Joint Discussion Paper Series in Economics

by the Universities of

Aachen · Gießen · Göttingen
Kassel · Marburg · Siegen

ISSN 1867-3678

No. 46-2014

Matthias Uhl

State Fiscal Policies and Regional Economic Activity

Coordination: Bernd Hayo • Philipps-University Marburg
Faculty of Business Administration and Economics • Universitätsstraße 24, D-35032 Marburg
Tel: +49-6421-2823091, Fax: +49-6421-2823088, e-mail: hayo@wiwi.uni-marburg.de

State fiscal policies and regional economic activity*

Matthias Uhl

University of Marburg

August 29, 2014

Abstract

In this paper, I estimate a structural panel vector autoregression to study the consequences of changes in U.S. state government fiscal policies for local economic activity in the short-term. My main result is that the state-level spending multiplier is relatively small and the tax multiplier relatively large. After four years, the government spending multiplier is 0.6 and the tax multiplier -2.62. This conclusion is found to be robust across different model specifications. I also find that both state spending and state revenue shocks increase out of state output.

Keywords Spending multiplier, Tax multiplier, Subnational government

JEL Classifications E62, H30, R50

*I thank Kerstin Friebel and seminar participants at the University of Marburg for their helpful comments.

1 Introduction

In recent years, research on consequences of changes in government's fiscal policy for economic activity has accelerated, partially because of questions raised in course of the 2007 financial crisis and of the ongoing economic crisis in the Eurozone.[1] Empirical estimates on the size of fiscal multipliers are relevant for the evaluation of economic policies, and also because they provide stylized facts for theoretical macroeconomic models. In this paper, I estimate a structural panel vector autoregression using annual data on 48 contiguous U.S. states and identify fiscal policy shocks adopting the structural vector autoregression approach by Blanchard and Perotti (2002). The main result of my study is that tax multipliers associated with state-level taxation are large. In my most preferred specification, the government spending multiplier is below unity, and the tax multiplier larger than 2.

I find fiscal multipliers associated with subnational governments interesting from both a practical policy making, as well as a theoretical perspective. First, state fiscal policy makers are interested in how local fiscal policy decisions affect economic activity in their home region. Second, fiscal policies of countries or regions in a monetary union can potentially be used to stabilize region-specific shocks that monetary policy cannot stabilize. Third, estimates on multipliers associated with regional government are informative on the role of fiscal shocks in explaining regional business cycles.

Finally, in this paper, I provide stylized facts on the size of fiscal multipliers in a monetary union that are potentially informative for builders of structural models. Fiscal multipliers in monetary unions can be expected to be different from their traditional counterpart because the monetary policy reaction to regional fiscal disturbances differs, and because states or countries in a monetary union are typically more open. Under the usual situation, monetary policy offsets fiscal policy shocks, and hence dampens their consequences for aggregate economic activity. In several cases it has been demonstrated that fiscal multipliers can be large when monetary policy does not react (Christiano et al., 2011, Davig and Leeper, 2011). This is related to the case of a regional fiscal policy shock that cannot be stabilized by monetary policy. On the other side, a regional fiscal policy shock may lead to higher regional inflation and hence a real exchange rate appreciation. This effect should dampen the size of the multiplier in a currency union comprised of open economies such as the U.S. (Illing and Watzka, 2013).

I see my paper as a supplement to the already existing literature on fiscal multipliers associated with national fiscal policies, and on multipliers on subnational spending. Traditionally, fiscal multi-

[1] Ramey (2011a), Parker (2011) and Illing and Watzka (2013) provide recent reviews on fiscal multipliers.

pliers have been estimated using single-country time series methods. Blanchard and Perotti (2002) and Mountford and Uhlig (2009) estimate structural vector autoregressive models to study the effects of spending and revenue shocks on aggregate economic activity. Ramey and Shapiro (1998), Ramey (2011b) and Romer and Romer (2010) use quasi-natural experiments to identify exogenous variation in government spending and revenues, respectively. Extensions to state-dependent fiscal multipliers can be found in Auerbach and Gorodnichenko (2012), and extensions to panels of countries in Beetsma and Giuliodori (2011), Ilzetzki et al. (2013) and Ravn et al. (2012). The size of the estimated effects differs across studies, but the overall message seems that fiscal policy can have an effect on economic activity.

My research is also related to the literature estimating multipliers on subnational government spending.[2] Nakamura and Steinsson (2014) use regional variation in military procurement spending to estimate relatively large spending multipliers exceeding unity, and provide a theoretical framework to interpret their results. Clemens and Miran (2012) use state budget institutions as a source for exogenous variation in spending, and find a multiplier of below one. Shoag (2013) uses shocks to state pension returns as a source of exogenous variation, and concludes that the spending multiplier is larger than one. Finally, Canova and Pappa (2007) use U.S. state level data to study the consequences of fiscal disturbances on price differentials within a monetary union.

I see my paper as a useful contribution to the extant literature. Many papers on subnational spending use creative sources of exogenous variations in fiscal variables, but the estimated models of macro dynamics are typically simple, and sometimes static, single-equation time series models. I use a multivariate time series approach, and believe the estimated macroeconometric model is better suited to describe the economies' dynamic adjustment to the identified fiscal shocks. Also, in some papers on subnational spending, the local population does not need to pay for the stimulus, which is problematic in light of the usual finding that fiscal shocks are associated with detrimental wealth and labor supply effects that matter for the size of the multiplier (Baxter and King, 1993). I believe, and argue below, that my conclusions are contaminated by this effect to a lesser degree. Finally, to the best of my knowledge, tax multipliers associated with state revenue decisions have not been studied previously.

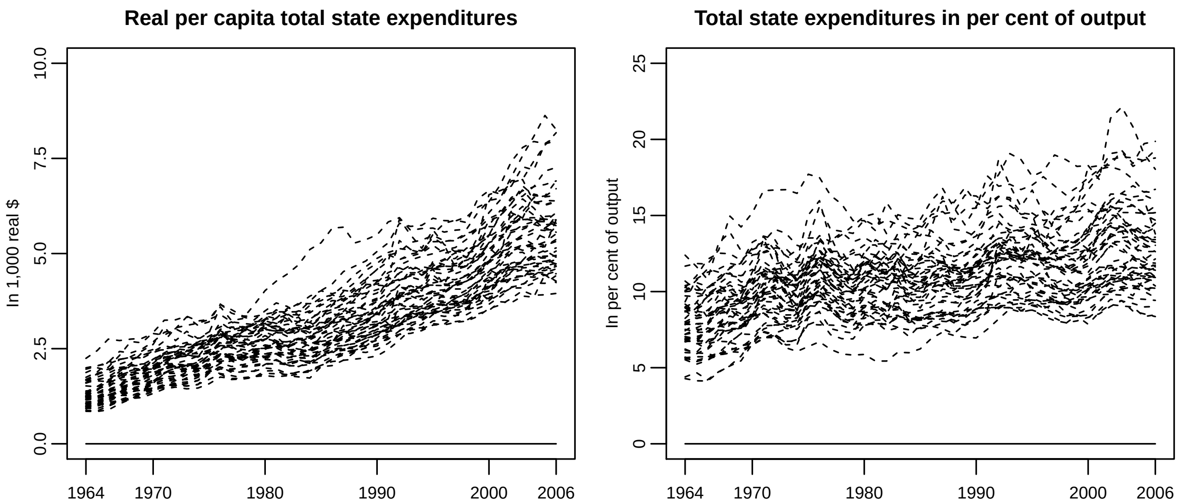
The paper is structured as follows. Section 2 characterizes state's fiscal policies, Section 3 discusses the empirical strategy, Section 4 contains the results, and Section 5 concludes. The Appendix describes the data used for this study.

