whether anticipatory effects are empirically relevant. This dissertation provides evidence of anticipation effects and does make an effort to understand the mechanism through which tax news shocks impact the economy. The first chapter shows whether tax news related to federal income taxes depress or stimulate state-level economic activity. I find that tax news - measured as a 1 percentage point increase in the implicit tax rate- resulted not only on larger GDP growth, but also increased personal income and employment growth across most states. States exhibit a similar hump shaped response but the timing and magnitude of the effect varied greatly across the states.

Further, I investigate which state-level characteristics explain the differences in the responses of economic activity to tax foresight. The results point to the importance of three mechanisms in the transmission of tax news at the state-level. First, as posited by a number of studies, tax news appear to have a larger effect in economies with a larger percentage of highly educated individuals most likely high earners and savers who have the ability to re-optimize by changing their employment and investment decisions. Second, differences in industry composition play a important role in how responsive personal income and employment are to tax news. Third, the larger the tax burden faced in an economy the greater the response of economic activity to tax news.

The second chapter focuses on understanding the propagation mechanism of tax news at national level. I study the impact of tax news on disaggregate measures of industrial production, employment per-worker, hours worked per worker, short term and long term unemployment rates, capacity utilization rate, purchasing manager index, housing starts, price level, and financial variables. I find that a positive shock to the implicit tax rate leads to large, persistent and positive effects on real economic activity. Overall, the results suggest that that news regarding an increase in future tax rates gives an incentive for firms and workers to switch the production over to the anticipation period where taxes are expected to be lower. I also show that tax news associated with legislations in 1986, 1993, and 2001 contributed to the fluctuations in real GDP.

The counterfactual analysis of the pre-and post-implementation shocks show that news of a tax increase results in an expansion. Yet, once the tax increase is actually implemented, the expansionary effect is tappered. Furthermore, simulations for three key historical tax episodes suggest that it is crucial to account for policy foresight in order to get a better grasp of the true effects of a change in tax policy.

Finally, the third chapter contributes to the empirical wok by allowing state dependence to measure the effect of tax news shocks on the economy. The impulse responses are computed to tax news shocks conditioning on business cycle dynamics (i.e., in boom and bust periods separately). The results indicate that news about future tax cuts has a contractionary effect on the economy for about four quarters. I also show that the response of consumption expenditures, durable goods purchases, nondurable good purchases and nonresidential investment is different in the recessionary phase to that in the expansionary phase of the economy. In light of these results, the dynamic effects estimated in the first two chapters should be interpreted as the estimated effect over periods of expansions and recessions.

A Appendix

A.1 Chapter 2 Appendix

Table A1.1: Data definitions and sources used in the FAVAR

Variable	Frequency	Description	Source and Construction
r_t^M	Quarterly	Yield on municipal bonds (1 year)	Leeper, Richter and Walker (2012)
r_t^T	Quarterly	Yield on Treasury bonds (1 year)	Leeper, Richter and Walker (2012)
τ_t	Quarterly	Implicit tax rate (1 year)	$1 - \frac{r_t^M}{r_t^T}$
GCE	Quarterly	Federal government expenditures	BEA (Table 1.1.5)
$P16$	Quarterly	Civilian non-institutional population, over 16	BLS (LNU00000000Q)
GDP	Quarterly	Gross domestic product	BEA (Table 1.1.5)
$RGDP$	Quarterly	Real gross domestic product	BEA (Table 1.1.6)
$GDPDEF$	Quarterly	GDP deflator	$\frac{GDP}{RGDP}$
g_t	Quarterly	Real per-capita federal government spending	$\frac{GCE}{P16*GDPDEF}$
$Net\,Tax$	Quarterly	Federal tax receipts net of transfer payments	BEA (Table 3.2)
t_t	Quarterly	Real per capita federal taxes	$\frac{Nettax}{(P16)*(GDPDEF)}$
y_t	Quarterly	Real per-capita GDP	$\frac{RGDP}{P16}$
Δpi_t	Quarterly	Personal income growth rates for individual states, first differences of its log levels	BEA (Regional Data)
Δemp_t	Quarterly	Employment growth rates for individual states	Hamilton and Owyang(2012)

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Table A2.1: Continued from previous page

ff_t	Quarterly	Federal funds Rate	Federal Reserve Bank of St. Louis
NBR	Quarterly	Nonborrowed reserves	Federal Reserve Bank of St. Louis
TS	Quarterly	Term spread	Federal Reserve Bank of St. Louis
PCT	Quarterly	Personal income taxes	BEA
CS	Quarterly	Contributions for government social insurance	BEA (Table 2.2)
PTI	Quarterly	Personal taxable income	BEA (Table 2.1)
$APITR$	Quarterly	Average personal income tax rate (APITR)	$\frac{(PCT+CS)}{PTI}$
$AMTR$	Quarterly	Average marginal income tax rate (AMTR)	Barro and Redlick (2011)

The aggregate variables t_t, g_t, y_t are converted to growth rates by taking first differences of its log levels and then included in the FAVAR model.

Table A1.2: Data definitions and Sources used in Cross State Regression Analysis

Variable	Description	Source
Dependent variable:		
$\Delta pi4$	Estimated cumulative response of personal income (4 quarter's)	Computed from IRF
$\Delta emp4$	Estimated cumulative response employment (4 quarter's)	Computed from IRF
Independent variables:		
Agriculture	Average agriculture share of total state GDP over the years 1963-2006	BEA (Regional Data)
Construction	Average construction share of total state GDP over the years 1963-2006	BEA (Regional Data)
Manufacturing	Average manufacturing share of total state GDP over the years 1963-2006	BEA (Regional Data)
Retail	Average retail share of total state GDP over the years 1963-2006	BEA (Regional Data)
FIRE	Average finance, insurance and retail share of total state GDP over the years 1963-2006	BEA (Regional Data)
Municipal bond issuer	Dummy variable for states where most municipal bonds are issued	Bloomberg's Municipal Fair Market Bond Index.
Tax exempt state	Dummy variable for states where there is no personal income tax	U.S. Internal Revenue Service
Female	Annual average percent of total population that is female, 1970-2006	U.S. Census Bureau
Education	Annual average percent of the total population 25 years and over with a bachelor degree or higher education, 1960-2000	U.S. Census Bureau
Nonwhite	Annual average percent of total population that is nonwhite, 1970-2006	U.S. Census Bureau
Median income	Median income is the average over years 1984-2006	U.S. Census Bureau
Median age	Median age for U.S. states, 2000	U.S. Census Bureau
Population density	Population density per square mile, 2000	U.S. Census Bureau
Per-capita federal tax burden	Federal tax burden (per-capita), 2005	Tax Foundation
House	Fraction of state representatives that are democrat,1980-2006	UKCPR
Senate	Fraction of state senators that are democrat,1980-2006	UKCPR

Table A1.3: Correlation with factors

States	Personal income			Employment		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
New England Region:						
Maine	0.481	-0.197	-0.008	0.670	0.270	0.206
New Hampshire	0.636	-0.654	0.220	0.680	0.337	0.113
Vermont	0.706	-0.549	0.012	0.686	0.274	0.093
Massachusetts	0.661	-0.446	-0.086	0.686	0.330	0.185
Rhode Island	0.586	-0.470	-0.033	0.701	0.217	0.183
Connecticut	0.646	-0.487	-0.026	0.679	0.346	0.180
Mean	**0.619**	**-0.467**	**0.013**	**0.684**	**0.296**	**0.160**
Mideast Region:						
New York	0.513	-0.329	-0.125	0.680	0.252	0.134
New Jersey	0.685	-0.509	-0.029	0.705	0.338	0.200
Pennsylvania	0.582	0.184	-0.388	0.715	0.368	0.078
Delaware	0.585	-0.638	0.010	0.520	0.270	0.071
Maryland	0.620	-0.708	0.128	0.727	0.150	0.145
Mean	**0.597**	**-0.400**	**0.081**	**0.669**	**0.275**	**0.126**
Southeast Region:						
Virginia	0.618	-0.634	0.185	0.782	0.159	0.134
North Carolina	0.676	-0.511	0.073	0.763	0.345	0.134
South Carolina	0.724	-0.395	0.090	0.727	0.375	0.111
Georgia	0.655	-0.636	0.197	0.780	0.361	0.089
Florida	0.544	-0.758	0.252	0.631	0.292	0.118
Kentucky	0.605	0.022	-0.511	0.653	0.435	0.074
Tenessee	0.744	-0.395	-0.161	0.779	0.406	0.049
Alabama	0.670	-0.076	-0.427	0.727	0.494	0.065
Missisppi	0.252	0.208	-0.394	0.660	0.406	0.045
Arkansas	0.421	-0.101	-0.427	0.659	0.399	0.044
Mean	**0.591**	**-0.327**	**-0.112**	**0.716**	**0.367**	**0.086**
Great Lakes Region :						
West Virgnia	0.002	0.539	-0.479	0.411	0.204	-0.151
Michigan	0.680	-0.043	-0.222	0.605	0.469	0.108
Ohio	0.774	-0.053	-0.294	0.774	0.427	0.108
Indiana	0.763	-0.122	-0.347	0.750	0.421	0.121
Illinois	0.688	-0.215	-0.380	0.726	0.347	0.190
Wisconsin	0.754	-0.371	-0.236	0.767	0.376	0.177
Minnesota	0.649	-0.439	-0.293	0.771	0.322	0.114
Mean	**0.616**	**-0.100**	**-0.322**	**0.686**	**0.367**	**0.095**
Plains Region:						
Missouri	0.627	-0.347	-0.385	0.754	0.379	0.161
Kansas	0.340	-0.079	-0.478	0.630	0.334	0.069
Nebraska	0.300	-0.026	-0.616	0.584	0.318	0.055
Iowa	0.278	0.163	-0.718	0.657	0.370	0.166
Mean	**0.386**	**-0.072**	**-0.549**	**0.656**	**0.350**	**0.113**

Continued on next page

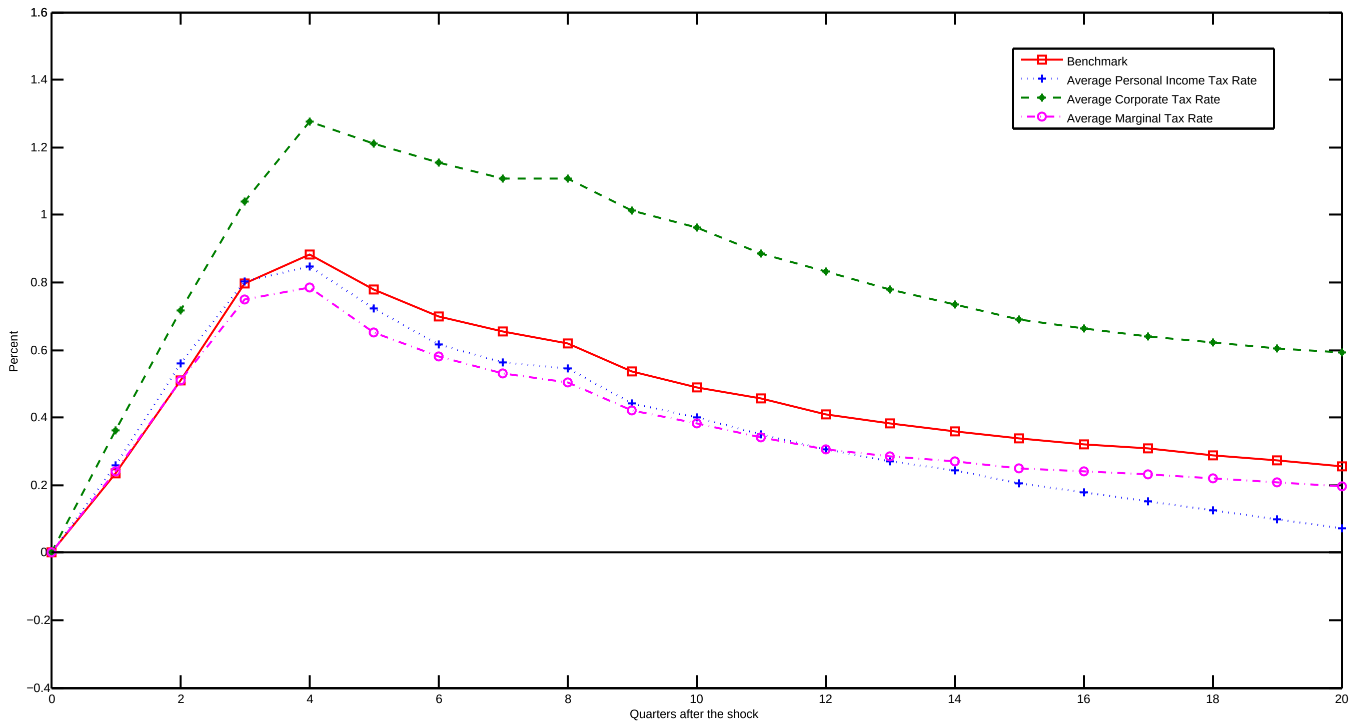
Table A1.3 – *Continued from previous page*

States	Personal income			Employment		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
Mountain/Northern Region:						
South Dakota	00.120	0.122	-0.542	0.497	0.269	0.052
North Dakota	0.095	0.064	-0.461	0.294	0.192	0.019
Montana	0.223	0.069	-0.500	0.373	0.346	-0.003
Idaho	0.528	-0.249	-0.253	0.503	0.306	-0.105
Mean	**0.242**	**0.002**	**-0.439**	**0.417**	**0.278**	**-0.009**
Energy Belt Region:						
Louisiana	0.483	-0.246	-0.368	0.433	0.222	-0.035
Wyoming	0.103	0.299	-0.508	0.210	0.178	-0.051
Utah	0.581	-0.693	0.148	0.567	0.288	0.030
Colorado	0.612	-0.681	-0.010	0.574	0.305	-0.052
Texas	0.582	-0.667	0.128	0.582	0.341	-0.012
Oklahoma	0.385	-0.327	-0.453	0.437	0.288	-0.116
New Mexico	0.392	-0.541	0.074	0.499	0.311	-0.062
Mean	**0.449**	**-0.408**	**-0.141**	**0.472**	**0.276**	**-0.043**
Far west Region :						
Arizona	0.577	-0.716	0.260	0.622	0.321	0.039
California	0.574	-0.741	0.253	0.697	0.371	0.200
Nevada	0.500	-0.771	0.232	0.546	0.259	0.065
Oregon	0.716	-0.528	0.003	0.685	0.356	0.147
Washington	0.563	-0.600	0.134	0.607	0.301	0.189
Mean	**0.586**	**-0.671**	**0.176**	**0.631**	**0.322**	**0.128**

Table A1.4: Average growth rate of personal income and employment (measured in percentage points) from 1957Q1-2006Q4.