[2] Ramey (2011a) reviews the literature, and provides additional references.

2 State fiscal policies

U.S. state governments have an economically relevant size, and considerable discretion about their expenditures and revenues. Figure 1 shows the size of state governments for the time period 1964 to 2006.[3] In 2006, the average of real per capita total state expenditures across states was $5,645, and the average of real per capita total state expenditures in per cent of Gross State Product (GSP) was 12.8 per cent. Hence, state governments are economically significant. Differences across the states reflect differences in the economic conditions, and discretionary fiscal policies.

Figure 1: Total state expenditures



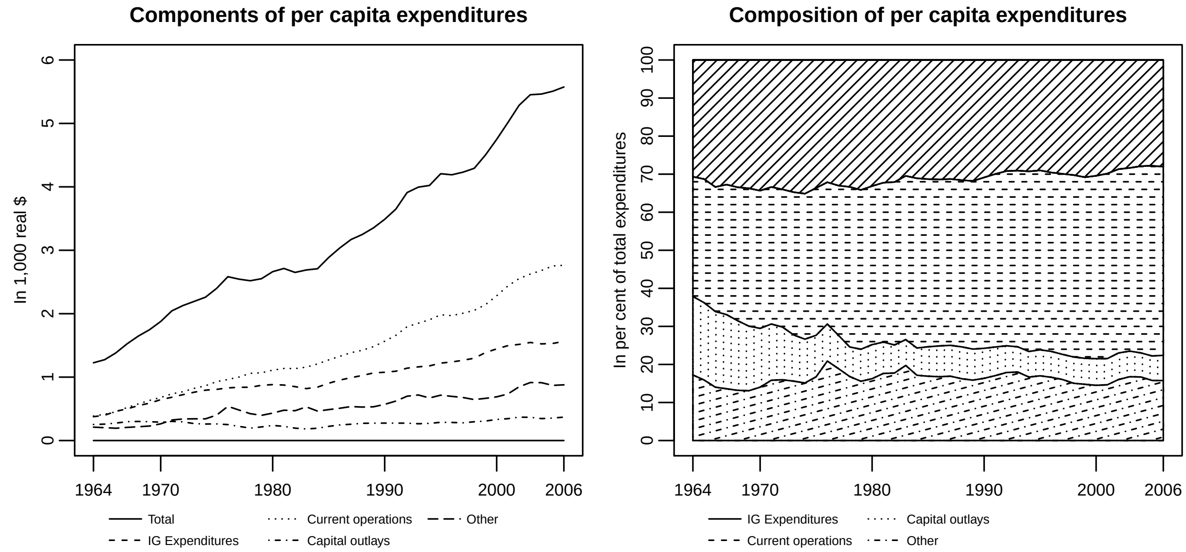
Notes: This figure shows real per capita total state expenditures, and total state expenditures as percent of GSP for the time period 1964 to 2006. Each line corresponds to one of the 48 contiguous states.

Figure 2 shows the composition of total state expenditures over time. A large fraction of state total expenditures is intergovernmental spending to local governments. Capital outlays are spending of states on new structures (buildings, roads, etc.) as well as on equipment. Current expenditures are expenditures on wages or supplies, for example. The "Other"-expenditures category consists largely of insurance benefits, but also of assistance and subsidies and interest on state debt. In my estimation, I use capital outlays plus current operations less public welfare spending. Public welfare spending, of which a considerable fraction consists in medical assistance to the needy, is automatically related to a state's output, and omitting it makes the identification assumptions to be presented in Section 3 more feasible.

Figure 3 shows size and composition of state revenues. For my estimation, I use total state taxes from own sources. States have considerable discretion in setting tax regulations. State taxes are

[3] Detailed data definitions, as well as data sources, can be found in the Appendix.

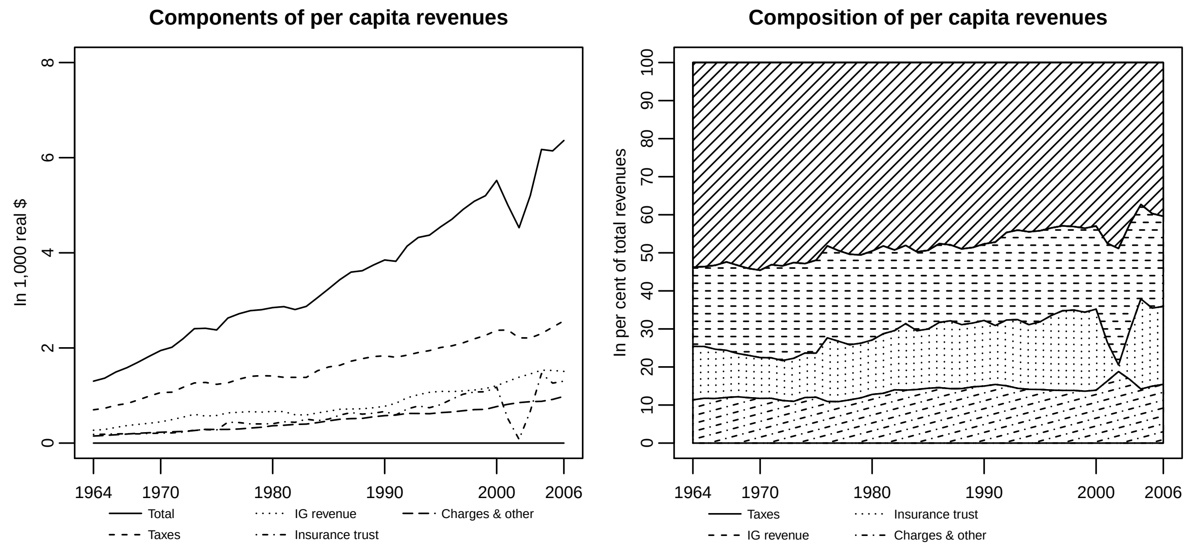
Figure 2: Composition of total state expenditures



Notes: This figure shows size and composition of state total per capita expenditures for the time period 1964 to 2006. Data is aggregated across the 48 contiguous states.

mostly from sales and other indirect taxes, but individual and corporate income taxation are also important.

Figure 3: Composition of total state revenues



Notes: This figure shows size and composition of state total per capita revenues for the time period 1964 to 2006. Data is aggregated across the 48 contiguous states.

3 Methodology

3.1 Model specification

My empirical approach is an adoption of the Blanchard and Perotti (2002) structural vector autoregression (SVAR) approach to a panel of 48 contiguous U.S. states. First, I estimate the following reduced form model

$$y_{it} = A_0 v_t + A_1 y_{i,t-1} + ... + A_p y_{i,t-p} + u_{it},\ t = 1, ..., T,\ i = 1, ..., N \tag{1}$$

where y_{it}, $t = -p + 1, ..., T$ is a $K \times 1$ vector of endogenous variables for $i = 1, ..., N$ regions, v_t is a $S \times 1$ vector of intercepts and deterministic trend terms, A_0,...,A_p are coefficient matrices, and u_{it} is a vector of innovations with $u_{it} \sim IID(0, \Sigma_u)$. In the baseline case, the vector of endogenous variables contains log real per capita Gross State Product (GSP), log real per capita government expenditures, and log real per capita government revenues. As exogenous variables, I include an intercept and a linear trend. The frequency of my data is annual, and I use the sample period 1964 to 2006. For the lag length p I find either 1 or 2 plausible. Out of the two, information criteria suggest a lag length of two, and that is my choice for the baseline case. I estimate the model in levels using least squares, and then construct an empirical sample of parameter estimates using a residual-based bootstrap. All statistics reported are based on percentiles of their empirical distribution.[4]

As a measure for state government expenditures, I use current expenditures plus capital outlays less public welfare spending. Taxes are state tax revenues from own sources. My output measure is the Gross State Product (GSP). One complication arises because state's fiscal years do not align with the calendar year. Hence, GSP data do not match the fiscal data. I solve the problem as follows. In a first step, I temporally disaggregate the annual GSP data to the quarterly frequency. In a next step, I aggregate the quarterly data across the fiscal year of the corresponding state. The temporal disaggregation is potentially problematic, and I show the results using the original GSP series. The Appendix contains extensive data descriptions.

The reduced-form model is transformed into a structural model using the Blanchard and Perotti (2002) identification scheme. Starting point is the following structural model that relates reduced-form innovations u_{it} to structural innovations ϵ_{it}.

[4] All analysis are conducted in R (R Core Team, 2013).

$$\begin{pmatrix} 1 & 0 & -a_1 \\ 0 & 1 & -b_1 \\ -c_1 & -c_2 & 1 \end{pmatrix} \begin{pmatrix} u_t^t \\ u_t^g \\ u_t^y \end{pmatrix} = \begin{pmatrix} 1 & a_2 & 0 \\ b_2 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \epsilon_t^t \\ \epsilon_t^g \\ \epsilon_t^y \end{pmatrix} \tag{2}$$

Here, superscripts t, g, y are used to denote the tax, spending, and output innovation, respectively. To identify the parameters, I proceed as follows (Blanchard and Perotti, 2002):

1. Choose values for the elasticity of spending to output a_1 and of the tax elasticity b_1. I discuss the choice for these parameters in Section 3.2.

2. Construct $u_t^t - a_1 u_t^y$ and $u_t^g - b_1 u_t^y$, and use them as instruments to estimate c_1 and c_2 in a regression of u_t^y on u_t^t and u_t^g.

3. Blanchard and Perotti (2002) set $a_2 = 0$ and estimate b_2 by regressing u_t^g on ϵ_t^t, and, as a robustness test, set $b_2 = 0$ and estimate a_2. Blanchard and Perotti (2002) show that the relative ordering of taxes and spending is not important, and this also holds at the state level. In the following, I assume that taxes come first.

After identification, I compute the structural response functions. The size of the structural innovations themselves are interpretable only in the context of the fiscal response they generate, and I am aware of two standard transformations of the structural response functions. The first I call impact normalization, and is computed as

$$\frac{f}{y} \times \frac{y_t}{f_o} \text{ for t=1,...,Max} \tag{3}$$

where y_t is the response of the output variable at step t, f_0 is the response of the fiscal variable at time 0, f over y is the share of the fiscal variable in output, and Max is the maximum number of periods over which the response functions are computed. After this normalization, the response functions have the interpretation of a dollar change in output at time t following a one dollar change in the fiscal variable at time 0. Because it takes into account the response of the fiscal variable over the whole horizon, I prefer the present value multiplier from Mountford and Uhlig (2009), which I compute as

$$\frac{f}{y} \times \frac{\sum_{i=1}^{t}(1+r)^{-i} y_t}{\sum_{i=1}^{t}(1+r)^{-i} f_t} \text{ for t=1,...,Max} \tag{4}$$

where all variables are defined similar as before, and r is the average long-term interest rate over the sample.

Most other empirical VAR studies I am aware of use quarterly data. The relative merits of using annual or quarterly data are well understood (Beetsma et al., 2008, Beetsma and Giuliodori, 2011). Some identification assumptions become stronger in the annual context, and quarterly data may be better suited for tracking the dynamic effects of macroeconomic shocks. On the other side, fiscal shocks in annual data are more likely to represent actual fiscal policy actions. More subtle, Beetsma and Giuliodori (2011) argue that anticipation effects are less likely to affect the results in studies using annual data. A central identification assumption in my and other research is that government spending is predetermined with regard to output at the annual frequency. Beetsma et al. (2009) and Born and Müller (2012) provide empirical evidence for this assumption.

I also provide the results of several robustness exercises, and extensions. Changes in the variable choices, and in the basic model specification, are discussed at the corresponding places in the text.

3.2 Choosing revenue and spending elasticities

My approach to choosing spending and revenue elasticities closely follows Blanchard and Perotti (2002). I implement the standard assumption that the spending elasticity is 0. In choosing revenue elasticities, Blanchard and Perotti (2002) closely follow Giorno et al. (1995). The overall elasticity of tax revenues to output is written as

$$\sum_i \eta_i \frac{T_i}{T} \tag{5}$$

where the summation is over the different tax types - sales and other taxes, personal income taxes, and corporate income taxes -, η_i is the elasticity of tax revenues to output for tax type i, T_i is tax revenue of tax type i, and T is total tax revenue. The standard assumption on the elasticity of sales and other taxes is 1. I find this estimate slightly too large to be plausible, and choose a value of 0.8. The reason is that the tax base for sales taxes is consumption, which is less volatile than output. Under a flat tax, the elasticity should then be less than 1. Other indirect state taxes such as property taxes or automobile taxes also likely move less than one-to-one with output. My assumption is also close to the result in Bruce et al. (2006), who estimate an elasticity of sales taxes of around 0.8. Following Giorno et al. (1995) the elasticity of personal income taxes is estimated as

$$\eta_{PIT} = H(FD + 1) \tag{6}$$

where H is the elasticity of employment to output, F is the elasticity of earnings to employment, and D is the elasticity of taxes to earnings. I choose D as 2.9, which is the mean value reported in Giorno et al. (1995). I estimate F and H as in Blanchard and Perotti (2002). F is the coefficient on

Table 1: Tax revenue elasticities

Tax category	Share in total taxes	Elasticity
Sales & other	0.66	0.8
Personal income	0.28	1.63
Corporate income	0.06	1.62
Overall	1.00	1.08

Notes: This table shows tax revenue elasticities and shares of tax types in total tax revenues.

lag zero from a regression of the log change in wages on one lead and lag 0 to 1 of the log change in employment. H is the coefficient on lag zero from a regression of the log change in employment on one lead and lag 0 to 1 of the log change in output.