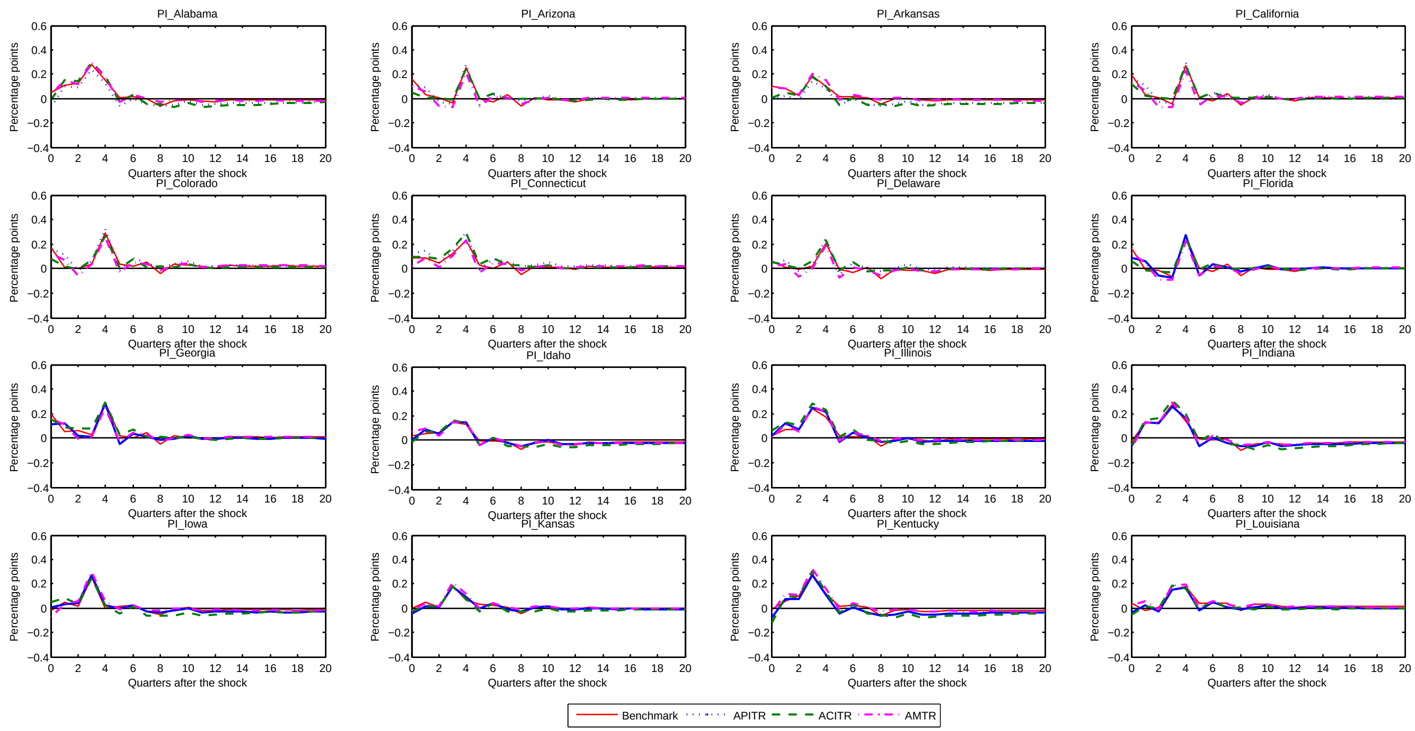
States	Average growth rate of personal Income	Average growth rate of employment
Alabama	0.686	0.502
Arizona	0.593	1.205
Arkansas	0.746	0.657
California	0.508	0.628
Colorado	0.598	0.823
Connecticut	0.593	0.317
Delaware	0.430	0.534
Florida	0.654	1.031
Georgia	0.678	0.729
Idaho	0.570	0.765
Illinois	0.499	0.264
Indiana	0.495	0.397
Iowa	0.571	0.436
Kansas	0.581	0.464
Kentucky	0.644	0.541
Louisiana	0.626	0.464
Maine	0.625	0.409
Maryland	0.632	0.558
Massachusetts	0.650	0.290
Michigan	0.437	0.311
Minnesota	0.641	0.566
Mississippi	0.778	0.591
Missouri	0.552	0.383
Montana	0.489	0.499
Nebraska	0.604	0.497
Nevada	0.485	1.412
New Hampshire	0.676	0.638
New Jersey	0.590	0.376
New Mexico	0.590	0.725
New York	0.560	0.175
North Carolina	0.687	0.677
North Dakota	0.612	0.553
Ohio	0.471	0.273
Oklahoma	0.625	0.524
Oregon	0.512	0.649
Pennsylvania	0.558	0.210
Rhode Island	0.592	0.281
South Carolina	0.714	0.653
South Dakota	0.649	0.559
Tennessee	0.684	0.589
Texas	0.594	0.735
Utah	0.544	0.845
Vermont	0.667	0.547
Virginia	0.704	0.697
Washington	0.560	0.666
West Virginia	0.585	0.191
Wisconsin	0.557	0.469
Wyoming	0.647	0.620
Average values	*0.60*	*0.560*

Figure A1.1: Impulse response of real per-capita GDP with respect to different tax variables in the FAVAR



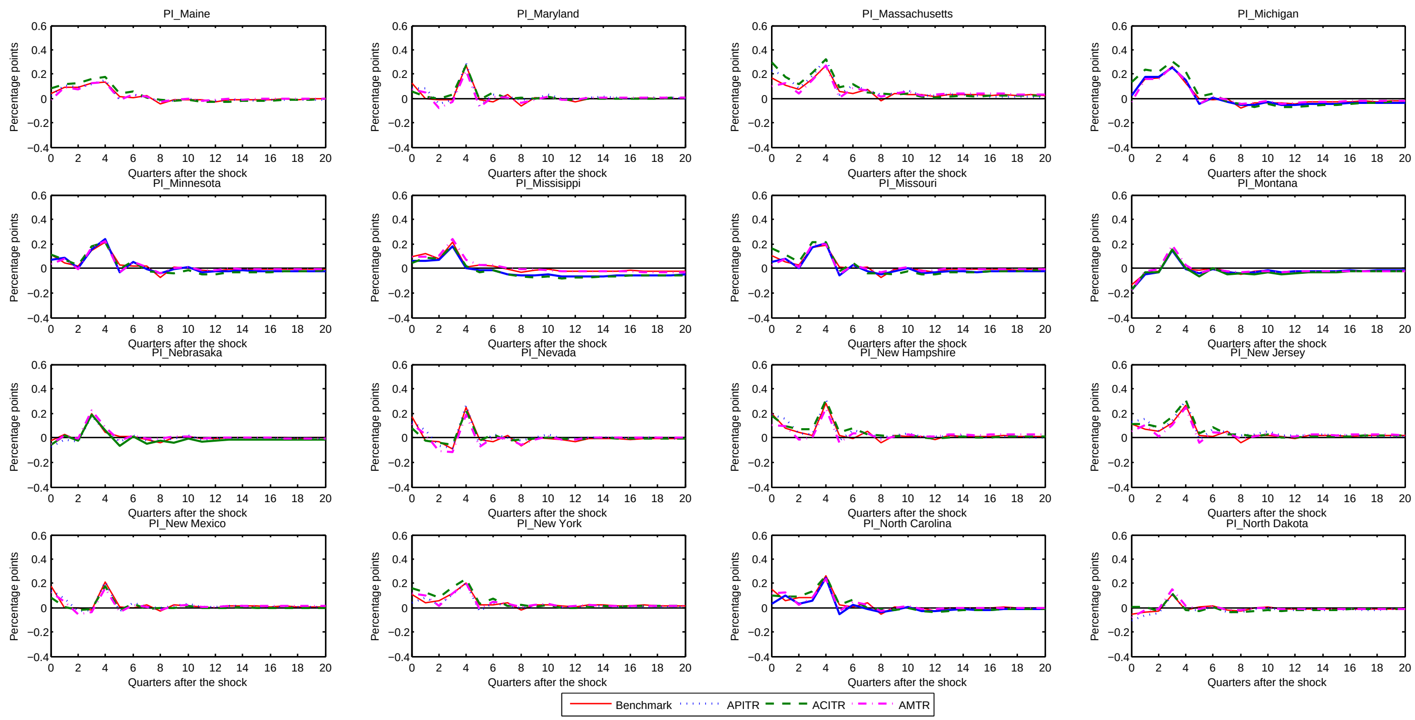
*Notes:*The figure shows the response of real per-capita GDP to one percentage point increase in implicit tax rate. Full lines are point estimates of real GDP from benchmark model. Dotted lines are point estimates using average personal income tax rate (APITR) in the benchmark specification. Dashed lines are point estimates for real GDP using average corporate tax rate (ACITR) in the benchmark specification. Finally, dashed-dot lines are point estimates for real GDP using average marginal tax rate (AMTR) in the benchmark specification. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.2: Impulse responses of state-level personal income with respect to different tax variables in the FAVAR



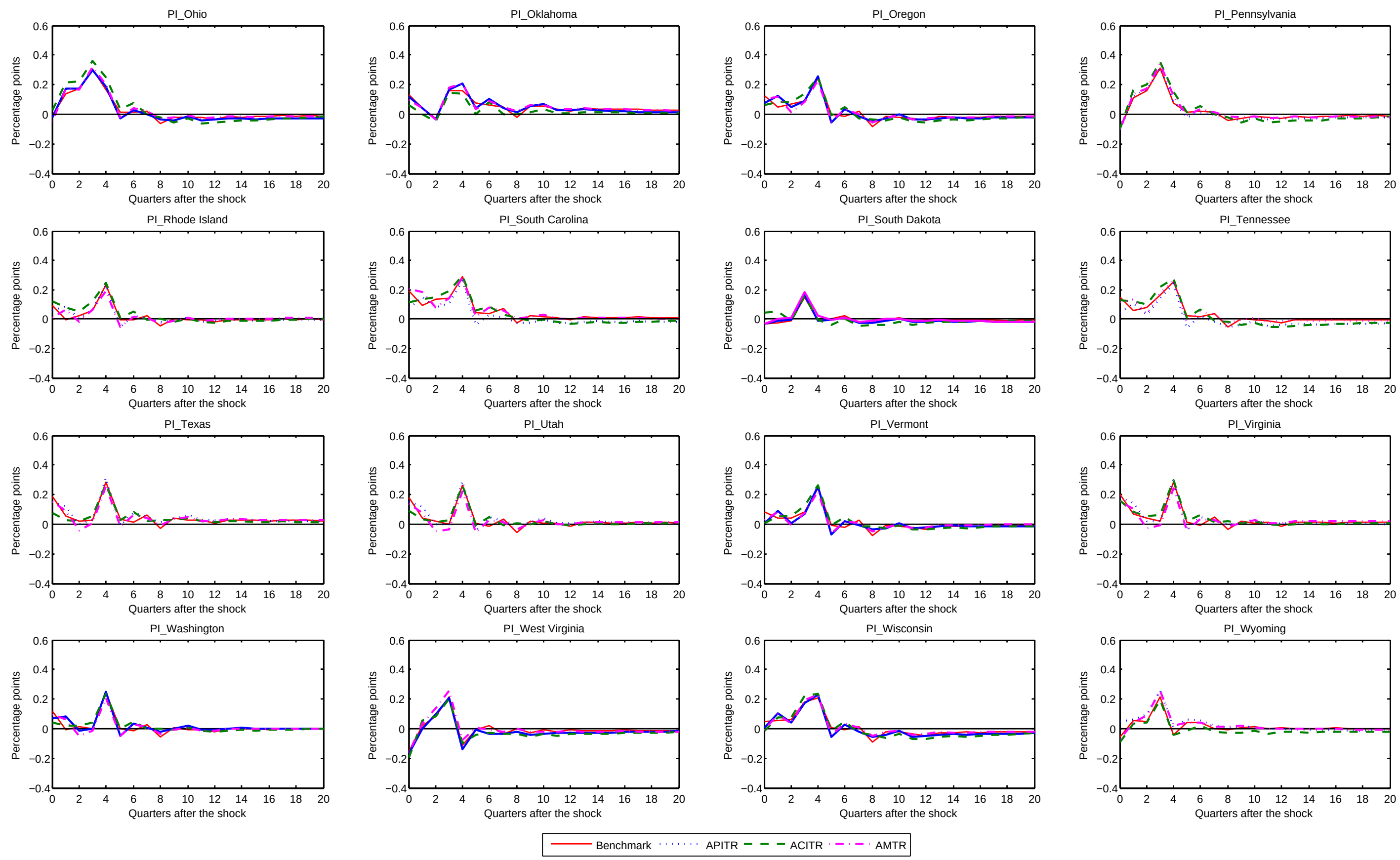
*Notes:*The figure shows the response of real per-capita personal income growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates with benchmark specification; dotted, dashed, and dashed-dot lines indicate point estimates using different tax variables. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.3: Impulse responses of state-level personal income with respect to different tax variables in the FAVAR