The elasticity of corporate income taxes is estimated as

$$\eta_{CIT} = \eta_{CIT,B_{CIT}} * \eta_{B_{CIT},Y} \tag{7}$$

where $\eta_{CIT,B_{CIT}}$ is the elasticity of the corporate income tax to the tax base and $\eta_{B_{CIT},Y}$ is the elasticity of the corporate income tax base to output. Following Blanchard and Perotti (2002) I set $\eta_{CIT,B_{CIT}} = 1$ and choose $\eta_{B_{CIT},Y}$ as the coefficient on lag zero from a regression of the log change in corporate profits on one lead and lag 0 to 1 of the log change in output. I estimate the elasticities on the panel of U.S. states, using the maximum number of observations available for each regression. Data are again at the annual frequency. Table 1 shows the results.

My choices for the values of spending and tax elasticities are in line with conclusions from other research. First, that the business cycle affects state tax revenues is evident from the dip in revenues in the 2001 recession, see Figure 3. Bruce et al. (2006) estimates tax revenue elasticities for sales and income taxes that are comparable to mine. The chosen income tax elasticity is comparable to estimates derived from the TAXSIM model (Feenberg and Coutts, 1993).

4 Results

4.1 Main results

Table 2 contains the main results. The spending multiplier is 0.4 on impact and then rises to 0.6 over four years. The tax multiplier is -2.04 on impact and -2.62 after four years. Hence, the tax multiplier is relatively large, and the spending multiplier relatively small.

Table 2: Main results

	0	1	2	3	4
Spending	0.39*	0.46*	0.50*	0.54*	0.57*
Taxes	-2.02**	-2.19**	-2.34**	-2.46**	-2.57**

Notes: This table shows present value multipliers for spending and taxes 0,...,4 years after the fiscal shock. Table shows median of the empirical distribution generated by 1,000 replications of a residual based bootstrap. ** significant at 95%, significant at 68%.

Taken together, the stylized facts on fiscal multipliers derived in my paper support macroeconomic models in which state fiscal policies can have an impact on economic activity. This opens up the possibility to use regional fiscal policies for the stabilization of regional output variation. However, the tax multiplier appears larger than the spending multiplier. Carlino and Inman (2013) study the consequences of local fiscal policies for state employment, and also conclude that state revenues have stronger impact then state expenditures.

My estimate for the state-level spending multiplier is comparable to other estimates derived at the state or country level .[5] In one specification, Blanchard and Perotti (2002) find a peak effect of 0.9 for the spending multiplier. Nakamura and Steinsson (2014) and Shoag (2013) conclude that the spending multiplier is larger than one. Clemens and Miran (2012) find a multiplier of below one. Beetsma and Giuliodori (2011) estimate a peak spending multiplier of 1.5 in a panel of EU countries.

Overall, my estimate for the state-level spending multiplier appears to be at the lower end of the available spectrum of estimates. In particular, despite the fact that monetary policy cannot counteract the region-specific fiscal shocks identified in this paper, spending multipliers are not larger than country-based estimates that are stabilized by monetary policy. One potential explanation is that state economies are relatively open to each other, and that part of the local stimulus spills over to neighbor states. Indeed, Beetsma and Giuliodori (2011) and Ilzetzki et al. (2013) argue that spending multipliers are smaller in more open economies. Beetsma and Giuliodori (2011) and Carlino and Inman (2013) find that local fiscal shocks spillover to other regions. Beetsma et al. (2008) estimate a panel VAR for the EU, and conclude that expansionary fiscal shocks lead to a deterioration of the trade balance, as do Ravn et al. (2012) using a panel structural VAR estimated on data from four industrialized countries.

[5] The definition of the multiplier differs across studies, which is a reservation that should be kept in mind when comparing estimates across studies.

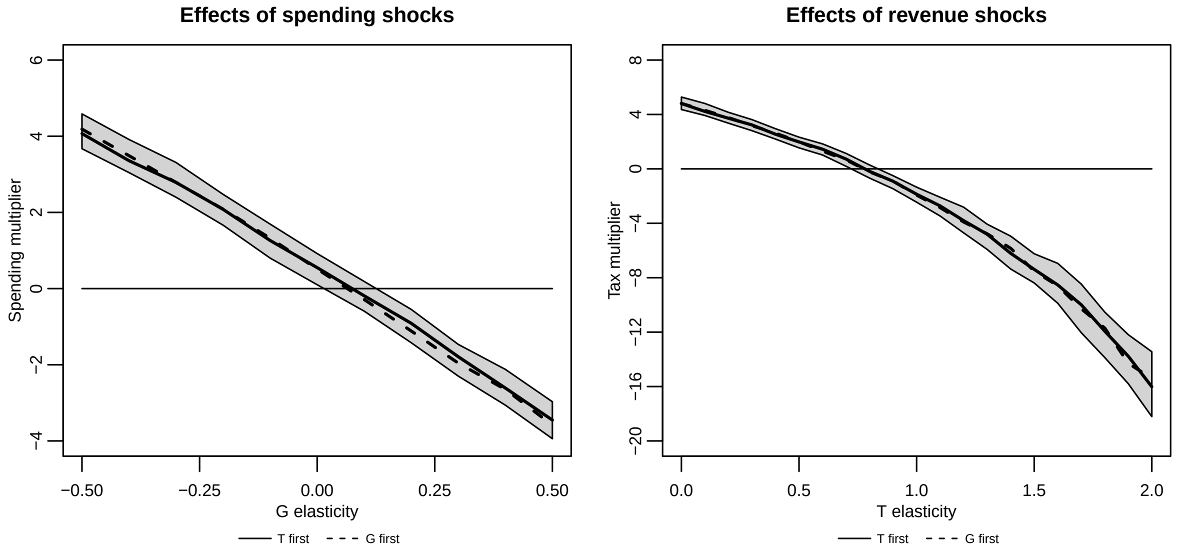
I estimate a tax multiplier of larger than 2 in absolute value. This is larger than the -1.3 estimated by Blanchard and Perotti (2002), and more in line with the larger estimates found in the literature using narrative tax shocks. Romer and Romer (2010) construct a historical account of U.S. tax changes, and use exogenous tax changes to estimate a tax multiplier of around -3. Cloyne (2013) and Hayo and Uhl (2014) also find large tax multipliers for the U.K. and Germany, respectively. Mertens and Ravn (2013) show that the disagreement between SVAR-based and narrative estimates of tax multipliers goes away as soon as one assumes the "right" tax elasticity. Given this background, it is interesting to note that my state-level based estimates confirm to the larger tax multipliers estimated in the literature using narrative tax shocks.