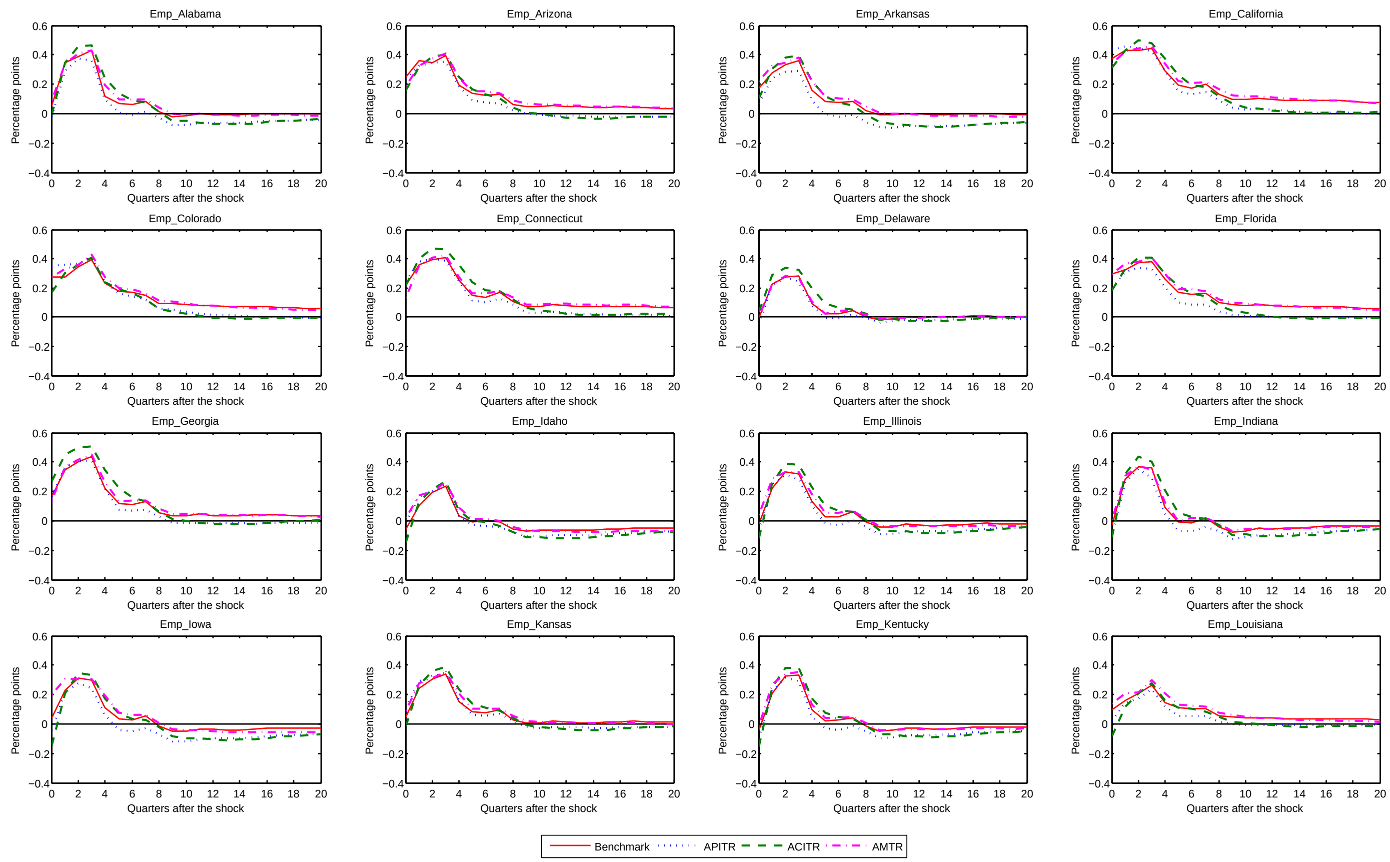
*Notes:*The figure shows the response of real per-capita personal income growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates with benchmark specification; dotted, dashed, and dashed-dot lines indicate point estimates using different tax variables. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.4: Impulse responses of state-level personal income with respect to different tax variables in FAVAR



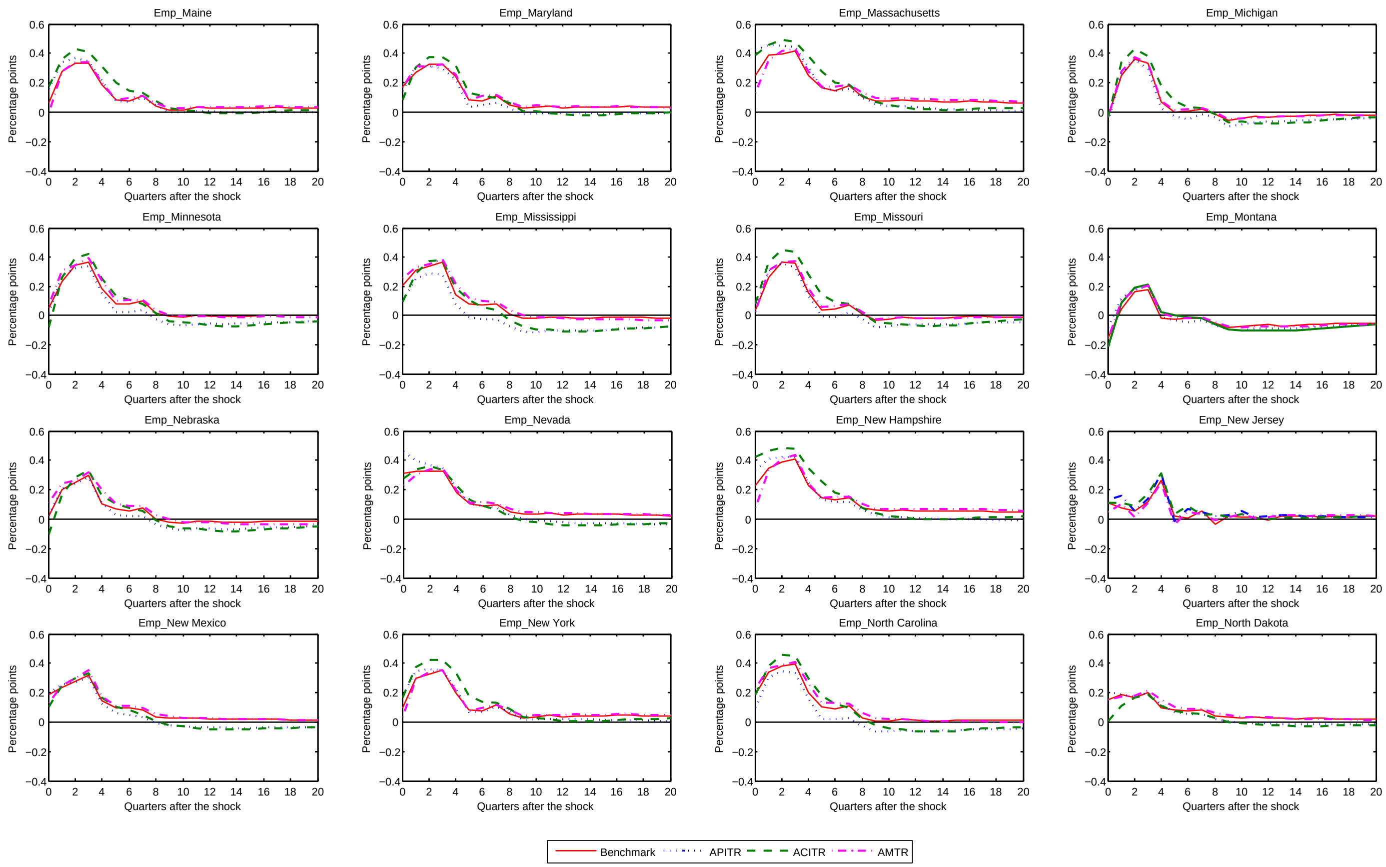
*Notes:*The figure shows the response of real per-capita personal income growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates with benchmark specification; dotted, dashed, and dashed-dot lines indicate point estimates using different tax variables. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.5: Impulse responses of state-level employment with respect to different tax variables in the FAVAR



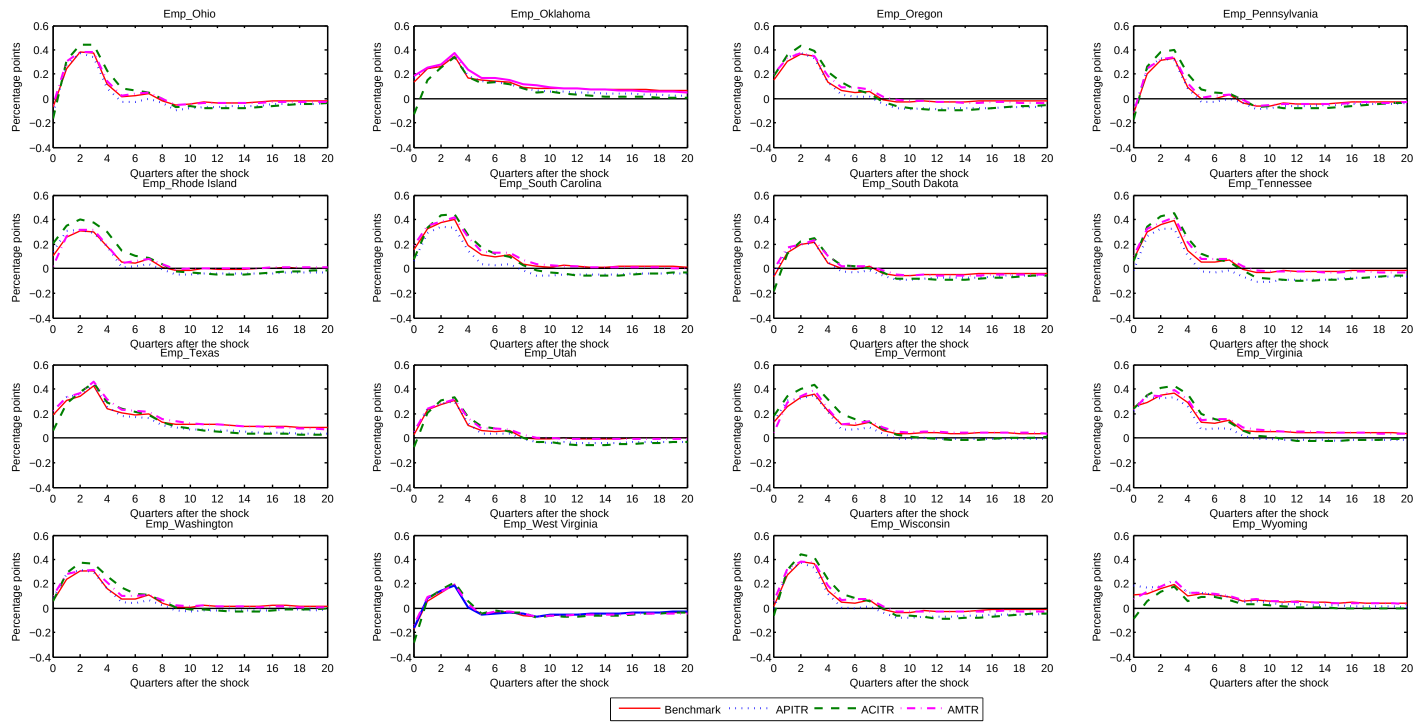
*Notes:*The figure shows the response of real per-capita employment growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates with benchmark specification; dotted, dashed, and dashed-dot lines indicate point estimates using different tax variables. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.6: Impulse responses of state-level employment with respect to different tax variables in the FAVAR



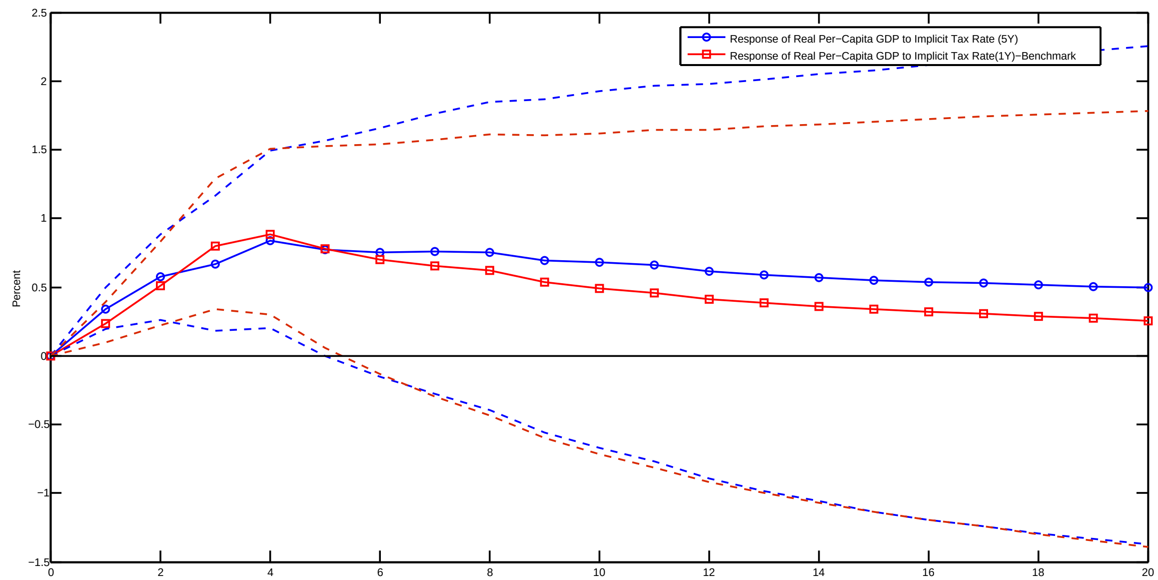
*Notes:*The figure shows the response of real per-capita employment growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates with benchmark specification; dotted, dashed, and dashed-dot lines indicate point estimates using different tax variables. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.7: Impulse responses of state-level employment with respect to different tax variables in the FAVAR



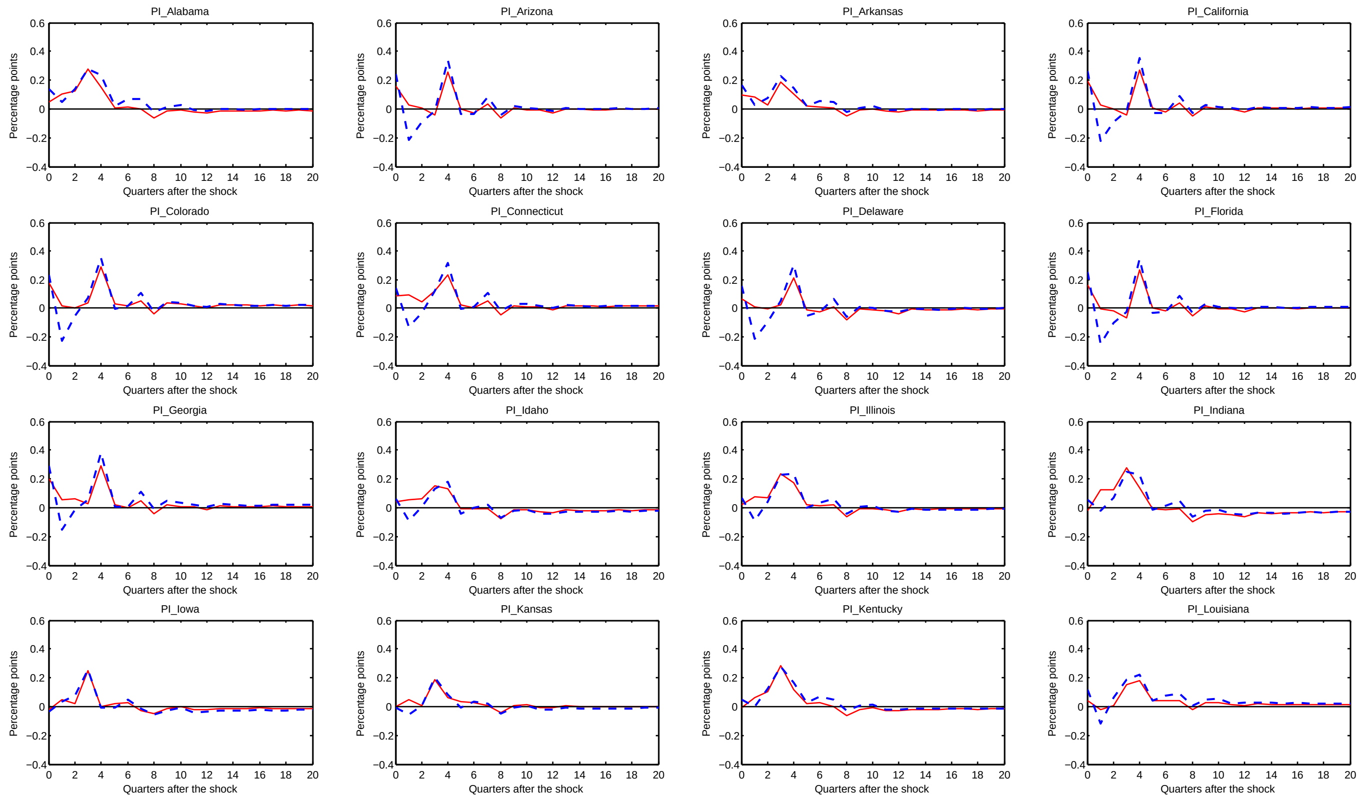
*Notes:*The figure shows the response of real per-capita employment growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates with benchmark specification;dotted, dashed, and dashed-dot lines indicate point estimates using different tax variables. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.8: Impulse response of real per-capita GDP (using 5-year bonds)



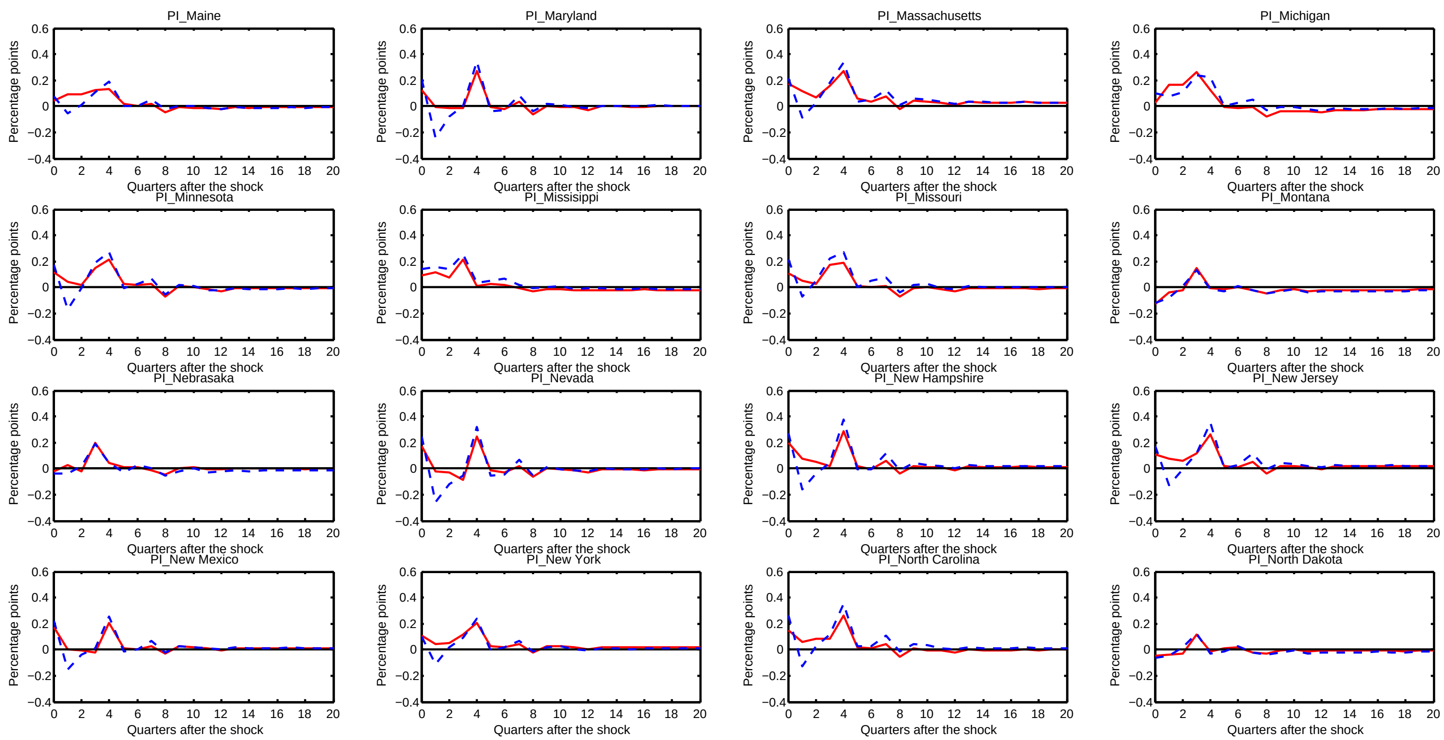
Notes: The figure shows the response of real per-capita GDP to a 1 percentage point increase in the implicit tax rate (5-year). Full lines are point estimates; dashed indicate the 95 percent confidence intervals constructed following Kilian and Gonclaves (2004) recursive wild-bootstrap method using 10,000 replications.

Figure A1.9: Impulse responses of state-level personal income (using 5-year bonds)



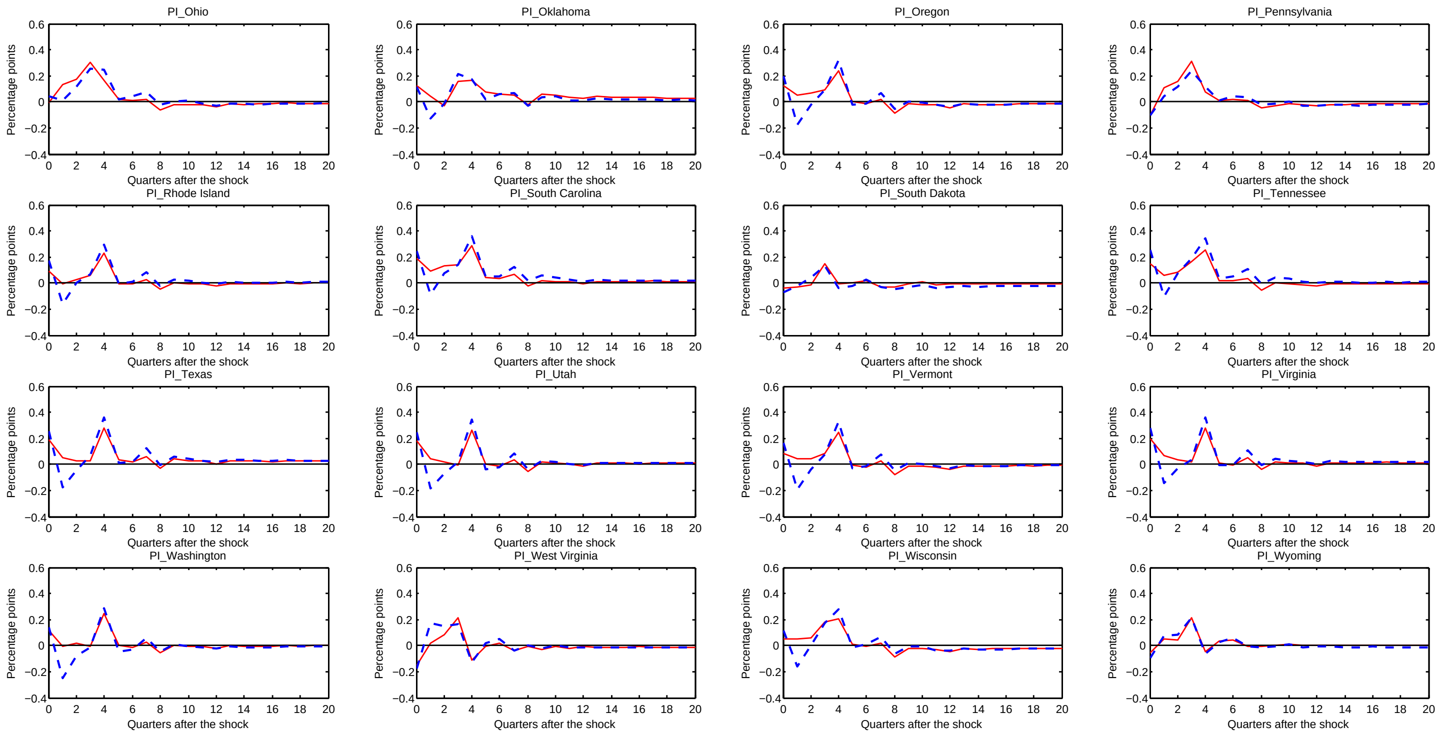
*Notes:*The figure shows the response of real per-capita personal income growth for different states to a 1 percentage point increase in the implicit tax rate (5-year). Full lines are point estimates with benchmark specification; dashed lines indicate point estimates of robust specification. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.10: Impulse responses of state-level personal income (using 5-year bonds)