4.2 Sensitivity of fiscal multipliers to spending and revenue elasticities

The Blanchard and Perotti (2002) approach to the estimation of fiscal multipliers makes at least three important assumptions corresponding to 1) the spending elasticity, 2) the revenue elasticity, and 3) the temporal ordering of expenditures and taxes. To investigate the importance of these assumptions, I estimate the model represented by Eq. 1 and Eq. 2 for both assumptions on the ordering of expenditures and taxes over a grid of values for the spending and revenue elasticity. The relative ordering of expenditures and taxes does not appear to matter much. A grid search over plausible values of the spending and revenue elasticities suggests that for spending multipliers, the spending elasticity is the main parameter of interest, and for the revenue multiplier it is the revenue elasticity. Other assumptions are of second-order importance. Hence, to illustrate the importance of the chosen elasticities, Figure 4 shows spending multipliers for different values of the spending elasticity conditional on a revenue elasticity of 1.1, and revenue multipliers for different values of the tax elasticity conditional on a spending elasticity of 0. The figure would look very similar for different cross-elasticity assumptions. The spending multiplier is decreasing in the assumed spending elasticity, and so is the revenue multiplier. The result that the tax multiplier in absolute value is increasing in the tax revenue elasticity is also present in Mertens and Ravn (2013).

My main result is that *for plausible values of the spending elasticity, spending multipliers are relatively small, and for plausible values of the tax revenue elasticity, tax multipliers are relatively large.* Craig and Hoang (2011) estimates a panel VAR using data from 50 U.S. states to study the impact of innovations in GSP on fiscal variables. One finding is that both government current and capital spending, as well as state government tax revenues are procyclical. Sørensen et al. (2001) conclude that state spending is moderately, and state revenues are strongly procyclical. Large government spending multipliers would result only with anticyclical state expenditures, but this

Figure 4: Sensitivity of fiscal multipliers to chosen elasticites



Notes: This figure shows fiscal multipliers for different values of spending and revenue elasticities. A 68% confidence interval based on 100 residual based bootstrap replications is reported for each elasticity.

seems to contrast the available evidence. Hence, spending multipliers at the state level are likely small. In addition, for plausible values of the overall tax elasticity of state revenues - maybe around 1 - tax multipliers are large.

It is also noteworthy that the confidence intervals conditional on chosen spending and revenue elasticities are of an order of magnitude much smaller than variations in multipliers that result from choosing different spending and revenue elasticities. This makes the usual practice of conditioning on fixed, but estimated elasticities somewhat questionable. Respecting the uncertainty associated with the estimated elasticities would induce larger confidence intervals.

4.3 Standard variations in the model specification

My results are robust under standard variations in the model specification, see Table 3. As mentioned earlier, there are two standard definitions of fiscal multipliers in SVAR models. For the baseline case, I have chosen a present-value multiplier. Table 3 shows the multiplier under impact normalization, and the results are generally very similar to the baseline case. Table 3 also shows the results when allowing for state-specific intercepts and linear trends, but the variation does not appear to matter. Based on information criteria, I have chosen a lag length of 2, and Table 3 shows the results for a lag length of 1. Spending multipliers are somewhat larger, but tax multipliers are similar. In the baseline case, I use the Denton-Cholette method to arrive at an estimate for GSP in line with a state's fiscal year. Results are similar when using the Chow-Lin method as an alternative. See the data appendix for an explanation of these methods.

Table 3: Variations in the model specification

	Spending			Taxes		
	0	2	4	0	2	4
Impact normal.	0.39*	0.59*	0.65*	-2.02**	-2.38**	-2.64**
Fixed effects	0.38*	0.69*	0.55	-2.18**	-2.72**	-3.05**
1 Lag	1.10**	1.14**	1.18**	-2.22**	-2.41**	-2.61**
Alt. interpolation	0.33*	0.46*	0.51*	-1.86**	-2.26**	-2.53**
First differences	0.76**	1.23**	1.30**	-2.12**	-2.34**	-2.34**
Unadj. data	0.62**	0.70**	0.76*	-4.75**	-6.85**	-7.71**

Notes: This table shows present value multipliers for spending and taxes 0, 2, 4 years after the fiscal shock for various alternations in the basic model specification. Table shows median of the empirical distribution generated by 1,000 replications of a residual based bootstrap. ** significant at 95%, * significant at 68%.

In the baseline case, I have estimated the model in levels, which seems to be the common choice in the related literature. The VAR-in-level specification is able to capture potential long-run relationships between the variables implicitly, and is hence my preferred model. Table 3 shows the results of a VAR-in-difference model. The spending multiplier is somewhat larger. Finally, the use of estimated GSP data is potentially problematic. I hence find it important to use original GSP data, where the GSP data for the year in which state's fiscal years ends is used. The results for the spending multiplier are robust, but the tax multipliers are much larger. This is not surprising, as Figure 4 makes clear that the tax multiplier is increasing in the tax elasticity. If GSP data is used that does not match the state's fiscal year, the assumed tax elasticity is inappropriately large as an innovation in the GSP variable does not affect the portion of the tax revenue variable that matches to last year's GSP. Under reduced tax elasticities, smaller tax multipliers would result. This point indicates the importance of aligning national account data with the state's fiscal year, which is an admittedly non-trivial problem that also likely introduces some noise.

In summary, the spending multiplier varies between slightly below unity and slightly above unity across specifications, but the tax multiplier is always larger than 2 in absolute terms. Figure 5 summarizes the discussion.

4.4 Conditioning on omitted variables

In my analysis, I have made several implicit orthogonality assumptions. For example, I assume that regions are independent at the annual horizon, and I omit federal fiscal policies from the empirical model. To the extent that out-of-state variables or federal fiscal policies matter for state fiscal policy outcomes, the identified structural shocks may then partially reflect other variables then discretionary state fiscal policies.

A SVAR analysis that explicitly takes spatial interactions or federal fiscal policies into account is beyond the scope of the present paper, but I find the following variation in the model specification indicative. Precisely, I estimate the model

$$y_{it} = A_0 v_t + A_1 y_{i,t-1} + ... + A_p y_{i,t-p} + B x_{it} + u_{it},\ t = 1, ..., T,\ i = 1, ..., N \tag{8}$$

where everything is as in Eq. 1 except for the presence of a vector of exogenous variables x_{it}. The general idea is that after conditioning on the elements in x_{it}, the reduced-form innovations u_{it} only contain innovations in y_{it} that are not explained by the elements in x_{it}. I condition on three different set of vectors. First, in my baseline regression, I make the implicit assumption that regions are independent. I hence include as exogenous variables a weighted average of out-of-state expenditures, revenues, and output. The weights are based on the inverse-distance between states, so that closer states obtain relatively more weight. The reduced-form residuals u_{it}, based on which the structural shocks are recovered, should then contain only innovations unrelated to out-of-state variables. Also, the estimated multipliers could partially represent federal fiscal policies. I hence condition on federal fiscal policy variables, and on federal grants in a third specification. Table 4 contains the results.