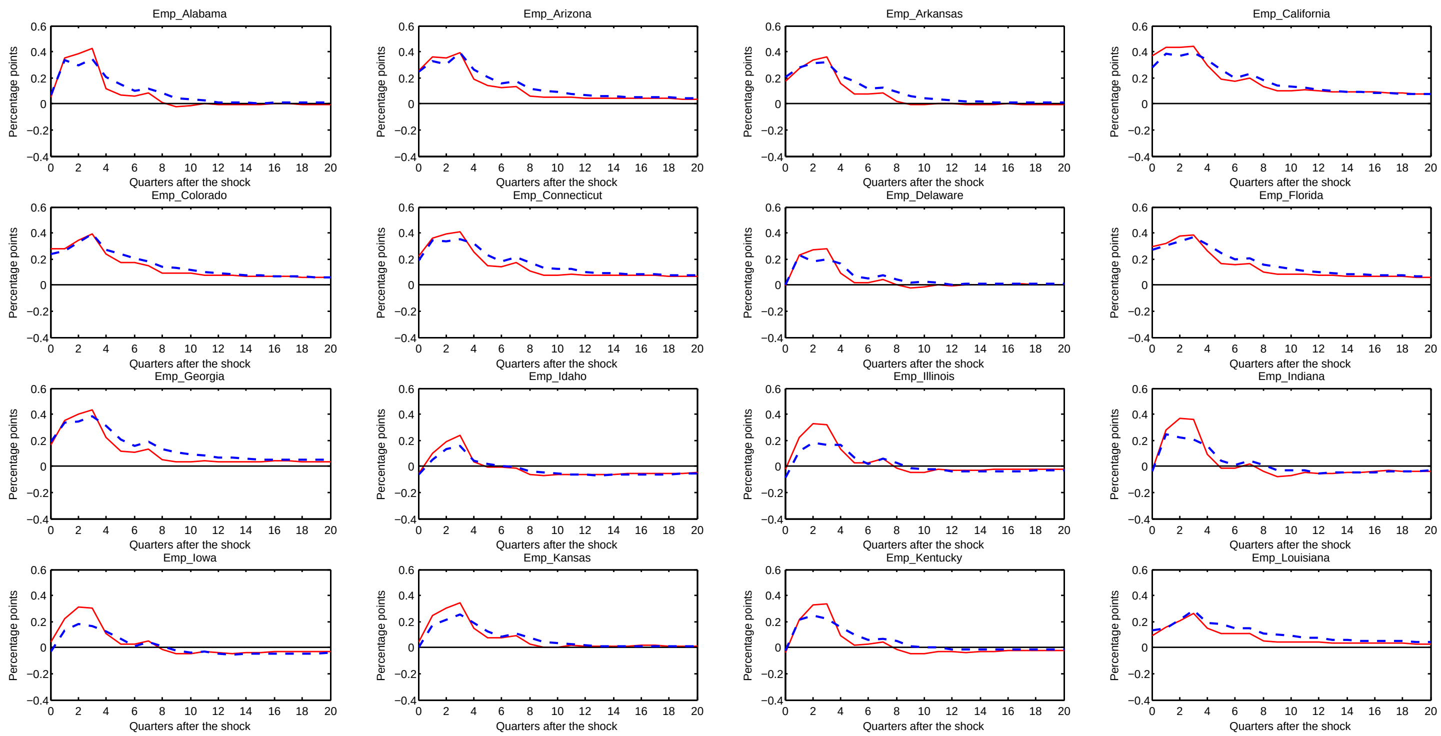
*Notes:*The figure shows the response of real per-capita personal income growth for different states to a 1 percentage point increase in the implicit tax rate (5-year). Full lines are point estimates with benchmark specification; dashed lines indicate point estimates of robust specification. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.11: Impulse responses of state-level personal income (using 5-year bonds)



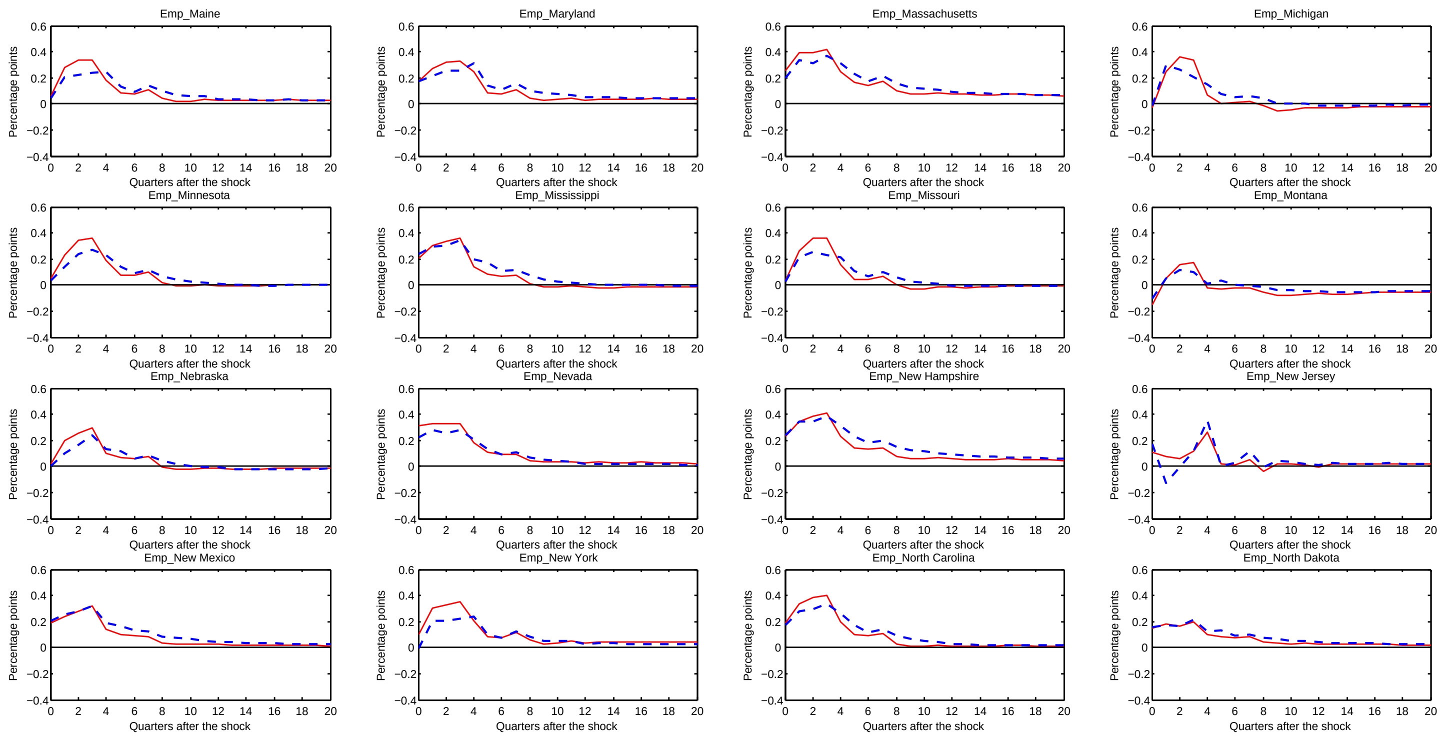
*Notes:*The figure shows the response of real per-capita personal income growth for different states to a 1 percentage point increase in the implicit tax rate (5-year). Full lines are point estimates with benchmark specification; dashed lines indicate point estimates of robust specification. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.12: Impulse responses of state-level employment (using 5-year bonds)



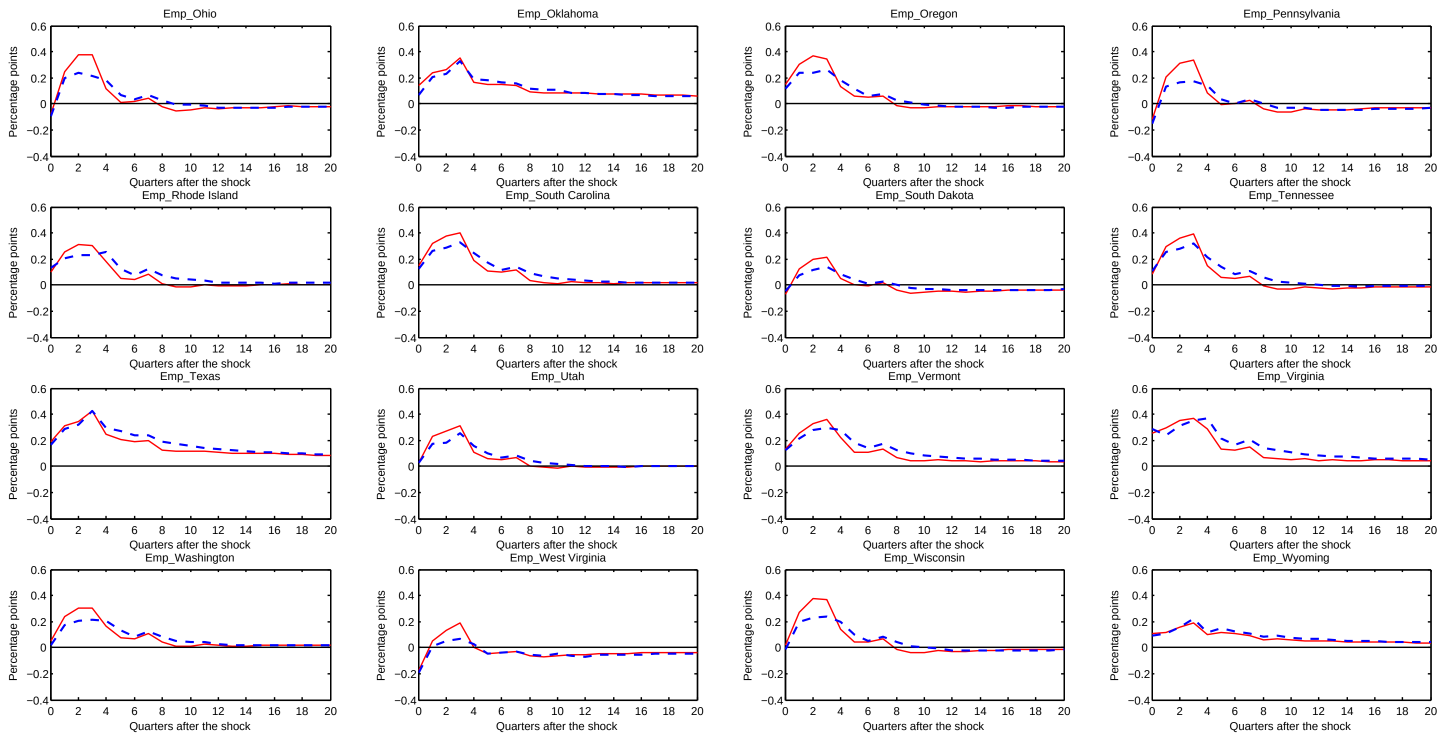
*Notes:*The figure shows the response of real per-capita employment growth for different states to a 1 percentage point increase in the implicit tax rate (5-year). Full lines are point estimates with benchmark specification; dashed lines indicate point estimates of robust specification. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.13: Impulse responses of state-level employment (using 5-year bonds)



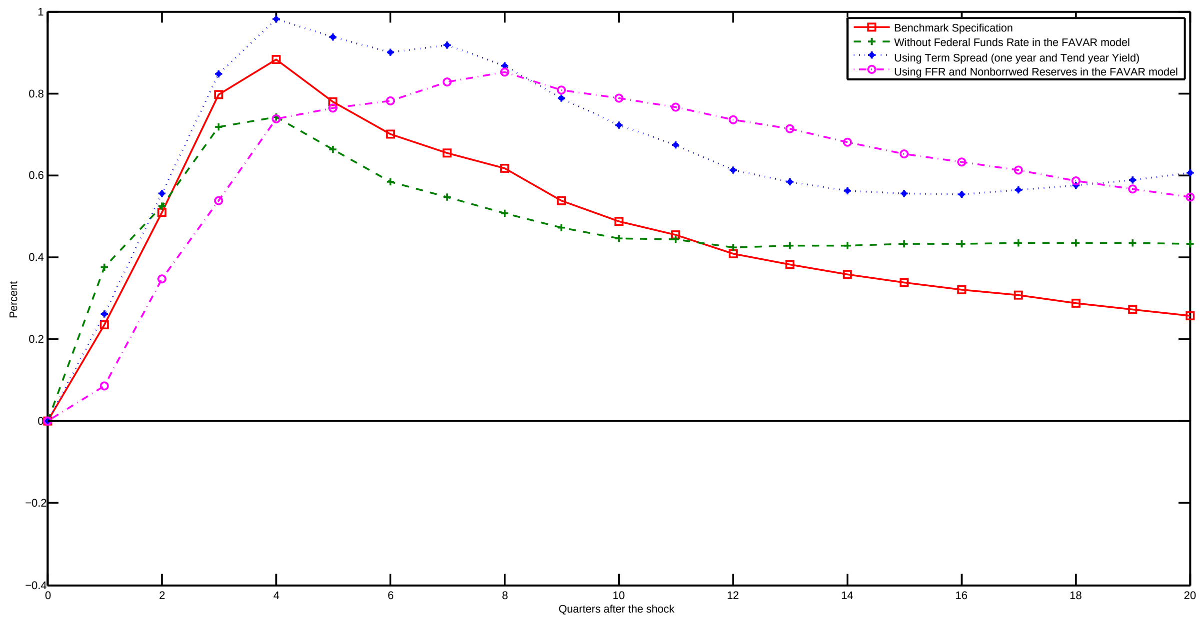
*Notes:*The figure shows the response of real per-capita employment growth for different states to a 1 percentage point increase in the implicit tax rate (5-year). Full lines are point estimates with benchmark specification; dashed lines indicate point estimates of robust specification. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.14: Impulse responses of state-level employment (using 5-year bonds)



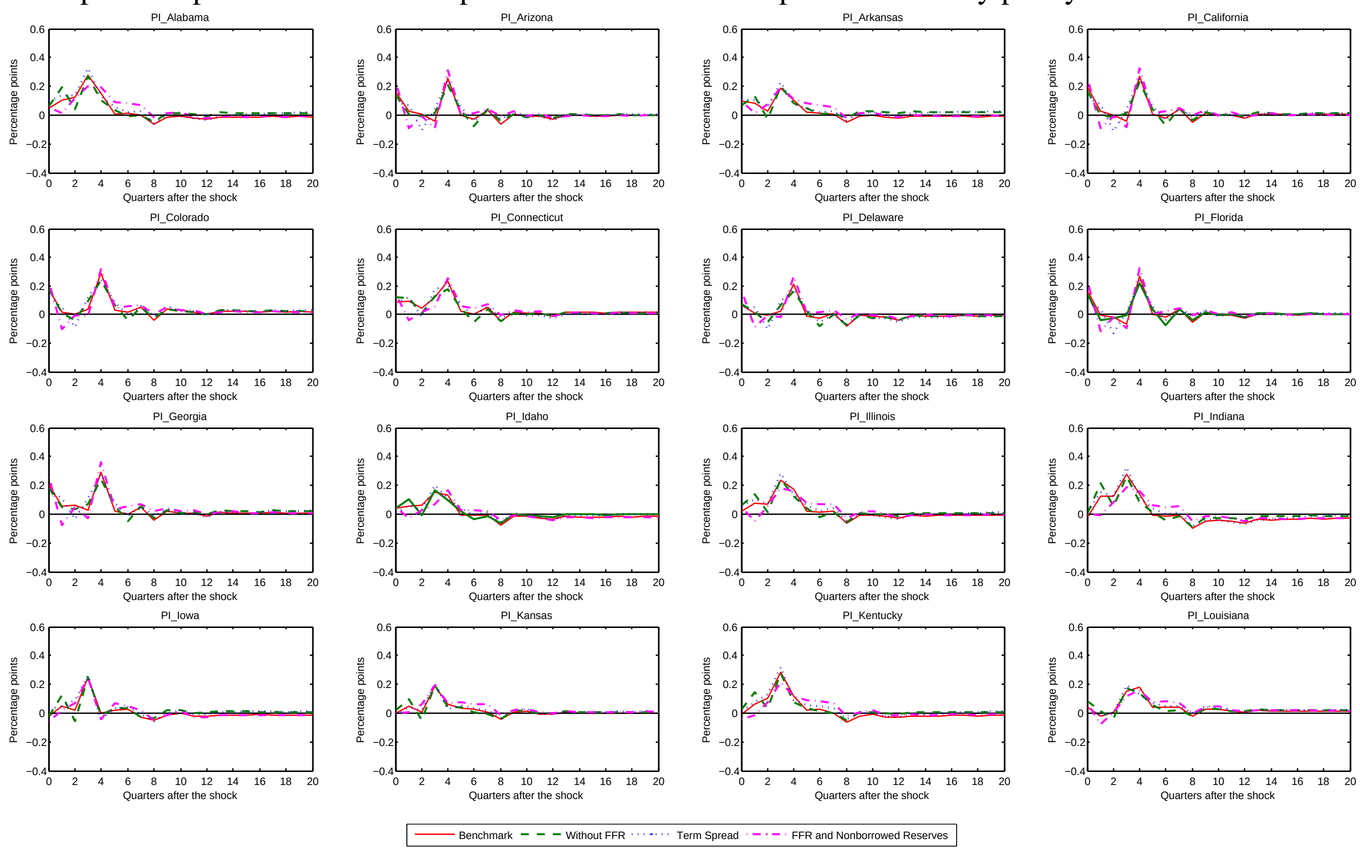
*Notes:*The figure shows the response of real per-capita employment growth for different states to a 1 percentage point increase in the implicit tax rate (5-year). Full lines are point estimates with benchmark specification; dashed lines indicate point estimates of robust specification. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.15: Impulse response of real per-capita GDP with respect to monetary policy variables in the FAVAR



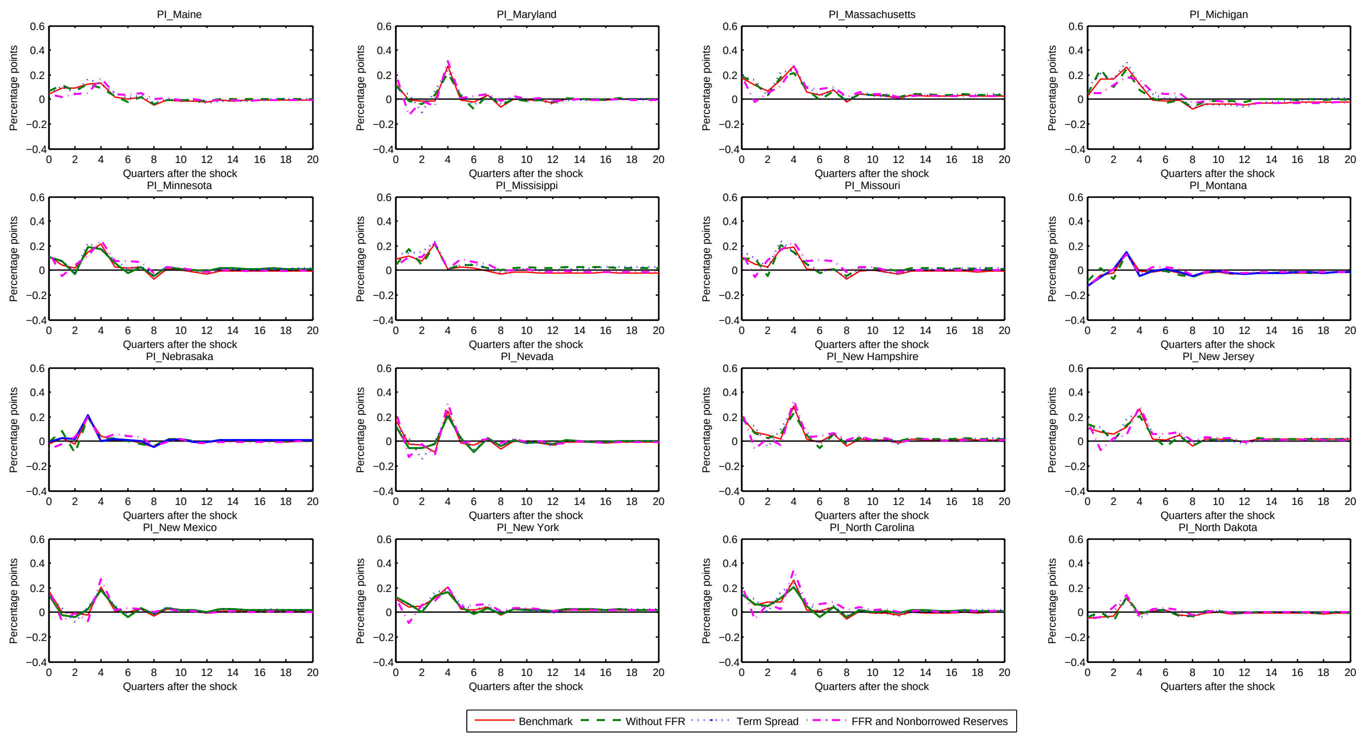
Notes: The figure shows the response of real per-capita GDP to a one percentage point increase in the implicit tax rate with respect to different monetary policy variables. The benchmark specification includes the federal funds rate as the monetary policy variable in the FAVAR model. The alternative specification consists: (a) without FFR: excluding federal funds rate from benchmark specification; (b) Long term spread: we augmented our benchmark specification by including the term spread as alternative indicator for monetary policy; (c) nonborrwed reserves: we augment our benchmark specification by including log growth of nonborrwed reserves in addition to federal funds rate in the benchmark specification.

Figure A1.16: Impulse responses of state-level personal income with respect to monetary policy variables in the FAVAR



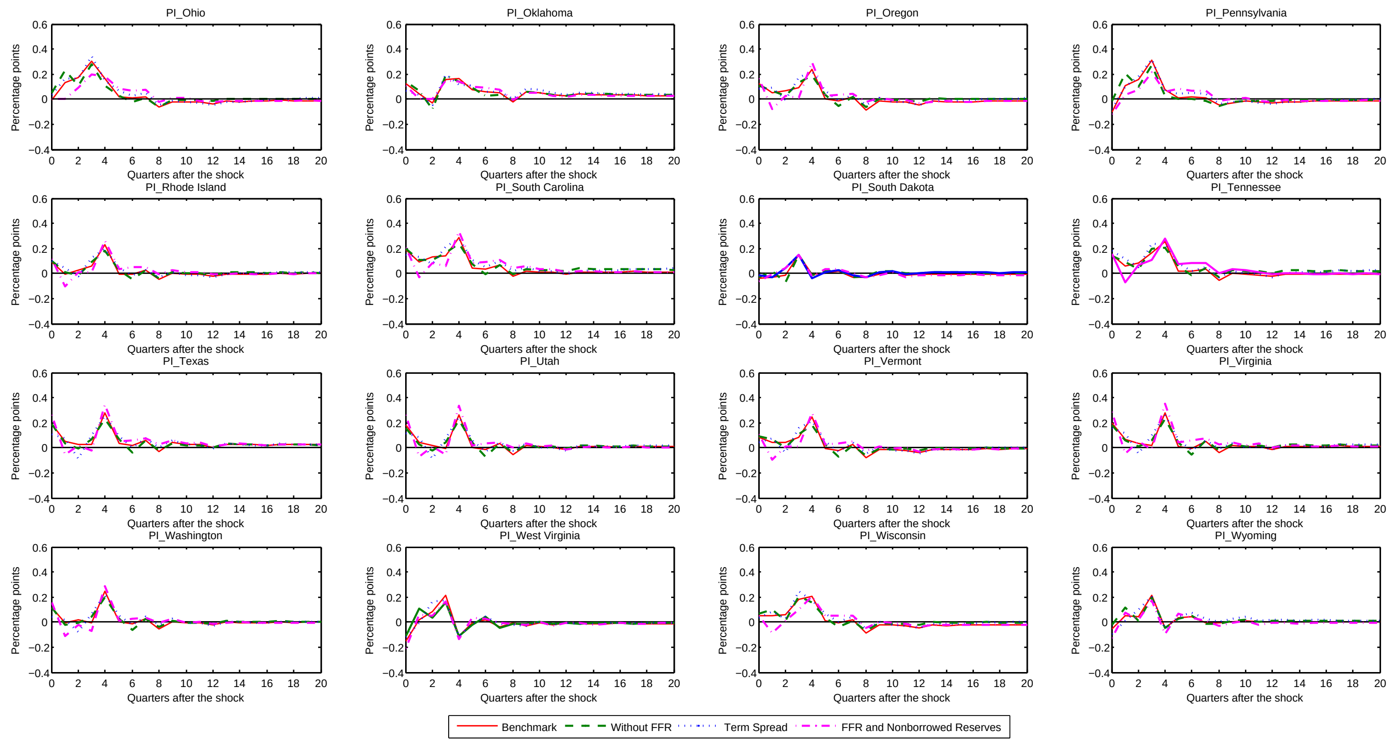
Notes: The figure shows the response of real per-capita personal income growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates with benchmark specification; dashed lines indicate point estimates of robust specification. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.17: Impulse responses of state-level personal income with respect to monetary policy variables in the FAVAR



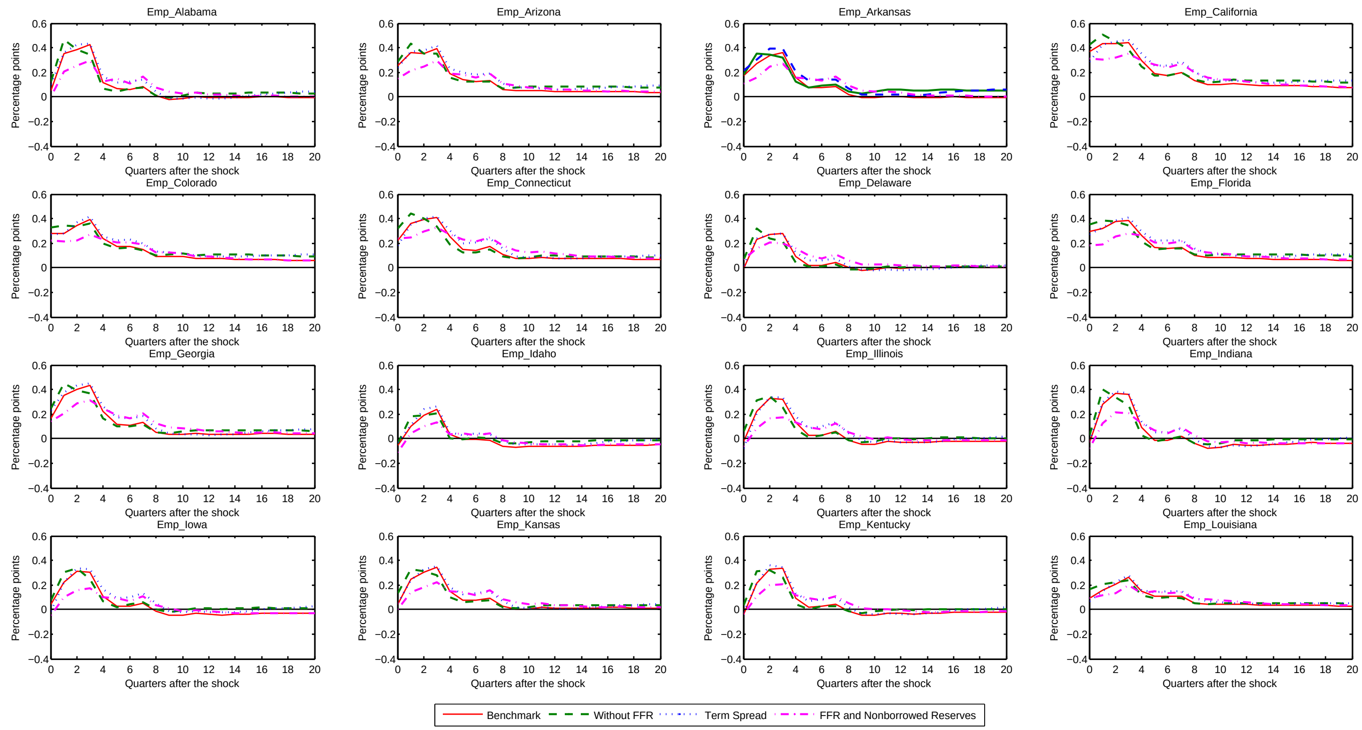
*Notes:*The figure shows the response of real per-capita personal income growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates with benchmark specification; dashed lines indicate point estimates of robust specification. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.18: Impulse responses of state-level personal income with respect to monetary policy variables in the FAVAR