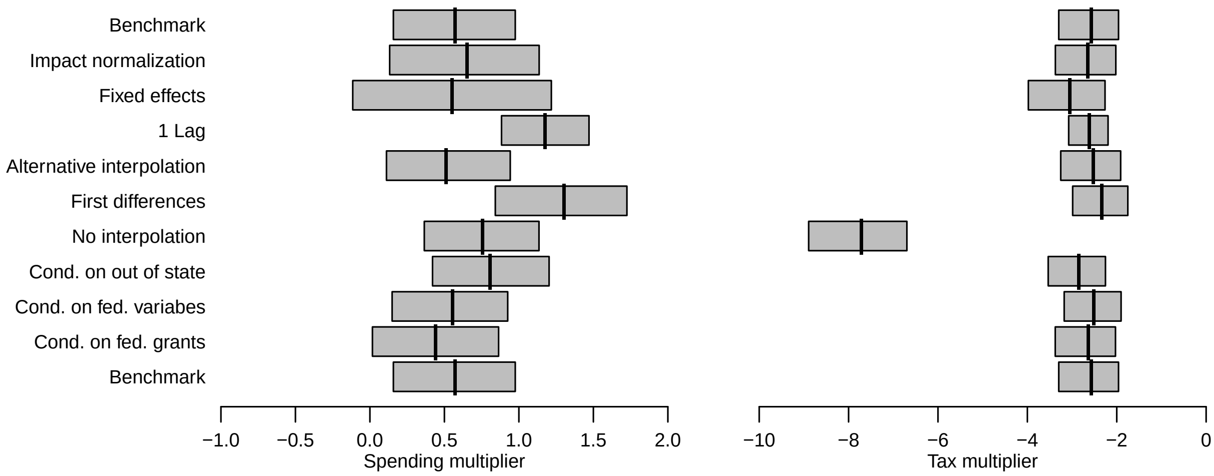
Table 4: Conditioning on omitted variables

	Spending			Taxes		
	0	2	4	0	2	4
Out of state	0.52**	0.74**	0.81**	-2.05**	-2.48**	-2.85**
Fed. fiscal policy	0.38*	0.50*	0.56*	-2.01**	-2.31**	-2.51**
Fed. grants	0.35*	0.42*	0.44*	-2.02**	-2.37**	-2.64**

Notes: This table shows present value multipliers for spending and taxes 0,2,4 years after the fiscal shock for various alternations in the basic model specification. Table shows median of the empirical distribution generated by 1,000 replications of a residual based bootstrap. ** significant at 95%, * significant at 68%.

Spending and tax multipliers are relatively similar to the baseline cases. In some parts of the literature estimating multipliers associated with subnational spending the local population does not need to pay for the stimulus. To the extent that the strategy in this section is successful, my results hold when using spending and revenue innovations not contaminated by federal fiscal policies or federal grants. Figure 5 summarizes the discussion.

Figure 5: Robustness



Notes: This figure shows a 68% percent confidence interval for spending and revenue multipliers after four years for different model specifications. Solid vertical lines indicate median values.

4.5 Output spillovers

To study the consequences of state fiscal policy changes for out-of-state income I supplement the model in Eq. 1 by a fourth endogenous variable, namely the distance weighted out-of-state GSP. The structural model in Eq. 2 is then slightly adjusted by ordering the distance-weighted out-of-state GSP variable last. More specifically, after the usual steps, I construct instruments that allow regressing the reduced-form innovation in out-of-state output on the innovations in the other equations. Table 5 contains the results.

Interestingly, it appears that both spending and tax revenue shocks increase out-of-state economic activity, which sheds some light on the transmission mechanism of state fiscal shocks. The following explanation would be in line with the observed responses: Increases in state expenditures increase demand for goods and services produced in other states, and hence spillover positively to other states. This should correspond to a deterioration in the trade balance between states, and hence

Table 5: **Output spillovers**

	0	1	2	3	4
Spending	0.06	0.20*	0.30*	0.37*	0.43**
Taxes	-0.16*	0.16	0.31*	0.38*	0.41*

Notes: This table shows present value multipliers for spending and taxes 0,...,4 years after the fiscal shock. Table shows median of the empirical distribution generated by 1,000 replications of a residual based bootstrap. ** significant at 95%, * significant at 68%.

might explain why state-level spending multipliers are relatively small. Note that Beetsma et al. (2008) conclude that expansionary fiscal shocks lead to a deterioration of the trade balance.

State tax shocks also increase out-of-state output. It could be argued that state tax rates affect the location of firms and workers, as well as the decision of where to shop for items, and that this mechanism produces a positive response of out-of-state output to the tax shock. Such a channel might explain the relatively large observed effects of tax changes on local output.

5 Conclusion

In this paper, I estimate a structural vectorautoregression on a panel of U.S. states to study the consequences of changes in state fiscal policies for regional economic activity. In my most preferred specification, the government spending multiplier is 0.4 on impact and 0.6 after four years. The tax multiplier is -2 on impact and -2.6 after four years. The tax multiplier is estimated highly robust across specifications, while the spending multiplier can be as large as 1.3 after four years in a VAR-in-difference specification. I also find that both regional spending and regional revenue shocks increase out-of-state income.

My results have implications for policy making and economic theory. Both state spending and revenue decisions appear to affect local output, which rules out cases of macroeconomic models in which fiscal shocks have no, or only small, effects on output. My state-level multipliers, however, are comparable to estimates derived at the country level, despite the fact that regional fiscal policy shocks should have a different transmission mechanism. In particular, monetary policy cannot stabilize output in response to regional fiscal policy shock, but the estimated spending multipliers are relatively small nevertheless. This could be explained by positive demand leakages to other states, and I indeed find that local fiscal policy shocks increase out-of-state output.

My results also indicate that state fiscal policies could potentially be used to stabilize regional output fluctuations that monetary policy cannot stabilize. However, state tax policies appear to have relatively stronger effects then spending shocks, which, to some extent, questions the focus of much of the related literature on spending multipliers. It is interesting to note that my estimates for the tax multiplier are closer to national estimates derived using narrative methods (Romer and Romer, 2010) than to those derived in conventional SVAR studies (Blanchard and Perotti, 2002).

Some aspects remain unaddressed. My treatment of regional interactions is simple, and it would be interesting to model regional interdependencies more explicitly in a structural vectorautoregression with spatial interactions. Finally, much more disaggregated data than used in this paper is available for U.S. states, and studying the consequences of changes in components of spending or tax revenues would be of interest.

References

Auerbach, A. J. and Y. Gorodnichenko (2012). Measuring the output responses to fiscal policy. *American Economic Journal: Economic Policy 4*(2), 1–27.

Baxter, M. and R. G. King (1993). Fiscal policy in general equilibrium. *American Economic Review 83*(3), 315–334.

Beetsma, R. and M. Giuliodori (2011). The effects of government purchases shocks: Review and estimates for the EU. *The Economic Journal 121*(550), F4–F32.

Beetsma, R., M. Giuliodori, and F. Klaassen (2008). The effects of public spending shocks on trade balances and budget deficits in the European Union. *Journal of the European Economic Association 6*(2-3), 414–423.

Beetsma, R., M. Giuliodori, and F. Klaassen (2009). Temporal aggregation and SVAR identification, with an application to fiscal policy. *Economics Letters 105*(3), 253–255.

Blanchard, O. and R. Perotti (2002). An empirical caracterization of the dynamic effects of changes in government spending and taxes on output. *Quarterly Journal of Economics 117*(4), 1329–1368.

Born, B. and G. J. Müller (2012). Government spending shocks in quarterly and annual time series. *Journal of Money, Credit and Banking 44*(2-3), 507–517.

Bruce, D., W. F. Fox, and M. H. Tuttle (2006). Tax base elasticities: A multi-state analysis of long-run and short-run dynamics. *Southern Economic Journal 73*(2), 315–341.

Canova, F. and E. Pappa (2007). Price differentials in monetary unions: The role of fiscal shocks. *The Economic Journal 117*(520), 713–737.

Carlino, G. A. and R. P. Inman (2013). Local deficits and local jobs: Can US states stabilize their own economies? *Journal of Monetary Economics 60*(5), 517–530.

Chen, B. and S. H. Andrews (2008). An empirical review of methods for temporal distribution and interpolation in the national accounts. *Survey of Current Business 88*(5), 31–37.

Cholette, P. A. (1984). Adjusting sub-annual series to yearly benchmarks. *Survey Methodology 10*(1), 35–49.

Chow, G. C. and A.-l. Lin (1971). Best linear unbiased interpolation, distribution, and extrapolation of time series by related series. *Review of Economics and Statistics 53*(4), 372–375.

Christiano, L., M. Eichenbaum, and S. Rebelo (2011). When is the government spending multiplier large? *Journal of Political Economy 119*(1), 78–121.

Clemens, J. and S. Miran (2012). Fiscal policy multipliers on subnational government spending. *American Economic Journal: Economic Policy 4*(2), 46–68.

Cloyne, J. (2013). Discretionary tax changes and the macroeconomy: New narrative evidence from the United Kingdom. *American Economic Review 103*(4), 1507–1528.

Craig, S. G. and E. C. Hoang (2011). State government response to income fluctuations: Consumption, insurance, and capital expenditures. *Regional Science and Urban Economics 41*(4), 343–351.

Davig, T. and E. M. Leeper (2011). Monetary-fiscal policy interactions and fiscal stimulus. *European Economic Review 55*(2), 211–227.

Denton, F. T. (1971). Adjustment of monthly or quarterly series to annual totals: an approach based on quadratic minimization. *Journal of the American Statistical Association 66*(333), 99–102.

Feenberg, D. and E. Coutts (1993). An introduction to the TAXSIM model. *Journal of Policy Analysis and Management 12*(1), 189–194.

Giorno, C., P. Richardson, D. Roseveare, and P. Van den Noord (1995). Potential output, output gaps and structural budget balances. *OECD Economic Studies 24*(1), 167–209.

Hayo, B. and M. Uhl (2014). The macroeconomic effects of legislated tax changes in Germany. *Oxford Economic Papers 66*(2), 397–418.

Illing, G. and S. Watzka (2013). Fiscal multipliers and their relevance in a currency union: A survey. *German Economic Review 15*(2), 259–271.

Ilzetzki, E., E. G. Mendoza, and C. A. Vegh (2013). How big (small?) are fiscal multipliers? *Journal of Monetary Economics 60*(2), 239–254.

Marini, M. and T. Di Fonzo (2012). On the extrapolation with the Denton proportional benchmarking method. *IMF Working Paper No. 12-169*.

Mertens, K. and M. O. Ravn (2013). A reconciliation of SVAR and narrative estimates of tax multipliers. *Journal of Monetary Economics*, forthcoming.

Mountford, A. and H. Uhlig (2009). What are the effects of fiscal policy shocks? *Journal of Applied Econometrics 24*(6), 960–992.

Nakamura, E. and J. Steinsson (2014). Fiscal stimulus in a monetary union: Evidence from US regions. *American Economic Review 104*(3), 753–792.

Parker, J. A. (2011). On measuring the effects of fiscal policy in recessions. *Journal of Economic Literature 49*(3), 703–718.

R Core Team (2013). *R: A Language and Environment for Statistical Computing.* Vienna, Austria: R Foundation for Statistical Computing.

Ramey, V. A. (2011a). Can government purchases stimulate the economy? *Journal of Economic Literature 49*(3), 673–685.

Ramey, V. A. (2011b). Identifying government spending shocks: It's all in the timing. *Quarterly Journal of Economics 126*(1), 1–50.

Ramey, V. A. and M. D. Shapiro (1998). Costly capital reallocation and the effects of government spending. *Carnegie-Rochester Conference Series on Public Policy 48*(1), 145–194.

Ravn, M. O., S. Schmitt-Grohé, and M. Uribe (2012). Consumption, government spending, and the real exchange rate. *Journal of Monetary Economics 59*(3), 215–234.

Romer, C. D. and D. H. Romer (2010). The macroeconomic effects of tax changes: Estimates based on a new measure of fiscal shocks. *American Economic Review 100*(3), 763–801.

Sax, C. and P. Steiner (2013). Temporal disaggregation of time series. *The R Journal 5*(2), 80–87.

Shoag, D. (2013). Using state pension shocks to estimate fiscal multipliers since the great recession. *American Economic Review 103*(3), 121–124.

Sørensen, B. E., L. Wu, and O. Yosha (2001). Output fluctuations and fiscal policy: US state and local governments 1978-1994. *European Economic Review 45*(7), 1271–1310.

Yu, Y. C. (2007). SPATDWM: Stata modules for US state and county spatial distance matrices. *Statistical Software Components*.

Appendix: Data

If not stated otherwise, all data are at the annual frequency and available for 1963 to 2006. All quarterly data are seasonally adjusted from the source.

Deflator For price adjustment, I use the national GDP deflator, base year is 2009. Source is the BEA Table 1.1.4. Price Indexes for Gross Domestic Product. For some series I need an annual price deflator in line with state's fiscal year. I construct it by aggregating quarterly national real and nominal GDP over the state's fiscal year, and then I compute the implicit price deflator.

Distance I get the distance between contiguous U.S. states from Yu (2007). I use normalized inverse distances as spatial weights in the computation of measures for out of state fiscal policies and out of state GSP.

Federal government Quarterly data are from BEA Table 3.2. Federal Government Current Receipts and Expenditures and transformed to real per capita values. I then aggregate in line with a state's fiscal year. My definition of spending is current expenditures plus gross government investment, and my definition of tax revenue is current tax receipts.

Fiscal data for the states' fiscal years are from the U.S. Census Bureau, Annual Survey of State Government Finances and Census of Governments. When appropriate, values are transformed to real per capita values using a deflator and a population estimate in line with the state's fiscal year.

Gross Domestic Product Quarterly national GDP is from BEA Table 1.1.5. Gross Domestic Product, and transformed to real per capita values.