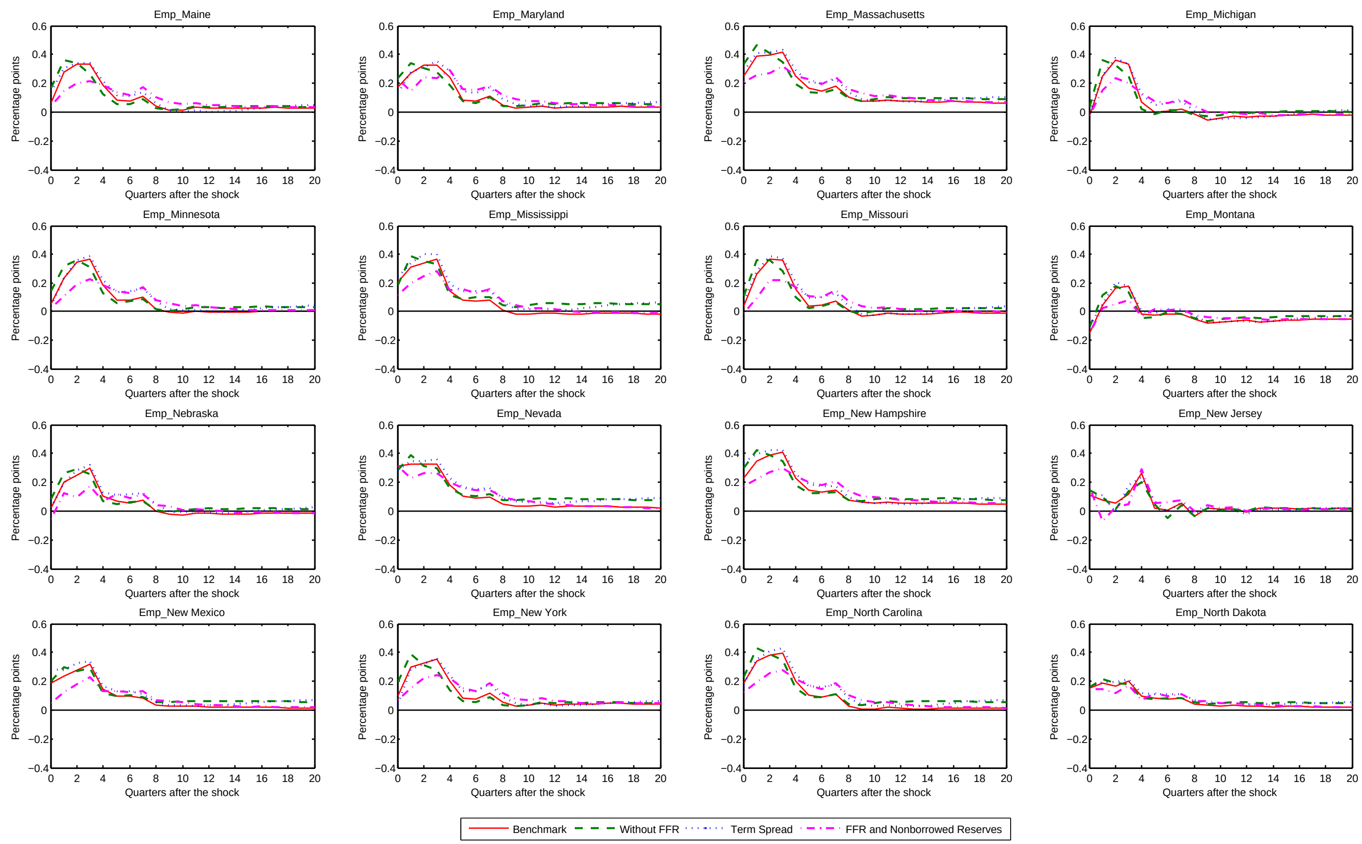
*Notes:*The figure shows the response of real per-capita personal income growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates with benchmark specification; dashed lines indicate point estimates of robust specification. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.19: Impulse responses of state-level employment with respect to monetary policy variables in the FAVAR



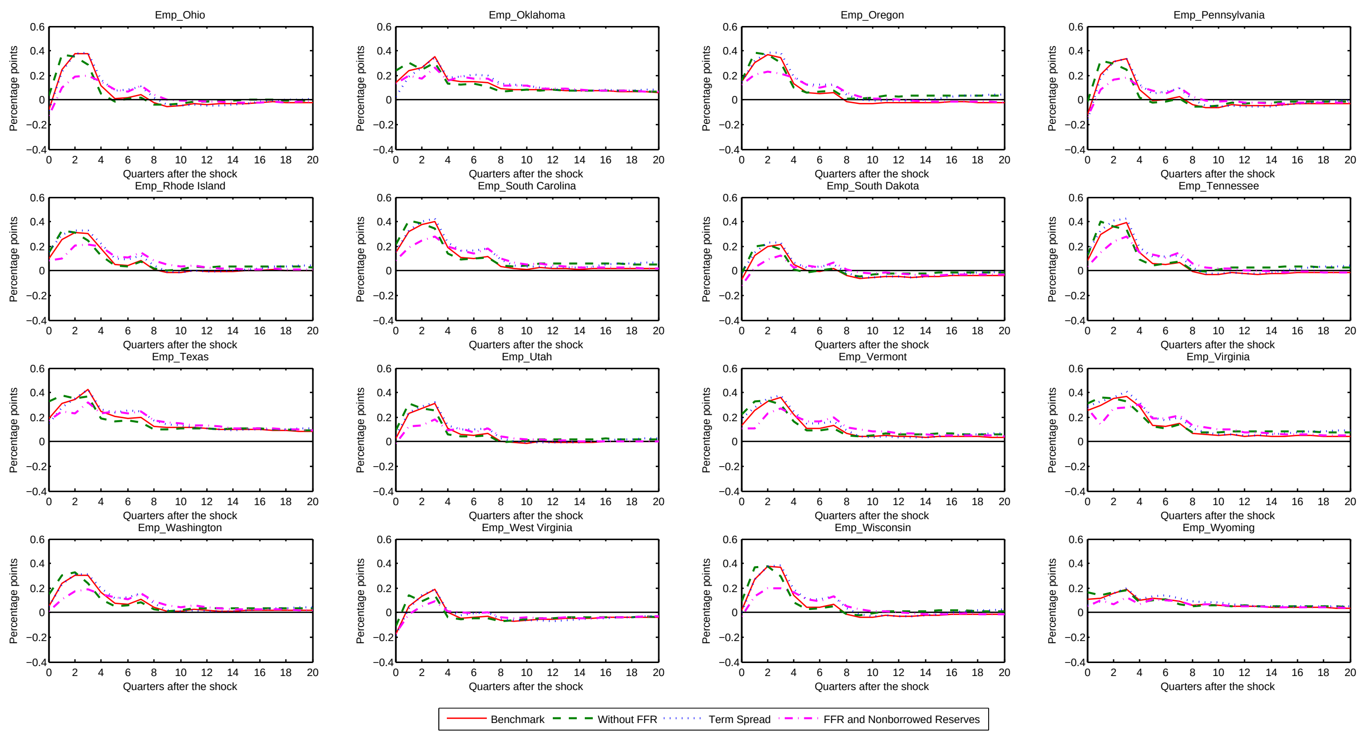
Notes: The figure shows the response of real per-capita employment growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates with with benchmark specification; dashed lines indicate point estimates of robust specification. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.20: Impulse responses of state-level employment with respect to monetary policy variables in the FAVAR



*Notes:*The figure shows the response of real per-capita employment growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates with with benchmark specification; dashed lines indicate point estimates of robust specification. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

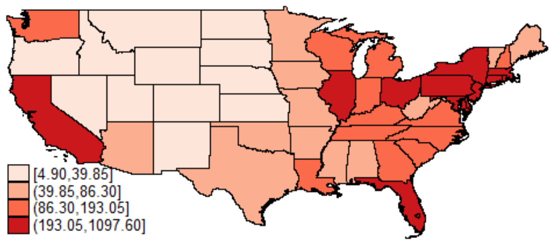
Figure A1.21: Impulse responses of state-level employment with respect to monetary policy variables in the FAVAR



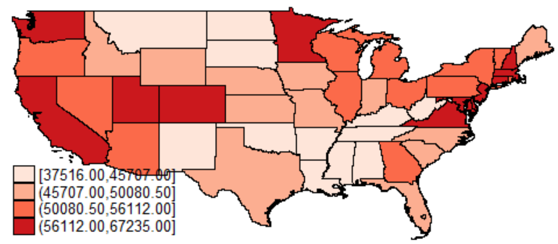
*Notes:*The figure shows the response of real per-capita employment growth for different states to a 1 percentage point increase in the implicit tax rate. Full lines are point estimates with with benchmark specification; dashed lines indicate point estimates of robust specification. Computations are based on 10,000 simulations of model (equations 2.1 and 2.2).

Figure A1.22: U.S. state-level demographic characteristics

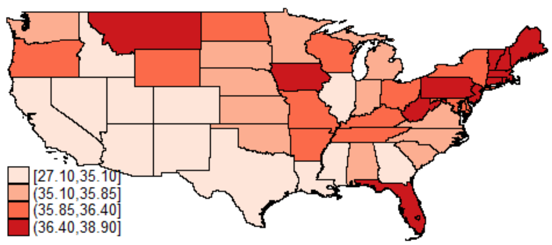
(a) Population density, 2000



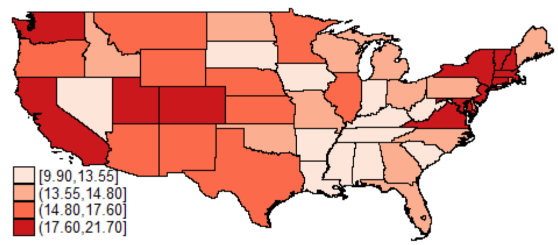
(b) Median income, 1984-2006



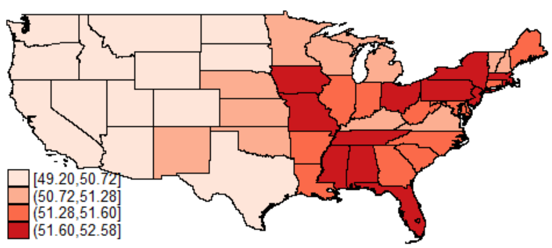
(c) Median age, 2000



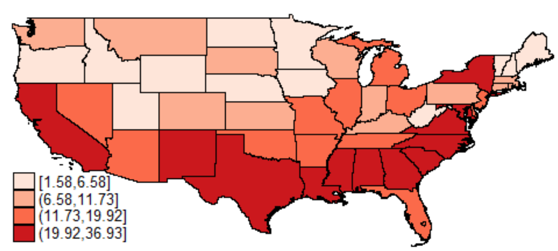
(d) Education, 1960-2000



(e) Female, 1970-2006



(f) Nonwhite, 1970-2006



*Notes:*The figure illustrates demographic characteristics across 48 contiguous states in the United States. The darker shade of red indicate the states with higher share to the specific demographic variable. Similarly, lighter shade of red indicate the states with smaller share to the related demographic variable. Population density is person per square mile of land area for the year 2000. Median income is the average median income of state over the 1984-2006 period. Median age corresponds to the median age in the state for the year 2000. Education is annual percent of total population of 25 years and over with bachelors degree or higher education over 1960-2000 period. Female is the annual average percent of total population that is female over 1970-2006 period, and Nonwhite is the annual average percent of total population that is nonwhite over 1970-2006 period. The data is collected from U.S. Census Bureau.