Gross State Product GSP is from BEA regional data, Gross Domestic Product by state. Years 1963 to 1996 are based on the SIC, 1997 onwards are based on the NAICS all industry total. Transformed to real per capita values. State's fiscal years do not align with the calendar year, and hence fiscaldata do not match the national account data. I first temporally disaggregate annual GSP to quarterly values, and then aggregate to a hypothetical annual observation that matches the state's fiscal year. In a very limited number of cases, state's fiscal years ended in May or August. I treat these cases symmetrically to state's with fiscal years ending in June or September, respectively. For the construction of quarterly GSP series, I use the R package tempdissag (Sax and Steiner, 2013). First, I follow Denton (1971) and Cholette (1984) and use the Denton proportional method with state quarterly personal income as indicator variable. This method is recommended in Chen and Andrews (2008). My exposition of the method follows Marini and Di Fonzo (2012). Let s be the number of subannual periods, N the number of annual periods, $y_0 = (y_{01}, ..., y_{0N})$ a $Nx1$ vector of annual observations, and $y = (y_1, ..., y_{sN})$ a $sNx1$ vector of unknown quarterly values. Let p denote a $sNx1$ vector of the indicator variable. The Denton-Cholette method solves

$$min_y \sum_{t=2}^{sN} \left(\frac{y_t}{p_t} - \frac{y_{t-1}}{p_{t-1}} \right)^2 \text{ s.t. } \sum_{t=4(T-1)+1}^{4T} y_t = y_{0T} \text{ for } T = 1, ..., N$$

Intuitively, the ratio of interpolated quarterly values to the indicator series should be as constant as possible, while satisfying the aggregation constraint.

As a robustness exercise, I use a regression based method following Chow and Lin (1971) with national GDP and state personal income as indicator variables. My exposition of the method follows Sax and Steiner (2013). The Chow and Lin (1971)-method consists in estimating a linear regression of the annual observations on the annualized indicator series, and assumes that the same linear relation also holds at the quarterly frequency. The aggregation constraint is respected by distributing the remaining residual across quarterly values allowing for autocorrelation of the quarterly residuals.

Gross operating surplus State gross operating surplus is from BEA regional data, Gross Operating Surplus by state. 1963 to 1996 based on the SIC, 1997 onwards based on the NAICS all industry total. Transformed to real per capita values.

Personal income State quarterly personal income is from BEA Table SQ1 Quarterly personal income, and transformed to real per capita values.

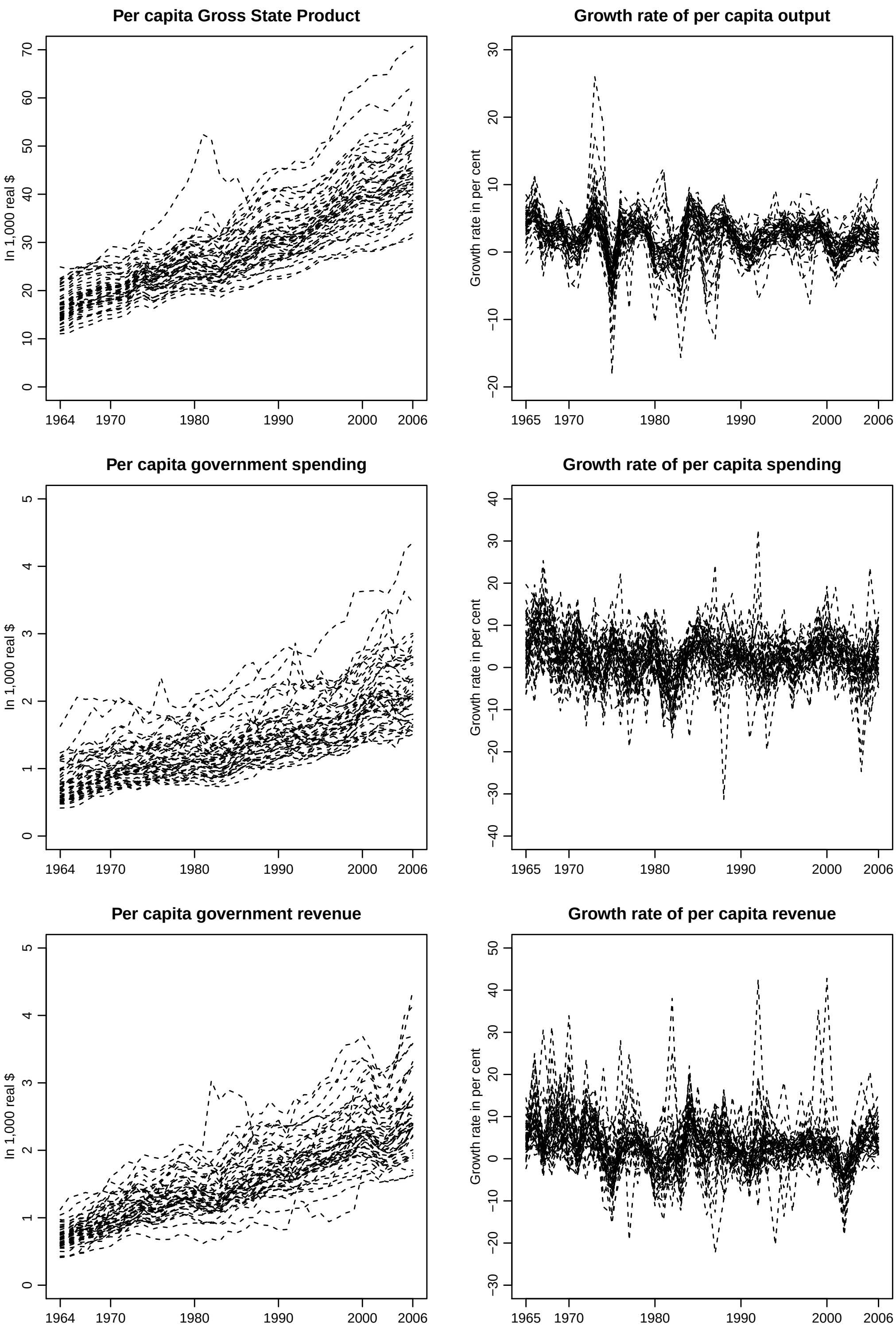
Population Annual state population are from BEA Table SA1-3 Personal income summary. Quarterly state population values are obtained by assigning the annual values to the second period, and interpolating linearly between observations. Quarterly population for the U.S. are from BEA Table 7.1. Selected Per Capita Product and Income Series in Current and Chained Dollars. State population in line with the state's fiscal year is obtained by averaging across quarters of the fiscal year.

Long-term interest rate Data on U.S. long-term interest rates are from OECD.Stat, Dataset: Key Short-Term Economic Indicators. The average value in 1964 to 2006 is 7.24 per cent.

Wages and salaries are from BEA Table SA04 State income and employment summary. Values are transformed to real per capita values.

Wage and salary employment is from BEA Table SA04 State income and employment summary, and observations are available from 1969 onwards. Values are transformed to per capita values.

Figure A.1: Dataplots



Notes: This figure shows level and growth rate series for real per capita GSP, government spending, and government tax revenue for the 48 contiguous U.S. states. The sample period is 1964 to 2006.