Table A2.1: Data definitions and sources used in the FAVAR

Variable	Frequency	Description	Source and Construction
r_t^M	Quarterly	Yield on municipal bonds (1 year)	Leeper, Richter and Walker (2012)
r_t^T	Quarterly	Yield on Treasury bonds (1 year)	Leeper, Richter and Walker (2012)
τ_t	Quarterly	Implicit tax rate (1 year)	$1-\frac{r_t^M}{r_t^T}$
GCE	Quarterly	Federal government expenditures	BEA (Table 1.1.5)
$P16$	Quarterly	Civilian non-institutional population, over 16	BLS (LNU00000000Q)
$NGDP$	Quarterly	Gross domestic product	BEA (Table 1.1.5)
$RGDP$	Quarterly	Real gross domestic product	BEA (Table 1.1.6)
$GDPDEF$	Quarterly	GDP deflator	$\frac{NGDP}{RGDP}$
G_t	Quarterly	Real per-capita federal government spending	$\frac{GCE}{P16*GDPDEF}$
$Net\,Tax$	Quarterly	Federal tax receipts net of transfer payments	BEA (Table 3.2)
T_t	Quarterly	Real per capita federal taxes	$\frac{Nettax}{(P16)*(GDPDEF)}$
GDP_t	Quarterly	Real per-capita GDP	$\frac{RGDP}{P16}$
R_t	Quarterly	Federal funds Rate	Federal Reserve Bank of St. Louis
tax_t	Quarterly	Tax liability changes	Romer and Romer (2010)

The aggregate variables T_t, G_t, GDP_t are converted to growth rates by taking first differences of its log levels and then included in the FAVAR model.

Table A2.2: Data definitions used in the FAVAR

Variable	Description	Transformation
IPP	INDUSTRIAL PRODUCTION INDEX - PRODUCTS, TOTAL	5
IPF	INDUSTRIAL PRODUCTION INDEX - FINAL PRODUCTS	5
IPC	INDUSTRIAL PRODUCTION INDEX - CONSUMER GOODS	5
IPCD	INDUSTRIAL PRODUCTION INDEX - DURABLE CONSUMER GOODS	5
IPCN	INDUSTRIAL PRODUCTION INDEX - NONDURABLE CONSUMER GOODS	5
IPE	INDUSTRIAL PRODUCTION INDEX - BUSINESS EQUIPMENT	5
IPI	INDUSTRIAL PRODUCTION, INTERMEDIATE PRODUCTS (FUELS)	5
IPM	INDUSTRIAL PRODUCTION INDEX - MATERIALS	5
IPMD	INDUSTRIAL PRODUCTION INDEX - DURABLE GOODS MATERIALS	5
IPMND	INDUSTRIAL PRODUCTION INDEX - NONDURABLE GOODS MATERIALS	5
IPMFG	INDUSTRIAL PRODUCTION INDEX - MANUFACTURING (SIC)	5
IPD	IP: DURABLE MANUFACTURING	5
IPN	IP NONDURABLE MANUFACTURING	5
IPMIN	IP MINING	5
IPUT	INDUSTRIAL PRODUCTION INDEX - RESIDENTIAL UTILITIES	5
IP	INDUSTRIAL PRODUCTION INDEX - TOTAL INDEX	5
IPXMCA	CAPACITY UTILIZATION - MANUFACTURING (SIC)	1
PMI	PURCHASING MANAGERS' INDEX (SA)	1
PMP	NAPM PRODUCTION INDEX (PERCENT)	1
GMPPYQ	PERSONAL INCOME (AR, bil. chain 2000 $)	5
GMYXPQ	PERSONAL INCOME LESS TRANSFER PAYMENTS (AR, bil. chain 2000 $)	5
LHEL	INDEX OF HELP-WANTED ADVERTISING IN NEWSPAPERS (1967$\bar{1}$00;SA)	5
LHELX	EMPLOYMENT: RATIO; HELP-WANTED ADS:NO. UNEMPLOYED CLF	4
LHEM	CIVILIAN LABOR FORCE: EMPLOYED, TOTAL (THOUS.,SA)	5
LHNAG	CIVILIAN LABOR FORCE: EMPLOYED, NONAGRIC.INDUSTRIES (THOUS.,SA)	5
LHUR	UNEMPLOYMENT RATE: ALL WORKERS, 16 YEARS OVER (%,SA)	1
LHU680	UNEMPLOY.BY DURATION: AVERAGE(MEAN)DURATION IN WEEKS (SA)	1
LHU5	UNEMPLOY.BY DURATION: PERSONS UNEMPL.LESS THAN 5 WKS (THOUS.,SA)	1
LHU14	UNEMPLOY.BY DURATION: PERSONS UNEMPL.5 TO 14 WKS (THOUS.,SA)	1
LHU15	UNEMPLOY.BY DURATION: PERSONS UNEMPL.15 WKS (THOUS.,SA)	1
LHU26	UNEMPLOY.BY DURATION: PERSONS UNEMPL.15 TO 26 WKS (THOUS.,SA)	1
EMP	TOTAL ECONOMY EMPLOYMENT (Francis and Ramey (2009)	5
LPNAG	EMPLOYEES, NONAG.PAYROLLS - TOTAL	5
LP	EMPLOYEES, NONFARM - TOTAL PRIVATE	5
LPGD	EMPLOYEES, NONFARM - GOODS-PRODUCING	5
LPMI	EMPLOYEES, NONFARM - MINING	5
LPCC	EMPLOYEES, NONFARM - CONSTRUCTION	5
LPEM	EMPLOYEES, NONFARM - MFG	5
LPED	EMPLOYEES, NONFARM - DURABLE GOODS	5
LPEN	EMPLOYEES, NONFARM - NONDURABLE GOODS	5
LPSP	EMPLOYEES, NONFARM - SERVICE-PROVIDING	5
LPTU	EMPLOYEES, NONFARM - TRADE, TRANSPORT, UTILITIES	5
LPTU	EMPLOYEES, NONFARM - WHOLESALE AND RETAIL TRADE	5
LPFR	EMPLOYEES, NONFARM - FINANCIAL ACTIVITIES	5
LPS	EMPLOYEES, NONFARM - SERVICES	5
LPGOV	EMPLOYEES, NONFARM - GOVERNMENT	5
LPHRM	AVG WKLY HOURS, PROD WRKRS, NONFARM - GOODS-PRODUCING	1
LPMOSA	AVG WKLY OVERTIME HOURS, PROD WRKRS, NONFARM - MFG	1
PMEMP	NAPM EMPLOYMENT INDEX (PERCENT)	1
HOURS	HOURS PER-CAPITA (Francis and Ramey (2009)	1
GMCQ	PERSONAL CONSUMPTION EXPENDITURES, PRICE INDEX (2000=100) , SAAR	5
GMCDQ	PERSONAL CONSUMPTION EXPENDITURES- DURABLE GOODS, PRICE INDEX(2000=100) , SA	5
GMCNQ	PERSONAL CONSUMPTION EXPENDITURES - NONDURABLE GOODS, PRICE INDEX (2000=100)	5
GMCSQ	PERSONAL CONSUMPTION EXPENDITURES - SERVICES, PRICE INDEX (2000=100) , SAAR	5
GMCANQ	PERSONAL CONSUMPTION EXPENDITURES-NEW CARS	5
HSFR	HOUSING STARTS:NONFARM(1947-58);TOTAL FARM&NONFARM	4
HSNE	HOUSING STARTS:NORTHEAST	4
HSMW	HOUSING STARTS:MIDWEST	4
HSSOU	HOUSING STARTS:SOUTH	4
HSWST	HOUSING STARTS:WEST	4
HSBR	HOUSING AUTHORIZED: TOTAL NEW PRIVATE HOUSING UNITS	4
HMOB	MOBILE HOMES	4
PMNV	NAPM INVENTORIES INDEX (PERCENT)	1
PMNO	NAPM NEW ORDERS INDEX (PERCENT)	1
PMDEL	NAPM VENDOR DELIVERIES INDEX (PERCENT)	1
MOCMQ	NEW ORDERS (NET) - CONSUMER GOODS MATERIALS, 1996 DOLLARS (BCI)	5
MSONDQ	NEW ORDERS, NONDEFENSE CAPITAL GOODS, IN 1996 DOLLARS (BCI)	5
FSNCOM	COMMON STOCK PRICES: DOW JONES INDUSTRIAL AVERAGE	5
FSPCOM	S&P'S COMMON STOCK PRICE INDEX: COMPOSITE (1941-43=10)	5
FSPIN	S&P'S COMMON STOCK PRICE INDEX: INDUSTRIALS (1941-43=10)	5
FSPCAP	S&P COMMON STOCK : CAPITAL GOODS (TOTAL SHARE INDEX)	5
FSPUT	S&P COMMON STOCK : UTILITIES	5
FSDXP	S&P'S COMPOSITE COMMON STOCK: DIVIDEND YIELD (% PER ANNUM)	1
FSPXE	S&P'S COMPOSITE COMMON STOCK: PRICE-EARNINGS RATIO (%,NSA)	1

continued on next page

Table A3.2: Continued from previous page

Variable	Description	Transformation
EXRSW	FOREIGN EXCHANGE RATE: SWITZERLAND (SWISS FRANC PER U.S.$)	5
EXRJAN	FOREIGN EXCHANGE RATE: JAPAN (YEN PER U.S.$)	5
EXRUK	FOREIGN EXCHANGE RATE: UNITED KINGDOM (CENTS PER POUND)	5
EXCAN	FOREIGN EXCHANGE RATE: CANADA (CANADIAN $PERU.S.$)	5
FYFF	INTEREST RATE: FEDERAL FUNDS (EFFECTIVE) (% PER ANNUM,NSA)	1
FYGM3	INTEREST RATE: U.S.TREASURY BILLS,SEC MKT,3-MO.(% PER ANN,NSA)	1
FYGM6	INTEREST RATE: U.S.TREASURY BILLS,SEC MKT,6-MO.(% PER ANN,NSA)	1
FYGT1	INTEREST RATE: U.S.TREASURY CONST MATURITIES,1-YR.(% PER ANN,NSA)	1
FYGT5	INTEREST RATE: U.S.TREASURY CONST MATURITIES,5-YR.(% PER ANN,NSA)	1
FYGT10	INTEREST RATE: U.S.TREASURY CONST MATURITIES,10-YR.(% PER ANN,NSA)	1
FYAAAC	BOND YIELD: MOODY'S AAA CORPORATE (% PER ANNUM)	1
FYBAAC	BOND YIELD: MOODY'S BAA CORPORATE (% PER ANNUM)	1
SFYGM3	SPREAD FYGM3-FYFF	1
SFYGM6	SPREAD FYGM6-FYFF	1
SFYGT1	SPREAD FYGT1-FYFF	1
SFYGT5	SPREAD FYGT5-FYFF	1
SFYGT10	SPREAD FYGT10-FYFF	1
SFYAAAC	SPREAD FYAAAC-FYFF	1
SFYBAAC	SPREAD FYBAAC-FYFF	1
FM1	MONEY STOCK: M1	5
FM2	MONEY STOCK:M2	5
FM3	MONEY STOCK: M3	5
FM2DQ	MONEY SUPPLY - M2 IN 1996 DOLLARS (BCI)	5
FMFBA	MONETARY BASE, ADJ FOR RESERVE REQUIREMENT CHANGES	5
FMRRA	MONETARY BASE, ADJ FOR RESERVE REQUIREMENT CHANGES	5
FMRBA	DEPOSITORY INST RESERVES:TOTAL,ADJ FOR RESERVE REQ CHGS	5
FCLNQ	COMMERCIAL AND INDUSTRIAL LOANS AT ALL COMMERCIAL BANKS (FRED) Billions	5
FCLBMC	WKLY RP LG COM'L BANKS:NET CHANGE COM'L & INDUS LOANS	5
CCINRV	CONSUMER CREDIT OUTSTANDING - NONREVOLVING	5
PMCP	NAPM COMMODITY PRICES INDEX (PERCENT)	1
PWFSA	PRODUCER PRICE INDEX: FINISHED GOODS (82=100,SA)	5
PWFCSA	PRODUCER PRICE INDEX:FINISHED CONSUMER GOODS (82=100,SA)	5
PWIMSA	PRODUCER PRICE INDEX:INTERMED MAT.SUPPLIES & COMPONENTS(82=100,SA)	5
PWCMSA	PRODUCER PRICE INDEX:CRUDE MATERIALS (82=100,SA)	5
PSM99Q	INDEX OF SENSITIVE MATERIALS PRICES (1990=100)(BCI-99A)	5
PUNEW	CPI ALL ITEMS	5
PU83	CPI-U: APPAREL	5
PU84	CPI-U: TRANSPORTATION	5
PU85	CPI-U: MEDICAL CARE	5
PIC	CPI-U: COMMODITIES	5
PICD	CPI-U: DURABLES	5
PUS	CPI-U: SERVICES	5
PUXF	CPI-U: ALL ITEMS LESS FOOD	5
PUXHS	CPI-U: ALL ITEMS LESS SHELTER	5
PUXM	CPI-U: ALL ITEMS LESS MEDICAL CARE	5
LEHCC	AVG HOURLY EARNINGS, PROD WRKRS, NONFARM - CONSTRUCTION	5
LEHM	AVG HOURLY EARNINGS, PROD WRKRS, NONFARM - MFG	5
HHSNTN	UNIVERSITY OF MICHIGAN CONSUMER EXPECTATIONS	5

The raw data is transformed to have stationarity in the model: $1 =$ No Transformation, $2 =$ First Differences, $4 =$ Logarithm, $5 =$ First Differences in Logs.

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